A COMPARATIVE STUDY OF GAME-BASED ONLINE LEARNING IN MUSIC APPRECIATION: AN ANALYSIS OF STUDENT MOTIVATION AND ACHIEVEMENT

By

YOUNGJU KANG

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

2017
To my family
ACKNOWLEDGMENTS

This dissertation is specially dedicated to my family, who has encouraged me to successfully complete this long journey. I am deeply grateful to my father Taeouk Kang for his confidence in me and for being a constant source of positivity and trustworthiness. I would especially like to thank my mother Jeonglim Kim for her unconditional love and support for me in fostering my own ideas and passion throughout this educational journey. I would also like to express my deep appreciation to my elder brother Dongsoo Kang, a senior software engineer in Silicon Valley, and my younger brother Minkyu Kang, a global hotelier in Korea. Their professionalism, intelligence, and humor have not only always encouraged me to constantly pursue my dream, but have also enabled me to find my vision for the future. In addition, I would like to express deep gratitude to my lovely grandmother, Sunglan Jeong, who passed away last year, and wish that may she rest in peace.

A sincere expression of thanks is extended to all my committee members, Dr. David Miller, Dr. William Bauer, Dr. Elizabeth Bondy, and Dr. Albert Ritzhaupt for their participation in my research and encouragement in accomplishing this research. I especially want to express my sincere appreciation to my advisor Dr. Ritzhaupt for his constant personal and professional guidance, concern, and evaluation during the journey of this research.

I also would like to thank my former teachers, mentors, and friends who helped me to finish my dissertation. I have always been impressed by their insight, talent, passion, and patience. First of all, I deeply appreciate all of my teachers in Korea, New York, and Florida. Some of them who strongly influenced me to successfully accomplish my academic goals and pursue this career were, in no particular order, Dr. Robert Rowe, Dr. John Gilbert, Dr. Kenneth Peacock, Professor James Progris, Professor Reynaldo Sanchez, Professor Taehyun Kim, Professor Yongho Choi, and Professor Seunghee Rhee. I would also like to extend a special
thanks to the faculty members at the University of Florida School of Music and the ETD office staff in helping me to complete my dissertation. I especially thank my friend Morgan Johnson who has provided me with various technical support during the dissertation process. It is difficult to identify everyone who has supported me during my long educational journey, and no doubt someone who should be included in my list is not presented in here. Without the sincere guidance and advice of so many people, I would not have completed this long journey; so again, I send my love and respect to them.
# TABLE OF CONTENTS

ACSNOLEDGMENTS .................................................................................................................. 4

LIST OF TABLES .......................................................................................................................... 9

LIST OF FIGURES ....................................................................................................................... 11

ABSTRACT .................................................................................................................................. 12

CHAPTER

1 INTRODUCTION ....................................................................................................................... 14

Background .................................................................................................................................. 14
Research Context ............................................................................................................................ 17
Research Problem .......................................................................................................................... 19
Purpose of the Study ....................................................................................................................... 21
Research Questions ....................................................................................................................... 21
Hypotheses .................................................................................................................................... 21
Significance of the Study ............................................................................................................... 22
Potential Ethical Issues .................................................................................................................. 23
Privacy Issues ............................................................................................................................... 23
Copyright Issues ........................................................................................................................... 24
Definition of Terms ....................................................................................................................... 25
ARCS Model ................................................................................................................................. 25
Qualtrics® .................................................................................................................................... 25
Digital Game-Based Learning (DGBL) ......................................................................................... 25
Instructional Materials Motivation Survey (IMMS) ...................................................................... 25
The Young Person’s Guide to the Orchestra® .............................................................................. 26
Organization of the Study ............................................................................................................. 26

2 LITERATURE REVIEW ............................................................................................................. 27

Online Learning ............................................................................................................................ 27
Game-Based Learning .................................................................................................................... 29
Music Education ............................................................................................................................ 36
Music Appreciation in the United States ....................................................................................... 37
Cognitivism in Music Education ................................................................................................... 41
Multimedia Learning ..................................................................................................................... 44
Multimedia .................................................................................................................................... 45
Multimedia Learning ..................................................................................................................... 46
Multimedia Learning Principles .................................................................................................... 50
ARCS Model ................................................................................................................................. 57
Conceptual Framework .................................................................................................................. 64
Cognitive Theory of Multimedia Learning .................................................................................... 66
Multimedia Learning for Game-based Online Instruction ............................................................ 69
3 METHODOLOGY ....................................................................................................................72

Research Design .....................................................................................................................72
  Experimental design .............................................................................................................72
  Sampling strategy ...............................................................................................................74
Participants ...............................................................................................................................74
Materials ....................................................................................................................................76
Instruments ...............................................................................................................................81
  Instructional Materials Motivation Survey (IMMS) ..............................................................81
  A Closed-Ended Questionnaire: A Pretest and Posttest ....................................................81
Procedures ................................................................................................................................86
  Phase 1: A Preliminary Research Design Session .................................................................88
  Phase 2: Field Test ................................................................................................................89
  Phase 3: Research Experiment ..............................................................................................92
  Data Collection ....................................................................................................................92
Data Analysis ........................................................................................................................96
  Quantitative Methods .........................................................................................................96
  Quantitative Data Analysis Techniques ..............................................................................97
Online Intervention ................................................................................................................98
  Basic Structure ....................................................................................................................98
  The Analysis of the Online Instruction with the Three Elements of Instruction.................99

4 RESULTS OF STUDY ............................................................................................................107

Sample Demographics .........................................................................................................108
  Basic Information ...............................................................................................................109
  Knowledge and Experience about Technology and Online Learning ..............................110
  Knowledge and Experience about Digital Games ..............................................................112
  Knowledge and Experience about Music Learning ............................................................112
Descriptive Statistics .............................................................................................................113
  ANCOVA for Student Achievement .................................................................................117
  MANOVA for Student Motivation .....................................................................................119
  Multivariate Coefficients for ARCS Measures ....................................................................123
Summary ...............................................................................................................................125

5 DISCUSSION .......................................................................................................................126

Overview ................................................................................................................................126
Discussion of Findings ..........................................................................................................128
  Student Achievement and Cognitive Theory of Multimedia Learning ............................128
  Student Motivation and ARCS Components .....................................................................135
Implications ..........................................................................................................................137
  Implications of Multimedia Learning Principles for Online Instruction ........................137
  Implications for ARCS Components in Online Instruction ..............................................146
Limitations .............................................................................................................................147
  Time Constraints ...............................................................................................................147
  Technological Constraints ...............................................................................................148
<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>Definitions of Multimedia</td>
<td>46</td>
</tr>
<tr>
<td>2-2</td>
<td>Three instructional goals in multimedia learning</td>
<td>51</td>
</tr>
<tr>
<td>2-3</td>
<td>Various Multimedia learning principles</td>
<td>54</td>
</tr>
<tr>
<td>2-4</td>
<td>Multimedia principles for game, e-learning, and three instructional goals</td>
<td>55</td>
</tr>
<tr>
<td>2-5</td>
<td>Four Main Components in the ARCS Model</td>
<td>59</td>
</tr>
<tr>
<td>3-1</td>
<td>The five Subject matter experts</td>
<td>83</td>
</tr>
<tr>
<td>3-2</td>
<td>The CVR for the closed-ended questionnaire</td>
<td>84</td>
</tr>
<tr>
<td>3-3</td>
<td>The basic structure of the online intervention</td>
<td>98</td>
</tr>
<tr>
<td>3-4</td>
<td>Three instructional components adopted from Clark</td>
<td>100</td>
</tr>
<tr>
<td>3-5</td>
<td>Multimedia learning principles and three instructional goals</td>
<td>105</td>
</tr>
<tr>
<td>4-1</td>
<td>Gender</td>
<td>109</td>
</tr>
<tr>
<td>4-2</td>
<td>Age and Education Level</td>
<td>109</td>
</tr>
<tr>
<td>4-3</td>
<td>Ethnicity and Nationality</td>
<td>110</td>
</tr>
<tr>
<td>4-4</td>
<td>Numbers of previous online courses</td>
<td>111</td>
</tr>
<tr>
<td>4-5</td>
<td>Online Learning Materials</td>
<td>111</td>
</tr>
<tr>
<td>4-6</td>
<td>Digital game play</td>
<td>112</td>
</tr>
<tr>
<td>4-7</td>
<td>Previous music education and levels</td>
<td>113</td>
</tr>
<tr>
<td>4-8</td>
<td>Descriptive Statistics for Dependent Measures</td>
<td>114</td>
</tr>
<tr>
<td>4-9</td>
<td>Pretest and Posttest Reliability Statistics</td>
<td>114</td>
</tr>
<tr>
<td>4-10</td>
<td>Item-Total Statistics for the Pretest</td>
<td>115</td>
</tr>
<tr>
<td>4-11</td>
<td>Item-Total Statistics for the Posttest</td>
<td>116</td>
</tr>
<tr>
<td>4-12</td>
<td>ARCS Reliability Statistics</td>
<td>117</td>
</tr>
<tr>
<td>4-13</td>
<td>Tests of Between-Subjects Effects</td>
<td>117</td>
</tr>
</tbody>
</table>
4-14  Levene's Test of Equality of Error Variances\textsuperscript{a} ................................................................. 118
4-15  Descriptive statistics for student achievement .............................................................................. 118
4-16  Tests of Between-Subjects Effects ................................................................................................. 119
4-17  Descriptive statistics for student motivation .................................................................................. 120
4-18  Mahalanobis’s distance .................................................................................................................. 120
4-19  Skewness and Kurtosis in ARCS ................................................................................................... 121
4-20  Test of Normality .......................................................................................................................... 121
4-21  Pearson’s correlation for IMMS .................................................................................................... 122
4-22  Box’s Test of Equality of Covariance Matrices\textsuperscript{a} ................................................................. 123
4-23  Levene's Test of Equality of Error Variances\textsuperscript{a} ................................................................. 123
4-24  Tests of Between-Subjects Effects ................................................................................................. 124
5-1   Non-equivalent instructional components adopted from Clark ................................................. 129
5-2   Multimedia learning principles and three instructional goals .................................................... 138
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>Gagné’s Events of Instruction, Keller’s ARCS Model, and common game design elements</td>
</tr>
<tr>
<td>2-2</td>
<td>Two different forms of online instruction in a music appreciation course</td>
</tr>
<tr>
<td>2-3</td>
<td>Cognitive theory of multimedia</td>
</tr>
<tr>
<td>3-1</td>
<td>Random assignment</td>
</tr>
<tr>
<td>3-2</td>
<td>The Table of Contents</td>
</tr>
<tr>
<td>3-3</td>
<td>Rearranged audio and video files in the web-based online instruction</td>
</tr>
<tr>
<td>3-4</td>
<td>A captured animation from the game</td>
</tr>
<tr>
<td>3-5</td>
<td>Exercise in web-based instruction</td>
</tr>
<tr>
<td>3-6</td>
<td>Game Link</td>
</tr>
<tr>
<td>3-7</td>
<td>The closed-ended questionnaire</td>
</tr>
<tr>
<td>3-8</td>
<td>An example of a close-ended question measuring student’s achievement</td>
</tr>
<tr>
<td>3-9</td>
<td>The three phases of the proposed research study</td>
</tr>
<tr>
<td>3-10</td>
<td>The Significant Results of the Field Test</td>
</tr>
<tr>
<td>3-11</td>
<td>The organization of the web-based and game-based online instruction</td>
</tr>
</tbody>
</table>
Abstract of Dissertation Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

A COMPARATIVE STUDY OF GAME-BASED ONLINE LEARNING IN MUSIC APPRECIATION: AN ANALYSIS OF STUDENT MOTIVATION AND ACHIEVEMENT

By

YoungJu Kang

August 2017

Chair: Albert Ritzhaupt
Major: Curriculum and Instruction

As online learning becomes a prevalent modern education trend, educational institutions continue to develop new innovative online courses for higher education. Whereas substantial research has been conducted on diverse online learning environments, there is insufficient empirical research regarding game-based online learning in music. Researchers have begun to explore digital games as an online learning tool to improve student motivation and achievement. Extensive research indicates music learning is becoming an important academic component for higher education as it encourages students to be intellectually engaged and well-balanced.

The primary purpose of this study was to investigate student motivation and achievement in music appreciation learning by comparing two different online learning environments: game-based and web-based online music learning. It considered how to design an effective game-based multimedia learning environment in the field of music, where more advanced instructional design techniques would be required. Undergraduate students (N=132) participated in an hour-long research experiment established within the pretest-posttest control-group design. Two groups of 66 students were randomly assigned to a control (web-based online instruction) or treatment group (game-based online instruction). A pretest and posttest were administered to
assess student achievement, and the IMMS motivation survey by John Keller (2010) was used to measure student motivation towards the online learning materials.

MANOVA and ANCOVA indicated that both the game-based and web-based online music instruction improved student achievement. However, student achievement in the web-based online instruction significantly outperformed achievement in the game-based online instruction. There was no significant difference in student motivation between the two groups even though the game-based online group was slightly more motivated than the web-based online learning group. The key implications suggest that minimizing extraneous multimedia learning materials is important for improving student achievement. Also, confidence was a significant motivation factor for student achievement in online music appreciation learning.
CHAPTER 1
INTRODUCTION

Background

The growth of online learning has steadily increased over the past ten years (Online Learning Consortium, 2012, 2014). Many academic institutions, organizations, companies, and government agencies have actively launched new online learning programs for their local and global learning communities to modernize their teaching and learning environments. Approximately 5.8 million students in the United States have enrolled in an online course, and the number of online learning students is still increasing today (Online Learning Consortium, 2016). Online learning is an extremely popular trend within educational institutions today, and they are accelerating to create new online courses for younger generations. This modern educational trend has grown alongside progress in advanced technologies as our society demands them in many sectors of our everyday life.

While the abundance of new technologies has enriched online learning environments, educators are often perplexed as to how to motivate their young students who grew up with a variety of digital media such as smartphones, social media, tablet devices, and games (Bourgonjon, Valcke, Soetaert, & Schellens, 2010; Vogel et al., 2006). Online learning may be a sound environment for the digital generation as it is a context where they can extend their learning experience with technology.

Researchers have indicated there are a variety of factors influencing the effectiveness of teaching online (Ally, 2004; Bowman, 2014; Carliner, 1999; Clark & Mayer, 2016; Ellis, 2004; Jolliffe, Ritter, & Stevens, 2001; Khan, 1997; Moore et al., 2011; Nicolas, 2003; Tavangarian, Leypold, Nölting, Röser, & Voigt, 2004; Triacca, Bolchini, Botturi, & Inversini, 2004). Dixon, Beveridge, Farror, Williams, Sugar, and Brown (2012) reported that student involvement and
content development were the most useful factors for improving online learning. They also concluded that the proper course sequences, units, certificate options, and a high level of consistency of hardware and software programs are important factors for online programs.

Bolliger and Martindale (2001) showed that the main factors that influenced student satisfaction in online courses were instructor variables, course management, and technical issues. Fisher and Coleman (2002) specifically indicated that it is an essential task in planning online courses to know how to select “the best tool to accomplish the work involved” (Fisher & Coleman, 2002, p.2).

Teaching and learning environments in the field of music have been expanded with a variety of new technologies. Many music educators have adopted new pedagogical challenges and creative approaches. Rees (2002) argued that using electronic information technology is an alternative way of supporting music learning and that computer-based or web-based instruction provides both students and teachers with new opportunities and challenges to learn music.

However, many music educators have been reluctant to use new technologies because of their discomfort with the unfamiliar learning technologies of the new learning environment (Bowman, 2014; Rees 2002). While academically oriented music courses such as music history, music education philosophy, and psychology of music have been well incorporated into the online learning environment, performance-based music courses (e.g., choir class) do not fit easily into this model (Bowman, 2014; Dammers, 2009). However, some innovative music educators have used technologies to create innovative music courses. Chizmar and Williams (1996, 1998, 1999, 2001) employed various online learning tools from the Internet when teaching their interdisciplinary music courses. Reese (1999, 2001) used the Network for Technology, Composing, and Music Mentoring project (NETCOMM) for Musical Instrument Digital

Researchers and scholars have found that new media such as digital games can be an effective learning tool (Aghababyan, 2014; Gee, 2003; Liu, Rosenblum, Horton, & Kang, 2014; Martin & Shen, 2014; Perry & Klopfer, 2014; Squire, 2002; Turkay, Hoffman, Kinzer, Chantes, & Vicari, 2014; Wu, Richards, & Saw, 2014). More importantly, many researchers have reported that digital games and simulations improve student motivation, engagement, and academic achievement in various teaching and learning situations (Liu, Rosenblum, Horton, & Kang, 2014; Martin & Shen, 2014; Perry & Klopfer, 2014; Vogel et al., 2006; Wu, Richards, & Saw, 2014). Some researchers have specifically shown that games and simulations positively motivate people to learn a variety of academic or non-academic subjects (Becker, 2008; Bourgonjon, Valcke, Soetaert, & Schellens, 2010; Gee, 2003; Gunter et al., 2008; Kappers, 2009; Liu & Chu, 2010; Liu, Rosenblum, Horton, & Kang, 2014; Marvel, 2012; Perry & Klopfer, 2014; Rouse, 2013; Squire, 2002; Wu, Richards, & Saw, 2014). However, even though many researchers have shown that games and simulations have positive educational effects in a variety of disciplines for both formal and informal learning environments, it is still challenging for educators and instructional designers to know how to use games as an effective online learning tool. It is therefore important to know how digital games can be effectively incorporated into a specific online learning environment where the learners, communities, learning tools, and objects are constantly interplaying with each other. While there are many insightful research studies on the importance of Digital Game-Based Learning (DGBL) and its promising features for 21st century teaching and learning (Aghababyan, 2014; Bourgonjon et al., 2010; Gee, 2003; Gunter et al.,
DGBL is a very new approach to online learning in music. It is imperative for music educators and instructional designers to implement or incorporate new DGBL online instruction models.

According to Van Eck (2006), several issues need to be resolved when incorporating or integrating DGBL in the classroom: choosing a game that suitably aligns with the curriculum, choosing a game with appropriate content, designing and evaluating the game, and the availability of technical support. To investigate this complex research issue, this research study not only examines whether DGBL online is as effective as traditional web-based instruction, but it also uncovers important factors that affect the students’ motivation and achievement in online learning. Thus, two relevant research questions were proposed:

1. Is there a significant difference in motivation (e.g., Attention, Relevance, Confidence, or Satisfaction) between students who learn music through traditional web-based approaches and students who learn through game-based online instruction?

2. Is there a significant difference in achievement between students who learn music through traditional web-based approaches and students who learn through game-based online instruction?

**Research Context**

Game-based online learning in the field of music is the research context addressed in this study. There are important reasons to choose music as a research context. To begin with, it is crucial to support art education for young adults. According to a 2012 report from the National Endowment for the Arts, there are distinctive findings from four longitudinal studies analyzing approximately 71,610 students (Catterall, Dumais, & Hampden-Thomson, 2012). Catterall, Dumais, and Hampden-Thomson (2012) reported that when socially and economically disadvantaged children and young adults were engaged in high levels of arts learning, they
generated more positive outcomes in a variety of areas such as “school grades, test scores, honors society membership, high school graduation, college enrollment and achievement, volunteering, and engagement in school or local politics” (p. 24). The research also found that school curricula or extracurricular programs integrated with “deep arts involvement” may narrow “the gap in achievement levels” between the youth of high Socio-Economic-Status (SES) and low SES (Catterall, Dumais, & Hampden-Thomson, 2012, p.24).

Many researchers have determined that music learning is important for both children and young adults. According to a 2011 report from the Arts Education Partnership, music education supports and prepares students to learn by enhancing motor skills (Forgeard, 2008; Hyde, 2009; Schlaug et al., 2005), working memory (Berti et al., 2006; Pallesen et al., 2010), and brain ability for achievement (Helmrich, 2010). It also facilitates and improves students’ academic achievements such as language learning (Baker, 2011; Catterall, 1998; Deasy, 2002), math achievement (Helmrich, 2010), and average SAT score (College Board, 2010). In the long term, music learning helps students develop characteristics necessary for life-long success by fostering perseverance, higher self-esteem, and success (Chesky & Hipple, 1997; Scott, 1992). Music as an academic discipline is a crucial and fundamental part of educating younger generations to become intellectually well-balanced and emotionally well-rounded individuals.

The students who participated in this study were enrolled in a large public university that offers a wide variety of courses in the arts and humanities, including an online music appreciation course. Instructors and instructional designers who are committed to online course design have raised critical issues about online learning media for music learning. Therefore, it is important to know how to design a specific multimedia learning environment where the student’s learning fundamentally involves many approaches to listening. It is also essential to identify how
the online learning environment should be designed for non-music majors who do not have sufficient prior knowledge about classical music.

**Research Problem**

Educational institutions are still following the antiquated traditional curriculum hierarchy that has been practiced for more than 2000 years (Bleazby, 2015; Lamb & Araos, 1996). Even though many academic areas such as music provide students with excellent benefits, they have been considered a less important academic discipline or of lower academic status compared to other disciplines such as mathematics and physics (Bleazby, 2015). To improve the quality of education for all students in the 21st century, the recent educational reform in the United States has replaced the *No Child Left Behind* (NCLB) Act with new legislation since its prescriptive requirements were ineffective and unworkable for schools and educators (U.S. Department of Education, 2015). The NCLB Act resulted in an excessive focus on the “STEM” (science, technology, engineering, and math) fields, test preparation, and remedial classes, which have prevented students from obtaining a well-rounded education. To overcome these educational drawbacks, the 2015 *Every Student Succeeds Act* (ESSA) was designed to ensure success for all students and schools (U.S. Department of Education, 2015). Art Education, including music, is part of ESSA’s definition of a well-rounded education, replacing NCLB’s concept of core academic subjects. Rather than being considered non-essential, music is predicted to be one of the important academic disciplines that will develop innovative and creative instruction in the 21st century (National Association for Music Education, 2017; U.S. Department of Education, 2015).

Music educators have made an enormous effort to teach various kinds of music courses in both traditional and innovative ways. Even though numerous technologies and multimedia learning materials have been applied to a variety of music learning environments, there are few
guidelines for how to design a motivating and effective online music course with different types of multimedia. Mayer (2005) argued that multimedia learning environments should be designed “in ways that help people build mental representations” (p. 3). Based on the cognitive psychology of multimedia learning, Mayer introduced principles of multimedia learning for how to present learning media (printed texts, pictures, audio recordings, videos, animations, and games) in an online learning environment (Clark & Mayer, 2016).

As Asmus and Harrison (1990) stated, motivation is an important factor that encourages students to learn music. Research in the field of music has also addressed the fact that educational games and simulations motivate people to learn music in dynamic ways (Birch, 2013; Denis & Jouvelot, 2005; Duysburgh, Slegers, Mouws, & Nouwen, 2015; Gomes, Figueiredo, & Bidarra, 2014; Gower & McDowall, 2012; Little, 2013; Nardo, 2010; Paney, 2015; Richardson & Kim, 2011; Yu, Lai, Tsai, & Chang, 2010). Another question that needs to be resolved is if the motivated students do learn something by playing a game. In the case of educational games, the research shows that games may support learners by promoting appropriate cognitive processing during gameplay.

To develop a new music curriculum and instruction for the digital generation, universities and art organizations such as the Weil Music Institute at Carnegie Hall have attempted to create community-based online music programs to encourage young adults. These online music programs provide a rich educational experience, stimulating creativity and innovation in various academic fields. However, it is quite challenging for colleges and universities to implement DGBL at the institutional level (Van Eck, 2006) due to complex teaching and learning environments. There are insufficient frameworks to explicate the problematic issues in an online learning environment. This research attempts to uncover the key to effective, motivational online
learning that improves individuals’ music learning while successfully utilizing educational
games in the field of music.

**Purpose of the Study**

The aim of this study is to examine how game-based online instruction affects
undergraduate students’ motivation and achievement in learning music. The study focuses on
whether the use of educational games would be effective and successful in terms of students’
motivation and academic achievement when learning specific content and precisely defined
objectives (Randel, Morris, Wetzel, and Whitehill, 1992).

**Research Questions**

The proposed research questions investigate not only how different types of online music
instruction models affect students’ motivation, but also how their academic achievement might
change when using educational games. The proposed research questions are as follows:

1. Is there a significant difference in motivation (e.g., Attention, Relevance, Confidence, or
   Satisfaction) between students who learn music through traditional web-based approaches
   and students who learn through game-based online instruction?

2. Is there a significant difference in achievement between students who learn music through
   traditional web-based approaches and students who learn through game-based online
   instruction?

**Hypotheses**

To answer the proposed research questions, the following hypotheses are tested:

Hypothesis 1. (For Research Question 1)

\( H_0: \) There is no significant difference in student motivation (Attention, Relevance,
Confidence, Satisfaction) between traditional web-based and game-based online music
instruction.
H1: There is a significant difference in student motivation (Attention, Relevance, Confidence, Satisfaction) between traditional web-based and game-based online music instruction.

Hypothesis 2. (For Research Question 2)

Ho: There is no significant effect of game-based online music instruction on students’ achievement controlling for students’ pretest scores.

H1: There is a significant effect of game-based online music instruction on students’ achievement controlling for students’ pretest scores.

**Significance of the Study**

The primary significance of the study comes mainly from its unique research design. This research is significant in that it might guide how to design a specific multimedia learning environment that requires more abundant auditory presentations than those of standard online teaching and learning. When the curriculum itself needs more audio learning materials or sound-related learning in multimedia lessons, this study may provide practical tips on instructional design. In other words, this research could provide some implications for designing sound-rich online learning environments based on multimedia learning principles. This study further sheds light on considerations for designing visual, animated, or picture-rich learning environments.

Furthermore, this study is significant in that it provides advanced evidence-based experimental research for online game-based learning in a new context, which is an extension of previous research contexts. This media comparison gaming research uses four essential requirements to be in line with the scientific evidence-based research that Mayer (2014a) proposed: 1) equivalent research settings, 2) dependent measures associated with learning outcomes, 3) statistical measurements, and 4) instructional content in the academic area. The design of this research fully met these essential requirements to yield unbiased findings. Most of
all, the research setting was designed to overcome potential drawbacks that may occur in media comparison research. As Mayer indicated (2014a), the game and the conventional groups were equated on relevant dimensions as closely as possible. Both the treatment and control groups were exposed to equivalent modes, methods, and media, which are the three components of the instruction. The same modes such as graphics, text, and audio were used in the experiment, aligning with the same learning objectives. The basic structure of the instructional methods was also the same in that both the game-based and web-based instruction models included a pre-training lecture section, an exercise section, and corresponding feedback in each module. The physical delivery media of the instructions were the same computers located in the lecture room at the indicated university. To control for extra confounding variables that may occur in ecologically different research settings, the space and time allocation of the experiments was equated by using the same online platform, Qualtrics®.

The research pursued a holistic analysis of online learning media. In other words, this research is not a simple media comparison approach, which analyzes and compares a single media component or function. Rather, this research holistically analyzed online learning media examined through multiple dimensions regarding instructional methods, instructional design, and interactive learning media within an online learning environment. More importantly, the web-based online intervention was developed based on multimedia learning theory. Online learning materials such as text, audio, and video files were rearranged to consider multimedia learning principles.

**Potential Ethical Issues**

**Privacy Issues**

The identities of research participants were kept confidential to the extent provided by law. Four confidentiality solutions were carried out during the entire research process. First, all
research processes including the field test were approved by the Institutional Review Board (IRB). All materials used in this research such as email advertisements, survey instruments, and a letter of waiver of consent were carefully reviewed by the IRB to protect any potential legal and ethical problems that might affect the physical or psychological conditions of the research participants. Not only were the participants able to review the research announcements before taking part in the research activity, but they also had an opportunity to discontinue their research participation at any time without reason or penalty. Second, the researcher vigilantly protected the privacy of students and any sensitive personal information, especially information related to personal comments during or after the focus group discussion sessions. Each response from the open-ended questionnaires was assigned a pseudonym; all student data and personal information were recorded as numbers or specific letters, and the identifiers used in the study were removed from the interview transcripts. After the experiments, the collected data and files were kept in a secure place. The hard copies were locked, and the computer files were password protected. Lastly, all original data were securely destroyed after completing the study, and only the results were retained. For instance, all transcribed or transcription data from audio recordings of the focus group discussion session were removed after the research. The personal information of participants will not be used in any report.

Copyright Issues

To prevent potential copyright infringement, the researcher obtained permission from copyright owners for using any research instruments and multimedia learning materials that are not in public domain. All materials in the research were particularly used within the statutory framework of fair use (Section 107 of the Copyright Act). All research materials were used for scholarship and research purposes; these uses were educational and not for profit as well as non-commercial. All reproduced audiovisual materials were not publicly performed or displayed.
Definition of Terms

**ARCS Model**

The ARCS model is a systematic motivational design created by John Keller in an attempt to overcome the instructional deficiencies and ineffectiveness of the instructional system design (ISD), which is often characterized as an inflexible and rigid. It is a systematic problem-solving approach used not only to analyze knowledge of human motivation, but also to enhance learner motivation in processing the four steps of the ARCS motivational design: Attention, Relevance, Confidence, and Satisfaction.

**Qualtrics®**

Qualtrics® is an online survey software program used for online data collection. It enables users not only to collect many kinds of data, but it also provides them with an analysis of a variety of fields such as market research, employee evaluations, and website feedback. Various design features are also available within the system. Users can design their survey instruments by importing different types of multimedia files into the survey platform.

**Digital Game-Based Learning (DGBL)**

Digital Game-Based Learning (DGBL) is a term coined by Gee (2003) to give new insight into the 21st century teaching and learning environment. The new digital generation uses digital technologies on a daily basis that are in need of innovative curriculum and instruction. As online education has gained popularity in school communities, DGBL has expanded its justification of why it is beneficial for students, teachers, and instructional design specialists.

**Instructional Materials Motivation Survey (IMMS)**

The Instructional Materials Motivation Survey (IMMS) is a survey instrument created by John Keller. It is composed of 36 questionnaire items derived from Keller’s ARCS model and has been used to measure the situational motivation of learners toward learning materials.
The Young Person’s Guide to the Orchestra®

This game is one of the educational music games provided by the Weil Music Institute at Carnegie Hall. The game was initially designed for K-12 students and music educators who need professional music training. The name of the game and game design are fundamentally based on Benjamin Britten’s well-known 1946 musical piece The Young Person’s Guide to the Orchestra, subtitled Variations and Fugue on a Theme of Purcell. It was originally composed for an educational purpose rather than as an aesthetic statement; the musical piece was used in the educational narrative documentary film Instruments of the Orchestra.

Organization of the Study

This study consists of five chapters. Chapter 1 of this study is an introduction to the entire research study, which provides a brief overview of the study, research questions, the purpose of the study, the significance of the study, and the definitions and terms used in the study. Chapter 2 is a literature review covering all theories and areas related to the research. Chapter 3 provides detailed information about the methodology implemented in the study including research design, data collection, and data analysis. The web-based online and game-based online interventions will be analyzed based on instructional design, instructional methods, interactive media, and the online learning materials such as text, audio, video, and game sessions utilized in the study. Chapter 4 delivers findings of the study resulting from the data analysis. In Chapter 5, the study concludes with discussions, implications, limitations and delimitations, and suggestions derived from Chapter 4.
CHAPTER 2
LITERATURE REVIEW

Digital game-based learning has gained both positive and negative claims for its educational value in various teaching and learning situations. Most positive claims have shown that computer games could be a successful learning material in a variety of academic settings, and many researchers have focused on its potential to motivate learners (Clark & Mayer; 2016; Hannafin & Vermillion, 2008; Mayer, 2011; Van Eck, 2006). On the other hand, there is still a lack of empirical evidence about why, what, or how DGBL can support student motivation and achievement in school settings (Mayer, 2011; Van Eck, 2006).

Online learning has become popular in public schools, universities, private institutions, and academic organizations. It is technically the most feasible learning environment where teachers, students, and instructional designers can practice DGBL. However, many educators, instructional designers, and school administrators may be perplexed when implementing specific learning goals in online learning environments, especially when aligning serious learning subjects with the fun elements of the game, which may motivate students to learn (Mayer, 2011; Van Eck, 2006).

This literature review provides the background, theory, and a conceptual framework to answer how people learn from playing games as well as how optimal multimedia learning materials should be designed to achieve desired learning goals in an online learning environment.

**Online Learning**

Online learning has become a popular instructional medium today. Many academic institutions, non-profit organizations, government agencies, business organizations, and companies in the private sector have replaced their conventional learning programs with new online learning courses (U.S. Department of Education, 2012; Online Learning Consortium, 2015). According to a 2015 report from the Online Learning Consortium, online students have
been increasing at a rate of 3.9% per year, and approximately 5,828,826 students are taking at least one online course. Public institutions have launched new online learning programs, with a significant portion of online students including both undergraduates (72.7%) and graduates (38.7%). This is because online learning provides learners with flexible access to learning content and instruction (Online Learning Consortium, 2015). This burgeoning educational trend is not a transient phenomenon; nearly 5.8 million students in the United States have enrolled in an online course (Online Learning Consortium, 2016). Many academic leaders have reported that the quality of distance education is not only valuable and legitimate, but is also the same or superior to face-to-face instruction (Online Learning Consortium, 2015).

The definition of online learning is quite broad and complex as the terms, “e-learning” or “distant education” have been interchangeably used along with those of “online learning” in a variety of contexts. There are two different views when defining e-learning. The first view defines e-learning as instruction through technological tools (Ellis, 2004; Nicolas, 2003; Clark & Mayer, 2016). For instance, Clark and Mayer (2016) defined e-learning as “instruction delivered on [a] digital device” (p. 30). This definition focuses more on the technological characteristics of digital devices such as desktop computers, mobile phones, or tablets.

On the other hand, other researchers have argued that the definition of e-learning should be perceived as a procedural or transformative process concerning the learning experience (Tavangarian, Leypold, Nölting, Röser, & Voigt, 2004; Triacca, Bolchini, Botturi, & Inversini, 2004). Further, the definitions of “distance education” and “online learning” are broader than those of e-learning. They have often been used as umbrella terms depending on the researchers who use them in a specific learning environment context (Ally, 2004; Bowman, 2014; Jolliffe, Ritter, & Stevens, 2001; Moore, Dickson-Deane & Galyen, 2011). Other terminology includes
“Internet learning,” “distributed learning,” “computer-assisted learning,” “web-based learning,” and “telelearning” (Ally, 2004).

Moore et al. (2011) noted several commonalities found in distance education. The common definition of “distance education” is a type of instruction held at a different time and in a different place than traditional instruction and that uses a variety of instructional materials. While the definition of distance education stresses physical distance and location, many researchers have identified “online learning as a more recent version of distance learning” focused on the learning experience (Ally, 2004; Moore et al., 2011, p. 130). According to a report from the U.S. Department of Education (U.S. Department of Education, 2012), online education is defined as “instructional environments supported by the internet” (p. 2). The common definition of online learning found in the literature emphasizes learners and their learning experience with the Internet (Ally, 2004; Carliner, 1999; Khan, 1997; Bowman, 2014; Jolliffe, Ritter, & Stevens, 2001; Moore et al., 2011).

**Game-Based Learning**

Many university programs encourage students to take interdisciplinary music courses as part of their course requirements to improve their academic research in creative and innovative ways. Since advanced technologies have upgraded music instruction, it is important to provide them with a new learning venue such as game-based online learning. Even though numerous college students have grown up with a rich media and digital game culture that has been integrated into their lifestyle, there is still some debate as to whether the use of computer games for learning is educational and motivational.

Extensive discourses and questions have been raised by academic communities on whether games and simulations positively or negatively affect student learning and motivation in learning environments (Dempsey, 1994; Gee, 2003; Gunter et al., 2008; Squire, 2002; Hays,
The most critical issue is not only how educational communities can use games to support their formal and informal learning, but also why educational games are often unsuccessful when they are incorporated into a formal educational learning environment (Gunter et al., 2008; Squire, 2002; Kebritchi et al., 2010). Researchers and scholars have categorized the effectiveness and educational values of games in three ways: positive, negative, or neutral. Proponents of educational games have argued that educators should consider the digital culture of younger generations. Numerous young people have spent their spare time playing a variety of digital games. Since it is an integral part of their culture, some researchers think game-based learning is imperative for younger generations. In the same manner, Squire (2002) viewed gameplay as a vital social practice motivating people to learn. He argued that it is important to understand gameplay as an integral part of cultural practice to gather people and engage them in learning. Other researchers believe that a good game is equal to good pedagogy (Becker, 2008; Mayer, 2011, 2014a). Becker (2008), Squire (2002), and Gee (2003) have advocated popular commercial games such as SimCity and Civilization, noting their benefits for classroom use. Squire (2002) argued that SimCity adopts an endogenous game design where learners can experience academic content that is seamlessly integrated with gaming mechanics. The endogenous game is beneficial for the learners since they can experience “the properties of a virtual world through interacting with its symbology, learning to detect relationships among these symbols, and inferring the game rules that govern the system” (Squire, 2002).

On the contrary, Gunter et al. (2008) and Richard (2014) argued that the use of commercial games for education fails to gain support and legitimacy from academic communities due to their lack of accuracy, lack of resources, and bias. This is because many
Commercial games are incompatible with formal school environments (Brom et al., 2010). Commercial games are also designed only for entertainment purposes, so they fail to meet sound educational and instructional theories and intended educational goals (Gunter et al., 2008, p. 511; Richard, 2014).

Additional research reports the effectiveness of using games and simulations in formal educational settings. Vogel et al. (2006) conducted a meta-analysis comparing two teaching methods (computer gaming and interactive simulations versus traditional instruction) to investigate cognitive gains across people and situations. A total of 248 studies evaluated the statistical assessments of traditional instruction versus game and interactive simulations and specific moderating variables such as gender and learner control. The selected 32 studies reported that computer games and interactive simulations generated higher cognitive gain outcomes and better attitudes toward learning than those of traditional instructional methods. However, the results of the studies were complex and varied when examining different moderating variables such as gender, learner control, types of activity, age, realism, and user. All different age groups and individuals favored games and interactive simulations in general; however, females particularly showed a preference toward using the games and interactive simulations. Students also preferred games and interactive simulations when they had direct control or navigation of the program rather than when teachers controlled the program. When they followed computer-directed programs such as decision trees or artificial intelligence, students’ cognitive gains were less significant than those of the traditional instructional methods. The results of the study were complex in conjunction with the specific moderating variables. Even though unequivocal results were not properly gained due to insufficient research data from
various resources, the study proved that interactive experiential activities increase motivation and improve learning outcomes.

Randel, Morris, Wetzel, and Whitehill (1992) examined a total of 67 studies covering the years from 1984 to 1991 to investigate the effectiveness of using video games in conventional classroom instruction regarding students’ performance in the areas of social science, mathematics, language arts, physics, and biology. Thirty-eight studies revealed that games and traditional instruction are not fundamentally different. However, games were the preferred instruction over traditional instruction in the other 22 studies. Five studies also favored games, but there were some control issues in the studies, and only three studies favored traditional instruction. Additionally, there were different results depending on the academic subject. The areas of mathematics, language arts, and physics reported positive results when using games in the classroom. In particular, computer games were very effective in improving mathematics achievement scores for the first grade and junior high schools. Most importantly, when the learning content was very specific, and the objectives were precisely defined in the subject areas, the games were effective and successful in the classroom.

Hays (2005) analyzed the instructional effectiveness of games based on 105 articles. The results of the study from 26 review articles, 31 theoretical articles, and 48 empirical research articles showed the effectiveness of instructional games. The research reported that there wasn’t a preferred instructional method in all situations. It implied that the effectiveness of the games could not be generalized to a specific learning area, learner, group, or the type of game even though some games were effective in learning math or economics. This research also reported the importance of instructional information in instructional games. The requirements of the games, which guide instructional objectives through supportive feedback and debriefing, were
less important than the actual instruction information. As a result, a detailed analysis of the learning requirements should be completed before adopting games into instruction. The implication of the study was that instructional games should be substantial and functional, which supports properly designed learning objectives with clear feedback and debriefing.

Kebritchi et al. (2010) examined how games facilitate learning in a formal school setting. A total of 11 out of 16 studies revealed that achievements and motivation were improved by using games. However, there were mixed results in the comparison of literature reviews. While nine of the 16 studies showed that instructional games improved learners’ achievement, only four of the 16 studies reported that the learner’s motivation was promoted by the instructional games. In addition, there were no differences in learners’ achievement or motivation in five of the 16 studies.

Bourgonjon et al. (2010) and Gunter et al. (2008) argued that digital games are important learning materials motivating student learning in various learning environments. As Keller (2010) stated, learner motivation is not a simple learning event even though many researchers have attempted to set up a variety of research settings to better understand learner motivation. It is difficult to analyze and assess learner motivation because of “the sheer number of motivational concepts, constructs, and theories that have been formulated to explain aspects of motivation” (Beck, 1990; Keller, 2010, p. 12; Huang, Huang, Diefes-Dux, & Imbrie, 2006; Pittman & Boggiano, 1992). However, motivation is an important element for learning, and several research studies showed that educational games improved student motivation in various teaching and learning situations.

Liu and Chu (2010) examined how ubiquitous educational games affect student motivation and achievement in learning English listening and speaking. Three high school
teachers and 64 seventh grade students participated in the study. Two groups of students were assigned to either ubiquitous game-based learning or non-gaming learning conditions. Interviews were administered to the participants, and the English learning motivation scale based on the ARCS model was used to collect quantitative and qualitative data. To examine learning outcomes, learning motivation, and learner satisfaction, the collected data were not only analyzed using ANCOVA (Analysis of Covariance) and a one-way ANOVA (Analysis of Variance), but supportive qualitative data from in-depth interviews were also analyzed to investigate students’ feelings and perspectives toward the educational games. The results of the study showed that the student group using ubiquitous games achieved better learning outcomes and motivations regarding Attention, Relevance, Confidence, and Satisfaction than those of the student group using the non-gaming method.

Rouse (2013) examined the levels of student motivation by using the IMMS and the Flow Experience and Motivation questionnaires to investigate the effects of using educational games in a community college microbiology class (p.8). A total of 62 students took a pretest and posttest for examining academic achievement. Descriptive statistics, frequencies, a t-test, a repeated measures ANOVA, and Multivariate Analysis of Variances (MANOVAs) were used to investigate student motivation regarding educational games. The results of the study indicated that educational games promoted higher levels of student motivation and achievement than the conventional educational settings (Rouse, 2013, p. 57). Educational games clearly increased the student motivation and achievement in a community college microbiology class.

Some researchers have argued that the characteristics of the gamers and game design are also important components motivating participations. For instance, Dickey (2005) emphasized the motivational game design, stating that “player positioning, narrative, and interaction in game
design, in addition to providing more detailed methods for creating engaging learning environments, may also serve as a type of guiding architecture for the design of interactive learning environments” (p. 79). According to Kim (2010), digital game technology should: 1) be “interactive in the sense of context-sensitive responses to the learner’s actions,” 2) be “nonlinear so that learners can determine their own learning path,” and 3) should have a “multiplayer format to knowledge” (Kim, 2010, p. 99) to enhance the digital learning experience. Kim’s (2010) research suggested that the selection of the digital game technology is critical in that it encourages the community of learning as well as active engagement for learners when it is used as a learning tool.

Yee (2007) investigated a total of 3000 MMORPG players who participated in an online survey publicized at popular online portals to examine players’ motivation toward online games regarding age, gender, usage pattern, and in-game behaviors. By ten subcomponents based on a factor analytic approach, three overarching components (achievement, social, and immersion components) were defined in the study. The result of the study showed that it is critical to generalize video gamers’ motivations and behaviors into a simplistic archetype. It implied that personal preference, purpose, and time and space where the games had been played highly influenced players’ motivations in MMORPGs. While the female players’ relationship subcomponent was significantly higher than that of the male players, male players’ scores were higher in all the achievement components. This study indicated that the male players had different social preferences than the female players.

Marvel (2012) conducted a similar research study on distance learners’ motivations in an online gaming environment, investigating adult players’ motivations toward MMOGs. The study examined 400 adult gamers who participated in popular MMOGs and personality traits such as
introversion and extroversion, the adults’ primary motivational component, and gender differences. The results of the study showed that introverted, achievement-motivated males spent the most time playing MMOGs. It also implied that the characteristics of introversion and extroversion and gender should be taken into consideration when designing educational MMOGs.

**Music Education**

The succession of a variety of musical traditions from different cultures has also influenced modern life and culture, encouraging people to be better individuals as well as good citizens (Elliott, 2002, 2012; Mark, Gary, & MENC, 2007). Further, advanced technologies and democracy have developed traditional music curricula and instruction, dramatically changing the way of listening and sharing music in both schools and everyday life. In the 21st century, music is not just for the privileged; it is not limited to professional musicians, elites, or those rich enough to access high-quality music arts. Rather, music has become an imperative cultural form which can be closely integrated into quality education so that people become well-balanced and well-rounded members of society. Saettler (2004) argued that educational technologists should be aware of the importance of frontier research areas such as the arts (p. 15). As an educational technologist is an agent of change in educational development and design, and since the design of the instruction using technologies is becoming a new art form combined with sophisticated multimedia encompassing rigid technological functions, it is crucial for modern educational technologists to build a closer relationship between educational technology and the arts for 21st century education. In modern times, learning music is not only for professional musicians or music majors, but it is for all people who need to improve their quality of education on a personal or professional level, a goal achievable through creative instruction using multimedia. In particular, music, audio, or any form of sound constitute important multimedia that
instructional designers, educators, technologists, and researchers in the field of educational technology should pay attention to when creating high-quality research and instructional designs.

Music Appreciation in the United States

Music listening and appreciation is one area that has been greatly influenced by advanced technology. In early music education history, music learning communities in schools could not show students large-scale performances of concert music or opera performed in large concert halls or public spaces such as a park. However, with the advent of popular “new” media, such as radio, TV, and audio recordings, teachers and students could listen to original music from master recordings, not from piano accompaniments played in a classroom.

Frances Elliott Clark, a music teacher and music appreciation advocate during the early part of the 20th century, used photographs to teach children to listen to music. She not only prepared recordings for classroom teaching, but she also provided students with music instruction in connection with other academic subjects such as English (Mark, Gary, & MENC, 2007). In 1920, she also used the radio to teach music appreciation. The radio quickly became a new way of using technology to disseminate music to large communities in public. Alice Keith was a pioneer for teaching music with the radio. Her music appreciation course “Listening in on the Masters” was designed to teach students using the radio and records (Mark, Gary, & MENC, 2007, p. 294). Edgar B. Gordon introduced a statewide music program by using the radio, and Walter Damrosch broadcasted symphonic music to numerous schoolchildren (Mark, Gary, & MENC, 2007, p. 294-295). In 1931, Elizabeth Beach’s Christmas carol festivals on CBS radio also became popular, featuring a unique chorus comprised of forty boys selected from various schools (Mark, Gary, & MENC, 2007, p. 294-295). TV, movies, and documentary music programs have also provided other venues for music appreciation. For instance, an educational documentary film in 1945 called the Instruments of the Orchestra was created to teach
symphony orchestra by using the orchestral music piece *The Young Person’s Guide to the Orchestra* written by Benjamin Britten. The narration in the documentary film was used to provide listeners with general information about the musical instruments played in the orchestra.

In recent years, advanced computers, the Internet, and online learning environments have become new venues for music appreciation. Online learning environments have become a popular venue where teachers and students can practice teaching and learning music appreciation. For instance, students can listen to music that can be repeated and replayed in the learning modules as well as share their listening experience with their peers. Additionally, the online learning environment enables music learners to access music courses in a democratic way so that the value of music can be shared with many learning communities, rather than being limited to professional musicians or music majors.

Traditional music appreciation courses have been evaluated in a non-technology-based context, which is a face-to-face lecture in the classroom. Music appreciation teachers have continued to investigate new methods to enhance student involvement with music (Zalanowski, 1990), and music appreciation learning has been studied in various ways. For example, Payne (1980) conducted a pilot investigation on how people’s emotions evolve in music appreciation learning. One hundred and one students were compared to investigate listeners’ emotion, personality, and the impact of familiarity on music appreciation. The results of the study showed that the emotional appeal of music was less strong with well-trained listeners. When the music was familiar to the listeners, it had less appeal. Also, the study indicated that personality was not a primary concern or the most direct architect of music appreciation (Payne, 1980, p. 39). In terms of personality, this result was different compared to previous research. Payne (1973)
reported that the familiarity of music and the listener’s personality were related to each other; in other words, people became personally engaged if they knew the music.

Zalanowski (1990) compared three different music-involvement techniques: visual representation, verbal description, and a control condition. Seventy-two non-music majors attending introductory music courses were randomly assigned to each experimental condition. The research questionnaire measured the students’ enjoyment, attention, and understanding. The students in the visual and verbal condition drew an illustration or wrote a short description about the music listening examples. The results of the study indicated that there were no differences among three conditions. The analysis of the right-hemisphere or left-hemisphere of the brain revealed that left-oriented subjects received the highest verbal scores while the right-oriented subjects recorded the highest visual appreciation.

Halpern (1992) investigated the effect of historical and analytical teaching approaches in music appreciation. Forty-five non-music majors were randomly assigned to one of three conditions. Prior to listening to four music compositions, one group received analytical descriptions of the music while another group was provided historical background information on the music. The research indicated that the students without music training appreciated the historical background information regarding the composers and music.

Smialek and Boburka (2006) examined the effectiveness of cooperative listening exercises for non-music majors. Listening exercises on critical listening skills were used to test two experimental groups. The control group attended listening exercises in classrooms. The experimental group participated in cooperative exercises. The study found that when the students consistently used cooperative-listening exercises, their critical listening skills improved.
Zeigler (1974) noted that creating informed and interested audiences is an important goal in music education. Two primary goals in college-level music appreciation courses were stated in the research: student achievement and development of positive attitudes about music (Zeigler, 1974). One hundred-eleven undergraduates were evaluated in terms of knowledge and cognitive behavioral objectives on achievement and attitude on music appreciation. The results of the study from the two experimental and control sections showed that the students who had precise cognitive behavioral objectives not only had higher achievement, but also had increased positive attitudes toward the subject matter.

Online music appreciation courses have been investigated by comparing face-to-face instruction with online communication. McCabe (2007) researched collaborative online music appreciation courses. Ninety-one undergraduate students who were enrolled in online music appreciation classes participated in the study. The students’ cognitive level and satisfaction of each course assignment were analyzed using a one-way and a two-way ANOVA. The results indicated that collaborative small group assignments enhanced critical thinking skills. Even though students liked to interact with the other group members, the students preferred to work independently and had clear preferences regarding instructional strategies used in the class McCabe (2007). On the other hand, Eakes (2009) investigated students’ music achievement, music self-concept, and student course satisfaction regarding face-to-face or online course instruction. A music achievement test was conducted with 91 undergraduate students. The music achievement scores of the students in sociocultural sections had higher scores than those in the chronological sections. The study concluded that both face-to-face and online formats generated positive outcomes; however, some measures were significantly higher for traditional students than online students (Eakes, 2009).
Cognitivism in Music Education

After 1950, music educators adopted learning theories from educational psychology, including behaviorism, cognitivism, humanism, and the socio/biological model (Rideout, 2002). Music instruction and pedagogy were designed and practiced based on these psychological theories. Behaviorism, proposed by B. F. Skinner, influenced curriculum development and instruction in music. It focused on the behavioral objective, which defines “the learner, the action, and the assessment in a way that assured that learning was active and sequential and that assessment was based on demonstrable actions” (Rideout, 2002, p. 34). In this theory, learning objectives for music learners are clearly defined; the learners are motivated by external rewards; and the learning is controlled by the learning objectives. The music curriculum and frameworks for both music lesson plans and student evaluations are defined by the learning objectives (Rideout, 2002).

Instead of the generalized aspects of the music learning characteristic of behaviorism, cognitivism concentrated on the development of the human mind through iconic learning stages (Rideout, 2002). In particular, the cognitivists viewed “the human nervous system as a data processing and storage mechanism” (Abeles, Hoffer, & Klotman, 1995, p. 191). As indicated by their view, the cognitivists are interested in learners’ mental processes. In other words, this learning theory focuses on how individuals process and retain new information integrated with their prior knowledge, as well as resist the loss of memory.

Gestalt theory provides important aspects of music learning (Radocy & Boyle, 2003). Gestalt theorists such as Köhler, Wertheimer, and Koffka were primarily interested in organizing and reorganizing cognitive structures. They viewed learning as “a matter of perceptual organization” (Radocy & Boyle, 2003, p. 400). Gestalt theory emphasizes the coherence of cognitive organization, which can be well-explained by the four sub-categories of the law of
compactness: proximity, simplicity, similarity, and common direction. Many classical music compositions have followed these laws in nature, and patterns of visual and audio structures, such as the consistent rhythm of a heartbeat, make sense to human beings. The law of compactness in that sense implies “good” or “harmonious” figures related to the whole and the parts that can be effectively perceived or organized in the mind (Radocy & Boyle, 2003, p. 401; Richey, Klein & Tracey, 2011). In music learning, the law of proximity has been applied in various harmonic and rhythmic patterns. People naturally like grouped sounds closer to the pitches, tones, and rhythms that make harmonious musical patterns. For instance, larger tonal distances that make dissonant sounds cannot be easily perceived or organized in our regular tonal systems. Music composers consider this law when they compose musical pieces since singers and some instruments cannot easily play the sounds in the range of the large distance between the lowest and highest pitches. In the same manner, the law of simplicity is one of the vital rules in music teaching and learning. Music in nature pursues “perceptual preference for the smoothness, regularity, and symmetry” to avoid chaotic sounds that are rough, irregular, and asymmetric (Radocy & Boyle, 2003, p. 401). Music listeners also tend to group similar tone colors, timbres, rhythms, and pitches. The majority of music practices are based on this principle. For example, students may need to find similarly pitched sounds or tone colors that represent string instruments. In sight-singing practice, music learners find similar rhythmic or harmonic patterns so that they can follow or memorize melodies in the music score. The law of common direction implies the music should be grouped on “the basis of the extrapolated completion” (Radocy & Boyle, 2003, p. 401). Incomplete musical notations or handwriting can be perceived if they are grouped together toward common or expected directions in tones, rhythms, and pitches. In particular, Radocy and Boyle (2003) argued that the law of simplicity should be
considered for novice learners who start with music appreciation. In other words, music instruction should be predictable and perceivable in a way that the learner can understand and organize new patterns of music information.

Information processing theory views the human mind as similar to a computer in terms of receiving, analyzing, storing, and retrieving data (Richey, Klein & Tracey, 2011). This distinctive learning procedure from an information processing viewpoint includes three memory systems: sensory memory, working memory, and long-term memory (Abeles, Hoffer, & Klotman, 1995; Richey, Klein & Tracey, 2011). The sensory memory receives the first stage of audio and visual information. It has a limited capacity for holding new information, so irrelevant information is removed or deleted from the system. The rest of the relevant information moves forward to the next stage of the memory system, which is working memory. Working memory also has a limited capacity to store incoming information. For instance, even though musicians are professional, they could not learn to play 1000 different melodies from musical notations if given only a short time to learn the music. To memorize new melodies, professional musicians constantly work on the melodies by rehearsing the new information, which requires recalling and storing relevant music melodies from long-term memory. To recall, organize, and repeat the new musical knowledge is crucial for music teaching and learning. If novice music learners start a music appreciation course, instructors should start the course at a level appropriate to the learner’s ability to process new musical information. Finally, processed information from the working memory system enters and is stored in the long-term memory system. In this cognitive view, the music appreciation instructor may consider three instructional design techniques. The new information should be chunked or organized in a way that is easily perceivable and predictable. Teachers can also relate the new information with the learner’s prior knowledge by
using mnemonics techniques. The music learners will remember new melodies better if they can keep recalling the previous knowledge stored in their long-term memory. In other words, if the lectures are constantly relevant to their previous knowledge, they will process the new music information effectively (Abeles, Hoffer, & Klotman, 1995; Richey, Klein & Tracey, 2011).

**Multimedia Learning**

Traditional face-to-face instruction has heavily relied on the verbal forms of instructional presentations and materials such as textbooks or classroom lectures. As recent technological advances have allowed for transferring fast and extensive multimedia presentations in current learning environments, instructional designers can incorporate rich media into their course instructions (Clark, 2014; Clark & Mayer, 2012, 2016). Clark and Mayer (2012) defined rich media as “instructional programs that incorporate high-end media such as video, animation, and audio” (p. 310). Modern computers’ and computer platforms’ technologically complex systems support a variety of high-end media to process sophisticated audio and visual instructional materials (Clark, 2014; Clark & Mayer, 2012, 2016; Dorfman, 2013). Ironically, the abundance of media also presents a challenge for both instructors and instructional designers on how to establish effective instructional programs with rich media (Clark, 2014; Clark & Mayer, 2012, 2016). The paradox of using rich media has indicated that learning does not always improve simply by adding rich media because the human learning system has a limited capacity to process extraneous information from the multimedia learning environment (Clark & Mayer, 2012). Thus, the promise of multimedia learning based on the science of learning provides substantive rationales for how multimedia should be designed to promote learning (Clark & Mayer, 2012, 2016; Mayer, 2001, 2003, 2014a, 2014b; Tobia & Fletcher, 2011; Tobia, Fletcher, & Bediou, 2014).
Multimedia

Media researchers and artists have used the term “multimedia” to describe their works’ purpose through media research, presentations, or digital media performing arts incorporating text, audio, video, animation, or a combination of media. Using the term broadly, McLuhan (2003) considered media as technological extensions of the human being to the extent that media changes our experience of the world in all areas of society and culture. For example, a computer would be an extension of a human’s brain. Similarly, an amplified speaker and headset could be seen as an extension of a human’s voice and auditory systems.

Mayer (2001), on the other hand, specified the term “multimedia” as focusing on a human’s cognitive system. He defined multimedia as “the presentation of materials using both words and pictures” (Mayer, 2001, p. 1). The meanings of the words are printed texts or spoken languages, and the pictures are static (e.g., illustrations or photos) or dynamic materials (e.g., animation or video) (Mayer & Moreno, 2003). To conceptualize multimedia messages in detail, he further divided multimedia into three perspectives: 1) the delivery media view, 2) the presentation mode view, and 3) the sensory modalities view (Mayer, 2001). Mayer and his colleagues have proposed these core concepts to investigate a variety of multimedia learning situations for many years (Mayer, 2001, 2003, 2014a, 2014b, 2016). Mayer (2001, 2014b, 2016) also developed three main streams of evidence-based research in addition to the core views of multimedia messages. The three main streams were defined as 1) the media comparison approach, 2) the value-added approach, and 3) the cognitive consequence approach.

The first stream, media comparison research, straightforwardly focuses more on technology or the delivery device itself than the learner. The multimedia in this view refers to “presentation materials using two or more delivery devices” such as computer screens, projectors, or blackboards (Mayer, 2001, p. 5). The most important multimedia design issue in
this view is to identify effective technology or media for presenting information. It is the foundation of media comparison research, which is primarily technology-centered. Unlike the delivery media view, the second and the third views are more learner-centered than technology-centered. The second view, named the “presentation mode view,” is concerned with how to effectively present instructional materials to learners. The fundamental concept of the multimedia design is closely related to value-added research (Mayer, 2001, p. 6). The third is the sensory modalities view, which places more emphasis on the learner’s sensory system, such as the eyes and ears (Mayer, 2001, p. 6). This view says that multimedia presentation is visually and auditorily processed through the dual channels of the human information processing system. The multimedia design of the sensory modalities view is not only grounded in cognitive learning theory, but it is also a primary basis for cognitive consequence research.

**Multimedia Learning**

The definition of multimedia learning is different from the terms “multimedia” and “multimedia instruction” (Mayer, 2001, 2014b). Mayer (2001, 2014b) separately defined the terms “multimedia,” “multimedia learning,” “multimedia media instruction,” and “multimedia learning principles” in terms of the people present, the construct, and promoting learning from words and pictures, respectively. Multimedia learning refers to “learning from words and pictures” (Mayer, 2001, p.3) or “building mental representations from words and pictures” (Mayer, 2014b, p.2). These terms are compared in detail as follows (Table 2-1):

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimedia</td>
<td>“Presentation of materials using both words and pictures” (Mayer, 2001, p. 2)</td>
</tr>
<tr>
<td></td>
<td>“Presenting words (such as printed text or spoken text) and pictures (such as illustration, photos, animation, or video)” (Mayer, 2014b, p. 2)</td>
</tr>
</tbody>
</table>
Table 2-1. Continued

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multimedia learning</td>
<td>“Learning from words and pictures” (Mayer, 2001, p. 3)</td>
</tr>
<tr>
<td></td>
<td>“Building mental representations from words and pictures” (Mayer, 2014b, p. 2)</td>
</tr>
<tr>
<td>Multimedia instruction (or multimedia learning environment)</td>
<td>“Designing multimedia learning environments in ways that help people build mental presentations” (Mayer, 2014b, p. 2)</td>
</tr>
<tr>
<td>Multimedia instructional message, Multimedia instructional presentation, or Multimedia instruction</td>
<td>“Presentations involving words and pictures that are intended to foster learning” (Mayer, 2001, p. 3)</td>
</tr>
<tr>
<td>Multimedia message or multimedia presentation</td>
<td>“Presentations involving words and pictures” (Mayer, 2001, p. 3)</td>
</tr>
</tbody>
</table>

In particular, Mayer (2014b) conversely used the term “multimedia learning environment” as “multimedia instruction” (p. 4). Multimedia instruction is defined as “presenting words and pictures that are intended to foster learning” (Mayer & Moreno, 2003, p. 43; Mayer, 2014b, p. 4). It also refers to designing multimedia learning environments in a way that allows people to construct their mental representations (Mayer, 2014b, p. 4). As the term indicated, the central focus of designing multimedia learning environments is to present words and pictures that stimulate learning (Mayer, 2001; Mayer & Moreno, 2003; Mayer, 2014a; Mayer 2014b). Multimedia learning environments constitute dynamic forms of computer-based or face-to-face learning environments where different kinds of media are presented to improve learning. For example, they may include computer-based narrated animations, computer-based educational games, PowerPoint presentations, or paper-based teaching with texts and 3D graphics in a face-to-face learning environment.

The important research issue underlying multimedia learning is detecting whether adding pictures to words can generate meaningful learning outcomes such as knowledge transfer (or understanding) and retention (or remembering) (Clark & Mayer, 2012; Clark & Mayer, 2016; Mayer, 2001, 2014b, 2016). Mayer (2014b) argued that cognitively active learning promotes meaningful learning outcomes, in which learners can effectively integrate knowledge in new
situations as a result of good retention and transfer performances. In other words, meaningful learning occurs when learners engage in active cognitive processing such as selecting, organizing, and integrating new information with their prior knowledge (Mayer, 2001; Mayer & Moreno, 2003; Mayer, 2010; Mayer 2014c; Moreno & Durán, 2004; Sorden, 2012).

Mayer and his colleagues developed three research themes on multimedia learning by testing students’ retention and transfer performances: “How a Pump Works” (Mayer & Anderson, 1991; Mayer & Gallini, 1990), “How Breaks Work” (Mayer, 1989; Mayer & Anderson, 1992), and “How Lightning Storms Develop” (Mayer, Bove, Bryman, Mars & Tapangco, 1996; Levin & Mayer, 1993; Mayer & Moreno, 1998). Evidence on the proposed multimedia learning research indicated that visual presentations should be accompanied with auditory representations in multimedia instruction.

Mayer and Gallini (1990) researched book-based multimedia lessons to investigate effective illustrations to improve student learning of the concept, “how a pump works.” In the three experiments, four conditions were tested to find an effective illustration to enhance students’ performance in terms of the recall of conceptual information and creative problem-solving. The results of the study showed that the part-and-steps illustrations, which were dynamic illustrations with labels for each part and step, improved the students’ learning. A similar study also showed that students learned better when words and pictures were presented together in a narrated animation. Mayer and Anderson (1991) used animation and narration to study which words-with-pictures group performed better for the computer-based lesson describing how a pump works. The words-with-pictures group outperformed the words-only group and picture-only group on a problem-solving test (Mayer & Anderson, 1991).
Mayer (1989) also investigated how novice learners learn vehicle braking systems by testing three conditions: labeled illustrations, illustrations without labels, and labels without illustrations. The results of the study indicated that the students with labeled illustrations of the braking systems performed better on both retention and transfer tests than other groups of students who used illustrations without labels or labels without illustrations. Mayer and Anderson (1992) obtained similar results when testing how students studied an animation describing an automobile braking system. The study indicated that the learners with concurrent oral narration outperformed other experimental groups on retention and transfer tests. It implied that instructive animation was most effective when the pictures and words were continuously presented in time and space.

Mayer, Bove, Bryman, Mars, and Tapangco (1996) studied how visual and verbal summaries should be designed to promote meaningful learning. Their study suggested three criteria for an effective multimedia summary: conciseness, coherence, and scientific coordination. In depicting the process of lightning storm development, a series of three experiments revealed that the learners were successful on retention and transfer tests when concise illustrations and sentences were continuously presented in cause-and-effect sequences. Mayer and Moreno (1998) extended the same research subject in another study. The students took part in a multimedia lesson on the formation of lighting and completed retention and transfer tests describing the major steps of how lightning storms develop. The study showed that the animation should be presented with auditory narration rather than with on-screen text. This is called a split-attention effect in multimedia learning.

Butcher (2006) conducted two experiments to investigate the effect of visual representations of the heart and circulatory system on learning. Three experimental conditions
were tested: 1) text-only, 2) text with simplified diagrams, and 3) text with more detailed diagrams. The important implication for the multimedia instruction is that visual representation supports cognitive processes such as inference generation without comprehension errors in general. Indeed, the simplified visual representation effectively promoted information integration and factual learning (Butcher 2006; Butcher, 2014b; Clark & Mayer, 2012).

**Multimedia Learning Principles**

Mayer and his proponents have developed research on the instructional effect of multimedia learning in a variety of disciplines for decades (Clark & Mayer, 2012; Clark & Mayer, 2016; Mayer, 2001; Mayer, 2016; Sorden, 2012; Tobia, Fletcher, & Bediou, 2014). The multimedia learning research indicates that people learn better when the instructional materials are presented with pictures, rather than the words alone. This is called the “multimedia learning principle” (Mayer, 2001, p. 63). The theoretical rationale behind this principle is that learners can build both verbal and pictorial mental models when words and pictures are presented together. It implies that learners perform better in this situation since they have the opportunity to connect both verbal and pictorial mental models when processing new information (Mayer, 2001). This synchronized multimodal representation helps learners build referential connections; the evidence on multimedia learning research has continuously confirmed that learners perform better with both visual (e.g., illustration or animations) and auditory (e.g., texts or narration) information than with verbal information alone (Mayer, 2001; Moreno & Durán, 2004; Yu, Lai, Tsai, & Chang, 2010).

Based on the science of instruction, evidence-based multimedia learning principles were developed by numerous multimedia learning researchers. In particular, Mayer (2009) identified the most distinctive twelve multimedia learning principles based on numerous empirical studies (Mayer, 2001; Mayer, 2009; Moreno & Mayer, 1999; Moreno, 2004; Sorden, 2012). The basic
twelve principles are presented numbered from one to twelve in Table 2-2. Three more principles, the “Guided discovery principle,” “Self-explanation principle,” and “Drawing principle,” were added in the current version of multimedia learning principles (Mayer, 2014c, p. 63). The initial twelve principles are closely involved in cognitive overload processing. They can be matched with the three instructional goals to reduce extraneous processing, to manage essential processing, and to foster generative processing (Mayer, 2001; Mayer, 2014c; Mayer & Moreno, 2003; Sorden, 2012). As shown in Table 2-2, the three goals are matched with corresponding multimedia principles.

Table 2-2. Three instructional goals in multimedia learning (Mayer, 2014c, p.63)

<table>
<thead>
<tr>
<th>Goal</th>
<th>Representative technique</th>
<th>Description of technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimize extraneous processing</td>
<td>1) Coherence principle</td>
<td>Eliminate extraneous material</td>
</tr>
<tr>
<td></td>
<td>2) Signaling principle</td>
<td>Highlight essential material</td>
</tr>
<tr>
<td></td>
<td>3) Redundancy principle</td>
<td>Do not add printed text to spoken text</td>
</tr>
<tr>
<td></td>
<td>4) Spatial contiguity principle</td>
<td>Place printed text near the corresponding graphic</td>
</tr>
<tr>
<td></td>
<td>5) Temporal principle</td>
<td>Present narration and corresponding graphics simultaneously</td>
</tr>
<tr>
<td>Manage essential processing</td>
<td>6) Segmenting principle</td>
<td>Break presentation into parts</td>
</tr>
<tr>
<td></td>
<td>7) Pre-training principle</td>
<td>Describe names and characteristics of key elements before the lesson</td>
</tr>
<tr>
<td></td>
<td>8) Modality principle</td>
<td>Use spoken word rather than printed text</td>
</tr>
<tr>
<td>Foster Generative processing</td>
<td>9) Multimedia principle</td>
<td>Use words and pictures rather than words alone</td>
</tr>
<tr>
<td></td>
<td>10) Personalization principle</td>
<td>Put words in a conversational style</td>
</tr>
<tr>
<td></td>
<td>11) Voice principle</td>
<td>Use a human voice for spoken words</td>
</tr>
<tr>
<td></td>
<td>12) Embodiment principle</td>
<td>Give on-screen characters humanlike gestures</td>
</tr>
<tr>
<td></td>
<td>13) Guided discovery principle</td>
<td>Provide hints and feedback as learner solves problems</td>
</tr>
<tr>
<td></td>
<td>14) Self-explanation principle</td>
<td>Ask learners to explain a lesson to themselves</td>
</tr>
<tr>
<td></td>
<td>15) Drawing principle</td>
<td>Ask learners to make drawings for the lesson</td>
</tr>
</tbody>
</table>

Mayer and Moreno (2003) proposed cognitive load reduction methods in connection with multimedia principles. For instance, coherence and signaling principles can be applied when extraneous materials exceed cognitive capacity. To promote effective cognitive processing, extraneous materials should be eliminated even when the instructional materials are visually
interesting or attractive. A cue (signal) can also be used to reduce processing of extraneous materials by providing the signaling for how to process the materials (Mayer & Moreno, 2003). While coherent and signaling principles are involved in one or both auditory and visual channels, segmenting and pre-training principles can be considered when both visual and auditory channels are overloaded by new information (Mayer & Moreno, 2003). In this overload scenario, the information should be segmented into bite-sized portions or a pre-training should be provided that uses names or characteristics to create a better knowledge transfer (Mayer & Moreno, 2003, p.47).

Researchers in many academic disciplines have developed different types of multimedia principles in addition to the initial twelve multimedia learning principles. Based on newly updated information, Mayer (2014c) found three more multimedia principles that foster generative processing: the “Guided discovery principle,” “Self-explanation principle,” and “Drawing principle” (p. 63). Moreno (2004) investigated the guided discovery principle, examining the role of verbal guidance in multimedia mathematic learning. A discovery-based multimedia math game with verbal guidance caused elementary school students to be more successful at mathematics than those of pure discovery methods. However, individual differences such as the needs of a novice learner should be considered when applying the discovery principle to different contexts since learning outcomes will vary depending on the learner’s prior knowledge.

Chi, Bassok, Lewis, Reimann, and Glaser (1989) analyzed the self-generated explanations for both “good” and “poor” students while they were studying mechanical problems. The study showed that the self-explanations enabled the students to monitor their understanding or misunderstanding accurately so that they could more successfully understand
the texts. Wylie and Chi (2014d) further examined the self-explanation principle in multimedia learning to know how to maximize students’ cognitive engagement. They stated that self-explanation is a constructive learning activity that encourages learners to generate inferences using learning materials. Thus, this activity promotes deep and powerful learning (p. 413-415).

Leutner and Schmeck (2014e) argued that drawing with reading texts promotes generative processing as the learners build a referential connection between verbal and visual information. The drawing principle indicates that the learners become actively engaged in “deep cognitive and metacognitive processing” that leads to a complete understanding of the knowledge to be learned (Leutner & Schmeck, 2014e, p. 433). They also reported that extraneous materials should be removed from the learning environment to maximize the positive drawing effects.

There are several boundary conditions of the multimedia principles (Mayer, 2009). These boundary conditions indicate that some multimedia principles or instructional methods may not be applied to some contexts or individuals. As Moreno (2004) and Leutner and Schmeck (2014e) reported, individual differences among prior knowledge, cognitive capacity, the complexity of materials, or pace of instruction may affect the effectiveness of the multimedia learning principles (De Jong, 2010; Sorden, 2012). This implies that there are no absolute rules for multimedia principles that always have to be followed. This is because the “cognitive theory of multimedia is dynamic,” and many researchers keep developing a variety of rules and principles of multimedia learning (Sorden, 2012, p. 10). Thus, the application of the multimedia principles depends on the research situations or instructional methods that need to be achieved (Sorden, 2012). The following multimedia principles are current multimedia principles summarized by Mayer (2014b).
Table 2-3. Various multimedia learning principles (Mayer, 2014b, p. 8-9)

<table>
<thead>
<tr>
<th>Multimedia Learning Principles</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Split-attention principle</td>
<td>People learn better when words and pictures are physically and temporally integrated</td>
</tr>
<tr>
<td>2. Spatial contiguity principle</td>
<td>People learn better when corresponding words and pictures are presented near rather than far from each other on the screen or page, or in time</td>
</tr>
<tr>
<td>3. Temporal contiguity principle</td>
<td>People learn better from graphics and narration than from graphics, narration, and on-screen text</td>
</tr>
<tr>
<td>4. Modality principle</td>
<td>People learn better from graphics and narration than from graphics and printed text</td>
</tr>
<tr>
<td>5. Redundancy principle</td>
<td>People learn better when the same information is not presented in more than one format</td>
</tr>
<tr>
<td>6. Signaling principle</td>
<td>People learn better when cues are added that highlight the key information and its organization</td>
</tr>
<tr>
<td>7. Coherence principle</td>
<td>People learn better when extraneous materials is excluded rather than included</td>
</tr>
<tr>
<td>8. Segmenting principle</td>
<td>People learn better when a multimedia message is presented in learner-paced segments rather than as a continuous unit</td>
</tr>
<tr>
<td>9. Pre-training principle</td>
<td>People learn better from multimedia message when they know the names and characteristics of the main concepts</td>
</tr>
<tr>
<td>10. Personalization principle</td>
<td>People learn better when the words of a multimedia presentation are in conversational style rather than formal style</td>
</tr>
<tr>
<td>11. Voice principle</td>
<td>People learn better when the words are spoken in a standard-accented human voice rather than a machine voice or foreign-accented human voice</td>
</tr>
<tr>
<td>12. Embodiment principle</td>
<td>People learn better when on-screen agents display humanlike gestures and movements</td>
</tr>
<tr>
<td>13. Image principle</td>
<td>People do not necessarily learn better when the speaker’s image is on the screen</td>
</tr>
<tr>
<td>14. Guided discovery principle</td>
<td>People learn better when guidance is incorporated into discovery-based multimedia environments</td>
</tr>
<tr>
<td>15. Work examples principle</td>
<td>People learn better when they receive worked examples in initial skill learning</td>
</tr>
<tr>
<td>16. Self-explanation principle</td>
<td>People learn better when they are encouraged to generate self-explanations during learning</td>
</tr>
<tr>
<td>17. Drawing principle</td>
<td>People learn better when they create drawings as they read explanatory text</td>
</tr>
<tr>
<td>18. Feedback principle</td>
<td>People learn better from multimedia lesson when they receive explanatory feedback on their performance</td>
</tr>
<tr>
<td>19. Multiple representation principle</td>
<td>There are circumstances under which people learn better from multiple representations</td>
</tr>
<tr>
<td>20. Learner control principle</td>
<td>People do not necessarily learn better when they have more control of the selection and organization of the material</td>
</tr>
<tr>
<td>21. Animation principle</td>
<td>People do not necessarily learn better from animation than from static diagrams</td>
</tr>
<tr>
<td>22. Collaboration principle</td>
<td>People learn better with collaboration online learning activities</td>
</tr>
<tr>
<td>23. Prior knowledge principle</td>
<td>Instructional design principles that enhance multimedia learning for novice may hinder multimedia learning for more expert learners</td>
</tr>
<tr>
<td>24. Working memory principle</td>
<td>The effectiveness of instructional design principle depends on the learner’s working memory capacity</td>
</tr>
</tbody>
</table>
In this study, the current multimedia learning principles suggested for e-learning and games were used not only to design web-based instruction, but also to analyze the educational music game. The multimedia principles relevant to the three instructional goals were aligned with both game and e-learning principles to identify the principles that support an effective cognitive learning process. Table 2-4 shows summarized multimedia principles that are relevant to the study (Clark, 2014a; Clark & Mayer, 2016; Fiorella & Mayer, 2015; Hattie, 2009; Karich Burns, & Maki, 2014; Mayer, 2014c; Mayer & Fiorella, 2014; Mayer & Pilegard, 2014; Johnson & Priest, 2014).

Table 2-4. Multimedia principles for a game, e-learning, and the three instructional goals

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Split attention principle</td>
<td>Clark (2014a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animation principle</td>
<td>Clark (2014a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intelligent principle</td>
<td>Clark (2014a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Segmenting principle</td>
<td>Clark (2014a), Clark &amp; Mayer (2016),</td>
<td>Mayer (2014c)</td>
<td></td>
</tr>
<tr>
<td>Learner control principle</td>
<td>Clark (2014a), Karich Burns, &amp; Maki (2014)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback principle</td>
<td>Hattie (2009), Johnson &amp; Priest (2014)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coherence principle</td>
<td>Clark (2014a), Clark &amp; Mayer (2016),</td>
<td>Mayer (2014c)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mayer &amp; Fiorella (2014)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As shown in Table 2-4, there are distinctive multimedia principles that satisfy the three instructional goals, e-learning, and games. The majority of researchers shown in Table 2-4 agree that the “Modality principle,” “Personalization principle,” and “Pre-training Principle” should be considered when designing game-based online instruction. According to the researchers above, web-based instruction should apply the following principles to promote students’ learning: the 1) “Multimedia principle,” 2) “Signaling principle,” 3) “Modality principle,” 4) “Redundancy principle,” 5) “Segmenting principle,” 6) “Personalization principle,” 7) “Coherence principle,” 8) “Contiguity principle,” 9) “Embodiment principle,” and 10) “Pre-training principle.” Again, these principles are not absolute rules required for designing web-based instruction in general. However, it is worth identifying the appropriate principles based on researchers’ suggestions. The ten multimedia principles were used to design, develop, and analyze both the web-based and game-based online instruction in this study.
The ARCS model provides strategies that can be used to improve motivational instruction. It incorporates “a systematic design process” known as motivational design (Keller, 1987, p. 2; Richey et al., 2011). Keller (1987) defined the ARCS model as “a method for improving the motivation appeal of instructional materials” (p. 2). It is a systematic problem-solving approach used not only to identify problems with learning motivation, but also to design motivational learning environments (Keller, 1984; Keller, 1987; Keller, 2010). Keller’s motivational design model looks similar to the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model in the general system model of ID (Instructional Design). This is because it includes the same components found in the most general system model of ID: define, design, develop, and evaluate (Keller, 1987, p. 3; Richey et al., 2011, p. 122). However, the model does not follow all features and characteristics of the general system model of ID since Keller developed the ARCS model to overcome the common problems of the general system model of ID, which is too systematic and offers insipid instructional materials (Dick, Carey, & Carey, 2009). The ARCS model is grounded in Tolman’s and Lewin’s expectancy-value theory in addition to the macro theory of motivation, motivational instructional design, and the expectancy-value theory (Keller, 1987; Keller, 2010). Two important categories such as aspects and expectancy aspects form the original ARCS model. The two categories were further expanded as four categories after field tests, which has become the current ARCS model (Keller, 1987).

The ARCS model defines the four basic human characteristics that stimulate and sustain learning (Keller, 2010; Rodgers & Withrow-Thorton, 2005). As shown in Table 2-5, the four different conceptual categories are: Attention, Relevance, Confidence, and Satisfaction. Attention is the first step of the learning as a prerequisite, which implies that the learner must be
interested and curious about what they are learning, and their attentions sustained throughout the instruction (Keller, 1987; Keller, 2010; Richey et al., 2011). To sustain a learner’s attention, it is critical to “find a balance between boredom and indifference versus hyperactivity and anxiety” (Keller, 1987, p. 3). The relevance illustrates that personal needs and satisfactions are important factors so that the instructional materials, learning goals, and learning situations must be matched with the factors. Learners will perceive the relevance of the instruction when the learning materials properly reflect their personal needs and satisfactions (Keller, 1987; Keller, 2010; Richey et al., 2011). Appropriate expectations about the subject matter and other learning situations are emphasized in the third category, which indicates that confidence will affect the learner’s achievement and persistence. For example, the lesson should be given a reasonable amount of time and effort so that the learner can succeed (Keller, 1987; Richey et al., 2011). The fourth category encompasses the intrinsic and extrinsic rewards from the instruction. Keller (1987) argued that extrinsic motivation and “contingencies without overcontrolling” (p. 6) should be appropriately used to stimulate and encourage a learner’s intrinsic satisfaction. In the same manner, Becker (2008), Pittman and Boggiano (1992), and Toprac (2008) stated that increasing a learner’s intrinsic motivation potentially promotes deeper personal engagement and learning than those of extrinsic motivation. In other words, the learners must receive appropriate intrinsic and extrinsic rewards to help them feel good and accomplished about their achievements.
Table 2-5. The four main components of the ARCS Model

<table>
<thead>
<tr>
<th>Major Categories and Definitions</th>
<th>Process Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attention</strong></td>
<td>Capturing the interest of learners; stimulating the curiosity to learn</td>
</tr>
<tr>
<td><strong>Relevance</strong></td>
<td>Meeting the personal needs/goals of the learner to effect a positive attitude</td>
</tr>
<tr>
<td><strong>Confidence</strong></td>
<td>Helping the learners believe/feel that they will succeed and control their success</td>
</tr>
<tr>
<td><strong>Satisfaction</strong></td>
<td>Reinforcing accomplishments with rewards (internal and external)</td>
</tr>
</tbody>
</table>

Note. ARCS Model Categories, Definitions, and Process Questions (Keller, 2010, p. 45)

The Course Interest Survey (CIS) and the IMMS are different types of instruments used in the ARCS model. While the IMMS is used for self-directed learning materials, the CIS is specially designed for instructor-led settings either face-to-face or virtual (Keller, 2010). To evaluate motivation along with instructional materials, the IMMS is specifically used to measure only “state motivation,” which is “a temporary condition that affects the level of concentration and attention toward an assigned task” (Rodgers & Withrow-Thorton, 2005, p. 334). Since the IMMS was made based on K-12 settings, some research has suggested that the IMMS should be moderately modified, especially when measuring adult learners’ motivation. Also, its situational features may generate unexpected outcomes in the study unless it is used carefully. For example, Huang, Huang, Diefes-Dux, and Imbrie (2006) suggested that the IMMS should not only be evaluated before adopting it into research, but also modified depending on specific research settings. Huang et al. (2006) examined a total of 875 undergraduates in a 1st year engineering course to measure whether the IMMS was valid as a motivational evaluation instrument. The research participants had the slightly modified IMMS, and the data were analyzed by using
exploratory and confirmatory factor analyses. The results of the study reported that the original IMMS should have been modified before adopting it into research, based on learners’ characteristics and instructional features. It implied that the results of the survey might vary depending on the students’ characteristics, previous knowledge and experience, and instructional program features since the IMMS is situational and the characteristics of the environment where it is implemented are dynamic. For instance, while other student groups may feel pressure or be unhappy about computer-based learning materials, engineering students might be satisfied with computer-based tutorials and feel confident about using them since they are already knowledgeable about the learning materials.

Researchers have modified and customized the IMMS based on the nature of their research subjects. Rodgers and Withrow-Thorton (2005) modified the IMMS to investigate adult learners’ motivation in the workplace to cover a broad range of instructional format without being limited to just instructional materials. Dempsey and Johnson (1998) and Dempsey et al., (2002) also stated that instructional designers and game researchers have modified the IMMS to measure the components and degree of motivation for interactive instructional settings such as educational gaming. In particular, Dempsey and Johnson (1998) examined 40 adults aged 18-52 participating in the research playing five selected games for a two-year period to investigate the ARCS Gaming Scale, a modified version of the IMMS for games. The results of the study showed that there were some limits for using the ARCS Gaming Scale in the ARCS components, especially attention or interest (Dempsey & Johnson, 1998; Dempsey et al., 2002). They reported that the IMMS needs to be carefully modified and selected based on the characteristics of the research and appropriate research methods since it is difficult to measure and control the state of motivation in nature (Dempsey & Johnson, 1998; Dempsey, et al., 2002). For example, due to
correlated items across the scales and subscales, exploratory factor analysis might not have been a proper quantitative method for analyzing the ARCS model (Dempsey & Johnson, 1998). In other words, factor analysis is inappropriate for some components and subcomponents of the ARCS model (Dempsey & Johnson, 1998).

The ARCS model has been adopted as a sound educational principle for designing instruction rather than limited to a measurement of motivation. Several educational game designers have used the ARCS model because it can be easily incorporated with game mechanics and structures. Gunter, Kenny, and Vick (2006) argued that game design features should include well-established learning theories, suggesting Gagné’s Nine Events of Instruction and Keller’s ARCS model for serious game design. As shown in Figure 2-1, the ARCS model can be used with Gagné’s Nine Events of Instruction and Bloom’s scaffolding principle.

<table>
<thead>
<tr>
<th><strong>Gagné’s Nine Events</strong></th>
<th><strong>Keller’s ARCS Model</strong></th>
<th><strong>Common Game Elements</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain Attention</td>
<td>Attention</td>
<td>Scenario exposition</td>
</tr>
<tr>
<td>Inform of Objectives</td>
<td></td>
<td>Problem Setup</td>
</tr>
<tr>
<td>Stimulate Recall</td>
<td>Relevance</td>
<td><em>No existing game analog</em></td>
</tr>
<tr>
<td>Present Stimulus/Lesson</td>
<td></td>
<td>Offer Challenge / Choice</td>
</tr>
<tr>
<td>Provide Learner Guidance</td>
<td>Confidence/Challenge</td>
<td>Provide Direction</td>
</tr>
<tr>
<td>Elicit Performance</td>
<td></td>
<td>Elicit Action / Decision</td>
</tr>
<tr>
<td>Provide Feedback</td>
<td>Satisfaction/ Success</td>
<td>Discernable Outcome</td>
</tr>
<tr>
<td>Assess Performance</td>
<td></td>
<td>Success / Failure screens</td>
</tr>
<tr>
<td>Retention and Transfer</td>
<td></td>
<td><em>No existing game analog</em></td>
</tr>
</tbody>
</table>

Figure 2-1. Gagné’s Events of Instruction, Keller’s ARCS Model, and common game design elements (Gunter, Kenny, & Vick, 2006, p. 12)
Gunter et al. (2006) criticized that popular commercial games are often inappropriate for formal education since well-established popular video games are successful at engaging players but unsuccessful at helping students achieve educational goals. They proposed that educational game design should include both educational effectiveness and engagement as powerful educational tools. They proposed Gagné’s Nine Events of Instruction, Keller’s ARCS model, and Bloom’s scaffolding principle as three sound educational principles that can be adequately and formally incorporated with games (Gunter et al., 2006; Becker, 2008). Gunter et al. (2006) stated that these theories are suitable with game design, in that Keller’s ARCS model can be applied to game design events or encounters. Gagné’s Nine Events naturally includes basic instructional principles that are similar to video game structure, and Bloom's scaffolding principle can be beneficial for enhancing retention and transferring knowledge and experience in the game context.

The ARCS model has been used in a variety of computer tutoring settings such as distance education and online learning. Empirical research has applied the ARCS model and the IMMS in many research areas. Rodgers and Withrow-Thorton (2005) used a modified ARCS model not only to evaluate the motivation of 96 adult students in the workplace, but also to compare three different instructional formats. The example format includes lecture, video, and interactive computer-based instruction (Rodgers & Withrow-Thorton, 2005). According to the study, computer-based instruction is the most effective instructional format, stimulating the students’ motivation more than either video or lecture.

Huang et al. (2010) investigated a total of 264 undergraduates to examine the relationship between motivational processing and outcome processing in an online game. The participants were surveyed after playing the online game Trade Ruler. Regression analysis was used in the
study after data were collected using the IMMS. The results of the study showed that there was a distinctive model between motivational processing (Attention, Relevance, and Confidence) and outcome processing (Satisfaction). Both processes are needed for designing digital game-based learning. The study showed the IMMS could be used for the achievement of the proposed research questions involved in motivational processing (Attention, Relevance, and Confidence) and outcome processing (Satisfaction).

Kebritchi et al. (2010) investigated a total of 193 Algebra and Pre-Algebra high school students and ten teachers to examine the effect of an educational game on mathematics achievement and motivation by using the IMMS when considering prior knowledge and skills about mathematics, computers, and the English language. To test motivation toward the educational game, the IMMS was used to indicate the effectiveness of the game. In the study, playing games both in classrooms and school labs was better at motivating students than playing the games only in the school lab, even though there were no significant improvements in the motivation group. While prior knowledge, computer, and language skills did not impact achievement and motivation, the researchers were able to pose intriguing questions and discussions based on the data collected from the ARCS model.

Proske et al. (2014) conducted a study of 175 university students to investigate how computer game-based writing strategy training improves learner motivation. It examined four different practice conditions: computer game-based, question-based, model-based, and writing-based practice. The IMMS was used to evaluate four different groups of students who practiced writing after completing writing strategy instruction and tested students’ motivation toward four different learning conditions. The computer game-based practice was more motivating and engaging than the question-based practice. Interestingly, students were distinctively affected by
only the model-based and question-based practices to perform the writing strategies (Proske et al., 2014, p. 481). The ARCS model provided structural proposed research questions that identified the effects of different types of writing strategies on students’ motivation.

**Conceptual Framework**

The game-based online learning environment is a unique instructional environment. The critical question raised in academia is precisely how people learn with games since learning involves many definitions, strategies, processes, and developments. Sawyer (2006) criticized common sense assumptions about knowledge that most schools practice, citing that the assumptions lack scientific evidence about how people learn. Several views regarding knowledge and beliefs can be identified in educational research. While empiricism considers that knowledge comes from experience, rationalism defines reason as the primary source of knowledge (Johnson & Christensen, 2008, p. 14-15). Importantly, positivism is “the idea that only what we can empirically observe is important and that science is the only true source of knowledge” (Johnson & Christensen, 2008, p. 391). This research aligns with positivism in its conception of knowledge and beliefs about learning. In particular, when we talk about learning in terms of what we have learned as well as what makes us learn, motivation and achievement (learning outcomes) become central. If these research subjects are vital for discussing the game-based online learning environment, what would be the best theories to explain how people learn with games in a specific learning context? What should we consider in technologically complex online learning environments that would make a better educational venue for learning?

The Cognitive Theory of Multimedia Learning (CTML) and John Keller’s ARCS model were addressed in the study to support the theoretical rationales of how people learn with games and what motivates people to learn in a specific learning context. Based on the cognitive science principles of learning, the cognitive theory of multimedia learning not only supports the basic
question of how people process new information from multimedia instruction (e.g., the dual-channel assumption), but also explicates how to generate cognitively active learning processes (e.g., the active process assumption) in managing the limited cognitive capacity of the human (e.g., limited-capacity assumption).

To identify learners’ motivation toward instructional media such as web-based and game-based online instruction, John Keller’s ARCS model was used to measure the effectiveness of multimedia learning materials. John Keller’s ARCS model defines the four basic human characteristics stimulating and sustaining people to learn (Keller, 2010; Rodgers & Withrow-Thorton, 2005). The major dimensions of human motivation can be generally viewed through the four components (Attention, Relevance, Confidence, and Satisfaction) of the ARCS model (Keller, 2010). In particular, the ARCS model has been widely used by researchers and academic communities to analyze how learners were attended to, the relevance of the media to the learners, learners’ confidence, and learners’ satisfaction with the instructional media (Huang et al., 2006; Keller, 2010; Rodgers & Withrow-Thorton, 2005). It considers an effective research instrument for evaluating the motivational attitudes of undergraduate students who are attending a particular self-directed course such as game-based or web-based online music instruction (Keller, 2010, p. 277). Figure 2-2 illustrates the focus and purpose of the study.

Figure 2-2. Two different forms of online instruction in a music appreciation course
Cognitive Theory of Multimedia Learning

The cognitive theory of multimedia learning is largely defined by Mayer (Mayer, 2001; Mayer, 2009; Mayer, 2014a; Mayer, 2014b; Mayer, 2014c; Mayer & Moreno, 2003; Moreno, 2004; Sorden, 2012). It is a fundamental hypothesis about how multimedia instructional messages should be designed or processed based on how the human mind works (Mayer, 2014c; Mayer & Moreno, 2003). The cognitive theory of multimedia learning is composed of three assumptions: 1) the dual-channel assumption, 2) the limited-capacity assumption, and 3) the active process assumption (Mayer, 2015c, p. 52). The dual-channel assumption is grounded in Paivio’s (1986) dual coding theory, indicating that the human information processing system possesses separate channels for visual and auditory information. Psychophysicists and psychologists consider that our auditory and visual systems have separate functions and behavior. However, cognitive psychologists have assumed that a confluence of auditory and visual information occurs in the brain (Shepard & Levitin, 2002). How does this confluence occur? Can we perceive different visual images from ears instead of eyes? For example, there is size constancy when an object comes closer or farther away from the eyes (Shepard & Levitin, 2002). Similarly, loudness constancy creates the same effect in our ears; the intensity and amplitude of a sound make different sound perceptions in our brain. When the sound sources are close, the intensity of the sound increases; however, it decreases if the sound sources move farther away (Shepard & Levitin, 2002). The different time arrivals of the sound create similar visual perceptions in our brain. For example, we roughly perceive the size of a room even if we close our eyes since we hear different sound reflections and echoes from the room. A big empty room makes unique sound echoes so that we generally sense the size of the room. Different timbre, pitches, and tone colors also create dynamic sound perceptions, enabling humans to perceive different colors from the world (Radocy & Boyle, 2003). This example provides a
different scientific viewpoint on how our auditory and visual systems are naturally connected and working together simultaneously. Yu, Lai, Tsai, and Chang’s (2010) study examined the effects of multimodality on primary school students. When music (auditory information) and notations (visual information) were presented simultaneously, the students performed better on music appreciation learning as they could construct a referential connection between the two channels.

According to Baddeley’s (1992) model of working memory, people process only small amounts of information in each channel, and the information is very transient in the system. Each channel has a limited capacity for information processing so that extraneous information exceeding the capacity limits hinders learners from the deep learning process. Learners can hold visual or sound images in the channel of working memory during a short period of time (Mayer, 2014c). For instance, humans are unable to remember 2000 words from a textbook with only five minutes of preparation. The majority of learners work on learning the words by making a continuous effort to remember them. However, cognitive learning techniques such as chunking, segmenting, or grouping the unfamiliar information help the learners to manage their limited working memory span when they practice the words (Mayer, 2014c).

Figure 2-3. Cognitive theory of multimedia (Mayer, 2014c, p. 52)
On the other hand, when people engage in active learning processing, meaningful learning occurs by “attending to relevant incoming information, organizing selected information into coherent mental representations, and integrating mental representation with other knowledge” (Mayer, 2014c, p. 47). Moreno and Durán (2004) reported relevant research findings about active learning. In their study, the students, who were actively engaged in a cognitively active learning process, performed better on transfer and retention tests. The learners were actively organizing and integrating knowledge while playing a discovery-based multimedia mathematics game.

These three assumptions imply not only how multimedia learning environments should be designed, but also how games should be used in online learning environments to promote meaningful learning through active cognitive processing. Mayer (2014a) argued that understanding the way humans process information can help demonstrate how games can be used for learning. For example, humans’ memory system has distinctive features regarding information processing. While our working memory has a limited capacity to process vast information, sensory and long-term memory have an unlimited capacity to receive and store knowledge and information (Mayer, 2014c). Thus, a significant implication for learning with games is to create effective learning materials that draw on what we know about the human information processing system.

Critical issues in game-based learning environments are that it can easily overload learners’ working memory with numerous multimedia learning materials (Mayer, 2014a). Instructional designers or game designers need to be aware of learners’ cognitive process when designing a multimedia learning environment with games. For example, extraneous materials that may interrupt learners’ cognitive learning process should be removed from games. Further,
designers should incorporate cognitive processes such as selecting, organizing, and integrating learning materials into the games to engage learners in meaningful learning.

**Multimedia Learning for Game-based Online Instruction**

The game-based online learning environment is a new and alternative context for evidence-based multimedia learning research (Clark, 2014a; Clark & Mayer, 2016; Mayer, 2014b; Tobia, Fletcher, & Bediou, 2014). While educational computer games have the potential to foster learners’ motivation and achievement, game design should be consistent with the cognitive theory of multimedia learning theory that reflects how people learn as well as provides empirical evidence regarding what gaming features would work (Clark & Mayer, 2016; Mayer, 2011, Mayer, 2014b; Moreno & Durán, 2004; Tobia, Fletcher, & Bediou, 2014). Most of all, three cognitive processes are crucial for meaningful learning as well as designing effective game features: extraneous, essential, and generative processing (Clark & Mayer, 2016; Mayer, 2011, Mayer, 2014b; Moreno & Durán, 2004). How to apply game features is well explained in the three cognitive learning conditions. First, extraneous processing is not directly related to instructional goals or objectives. It is usually caused by poor instructional design, indicating that extraneous multimedia learning materials or gaming features should be eliminated from the educational game (Clark & Mayer, 2016; Mayer, 2011; Mayer, 2014b; Mayer & Moreno, 2003). For instance, irrelevant pictures or audio recordings need to be removed to promote meaningful learning. The crucial implications of game-based online music instruction are that extraneous audio materials such as unnecessary sound effects with vast music files should be deleted or reorganized to avoid overloading learners’ auditory channel. In the case of non-music majors, extraneous information diminishes learners’ motivation and achievement.

Essential processing occurs when the essential learning materials are presented in working memory. Since working memory capacity is limited, complex learning materials in the
game should be reorganized and relevant learning materials selected to further foster generative processing (Clark & Mayer, 2016; Mayer, 2011; Mayer, 2014b; Mayer & Moreno, 2003). For instance, music instructors should reconsider organizing and selecting audio learning materials in a way that non-music majors can easily understand new information in the online learning environment. Once all learning materials are corrected and make sense to the learners, they can enter generative cognitive processing. Learners in the cognitive learning stage can organize and integrate new information with their prior knowledge (Clark & Mayer, 2016; Mayer, 2011; Mayer, 2014b; Mayer & Moreno, 2003).

Mayer (2014a) proposed three genres of game research (2014a): value-added, cognitive consequences, and media comparison research. In the value-added research approach, Mayer and his colleagues outlined seven imperative multimedia principles: 1) the modality principle, 2) the personalization principle, 3) the redundancy principle, 4) the image principle, 5) the pre-training principle, coaching principle, 6) the self-explanation principle, and 7) the immersion principle. Interestingly, the modality principle ($ES = 1.4$, 9 of 9 studies) and the personalization principle ($ES = 1.5$, 8 of 8 studies) were highly effective game features for promoting learning (Moreno & Mayer, 2002; Moreno, Mayer, Spires, & Lester, 2001).

In cognitive consequences research, various cognitive skills (e.g., perceptual attention, 2D mental rotation) were tested using a first person shooter game, spatial puzzle game, real-time strategy game, and brain training game. The research revealed that the first person shooter game (e.g., Unreal Tournament) and the spatial puzzle game (e.g., Tetris) improved cognitive skills (Sims & Mayer, 2002). The first person shooter game stimulated learners’ perceptual attention ($ES = 1.2$, in 18 studies) and the spatial puzzle game improved 2D mental rotation ($ES = .8$, in six studies).
To test the effect of media on student learning, games and conventional media were compared to investigate which would be better for student learning (Moreno et al., 2001; Adams, Mayer, MacNamara, Koening, & Wainess, 2012). Three types of research conditions were tested by comparing different media: 1) Game vs. Online lesson, 2) Game 1 vs. Slideshow, and 3) Game 2 vs. Slideshow. The studies showed that students learned better from games (e.g., Design-a-Plant) than the online lesson. However, Adams, Mayer, MacNamara, Koening, and Wainess (2012) found that the student did not learn better from games than slideshows. In media comparison research, various content areas such as science, second language, mathematics, language arts, and social studies were tested. According to Mayer (2014a), games were effective in the fields of science (ES = .7) and second language (ES = 1.0).

As shown in the current evidence-based research guided by Mayer (2014a), there is little gaming research in the field of the arts and music. Therefore, this research may provide some modest contributions to future gaming research by extending the evidence-based research to a new context.
CHAPTER 3
METHODOLOGY

Research Design

Experimental design

The experimental design was the primary research design used in the study. The experiment is the most powerful research method within quantitative research methods not only because it establishes the cause-and-effect between independent and dependent variables, but also because it controls all variables that might affect the outcomes while keeping the others constant (Gall, Gall, & Borg, 2003; Creswell, 2005; Johnson & Christensen, 2008). Most of all, a true experimental design was selected to complete the research experiment. It is considered the strongest experimental design since it controls many types of threats to internal validity such as history, maturation, regression, selection, and mortality (Creswell, 2005, 2009; Johnson & Christensen, 2008). The main focus of a true experimental design is to equate different groups through random assignment (Creswell, 2005, 2009; Gall, Gall, & Borg, 2003; Johnson & Christensen, 2008). In this research, the pretest-posttest control-group design was conducted by randomly assigning a group of research participants to an experimental or a control group. The two groups were administered both a pretest and posttest, but only the control group received a treatment (Creswell, 2005, 2009; Gall, Gall, & Borg, 2003; Johnson & Christensen, 2008). Throughout the experimental control, all extraneous variables that could not be eliminated, such as prior knowledge, were controlled by equating all the differences of the extraneous variables. To maximize the experimental control, random assignment was conducted at the beginning of the research experiment. Random assignment is “a procedure that makes assignments to conditions on the basis of chance” (Johnson & Christensen, 2008, p. 297). It maximizes the probability that equates the different groups on all extraneous variables (Creswell, 2005, 2009;
Gall, Gall, & Borg, 2003; Johnson & Christensen, 2008). In the research, the process of random assignment was established to assign 132 research participants at random to two different groups (Figure 3-1). The simple random assignment was conducted by randomly distributing a card to each participant; a group of sixty-six students was randomly assigned to a treatment (game-based online instruction) or control group (web-based online instruction).

Figure 3-1. Random assignment

This procedure made the two experiment conditions equivalent and comparative by equally distributing existing variables between the two groups such as different music education levels or nationality. To control potential variables from different learning environments, the research experiment was set up with a laboratory experiment, where all the confounding variables from different environments were removed or controlled. This procedure was initially set up to eliminate the ecological variables that influence outcomes. For instance, the research experiment was conducted in the same laboratory, and the 132 participants used the same computers and headphones.
Sampling strategy

The main sampling technique was convenience sampling, and the sampling unit was a college student. To determine a proper sample size for the research, a power analysis was conducted (Cohen, 1988; Leon, Davis, & Kraemer, 2011). In general, a larger sample size generates more power (Creswell, 2005; Johnson & Christensen, 2008; Gall, Gall, & Borg, 2003; Gravetter & Wallnau, 2008). However, it is important to select an appropriate sample size at the beginning of the study. This is because not all large sample sizes increase the power (Johnson & Christensen, 2008), and sometimes a large sample size may be inappropriate for specific research situations, especially when having time constraints.

To calculate the sample size, the alpha (α) was set at .05, and the power was set as .8. Selecting $\alpha = .05$ and Power $= .8$ is commonly used in many research situations. Importantly, the power should be at least .8 to reject the null hypothesis. When $\alpha = .05$, Power $= .8$, and a large effect size ($f^2 = .40$) were applied, a total estimated sample size for the study was approximately 66. Based on the estimated sample size, the researcher selected 133 university students with various majors in the arts, sciences, engineering, and other social science programs. Each student was asked to choose one card from a stack of cards numbered from 1 to 100 before starting their research experiment session. A total of 133 students were randomly assigned to a treatment condition; the 67 students who selected even numbers were assigned to the web-based online instruction, and the 66 other students who chose odd numbers were assigned to the game-based online instruction.

Participants

The target research population was focused on university students in the Southeastern United States. The researcher selected undergraduates who were enrolled in various academic courses at a Southeastern public university from the Spring to Summer 2017 semesters. The
participants were recruited without specific exclusions on gender, ethnicity, or major. All participants were over 18 years old, so no permission was required from their parents or guardians. Previous knowledge and experience of music performance or prerequisite courses were not required for students to participate in the study. The online music instruction embedded into the online interventions was designed for non-music majors who were novices in the field of music. Also, prior gaming experience or skills were not required for the game-based music instruction in the online intervention.

The participants were not only recruited from various academic courses, but they also enlisted themselves as volunteers for the research study. The researcher visited classrooms by contacting the instructors or administrators of the courses and directly signed up students on the campus. All participants voluntarily entered the study and were informed of their compensation for participating. The students were rewarded with 1% extra credit as a part of their course; however, it was the instructors’ decision to provide the compensation. After confirming their participation via email, the participants were invited to a computer lab for the research experiment.

A total of ten participants took part in the field test. The main purpose of the field test was not only to improve the initial online intervention before the actual experiment, but also to increase the reliability and validity of the data by eliminating unexpected mistakes or redundancies in advance. Ten participants in the field test were split into two groups. Each group was asked to complete their online intervention comprised of a demographic survey, pretest, online instruction (a traditional web-based or game-based instruction), posttest, and the IMMS questionnaire. After the online intervention, the participants joined a focus group discussion. They were specifically asked to evaluate the online intervention based on 17 questions regarding
the instructional design, instruments, and online learning environment. They freely shared their feedback with others in the group after completing the online intervention.

For the research experiment, a total of 216 students were newly recruited after the field test. Of these, 133 students participated in the research experiment; 83 students missed their experiment sessions even though they had signed up for the sessions. The participants in the experiment were split into two groups and were provided a demographic survey, pretests, online instruction, posttests, and the IMMS survey. After the research experiment, one mortality was found in the raw data. One female student completed only 71% of her online intervention, so the incomplete data was excluded from the final data analysis. She was a senior international student categorized as Asian/Pacific Islander between 21 to 25 years old, and she expressed herself as a beginner in music education with less confidence about browsing the Internet from her computer or mobile phone. To minimize potential threats to internal validity such as compensatory or resentful demoralization, the researcher provided the students in the control group with the same treatment (the educational music game) that the treatment group had tried. They received a link to the game that was used in the game-based online intervention after the experiment.

Materials

The research materials used in this study were educational games in the online intervention, redesigned learning materials derived from the games, and other miscellaneous materials such as an electronic introduction sheet for online instruction and audio and visual materials. In addition, two instruments, the electronic pretest/posttest questionnaire and an electronic survey questionnaire (the IMMS survey) were included as parts of the online intervention. While the electronic survey questionnaire (the IMMS survey) was retrieved from John Keller’s 36 original questions in the IMMS survey, the researcher specifically designed the electronic pretest and posttest questionnaire, which were evaluated by subject matter experts.
The Carnegie Hall Listening Adventures®, a program supported by the U.S. Department of Education, has released the educational music game, *The Young Person’s Guide to the Orchestra®*. It was designed by music educators in the Weil Music Institute at Carnegie Hall in collaboration with an interactive media company, Rolling Orange, Inc. They created the music game to support teachers in monitoring the learning progress of their students through an interactive gaming experience. The story of this adventure game is based on Benjamin Britten’s *The Young Person’s Guide to the Orchestra*, a famous orchestral music piece which is often performed in public. The structure and organization of the game are similar to Britten’s musical piece. The game is comprised of six different learning subjects: 1) Benjamin Britten, 2) The Orchestra, 3) The Woodwind family, 4) The Brass Family, 5) The String Family, and 6) The Percussion Family. Figure 3-2 shows the game’s Table of Contents.

Figure 3-2. The Table of Contents

The game is about a young girl who learns a variety of musical instruments while exploring musical safari adventures. A total of 24 musical instruments to be learned were displayed in the game. In the study, only the first two instrument families were selected for
developing the online interventions. Two online interventions were developed based on this research plan. Four learning modules and relevant materials associated with each module were redesigned in the web-based online intervention:

- Module 1: Benjamin Britten
- Module 2: The Orchestra
- Module 3: The Woodwind Family
- Module 4: The String Family

To prevent potential extra confounding variables, the same texts, audio/visual images, and animations used in the game were imported into the web-based online intervention. The same audio played on the game site was extracted and embedded into the Qualtrics® system. The visual images were captured and rearranged with appropriate learning objects (Figure 3-3).
Each animation appearing in the game was also captured using a screen capture software program, Camtasia® (Figure 3-4).

![Example 2. Pitch Ranges of Woodwinds](image)

Figure 3-4. A captured animation from the game

Additional materials in each exercise section were inserted at the end of each module. The texts or images in the exercise section were not extracted from the game; the equivalent learning materials were selected from other online resources and rearranged by the researcher (Figure 3-5).

![Exercise](image)

Figure 3-5. Exercise in web-based instruction
The same online intervention formats were used for the game-based online intervention. However, the participants learned music directly through the game link embedded into the Qualtrics® platform (Figure 3-6). The closed-ended questionnaires (pretest and posttest) were uploaded before and after the online instruction (Figure 3-7). The IMMS was displayed immediately following the posttest.

Figure 3-6. Game Link

Figure 3-7. The closed-ended questionnaire
Instruments

Two instruments were used to answer the research questions: the Instructional Materials Motivation Survey (IMMS) and an achievement questionnaire. The researcher developed the achievement questionnaire, testing reliability and validity before the research experiment. Quantitative data were obtained using the IMMS questionnaire derived from Keller’s ARCS model, which has been widely applied by researchers and academic communities for measuring learner motivation toward instructional media (Choi & Johnson, 2005; Keller, 2010; Huang et al., 2006; Rodgers & Withrow-Thorton, 2005).

Instructional Materials Motivation Survey (IMMS)

Selecting the IMMS as an instrument was appropriate for achieving the proposed research questions as it was used to measure the effectiveness of the learning materials based on students’ IMMS motivation scores. To test reliability, Keller’s IMMS was administered to 90 undergraduate students, and the internal consistency estimates were satisfactory (Keller, 2010). The original IMMS internal consistency estimates based on Cronbach’s alpha were: Attention (.89), Relevance (.81), Confidence (.90), Satisfaction (.92), and Total Scale (.96). The IMMS internal consistency estimations of the research administered to 132 undergraduate students were: Attention (.85), Relevance (.76), Confidence (.76), Satisfaction (.93), and Total Scale (.92). The original IMMS questionnaire designed by Keller was not modified in the research since it was also tested on undergraduate students, who were the same age group and education level as the research participants.

A Closed-Ended Questionnaire: A Pretest and Posttest

Twenty closed-ended questions were developed by the researcher to measure students’ prior knowledge and achievement toward music appreciation learning. It was based on specific learning subjects regarding a classical music orchestra, and all students took the test before and
after completing their online modules. The scales of the measurement used for the achievement test were nominal scales (or categorical scales), where the participants checked one correct answer or category that described specific knowledge, information, or characteristics. An example of the close-ended questionnaire was as follows (Figure 3-8):

Arrange these string instruments from the smallest (highest pitches) to the largest (lowest pitches).

- Viola - Cello - Violin - Double Bass
- Violin - Viola - Cello - Double Bass
- Cello - Viola - Violin - Double Bass
- Double Bass - Cello - Violin - Viola
- Double Bass - Violin - Viola - Cello

Figure 3-8. An example of a close-ended question measuring student’s achievement

Lawshe’s (1975) content validity ratio (CVR) was used to measure whether each question in the close-ended questionnaire accurately represented all learning objectives of the online instructions. According to Wilson, Pan, and Schumsky (2012), the Lawshe’s CVR is “one of the earliest and most widely used methods for quantifying content validity” (p. 197). It has been used in many academic fields such as medical education, nurse education, science education, general education, and business. The CVR methodology can be applied to evaluate the content validity of various educational assessment tools (e.g., checklists, training manuals, or interview questionnaires).

In the study, the Lawshe’s CVR was used to measure the content validity of the close-ended questionnaire. Five subject matter experts (SMEs) assessed each closed-ended question based on 3-points scales, which were adopted from the CRV methodology: 1) “Essential,” 2) “Useful, but not essential,” and 3) “Not necessary” (Lawshe, 1975, p. 567). The five subject
matter experts were professionals who had taught undergraduate music courses for many years (Table 3-1).

### Table 3-1. The five Subject matter experts

<table>
<thead>
<tr>
<th>SMEs</th>
<th>Position</th>
<th>Areas of expertise</th>
<th>Music courses taught</th>
</tr>
</thead>
</table>
| Music Expert 1 | A college professor/orchestra conductor | 1) Orchestra/conducting  
2) General knowledge about all instruments played in orchestra | Orchestra & conducting music courses for both undergraduates and graduates |
| Music Expert 2 | A college professor/woodwind player | 1) Woodwind instruments  
2) General knowledge about all instruments played in orchestra | Woodwind music courses for both undergraduates and graduates - Music history/theory |
| Music Expert 3 | A college professor/percussion player | 1) Percussion instruments  
2) General knowledge about all instruments played in orchestra | Music appreciation courses for undergraduates - Percussion music courses for both undergraduates and graduates |
| Music Expert 4 | A college lecturer/violin player | 1) String instruments  
2) General knowledge about all instruments played in orchestra | String instrument music courses for non-music majors - Music theory/history |
| Music Expert 5 | A college lecturer/composer | 1) Composition for orchestral music  
2) General knowledge about all instruments played in orchestra | Music appreciation courses for undergraduates - Music theory /composition courses |

Lawshe (1975) developed a formula to quantify content validity as shown below:

\[
CVR = \frac{n_e - (N/2)}{N/2}
\]

(3-1)

According to Lawshe (1975), \( n_e \) is equal to the number of SMEs indicating “Essential,” and \( N \) is the total number of SMEs. The formula yields a range of values from +1 to -1. If all SMEs agree that the item is “Essential,” then the item is considered to be essential and will be computed as the number 1. The positive number indicates that more than half of the SMEs rate the item as being essential. The negative number will be computed when less than half of the
SMEs rate the item as being essential. Lawshe (1975) stated that if more than half of the SMEs (beyond 50%) perceive the item as being essential, then the item has at least some degree of content validity. The following is the CVR based on the five SMEs in the field of music (Table 3-2).

Table 3-2. The CVR for the closed-ended questionnaire

<table>
<thead>
<tr>
<th>Item</th>
<th>CVR</th>
<th>Description</th>
<th>Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 1</td>
<td>0.60</td>
<td>The item has at least some degree of content validity</td>
<td>Some changes were made based on SMEs’ suggestions</td>
</tr>
<tr>
<td>Question 2</td>
<td>0.60</td>
<td>The item has at least some degree of content validity</td>
<td>Some changes were made based on SMEs’ suggestions</td>
</tr>
<tr>
<td>Question 3</td>
<td>0.60</td>
<td>The item has at least some degree of content validity</td>
<td>Some changes were made based on SMEs’ suggestions</td>
</tr>
<tr>
<td>Question 4</td>
<td>1.00</td>
<td>The item has a great level of content validity</td>
<td>None</td>
</tr>
<tr>
<td>Question 5</td>
<td>1.00</td>
<td>The item has a great level of content validity</td>
<td>None</td>
</tr>
<tr>
<td>Question 6</td>
<td>0.60</td>
<td>The item has at least some degree of content validity</td>
<td>Some changes were made based on SMEs’ suggestions</td>
</tr>
<tr>
<td>Question 7</td>
<td>1.00</td>
<td>The item has a great level of content validity</td>
<td>None</td>
</tr>
<tr>
<td>Question 8</td>
<td>1.00</td>
<td>The item has a great level of content validity</td>
<td>None</td>
</tr>
<tr>
<td>Question 9</td>
<td>1.00</td>
<td>The item has a great level of content validity</td>
<td>None</td>
</tr>
<tr>
<td>Question 10</td>
<td>0.60</td>
<td>The item has at least some degree of content validity</td>
<td>Some changes were made based on SMEs’ suggestions</td>
</tr>
<tr>
<td>Question 11</td>
<td>0.20</td>
<td>The item has less content validity</td>
<td>Significant changes were made based on SMEs’ suggestions</td>
</tr>
<tr>
<td>Question 12</td>
<td>0.20</td>
<td>The item has less content validity</td>
<td>Significant changes were made based on SMEs’ suggestions</td>
</tr>
</tbody>
</table>
The SMEs indicated that nine out of the 20 questions were essential for the non-music majors. They rated the other seven questions out of the 20 questions as important, but not truly essential, as the questions were too technical for them to find the correct answers. The SMEs also reported that the remaining four questions were somewhat irrelevant to the core learning objectives presented in the online lessons. All SMEs mentioned that the questions were too complex for non-music majors even if they were directly related to the learning content in the online instruction. The CVR in this study for the total scale was 0.7, which was an acceptable
number indicating a satisfactory result. It indicated that the entire closed-ended questionnaire had at least some degree of content validity. Before conducting the field test, the initial questions were updated followed by the SMEs’ suggestions.

As shown in Lawshe’s (1975) CVR methods, the CVR formula only concerns the essential items judged by the SMEs. This straightforward statistic indicated which item should be included or discarded from the closed-ended questionnaire. The CVR methods were also relevant to the cognitive theory of multimedia learning. According to the cognitive theory of multimedia learning, poorly designed instructional messages may cause unnecessary cognitive processing, which hinders learner’s understanding of primary knowledge (Mayer, 2001; Mayer, 2014c; Mayer, & Moreno, 2003; Sorden, 2012). The CVR methods helped the researchers to include only the most essential closed-ended questions, testing the participants’ prior knowledge and relevant learning outcomes by excluding unnecessary information (e.g., the complex names of Bassoon parts).

**Procedures**

Three systematic procedures were carried out to successfully achieve the primary purpose of the study. The three phases are shown in Figure 3-9. The first phase was the pre-designing and planning process before the field test. The researcher developed a preliminary draft for an online course module, named “An Instruction of Orchestra.” Two online instructional models were built in the Qualtrics® platform: a traditional web-based and a game-based online instruction model. Also, the initial design process of the three instruments was developed in the first phase. The original IMMS questionnaire was reviewed aligning with research participants’ backgrounds. The researcher developed the initial designs of closed-ended questions. Experts and professionals in the fields carefully reviewed each instrument, and adjustments were made based on their feedback.
In the second phase, a field test was conducted to implement a successful pilot study without having research bias or errors. Each online model (the traditional web-based and game-based online instruction model) was improved during the field test. Erroneous research assumptions, bias, and redundant research procedures were updated through sufficient evaluation processes. Also, the initial instruments developed in the first phase were tested throughout the field test.

The last phase was the actual research experiment implementing the experimental design. One hundred thirty-three students participated in the actual research experiment; data collection, data analysis, and data interpretation followed. Quantitative data were collected through Qualtrics®, an electronic survey instrument software, and the collected quantitative data were analyzed and summarized at the end. A discussion section provided the research limitations and implications of the featured study. The following diagram is a concise summary of the three phases implemented in the study (Figure 3-9):

![Diagram of three phases of the proposed research study]

Figure 3-9. The three phases of the proposed research study
Phase 1: A Preliminary Research Design Session

**Preliminary Online Instruction Draft.** The researcher developed the two online instruction models, traditional web-based online instruction and game-based online instruction. The online instruction was built in Qualtrics®, a popular survey software program which has been used for designing and supporting online courses in universities, institutions, and organizations. To compare the two different instructional models properly, the basic structures and learning content of the online learning modules were the same and equivalent to avoid potential extra confounding variables. The researcher designed an initial online learning module, titled “An Instruction to the Orchestra.” The traditional web-based online intervention was set up based on the specific learning content integrated with the multimedia learning materials derived from the music game. The instructional structure, learning subjects, and learning materials were equivalent in terms of the structure of the lecture, learning subjects, content, and multimedia materials such as texts, audio-visual materials, and animations. Based on the initial web-based online intervention, the game-based intervention was created by slightly modifying the web-based online intervention. The same research procedures were implemented. However, the game-based online intervention was designed to enable the research participants to play the music game through a direct game link embedded into Qualtrics®.

**A field test preliminary draft.** The researcher reviewed all anticipated student prerequisites and made accurate assumptions about their competencies regarding educational games and music education. A focus group was set up to review the interventions and collect appropriate feedback. The group discussion was carefully planned to provide the participants with a suitable environment in which they could openly talk about their learning experiences. Based on the plan, 17 discussion questions were prepared for the focus group, and a program
evaluation sheet was made to detect potential problems that might occur in the actual research experiment.

**Phase 2: Field Test**

**Basic procedures.** Before the actual experiment, a field test was implemented on a small-scale basis with students who were enrolled in undergraduate courses in the College of Education. A total of ten undergraduate students participated in the field test; five students were assigned to the game-based group, and the rest of the participants were placed in the web-based group. To minimize any ecological compounding variables, each group of students was invited to the same classroom facility with the same computers and headphones. After a brief introduction of the research experiment, the participants in each group completed their online intervention in the same way that the actual study would be conducted. The focus group discussion was conducted immediately following the try-out session. Three students in the game-based group and five students in the web-based group voluntarily joined each focus group session, and each group of participants freely discussed the advantages and disadvantages of the online instruction. Each group of students evaluated the online intervention, focusing specifically on the overall procedure of the experiment, design of the online lectures, type of educational media, and instruments (e.g., open-ended questions) by using the program evaluation sheets provided by the researcher.

**Initial results.** The majority of the participants were female (9 out of 10) and 18-20 years old. They were confident in using computers, the Internet, and being in an online learning environment. The participants were positive about a fully online course regarding learning content, environment, and technologies delivered through the online course. In particular, their favorite multimedia online learning material was video-based learning.
Nine students did not play digital games regularly; only one student played digital games 3-5 hours per week. Despite their frequency of digital gameplay, a total of eight students agreed that digital games and simulations could be used in a regular curriculum and instruction, and six students said they would like to use digital games and simulations to improve their online learning experience. In addition, six participants had stopped their music education in elementary or middle school, and most of them considered themselves to be pre- or beginner level musicians who could play few musical instruments or none. Figure 3-10 summarizes the significant results from the two research experiments and the focus group discussions from the field test.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Game-Based Session</th>
<th>Web-Based Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>• Females (9 out of 10)</td>
<td>• Females (9 out of 10)</td>
</tr>
<tr>
<td></td>
<td>• White/Caucasian</td>
<td>• White/Caucasian</td>
</tr>
<tr>
<td></td>
<td>• Freshmen (18-20 years old)</td>
<td>• Freshmen (18-20 years old)</td>
</tr>
<tr>
<td>Learning Technology</td>
<td>• They felt confident about computers, the Internet, and mobile phones</td>
<td>• They felt confident about computers, the Internet, and mobile phones</td>
</tr>
<tr>
<td></td>
<td>• Their favorite online learning tool was video-based online learning material</td>
<td>• Their favorite online learning tool was video-based online learning material</td>
</tr>
<tr>
<td></td>
<td>• They were positive about using digital games as a new online learning tool</td>
<td>• They were positive about using digital games as a new online learning tool</td>
</tr>
<tr>
<td></td>
<td>• They agreed games would be useful especially for music learning</td>
<td>• They agreed games would be useful especially for music learning</td>
</tr>
<tr>
<td></td>
<td>• Digital games and simulations could improve their online learning experience</td>
<td>• Digital games and simulations could improve their online learning experience</td>
</tr>
<tr>
<td>Learning Environments</td>
<td>• They had taken online learning courses before</td>
<td>• They had taken online learning courses before</td>
</tr>
<tr>
<td></td>
<td>• They were generally positive about online learning environments, but they also</td>
<td>• They were generally positive about online learning environments, but they also</td>
</tr>
<tr>
<td></td>
<td>like face-to-face learning environments</td>
<td>like face-to-face learning environments</td>
</tr>
<tr>
<td></td>
<td>• They felt comfortable about the surrounding classroom environment where the</td>
<td>• They felt comfortable about the surrounding classroom environment where the</td>
</tr>
<tr>
<td></td>
<td>experiments were conducted</td>
<td>experiments were conducted</td>
</tr>
<tr>
<td>Community</td>
<td>• The majority of students had stopped their music education after middle school</td>
<td>• The majority of students had stopped their music education after middle school</td>
</tr>
<tr>
<td></td>
<td>• They did not play games on a weekly basis</td>
<td>• They did not play games on a weekly basis</td>
</tr>
<tr>
<td></td>
<td>• They were pre- or beginner level musicians</td>
<td>• They were pre- or beginner level musicians</td>
</tr>
<tr>
<td></td>
<td>• They were positive about music learning, but it was not directly related to their major</td>
<td>• They were positive about music learning, but it was not directly related to their major</td>
</tr>
</tbody>
</table>

Figure 3-10. The Significant Results of the Field Test
<table>
<thead>
<tr>
<th>Rules</th>
<th>Instructional Design</th>
<th>Motivations (ARCS)</th>
<th>Achievements</th>
</tr>
</thead>
<tbody>
<tr>
<td>- A one-hour total experiment</td>
<td>- They were generally satisfied with the creator’s design of the online instruction</td>
<td>- The online instruction was appealing enough to hold or get their attention</td>
<td>- Learning outcomes (14 questions out of 20 questions) were improved after playing the game-based instruction</td>
</tr>
<tr>
<td>- 30 minutes of gameplay</td>
<td>- They liked the design and curriculum of the online game</td>
<td>- They got bored with the style of the writing</td>
<td></td>
</tr>
<tr>
<td>- Minor time constraints</td>
<td>- They did not enjoy elementary-level graphic design and digital game storytelling</td>
<td>- The lesson stimulated their curiosity and desire to learn</td>
<td></td>
</tr>
<tr>
<td>- They were satisfied with the general procedure of the online intervention</td>
<td></td>
<td>- Completing the lesson was important to them</td>
<td></td>
</tr>
<tr>
<td>- The level and sequence of the pre/posttests, content knowledge, and instructional information in the online intervention were appropriate</td>
<td></td>
<td>- The learning content was beneficial, but not directly relevant to their interests</td>
<td></td>
</tr>
<tr>
<td>- Some students liked the repetitive features of the online game due to learning practice</td>
<td></td>
<td>- They liked the exercises, reading passages, illustrations, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- They were confident that they could understand the content of the online lesson</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- They moderately liked the well-designed lesson</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- They were satisfied with the feedback, comments, and rewards</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- They felt good about successful completion</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3-10. Continued
Adjustments were made based on the evaluations from the field test; irrelevant learning content and the inappropriate structure of the instructions were removed according to the feedback. The instruments were revised regarding their content, clarity, and length as necessary. Based on feedback and modifications suggested in the preliminary field test, the instruments were modified and finalized after the field test session, which checks the reliability and validity of the instruments.

**Phase 3: Research Experiment**

A revised online intervention was implemented after the field test. There were two different treatments in the experimental design: the control group (web-based online instruction) and the experimental group (game-based instruction). The control group was given traditional web-based instruction that aligned with multimedia principles, which was similar to a common online instruction available in university settings. The experimental group used a game-based online instructional model integrated with a music appreciation game as a treatment condition. Based on the pretest-posttest control-group design, the sample of research participants was randomly assigned to the treatment condition.

To achieve the proposed research questions 1 and 2, the pretest-posttest control-group design was used to measure differences in students’ motivation and achievement scores between the two different online instruction models. Selecting the pretest-posttest control-group design is appropriate because it is a strong experimental design controlling for many types of internal validity such as history, maturation, instrumentation, testing, regression, and differential attrition (Johnson & Christensen, 2008).

**Data Collection**

**Basic procedures.** Quantitative data were collected during the Spring and Summer 2017 semesters. The research study was officially approved by the Institutional Review Board (IRB)
prior to data collection. To invite research participants, the researcher directly contacted instructors or administrators who were responsible for courses to get permission to conduct the research study. After discussing the research plans, the instructors and administrators initially informed the researcher of the best time for visiting their classrooms to advertise the research study. Class schedules, course assignments, time constraints, technical support, and potential administrative issues were also checked before the classroom visits. The researcher provided a brief presentation based on advertisements and informational letters with detailed information about the research including basic procedures, compensation, and requirements for their research participation. In addition, the researcher directly contacted research volunteers on campus to extend the size of the target population for the research. The research participants were given a summary of the research study in the advertisement and informational letters.

All participants signed up for one of four research experiment sessions during the meetings with the researcher. After confirming their participation via email, the location and time for the experiment session were announced. Participants were invited to a computer lab located in the College of Education. To conduct a random assignment, the researcher asked each student to select a card from a stack of 100 shuffled cards before starting their online intervention in the lab. The students who chose even numbers were assigned to even numbered computers, and those with odd numbers were assigned to odd numbered computers. The computers numbered with an even number were previously set up to have the traditional web-based online instruction while the game-based online instruction was installed on the odd numbered computers. The two different groups of students completed their online intervention within an hour. All data were electronically submitted through Qualtrics®.
**Field test.** In the field test, ten volunteers signed up for the research experiment session. The random assignment procedure was not conducted in the field test as the data was used only to improve the initial online intervention, not as a part of the final data to be analyzed for the results of the study. The selected research participants were split into two groups; one group of students took a web-based intervention, and the other participated in a game-based online intervention. Each participant started the online intervention via an anonymous link on each computer in the lab. Participants completed all research procedures as they followed the instructions; a demographic survey, online instruction, a pretest/posttest, and the IMMS were provided to the research participants. The participants were expected to complete their study within an hour. After the online intervention, eight research participants participated in a focus group discussion. The focus group session lasted for one hour and was recorded by audio recording and field notes. Focus group consent forms were collected before starting the discussion session. A total of 17 questions were asked in order to identify whether the design and structure of the research process were appropriate for them to successfully complete their participation. By reviewing the participants’ feedback, the researcher corrected any mistakes and errors that occurred in the online intervention to improve the initial online intervention. For instance, the online instruction and survey instruments were carefully analyzed in terms of the duration of the entire online intervention, the design patterns of the online instruction, and the content of the research instruments. The final drafts of the online interventions were prepared after the modifications were completed.

**Research experiment.** The same research procedure was replicated in the actual experiment, except without a focus group discussion; the participants did not have a group discussion after the online intervention. The researcher not only contacted course instructors or
administrators for classroom visits, but also directly met research participants on campus who were interested in the study. The research participants obtained detailed information about the study through the advertisement and informational letters. The students who wished to participate in the study signed up for a research experiment session convenient for their schedule. After confirming their participation via email, they were invited to the same computer lab where the field test was conducted. The selected participants were randomly assigned one of the online interventions such as the traditional web-based or game-based online instruction via the Qualtrics® link. The participants completed a demographic survey and pretest at the beginning. After that, they participated in the online lecture, which introduced general knowledge about classical music orchestra and musical instruments played in orchestra based on Benjamin Britten’s orchestral piece *The Young Person’s Guide to the Orchestra*. The posttest and IMMS survey were completed at the end, and participants completed the research experiment within an hour.

All data were automatically recorded in the Qualtrics® platform under a pseudonym to maintain participants’ anonymity. The quantitative data from the Qualtrics® system was transferred into an Excel file after removing any errors or incomplete data. The final data were recorded into SPSS to be analyzed. All the files were securely locked and protected by a password. After the research experiment sessions, the researcher not only sent thank you messages to the participants, but also shared important learning materials used in the online instruction (e.g., music games and an answer sheet for the pretest/posttest), eliminating any potential threat to the internal validity such as compensatory and resentful demoralization or compensatory rivalry (Creswell, 2009).
Data Analysis

Two main data analysis techniques were used based on the proposed research questions. The IMMS survey questionnaire consisting of 36 questions was used to measure the quantitative data from the student motivation survey. To examine student achievement, 20 pretest and posttest questions were developed in conjunction with the second research question. The validity and reliability of the instruments were tested prior to the data analysis. The collected quantitative data were analyzed by using effective quantitative data analysis techniques for each research question. Research questions 1 and 2 were analyzed by using MANOVA (Multivariate Analysis of Variance) and ANCOVA (Analysis of Covariance). The analyzed quantitative data were adequately compared and interpreted in comprehensive ways. The results of the study and discussion extended a complete understanding of students’ motivation and achievement.

Quantitative Methods

The proposed research questions investigated how two music online instructional models affected students’ motivation and achievement when using different types of online learning media. For Research Question 1, the independent variables were the two different online instruction models, the traditional web-based and game-based online instruction model. Dependent variables were the posttest scores measuring students’ motivation (Attention, Relevance, Confidence, and Satisfaction) regarding the different types of instruction. For research question 2, independent variables were two different instruction models; the dependent variable was the posttest scores of the students’ achievements, and the pretest was used as a control variable. To control other extraneous variables such as students’ previous knowledge and experience, preferences of game types or online learning styles, random assignment was used since it is an effective way to control for extraneous variables in an experiment (Johnson &
Christensen, 2008). With a random assignment, the research participants in the groups to be compared became similar or equivalent before the intervention or manipulation.

**Quantitative Data Analysis Techniques**

Multivariate analysis of variance (MANOVA) and analysis of covariance (ANCOVA) were the main statistical techniques. For Research Question 1, MANOVA was used to test the significance of the four different variables related to student motivation on the experiment condition. While analysis of variance (ANOVA) was used to compare one dependent variable across two or more groups, MANOVA should be used for quantitative data analysis when correlating several dependent variables with two or more groups (Kim & Keller, 2008; Klein & Freitag, 1991; Hair, Black, Babin, & Anderson, 2014; Schartz, 2014; Stevenson, 1986). Thus, conducting MANOVA was appropriate for this study since the four dependent variables (Attention, Relevance, Confidence, and Satisfaction) were compared across the two independent variables (web-based and game-based online instruction) in the study. For research question 2, ANCOVA was used to answer whether the independent variables (e.g. game-based instruction) had an effect on achievement scores. It is an effective statistical technique because the differences between pretest and posttest scores can be statistically compared, controlling for any confounding variables caused by the pretest.

**Research Question 1**

Five basic assumptions of MANOVA were tested to answer Research Question 1: 1) independent random sampling, 2) multivariate normality, 3) linearity of the dependent variables, 4) multivariate homogeneity of covariance, and 5) multivariate homogeneity of variance. To test the linearity of the dependent variables, Pearson $r$ was calculated along with correlation coefficients. Box M was calculated to test multivariate homogeneity of covariance between groups, and multivariate homogeneity of variance between groups was examined by using
Levene’s test. Lastly, Kurtosis and skewness and Shapiro-Wilk were used to measure the normality of the dependent variables.

To identify the most and least effective online instruction models on students’ motivation, means and standard deviations were summarized. Effect size and power were also calculated to estimate how each motivation variable (Attention, Relevance, Confidence, and Satisfaction) was significantly correlated with the independent variables (the web-based and game-based instruction).

**Research Question 2**

Differences between the posttest scores on students’ achievements in the two different instruction models were identified in setting the pretest scores as covariates. There were two assumptions of ANCOVA for student achievement: 1) homogeneity of regression, and 2) homogeneity of variance. To examine the differences, effect sizes were calculated by using Cohen’s \( d \). The small effect (.20), moderate effect (.50), and large effect (.80) were interpreted by a significance level of .05.

**Online Intervention**

**Basic Structure**

The basic structure of the online intervention was built into Qualtrics®. The shared basic structure of the online intervention was as follows:

<table>
<thead>
<tr>
<th>Table 3-3. The basic structure of the online intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Online Intervention</strong></td>
</tr>
<tr>
<td>1. The Front Page</td>
</tr>
<tr>
<td>2. Introduction</td>
</tr>
<tr>
<td>3. Demographic survey</td>
</tr>
</tbody>
</table>
Table 3-3. Continued

<table>
<thead>
<tr>
<th>Online Intervention</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. A pretest</td>
<td>20 questions for testing previous knowledge</td>
</tr>
<tr>
<td>5. Online instruction front page</td>
<td>The image on the front page</td>
</tr>
<tr>
<td>6. Learning objectives</td>
<td>Instruction for the learning objectives</td>
</tr>
<tr>
<td>7. Online instruction</td>
<td>The web-based or game-based lecture</td>
</tr>
<tr>
<td>8. A posttest</td>
<td>20 questions for testing learning outcomes</td>
</tr>
<tr>
<td>9. The IMMS questionnaire</td>
<td>The four sections of motivation survey</td>
</tr>
</tbody>
</table>

The music appreciation lecture in the online intervention was intensely focused on specific learning content: the orchestra and musical instruments played in the orchestra. All learning materials were based on Benjamin Britten’s orchestral composition *The Young Person’s Guide to the Orchestra*. A narrative adventure music game, *The Young Person’s Guide to the Orchestra®*, created by Carnegie Hall, was incorporated into the game-based online intervention. The selected music game contained basic knowledge regarding orchestra and musical instruments, corresponding with listening comprehension examples and gameplay practices in each learning module. The web-based instruction was an identical online lecture integrating equivalent multimedia learning materials taken from the same educational game.

The learning subjects were identified after analyzing the major learning content in each game session. The learning subjects were introduced to the participants prior to the online instruction so that the participants familiar with what would have been in the lecture content. The four learning subjects in the online instructions were: 1) Benjamin Britten, 2) The Orchestra, 3) The Woodwind Family, and 4) The String Family.

The Analysis of the Online Instruction with the Three Elements of Instruction

As Mayer (2016) suggested for media comparison research, the game and the conventional instruction were equated on relevant dimensions as closely as possible. Both the
treatment and control groups were exposed to equivalent modes, methods, and media, which are the three components of instruction defined by Clark (2008) and Mayer (2014).


<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Example</th>
<th>Web-based Instruction</th>
<th>Game-based Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modes</td>
<td>“Basic communication elements of all instruction: graphics, text, and audio” (Mayer, 2012, p. 313)</td>
<td>Texts</td>
<td>Identical</td>
<td>Identical</td>
</tr>
<tr>
<td></td>
<td>Modes are communication vehicles to promote learning (Clark, 2008, p.19-20)</td>
<td>Audios</td>
<td>Identical</td>
<td>Identical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pictures</td>
<td>Equivalent</td>
<td>Equivalent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2D Graphics</td>
<td>Identical</td>
<td>Identical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moving images</td>
<td>None</td>
<td>Complex</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in the game</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Animations</td>
<td>Identical</td>
<td>Identical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in the game</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Audio narrations</td>
<td>None</td>
<td>Complex</td>
</tr>
<tr>
<td>Instructional Methods</td>
<td>“Instructional components that facilitate learning process of selecting, organizing, and integrating” (Mayer, 2012, p. 313)</td>
<td>Definitions</td>
<td>Identical</td>
<td>Identical</td>
</tr>
<tr>
<td></td>
<td>“Techniques such as examples and practice exercise that lead to learning” (Clark, 2008, p. 19-20)</td>
<td>Examples</td>
<td>Equivalent</td>
<td>Equivalent</td>
</tr>
<tr>
<td></td>
<td>“a core mechanic to make meaningful choices and explore a space of possibility.” (Tekinbaş &amp; Zimmerman, 2004, p. 389)</td>
<td>Practices</td>
<td>Equivalent</td>
<td>Equivalent</td>
</tr>
<tr>
<td></td>
<td>“core mechanics represent the essential moment-to-moment activity…” (Tekinbaş &amp; Zimmerman, 2004, p. 389)</td>
<td>Analogies</td>
<td>Equivalent</td>
<td>Equivalent</td>
</tr>
<tr>
<td></td>
<td>“core mechanics create patterns of repeated behavior, the experiential building blocks of play” (Tekinbaş &amp; Zimmerman, 2004, p. 389)</td>
<td>Feedback</td>
<td>One-time feedback</td>
<td>Frequent, immediate feedback</td>
</tr>
<tr>
<td></td>
<td>“…interacting with and within a representational universe, a space of possibility with narrative dimensions” (Tekinbaş &amp; Zimmerman, 2004, p. 378)</td>
<td>Narrative Storytelling/ Exploration</td>
<td>Not Equivalent</td>
<td>Not Equivalent</td>
</tr>
<tr>
<td>Media</td>
<td>“Devices that deliver instruction” (Mayer, 2012, p. 313)</td>
<td>Instructor</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Computer</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Book</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
As shown in Figure 3-11, the structure and organization of the two types of online instruction are equivalent. The same modes such as texts, audios, and graphics were used in the experiment, aligning with the same learning objectives. The basic structure of the instructional methods was also identical in that both the game-based and web-based instruction included a preview section, the main lecture, and an exercise section (a gameplay or exercise questions) with feedback in each module. The physical delivery media of the instructions were the same computers located in the lecture room at the indicated university. To control extra confounding variables that may occur in ecologically different research settings, the space and time allocation of the experiments were equated by using the same online platform, Qualtrics®.

The learning modules of the online instructions consisted of main chapters, sub-chapters, and practice sessions. Also, the web-based and game-based online instruction shared the same learning objects. The learning objective in each game section was carefully analyzed before designing the exercise sections in the web-based online instruction to provide the learners with equivalent learning practices that might influence learning outcomes at the end. The exercise questions in the web-based online instruction were equivalent in the sense that the basic elements of the instructional methods were similar to those of the game-based online instruction. For example, the participants in the control group practiced an exercise question in the woodwind family lesson by dragging the relevant woodwind instruments into the box. Similarly, the participants in the treatment group, who were taking part in the gameplay, were exposed to the equivalent practice while playing a puzzle-solving game for the woodwind family lesson. The participants clicked and matched each woodwind instrument in the box. These two practices employed equivalent instructional methods as they included the same learning subjects (e.g., the woodwind family); the architecture of the exercise was similar (e.g., match the correct woodwind
instrument in the box); and participants received feedback after the exercise. A detailed analysis of the types of online instruction is shown in Figure 3-11.

<table>
<thead>
<tr>
<th>Learning Module</th>
<th>Practice Session</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The Organization of the Music Lesson</strong>: Web-based/Game-based Online Instructions</td>
<td><strong>Web-based Online Instruction</strong></td>
</tr>
<tr>
<td><strong>Main Chapters</strong></td>
<td><strong>Sub-Chapters</strong></td>
</tr>
<tr>
<td><strong>Orchestra</strong></td>
<td>None</td>
</tr>
<tr>
<td><strong>Benjamin Britten</strong></td>
<td>None</td>
</tr>
</tbody>
</table>
| **Woodwind Family** | Woodwind family (Intro) | 1) General descriptions of the woodwind family  
2) Different shapes, sizes, and pitches of the woodwind family | 1) Drag and match the woodwind family in the box  
2) Answer the correct notes and feedback | 1) Click and match the woodwind family in the box  
2) A puzzle-solving game |
| **Woodwind Family** | Flute & Piccolo | 1) The basic structure of the flute and piccolo  
2) The relationship between the size and pitch of the flute and piccolo  
3) The definition of mouthpiece | 1) Click the correct sound clip that represents the flute and piccolo  
2) A self-explanation question about the size and pitch in the flute and piccolo | 1) Point and click an empty bottle that represents the flute and piccolo sounds  
2) Matching game |

Figure 3-11. The organization of the web-based and game-based online instruction
<table>
<thead>
<tr>
<th>Instrument</th>
<th>Sections</th>
<th>Lessons</th>
</tr>
</thead>
</table>
| **Oboe**   | 1) The basic structure of the oboe  
2) The definition of the double reed | 1) Click the correct oboe reed  
2) A self-explanation question about the size and pitch in the flute and piccolo |
| **Clarinet** | 1) The basic structure of the clarinet  
2) The relationship between holes and pitches | 1) Find the correct fingering to play clarinet pitches  
2) A puzzle-solving game |
| **Bassoon** | 1) The basic structure of the bassoon  
2) The size and pitch of the bassoon | 1) Drag and construct the bassoon parts in the box  
2) Matching game |
| **String Family (Intro)** | 1) General descriptions of the string family  
2) Different shapes, sizes, and pitches of the string family | 1) Drag and match the string family in the box  
2) A puzzle-solving game |
| **Violin** | 1) The basic structure of the violin  
2) The styles of violin play such as “arco” and “pizzicato” | 1) Listen to a short music sample and find the correct order of the “arco” and “pizzicato” sounds  
2) A puzzle-solving game |

Figure 3-11. Continued
The analysis of the two types of online instruction was made based on the principles of multimedia learning and the three instructional goals proposed by Mayer (2014c).
Table 3-5. Multimedia learning principles and the three instructional goals (Adopted from Mayer, 2014c, p. 63)

<table>
<thead>
<tr>
<th>Goal</th>
<th>The Principles of Multimedia Learning</th>
<th>Web-based online music instruction</th>
<th>Game-based online music instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimize extraneous</td>
<td>1) Coherence principles</td>
<td>Unnecessary narrations, background music, and still images were removed from the original game (e.g., all learning modules).</td>
<td>Not fully applicable.</td>
</tr>
<tr>
<td>processing</td>
<td></td>
<td></td>
<td>Numerous instructional modes such as background music, audio narrations, still images, and moving images were presented in each section of the game.</td>
</tr>
<tr>
<td></td>
<td>2) Signaling principle</td>
<td>Essential learning subjects were highlighted (e.g., all learning modules).</td>
<td>Some important learning subjects were highlighted.</td>
</tr>
<tr>
<td></td>
<td>3) Redundancy principle</td>
<td>The original spoken texts were removed from corresponding printed texts (e.g., The orchestra and Benjamin Britten sections).</td>
<td>Not fully applicable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Spoken texts with corresponding printed texts were presented in the lessons.</td>
</tr>
<tr>
<td></td>
<td>4) Spatial contiguity principle</td>
<td>Printed texts were placed near corresponding still images (e.g., all learning modules).</td>
<td>Printed texts were placed near corresponding still images.</td>
</tr>
<tr>
<td></td>
<td>5) Temporal principle</td>
<td>Not fully applicable.</td>
<td>Narration and corresponding graphics were presented simultaneously.</td>
</tr>
<tr>
<td>Manage essential</td>
<td>6) Segmenting principle</td>
<td>Each learning module was broken into parts based on the core learning subject (e.g., all learning modules).</td>
<td>Each learning module was broken into parts based on the core learning subject.</td>
</tr>
<tr>
<td>processing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7) Pre-training principle</td>
<td>The general descriptions of musical instruments were presented at the beginning of the lessons (e.g., all learning modules).</td>
<td>The general descriptions of musical instruments were presented at the beginning of the lessons.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A brief information of the musical instruments was presented in each animation.</td>
<td>Moving graphics about musical instruments were presented before the main lesson.</td>
</tr>
<tr>
<td></td>
<td>8) Modality principle</td>
<td>Animations with audio narrations were separated from the corresponding printed texts (e.g., all learning modules).</td>
<td>Not fully applicable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Printed texts and corresponding narrations were presented together.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Animations with audio narrations and the corresponding printed texts were adjacent.</td>
<td></td>
</tr>
<tr>
<td>Goal</td>
<td>The Principles of Multimedia Learning</td>
<td>Web-based online music instruction</td>
<td>Game-based online music instruction</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------</td>
<td>-----------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>9) Multimedia principle</td>
<td>Both words and pictures were used in the lesson, rather than the words alone (e.g., all learning modules).</td>
<td>Both words and pictures were used in the lesson, rather than the words alone.</td>
<td></td>
</tr>
<tr>
<td>10) Personalization principle</td>
<td>The words are presented in conversational styles (e.g., all learning modules).</td>
<td>The words are presented in conversational styles.</td>
<td></td>
</tr>
<tr>
<td>11) Voice principle</td>
<td>Human voices were used for all audio narrations (e.g., animations clips).</td>
<td>Human voices were used for all audio narrations.</td>
<td></td>
</tr>
<tr>
<td>12) Embodiment principle</td>
<td>Not fully applicable.</td>
<td>An on-screen character, a girl named Agelia, appeared throughout the entire game to guide learning subjects in the lesson.</td>
<td></td>
</tr>
<tr>
<td>13) Guided discovery principle</td>
<td>Each exercise in the lesson provided the learners with text-based hints and feedback before and after solving problems (e.g., all exercise questions in the learning modules).</td>
<td>Each game session provided the learners with frequent hints and interactive feedback while playing the game.</td>
<td></td>
</tr>
<tr>
<td>14) Self-explanation principle</td>
<td>Exercise questions ask learners to explain learning subjects in the lesson (e.g., flute &amp; piccolo and oboe sections).</td>
<td>Not applicable.</td>
<td></td>
</tr>
<tr>
<td>15) Drawing principle</td>
<td>Exercise questions ask learners to make drawing different sizes of musical instruments (e.g., string family section).</td>
<td>Not applicable.</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 4
RESULTS OF STUDY

Chapter 4 reports the results of the study based on data analysis from the research experiment administered to 132 undergraduate students. The purpose of the study is to investigate whether student motivation and achievement are significantly different in traditional web-based vs. game-based online instruction. The following are the proposed research questions and hypotheses that have been tested:

1. Is there a significant difference in motivation (e.g., Attention, Relevance, Confidence, and Satisfaction) between students who learn music through traditional web-based approaches and students who learn through game-based online instruction?

2. Is there a significant difference in achievement between students who learn music through traditional web-based approaches and students who learn through game-based online instruction?

Hypothesis 1. (For Research Question 1)

\( H_0 \): There is no significant difference in student motivation (Attention, Relevance, Confidence, Satisfaction) between traditional web-based and game-based online music instruction.

\( H_1 \): There is a significant difference in student motivation (Attention, Relevance, Confidence, Satisfaction) between traditional web-based and game-based online music instruction.

Hypothesis 2. (For Research Question 2)

\( H_0 \): There is no significant effect of game-based online music instruction on students’ achievement controlling for students’ pretest scores.

\( H_1 \): There is a significant effect of game-based online music instruction on students’ achievement controlling for students’ pretest scores.
A total of 133 undergraduate students participated in the beginning of the research experiment; 67 students for the control group (web-based online instruction) and 66 students for the treatment group (game-based online instruction). However, the final data analysis was performed on only 132 participants consisting of 66 students for each group. One participant’s data in the web-based instruction were removed since the participant had completed only 71% of the entire online learning session. While incomplete or missing data were excluded before executing the data analysis, the research included students who had different levels of previous knowledge and experience in music education as well as different nationalities. There were no significant differences in the student groups that had high levels of music knowledge and experience (e.g., participation in high school band or orchestra) vs. student groups inexperienced in music education, and in the same manner, American vs. non-American.

**Sample Demographics**

There were four sections in the demographic survey: Basic information (section 1), Knowledge and Experience about Technology and Online Learning (section 2), Knowledge and Experience about Digital Games (section 3), and Knowledge and Experience about Music Learning (section 4). The basic information (section 1) consisted of five questions about the gender, age, ethnicity, nationality, and educational level of the 132 participants. In section 2, there were eight questions about how the participants learned and experienced various online learning and multimedia learning tools. Section 3 included four questions about hours of playing digital games and preferences regarding using digital games as an online learning experience. Section 4 was designed to see whether the participants had previous knowledge and experience in music education. Some music experience (e.g., extracurricular activities in a high school band or orchestra) was carefully reviewed since students’ previous knowledge might affect their achievement scores.
Basic Information

Participants reported basic information about their age, gender, ethnicity, nationality, and current education status in school. Ninety-three females accounted for 70.5% of the total population, and 39 males represented the other 29.5% (Table 4-1).

Table 4-1. Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
</table>
| Female | 93  | 70.5%
| Male   | 39  | 29.5%
| Total  | 132 | 100% |

As shown in Table 4-2, there was one missing piece of data in the age category so that the total percentage rate of the age was calculated based on $N = 131$. The most prevalent age group of the research was 18-20 years old (60.6%), and 96.2% of the total population was between 18 and 25 years old. The educational classifications of the participants varied in each level. Freshmen and juniors accounted for 62.9% of the total population; 36 freshmen (27.3%), 27 sophomores (20.5%), 47 juniors (35.6%), and 22 seniors (16.7%) participated in the research sessions.

Table 4-2. Age and Education Level

<table>
<thead>
<tr>
<th>Age</th>
<th>N</th>
<th>%</th>
<th>Education Level</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-20</td>
<td>80</td>
<td>60.6%</td>
<td>Freshman</td>
<td>36</td>
<td>27.3%</td>
</tr>
<tr>
<td>21-25</td>
<td>47</td>
<td>35.6%</td>
<td>Sophomore</td>
<td>27</td>
<td>20.5%</td>
</tr>
<tr>
<td>26-29</td>
<td>2</td>
<td>1.5%</td>
<td>Junior</td>
<td>47</td>
<td>35.6%</td>
</tr>
<tr>
<td>30-35</td>
<td>2</td>
<td>1.5%</td>
<td>Senior</td>
<td>22</td>
<td>16.7%</td>
</tr>
<tr>
<td>Missing</td>
<td>1</td>
<td>.8%</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>131</td>
<td>99.2%</td>
<td></td>
<td>132</td>
<td>100%</td>
</tr>
</tbody>
</table>

The majority of the research participants were White Caucasian (58.3%) and American (65.9%). The rest of the ethnicity groups were Asian/Pacific Islander (21.2%), Hispanic American (8.3%), Black or African American (5.3%), American Indian or Alaskan Native (0.8%), and Multiple ethnicity/Other (6.1%). Of the total 132 participants, 45 students (34.1%)
were recorded as non-American, and another 11 identified themselves as neither international nor American (Table 4-3).

Table 4-3. Ethnicity and Nationality

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>N</th>
<th>%</th>
<th>Nationality</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Indian or Alaskan Native</td>
<td>1</td>
<td>.8</td>
<td>American</td>
<td>87</td>
<td>65.9</td>
</tr>
<tr>
<td>Asian / Pacific Islander</td>
<td>28</td>
<td>21.2</td>
<td>International</td>
<td>34</td>
<td>25.8</td>
</tr>
<tr>
<td>Black or African American</td>
<td>7</td>
<td>5.3</td>
<td>Other</td>
<td>11</td>
<td>8.3</td>
</tr>
<tr>
<td>Hispanic American</td>
<td>11</td>
<td>8.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White / Caucasian</td>
<td>77</td>
<td>58.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple ethnicity/Other</td>
<td>8</td>
<td>6.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>132</td>
<td>100</td>
<td>Total</td>
<td>132</td>
<td>100</td>
</tr>
</tbody>
</table>

Knowledge and Experience about Technology and Online Learning

In section 2 of the demographic survey, the participants recalled their previous knowledge and experience regarding online courses and multimedia learning materials used for their education. Most participants (92.4%) were extremely (59.1%) or very confident (33.3%) about using the Internet with computers or mobile phones; less than 10% were not highly confident while browsing the Internet from computers or mobile phones.

The research participants had actively participated in various online courses using multimedia online learning materials. The majority of the students (47.7%) had taken 3-5 online courses during their high school or college years. Thirty-eight students had been enrolled in at least one or two online courses (28.8%). While only seven students did not sign up for online learning courses (5.3%), nine students registered in more than ten online courses for their education (Table 4-4).
Table 4-4. Numbers of previous online courses

<table>
<thead>
<tr>
<th>Previous online courses</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>7</td>
<td>5.3</td>
</tr>
<tr>
<td>1-2</td>
<td>38</td>
<td>28.8</td>
</tr>
<tr>
<td>3-5</td>
<td>63</td>
<td>47.7</td>
</tr>
<tr>
<td>6-10</td>
<td>15</td>
<td>11.4</td>
</tr>
<tr>
<td>More than ten courses</td>
<td>9</td>
<td>6.8</td>
</tr>
<tr>
<td>Total</td>
<td>132</td>
<td>100</td>
</tr>
</tbody>
</table>

As for multimedia learning materials, over half of the students were more familiar with text-based online learning (57.6%) than video-based (37.1%), audio-based (4.5%), or game-based learning (0.8%). Nevertheless, the favorite type of online learning was video-based online learning (58.3%) rather than text-based learning (16.7%). Interestingly, even though most of the students were not familiar with game-based learning, at least 25 students (18.9%) expressed that they were interested in game-based learning more than text-based learning (16.7%), audio-based learning (3.8%), or others (2.3%).

Table 4-5. Online Learning Materials

<table>
<thead>
<tr>
<th>Familiar online learning material</th>
<th>N</th>
<th>%</th>
<th>Favorite online learning material</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text-based learning</td>
<td>76</td>
<td>57.6</td>
<td>Text-based learning</td>
<td>22</td>
<td>16.7</td>
</tr>
<tr>
<td>Audio-based learning</td>
<td>6</td>
<td>4.5</td>
<td>Audio-based learning</td>
<td>5</td>
<td>3.8</td>
</tr>
<tr>
<td>Video-based learning</td>
<td>49</td>
<td>37.1</td>
<td>Video-based learning</td>
<td>77</td>
<td>58.3</td>
</tr>
<tr>
<td>Game-based learning</td>
<td>1</td>
<td>.8</td>
<td>Game-based learning</td>
<td>25</td>
<td>18.9</td>
</tr>
<tr>
<td>Others</td>
<td>0</td>
<td>0</td>
<td>Others</td>
<td>3</td>
<td>2.3</td>
</tr>
<tr>
<td>Total</td>
<td>132</td>
<td>100</td>
<td>Total</td>
<td>132</td>
<td>100</td>
</tr>
</tbody>
</table>

Approximately 74% of the students not only agreed that a fully online course would be useful for accessing their grades and multimedia learning materials, but also found it effective
for learning due to its flexibility and interactivity (80.3%). Even though some students felt that an online learning environment would be challenging (22%) and not comfortable (31.1%) enough, more than half of the students agreed that a fully online learning course would be easy (59.9%) and comfortable (47%).

Knowledge and Experience about Digital Games

As shown in Table 4-6, most students in the study did not regularly use either digital games or experience a game-based learning environment. While 35 students played digital games for 1-2 hours per week, nearly half of the students ($N = 62$) did not play digital games at all. However, 104 students (78.7%) reported that digital games and simulations could be used in a regular curriculum and instruction, and 96 students (72.8%) expressed that they would like to use digital games and simulations to improve their online learning experience.

<table>
<thead>
<tr>
<th>Hours of game play per week</th>
<th>$N$</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>62</td>
<td>47.0</td>
</tr>
<tr>
<td>1-2 hours</td>
<td>45</td>
<td>34.1</td>
</tr>
<tr>
<td>3-5 hours</td>
<td>16</td>
<td>12.1</td>
</tr>
<tr>
<td>5-8 hours</td>
<td>7</td>
<td>5.3</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>132</td>
<td>100</td>
</tr>
</tbody>
</table>

Knowledge and Experience about Music Learning

A total of 132 students also reported their previous knowledge and experience about music education. Nearly half of them (48.4%) had stopped their music education by middle school, and most of them (87%) discontinued their music education after high school. Thirty-two students participated in a high school band or orchestra. However, the remaining 100 students did not participate in musical activities. As shown in Table 4-7, many students (61.4%) considered themselves as a pre-beginner (36.4%) or beginner level musician (25%). While 59
students (44.7%) answered that they could read and play musical scores, 56 students (42.4%) reported that they were not able to read and play musical scores. Regardless of their previous knowledge and experience, 46 students (34.9%) agreed that learning music would be important for both their academic and personal life success. On the other hand, 43 students (32.6%) reported that the music education would be neither important nor unimportant, and the remaining 43 students (32.6%) expressed that it would not be important for their academic and personal success.

Table 4-7. Previous music education and levels

<table>
<thead>
<tr>
<th>Previous music education</th>
<th>N</th>
<th>%</th>
<th>Music levels</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preschool</td>
<td>0</td>
<td>0</td>
<td>Pre-Beginner Level</td>
<td>48</td>
<td>36.4</td>
</tr>
<tr>
<td>Elementary School</td>
<td>32</td>
<td>24.2</td>
<td>Beginner Level</td>
<td>33</td>
<td>25.0</td>
</tr>
<tr>
<td>Middle School</td>
<td>32</td>
<td>24.2</td>
<td>Intermediate Level</td>
<td>34</td>
<td>25.8</td>
</tr>
<tr>
<td>High School</td>
<td>51</td>
<td>38.6</td>
<td>Upper Intermediate Level</td>
<td>14</td>
<td>10.6</td>
</tr>
<tr>
<td>Informal learning outside of school</td>
<td>17</td>
<td>12.9</td>
<td>Professional Level</td>
<td>3</td>
<td>2.3</td>
</tr>
<tr>
<td>Total</td>
<td>132</td>
<td>100</td>
<td>Total</td>
<td>132</td>
<td>100</td>
</tr>
</tbody>
</table>

**Descriptive Statistics**

A total of 132 students reported their pretest and posttest scores. The mean and standard deviation for the pretest were $M = 12.10$ ($SD = 3.667$); the lowest pretest score was three and the highest pretest score was 19. All pretest scores were skewed to the right and had substantial kurtosis. The students recorded higher means and standard deviations in the posttest than they did for the pretest ($M = 12.10$, $SD = 3.667$); the lowest pretest score was four, and the highest pretest score was 20. The skewness and kurtosis were appropriate in making a normal distribution.
The ARCS scores for student motivation were Attention \((M = 3.568, SD = .690)\), Relevance \((M = 3.253, SD = .721)\), Confidence \((M = 4.047, SD = .594)\), and Satisfaction \((M = 3.063, SD = 1.076)\), respectively. While Confidence \((M = 4.047, SD = .594)\) had the highest mean and standard deviation within the ARCS subcales, Satisfaction \((M = 3.063, SD = 1.076)\) had the lowest subscale. There was some skewness in all motivation subscales; Confidence (-.909) was substantially skewed to the right. Some serious kurtosis was shown in Relevance (-.220) and Satisfaction (-.916).

Table 4-8. Descriptive Statistics for Dependent Measures

<table>
<thead>
<tr>
<th>Statistics</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>132</td>
<td>3</td>
<td>19</td>
<td>12.10</td>
<td>3.667</td>
<td>-.265</td>
<td>-.634</td>
</tr>
<tr>
<td>Posttest</td>
<td>132</td>
<td>4</td>
<td>20</td>
<td>17.48</td>
<td>3.010</td>
<td>-1.873</td>
<td>4.097</td>
</tr>
<tr>
<td>Attention</td>
<td>132</td>
<td>1.333</td>
<td>4.916</td>
<td>3.568</td>
<td>.690</td>
<td>-.429</td>
<td>.136</td>
</tr>
<tr>
<td>Relevance</td>
<td>132</td>
<td>1.666</td>
<td>5</td>
<td>3.253</td>
<td>.721</td>
<td>-.018</td>
<td>.220</td>
</tr>
<tr>
<td>Confidence</td>
<td>132</td>
<td>2.333</td>
<td>5</td>
<td>4.047</td>
<td>.594</td>
<td>-.909</td>
<td>.731</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>132</td>
<td>1</td>
<td>5</td>
<td>3.063</td>
<td>1.076</td>
<td>-.049</td>
<td>-.916</td>
</tr>
</tbody>
</table>

The Kuder-Richardson Formula 20 (or KR-20) was used to not only access whether the pretest and posttest consistently measured student achievement, but also to examine whether all test questions were internally consistent at the dichotomous level (e.g., true or false). In other words, it measured the level of internal consistency across the questions since the test results were evaluated to be correct or incorrect as categorical scores. As shown in Table 4-9, the overall reliability for the pretest \((KR-20 = 0.727, N = 20)\) and posttest \((KR-20 = 0.813, N = 20)\) was satisfactory to measure student achievement; the students’ scores were internally consistent across all questions on both the pretest and posttest.

Table 4-9. Pretest and Posttest Reliability Statistics

<table>
<thead>
<tr>
<th>Statistics</th>
<th>KR-20</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>.727</td>
<td>20</td>
</tr>
<tr>
<td>Posttest</td>
<td>.813</td>
<td>20</td>
</tr>
</tbody>
</table>
The internal consistency of each question was examined more in-depth when the students answered the same questions on the pretest and posttest. As shown in Table 4-10, Question 1, 2, 3, 11, and 12 affected the overall internal consistency of the pretest (KR-20 = .727) due to low correlations with other questions on the pretest. For instance, if Question 1, the item with insufficient correlation, was deleted from the pretest, the overall internal consistency would increase from $KR-20 = .727$ to $KR-20 = .740$. This indicated that these five questions could be revised to increase internal consistency, but that the other 15 questions should not be excluded from the pretest; otherwise, the overall internal consistency would decrease.

<table>
<thead>
<tr>
<th>Pretest Question</th>
<th>Scale Mean if Item Deleted</th>
<th>Scale Variance if Item Deleted</th>
<th>Corrected Item-Total Correlation</th>
<th>Squared Multiple Correlation</th>
<th>KR-20 if Item Deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 1</td>
<td>11.66</td>
<td>13.094</td>
<td>.040</td>
<td>.</td>
<td>.740</td>
</tr>
<tr>
<td>Question 2</td>
<td>11.85</td>
<td>12.916</td>
<td>.111</td>
<td>.</td>
<td>.732</td>
</tr>
<tr>
<td>Question 3</td>
<td>11.63</td>
<td>12.669</td>
<td>.159</td>
<td>.</td>
<td>.729</td>
</tr>
<tr>
<td>Question 4</td>
<td>11.32</td>
<td>12.592</td>
<td>.276</td>
<td>.</td>
<td>.718</td>
</tr>
<tr>
<td>Question 5</td>
<td>11.45</td>
<td>11.458</td>
<td>.584</td>
<td>.</td>
<td>.691</td>
</tr>
<tr>
<td>Question 6</td>
<td>11.56</td>
<td>11.954</td>
<td>.378</td>
<td>.</td>
<td>.709</td>
</tr>
<tr>
<td>Question 7</td>
<td>11.57</td>
<td>12.185</td>
<td>.306</td>
<td>.</td>
<td>.716</td>
</tr>
<tr>
<td>Question 8</td>
<td>11.50</td>
<td>12.128</td>
<td>.339</td>
<td>.</td>
<td>.713</td>
</tr>
<tr>
<td>Question 9</td>
<td>11.48</td>
<td>12.112</td>
<td>.349</td>
<td>.</td>
<td>.712</td>
</tr>
<tr>
<td>Question 10</td>
<td>11.35</td>
<td>11.965</td>
<td>.491</td>
<td>.</td>
<td>.702</td>
</tr>
<tr>
<td>Question 11</td>
<td>11.76</td>
<td>13.020</td>
<td>.066</td>
<td>.</td>
<td>.737</td>
</tr>
<tr>
<td>Question 12</td>
<td>11.68</td>
<td>12.670</td>
<td>.160</td>
<td>.</td>
<td>.729</td>
</tr>
<tr>
<td>Question 13</td>
<td>11.17</td>
<td>13.242</td>
<td>.205</td>
<td>.</td>
<td>.725</td>
</tr>
<tr>
<td>Question 14</td>
<td>11.74</td>
<td>11.931</td>
<td>.386</td>
<td>.</td>
<td>.708</td>
</tr>
<tr>
<td>Question 15</td>
<td>11.50</td>
<td>11.988</td>
<td>.382</td>
<td>.</td>
<td>.709</td>
</tr>
<tr>
<td>Question 16</td>
<td>11.43</td>
<td>12.325</td>
<td>.302</td>
<td>.</td>
<td>.716</td>
</tr>
<tr>
<td>Question 17</td>
<td>11.34</td>
<td>12.133</td>
<td>.436</td>
<td>.</td>
<td>.707</td>
</tr>
<tr>
<td>Question 18</td>
<td>11.33</td>
<td>12.378</td>
<td>.350</td>
<td>.</td>
<td>.713</td>
</tr>
<tr>
<td>Question 19</td>
<td>11.73</td>
<td>11.950</td>
<td>.379</td>
<td>.</td>
<td>.709</td>
</tr>
<tr>
<td>Question 20</td>
<td>11.72</td>
<td>12.279</td>
<td>.278</td>
<td>.</td>
<td>.718</td>
</tr>
</tbody>
</table>
The overall internal consistency of the posttest ($KR-20 = .813$) was higher than that of the pretest ($KR-20 = .727$). All 20 questions were adequately correlated with each other when the students took the same test right after the online instruction. This implied that all questions should be included on the posttest; otherwise, the overall internal consistency would decrease (Table 4-11).

**Table 4-11. Item-Total Statistics for the Posttest**

<table>
<thead>
<tr>
<th>Posttest Question</th>
<th>Scale Mean if Item Deleted</th>
<th>Scale Variance if Item Deleted</th>
<th>Corrected Item Total Correlation</th>
<th>Squared Multiple Correlation</th>
<th>KR-20 if Item Deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 1</td>
<td>16.52</td>
<td>8.541</td>
<td>.431</td>
<td>.</td>
<td>.805</td>
</tr>
<tr>
<td>Question 2</td>
<td>16.61</td>
<td>8.332</td>
<td>.329</td>
<td>.</td>
<td>.808</td>
</tr>
<tr>
<td>Question 3</td>
<td>16.61</td>
<td>8.269</td>
<td>.351</td>
<td>.</td>
<td>.807</td>
</tr>
<tr>
<td>Question 4</td>
<td>16.52</td>
<td>8.618</td>
<td>.409</td>
<td>.</td>
<td>.807</td>
</tr>
<tr>
<td>Question 5</td>
<td>16.53</td>
<td>8.572</td>
<td>.364</td>
<td>.</td>
<td>.807</td>
</tr>
<tr>
<td>Question 6</td>
<td>16.70</td>
<td>7.969</td>
<td>.399</td>
<td>.</td>
<td>.805</td>
</tr>
<tr>
<td>Question 7</td>
<td>16.62</td>
<td>8.146</td>
<td>.405</td>
<td>.</td>
<td>.804</td>
</tr>
<tr>
<td>Question 8</td>
<td>16.60</td>
<td>8.212</td>
<td>.410</td>
<td>.</td>
<td>.803</td>
</tr>
<tr>
<td>Question 9</td>
<td>16.61</td>
<td>7.935</td>
<td>.552</td>
<td>.</td>
<td>.795</td>
</tr>
<tr>
<td>Question 10</td>
<td>16.58</td>
<td>8.155</td>
<td>.499</td>
<td>.</td>
<td>.799</td>
</tr>
<tr>
<td>Question 11</td>
<td>16.58</td>
<td>8.443</td>
<td>.304</td>
<td>.</td>
<td>.809</td>
</tr>
<tr>
<td>Question 12</td>
<td>16.70</td>
<td>8.030</td>
<td>.371</td>
<td>.</td>
<td>.807</td>
</tr>
<tr>
<td>Question 13</td>
<td>16.49</td>
<td>8.863</td>
<td>.368</td>
<td>.</td>
<td>.811</td>
</tr>
<tr>
<td>Question 14</td>
<td>16.64</td>
<td>7.834</td>
<td>.531</td>
<td>.</td>
<td>.796</td>
</tr>
<tr>
<td>Question 15</td>
<td>16.64</td>
<td>8.142</td>
<td>.384</td>
<td>.</td>
<td>.805</td>
</tr>
<tr>
<td>Question 16</td>
<td>16.55</td>
<td>8.417</td>
<td>.395</td>
<td>.</td>
<td>.805</td>
</tr>
<tr>
<td>Question 17</td>
<td>16.52</td>
<td>8.664</td>
<td>.320</td>
<td>.</td>
<td>.809</td>
</tr>
<tr>
<td>Question 18</td>
<td>16.61</td>
<td>8.271</td>
<td>.362</td>
<td>.</td>
<td>.806</td>
</tr>
<tr>
<td>Question 19</td>
<td>16.70</td>
<td>7.889</td>
<td>.428</td>
<td>.</td>
<td>.803</td>
</tr>
<tr>
<td>Question 20</td>
<td>16.89</td>
<td>7.857</td>
<td>.349</td>
<td>.</td>
<td>.811</td>
</tr>
</tbody>
</table>

To access the reliability of ARCS, Cronbach’s Alpha ($\alpha$) was calculated for each subscale. According to Johnson and Christensen (2008), when the size of Cronbach’s alpha ($\alpha$) is greater than or equal to a minimum of .70, it is generally acceptable for research purposes. The
The total number of survey questions for the ARCS subscales was 36: Attention ($\alpha = 0.847, N = 12$), Relevance ($\alpha = 0.763, N = 9$), Confidence ($\alpha = 0.759, N = 9$), and Satisfaction ($\alpha = 0.926, N = 6$). The reliabilities for all subscales were satisfied for measuring student motivation; of them all, Attention ($\alpha = 0.847$) and Satisfaction ($\alpha = 0.926$) had particularly high reliabilities.

Table 4-12. ARCS Reliability Statistics

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Cronbach’s Alpha</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>0.847</td>
<td>12</td>
</tr>
<tr>
<td>Relevance</td>
<td>0.763</td>
<td>9</td>
</tr>
<tr>
<td>Confidence</td>
<td>0.759</td>
<td>9</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>0.926</td>
<td>6</td>
</tr>
<tr>
<td>Total ARCS</td>
<td>0.922</td>
<td>36</td>
</tr>
</tbody>
</table>

**ANCOVA for Student Achievement**

Two important assumptions of ANCOVA were tested for student achievement: 1) homogeneity of regression, and 2) homogeneity of variance. The first assumption was whether the homogeneity of regression was met in the data set. Since the interaction effect was not significant ($p = 0.889$), the homogeneity of the regression condition was not violated.

Table 4-13. Tests of Between-Subjects Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>505.728</td>
<td>3</td>
<td>168.576</td>
<td>31.674</td>
<td>.000</td>
<td>.426</td>
</tr>
<tr>
<td>Intercept</td>
<td>1400.217</td>
<td>1</td>
<td>1400.217</td>
<td>263.090</td>
<td>.000</td>
<td>.673</td>
</tr>
<tr>
<td>Online Group</td>
<td>2.450</td>
<td>1</td>
<td>2.450</td>
<td>.460</td>
<td>.499</td>
<td>.004</td>
</tr>
<tr>
<td>Pretest</td>
<td>462.387</td>
<td>1</td>
<td>462.387</td>
<td>86.879</td>
<td>.000</td>
<td>.404</td>
</tr>
<tr>
<td>Online Group * Pretest total</td>
<td>.103</td>
<td>1</td>
<td>.103</td>
<td>.019</td>
<td>.889</td>
<td>.000</td>
</tr>
<tr>
<td>Error</td>
<td>681.241</td>
<td>128</td>
<td>5.322</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>41542.000</td>
<td>132</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>1186.970</td>
<td>131</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. R Squared = .426 (Adjusted R Squared = .413)
Levene’s test was also conducted to see the null hypothesis that the error variance of the dependent variable was equal across groups. The results of the test indicated that the equal variance assumption was not violated for the dependent variable, \( F (1, 130) = .123, p = .727 \).

Table 4-14. Levene's Test of Equality of Error Variances

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posttest</td>
<td>.123</td>
<td>1</td>
<td>130</td>
<td>.727</td>
</tr>
</tbody>
</table>

*Note. a. Design: Intercept + PreTotal + OnlineGroup*

Descriptive statistics showed that the students in the web-based group achieved a higher mean score on the posttest and standard deviation than those of the game-based group. It indicated that the web-based group \((M = 18.05, SD = 3.155, N = 66)\) performed better than the game-based group \((M = 16.92, SD = 2.770, N = 66)\). However, the students in both groups improved their academic achievement after completing the web-based or game-based online instruction. The students in the web-based group earned 5.96 more points on the posttest than they did on the pretest. The students in the game-based group earned 4.81 more points on the posttest than they did on the pretest (Table 4-15).

Table 4-15. Descriptive statistics for student achievement

<table>
<thead>
<tr>
<th>Online Group</th>
<th>Pretest Mean</th>
<th>Std. Deviation</th>
<th>N</th>
<th>Posttest Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web-based Instruction</td>
<td>12.09</td>
<td>3.769</td>
<td>66</td>
<td>18.05</td>
<td>3.155</td>
<td>66</td>
</tr>
<tr>
<td>Game-based Instruction</td>
<td>12.11</td>
<td>3.591</td>
<td>66</td>
<td>16.92</td>
<td>2.770</td>
<td>66</td>
</tr>
</tbody>
</table>

When comparing the control and treatment groups, there was a statistically significant difference between the groups on the posttest when controlling for the pretest value \((p = .006)\). According to Cohen (1988), small effect size was defined as \(d = .2\), medium size as \(d = .5\), and large size for \(d = .8\). The student achievement results showed that the effect size was medium \((d = .380)\). It indicated that the mean of the game-based group was approximately at the 62nd
percentile of the web-based group. The partial eta squared was also .058, which showed approximately 5% of the variation in the dependent variable (Table 4-16). Overall, there was a moderate effect of the game-based online music instruction.

Table 4-16. Tests of Between-Subjects Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>505.625</td>
<td>2</td>
<td>252.813</td>
<td>47.865</td>
<td>.000</td>
<td>.426</td>
</tr>
<tr>
<td>Intercept</td>
<td>1402.174</td>
<td>1</td>
<td>1402.174</td>
<td>265.476</td>
<td>.000</td>
<td>.673</td>
</tr>
<tr>
<td>Pretest total</td>
<td>464.140</td>
<td>1</td>
<td>464.140</td>
<td>87.876</td>
<td>.000</td>
<td>.405</td>
</tr>
<tr>
<td>Web-based vs. Game-based Group</td>
<td>42.062</td>
<td>1</td>
<td>42.062</td>
<td>7.964</td>
<td>.006</td>
<td>.058</td>
</tr>
<tr>
<td>Error</td>
<td>681.344</td>
<td>129</td>
<td>5.282</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>41542.000</td>
<td>132</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>1186.970</td>
<td>131</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. a. R Squared = .426 (Adjusted R Squared = .417)

**MANOVA for Student Motivation**

There were four assumptions of MANOVA for student motivation: 1) independent random sampling, 2) multivariate normality, 3) linearity of the dependent variables, 4) multivariate homogeneity of covariance, and 5) multivariate homogeneity of variance. The basic assumptions of MANOVA were tested by using SPSS except for the first assumption, independent random sampling. The first assumption was initially achieved in the research design. For instance, the measurements of the samples were made based on two different sets of data from the control group (web-based) and treatment group (game-based). The samples are independent, as the measurements of the samples are from the different groups of students. In other words, the values in one sample do not affect those of the other sample.
Table 4-17. Descriptive statistics for student motivation

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web-based Instruction</td>
<td></td>
<td></td>
<td></td>
<td>Game-based Instruction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td>3.479</td>
<td>.631</td>
<td>66</td>
<td>Attention</td>
<td>3.658</td>
<td>.740</td>
<td>66</td>
</tr>
<tr>
<td>Relevance</td>
<td>3.191</td>
<td>.744</td>
<td>66</td>
<td>Relevance</td>
<td>3.316</td>
<td>.697</td>
<td>66</td>
</tr>
<tr>
<td>Confidence</td>
<td>4.143</td>
<td>.507</td>
<td>66</td>
<td>Confidence</td>
<td>3.951</td>
<td>.660</td>
<td>66</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>2.970</td>
<td>1.026</td>
<td>66</td>
<td>Satisfaction</td>
<td>3.156</td>
<td>1.125</td>
<td>66</td>
</tr>
<tr>
<td>Total</td>
<td>13.783</td>
<td>2.908</td>
<td>66</td>
<td>Total</td>
<td>14.081</td>
<td>3.222</td>
<td>66</td>
</tr>
</tbody>
</table>

MANOVA assumed multivariate normality so that multivariate normality was tested to check student motivation. Since it is sensitive to outliers, Mahalanobis’s distance was calculated to check whether any outliers would have existed in the data. As shown in Table 4-18, the maximum of Mahalanobis’s distance (MD) is 15.37, which was less than the critical value for df = 18.47. This indicates that there were no problematic outliers in the data.

Table 4-18. Mahalanobis’s distance

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mahalanobis’s Distance</td>
<td>2.64</td>
<td>15.375</td>
<td>3.970</td>
<td>2.774</td>
<td>132</td>
</tr>
</tbody>
</table>

The normality for each of the dependent variables was reviewed to examine the multivariate normality. As shown in Table 4-19, there was some skewness and kurtosis in the data sets. The skewness coefficients in all the dependent variables were negative: Attention (-.429), Relevance (-.018), Confidence (-.909), and Satisfaction (-.049). All dependent variables were skewed to the right in general; however, Attention (-.429) and Confidence (-.909) were substantially skewed further to the right. As for the kurtosis, Attention (.136), Relevance (-.220), and Satisfaction (-.916) were substantially flatter than those of Confidence (.731). Relevance (-.220) and Satisfaction (-.916) had serious kurtosis since kurtosis approaching 3.00 would be more appropriate for a normal distribution.
Table 4-19. Skewness and Kurtosis in ARCS

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>-.429</td>
<td>.136</td>
</tr>
<tr>
<td>Relevance</td>
<td>-.018</td>
<td>-.220</td>
</tr>
<tr>
<td>Confidence</td>
<td>-.909</td>
<td>.731</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>-.049</td>
<td>-.916</td>
</tr>
</tbody>
</table>

To access the normality, the Shapiro-Wilk test was used to test each dependent variable. The values of the significance levels of the Shapiro-Wilk test in the average of each variable were Attention (.115), Relevance (.123), Confidence (.001), and Satisfaction (.008). While there were normal distributions in the Attention (.115) and Relevance (.123) scores, as they were greater than .05, the significance levels of the Shapiro-Wilk test in Confidence (.001) and Satisfaction (.008) were less than .05, which were non-normal distributions in the scores.

Table 4-20. Test of Normality

<table>
<thead>
<tr>
<th></th>
<th>Kolmogorov-Smirnov&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistic</td>
<td>df</td>
<td>Sig.</td>
</tr>
<tr>
<td>Attention</td>
<td>.065</td>
<td>132</td>
</tr>
<tr>
<td>Relevance</td>
<td>.081</td>
<td>132</td>
</tr>
<tr>
<td>Confidence</td>
<td>.111</td>
<td>132</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>.073</td>
<td>132</td>
</tr>
</tbody>
</table>

<sup>Note</sup>. *This is a lower bound of the true significance.

a. Lilliefors Significance Correction

To examine any linear relationships in the dependent variables, correlations were also checked to see if there were enough relationships between variables. Satisfaction (.785) and Relevance (.591) were highly correlated to Attention. However, Confidence (.312) had a moderate relationship with Attention. Relevance was strongly correlated to Satisfaction (.749) and Attention (.591), and it had a moderate correlation with Confidence (.316). In particular, Satisfaction was not only strongly correlated to Attention (.785) and Relevance (.749), but it was also moderately correlated to Confidence (.339). Confidence had a moderate correlation across all dependent variables, Attention (.312), Relevance (.316), and Satisfaction (.339).
Table 4-21. Pearson’s Correlation for ARCS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Attention</th>
<th>Relevance</th>
<th>Confidence</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>1</td>
<td>.591**</td>
<td>.312**</td>
<td>.785**</td>
</tr>
<tr>
<td>Relevance</td>
<td>.591**</td>
<td>1</td>
<td>.316**</td>
<td>.749**</td>
</tr>
<tr>
<td>Confidence</td>
<td>.312**</td>
<td>.316**</td>
<td>1</td>
<td>.339**</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>.785**</td>
<td>.749**</td>
<td>.339**</td>
<td>1</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (2-tailed)

There was a meaningful correlation between student achievement and motivation. As shown in Table 4-22, the students’ achievements in both online groups were not only correlated to Confidence, but the level of their Confidence also generally increased in the posttest. For instance, the posttest scores in both groups were highly correlated to Confidence \((r = .543)\), which was increased by .09 points more than those of the pretest \((r = .453)\). In particular, the students’ achievement in the web-based group were strongly correlated to Confidence. There was also a high correlation between their posttest scores and Confidence \((r = .629)\). The posttest scores of the game-based group were moderately correlated to Confidence \((r = .461)\).

Table 4-22. Pearson’s Correlation for Student Achievement and Motivation

<table>
<thead>
<tr>
<th>Online Instruction</th>
<th>Pretest</th>
<th>Posttest</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web-based Instruction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td>-.255</td>
<td>-.117</td>
<td>66</td>
</tr>
<tr>
<td>Relevance</td>
<td>.015</td>
<td>-.009</td>
<td>66</td>
</tr>
<tr>
<td>Confidence</td>
<td>.536**</td>
<td>.629**</td>
<td>66</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>-.163</td>
<td>-.118</td>
<td>66</td>
</tr>
<tr>
<td>Game-based Instruction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td>.073</td>
<td>.223</td>
<td>66</td>
</tr>
<tr>
<td>Relevance</td>
<td>-.017</td>
<td>.182</td>
<td>66</td>
</tr>
<tr>
<td>Confidence</td>
<td>.407**</td>
<td>.461**</td>
<td>66</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>-.011</td>
<td>.149</td>
<td>66</td>
</tr>
<tr>
<td>Online Groups Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td>-.080</td>
<td>.029</td>
<td>132</td>
</tr>
<tr>
<td>Relevance</td>
<td>.000</td>
<td>.059</td>
<td>132</td>
</tr>
<tr>
<td>Confidence</td>
<td>.453**</td>
<td>.543**</td>
<td>132</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>-.085</td>
<td>-.003</td>
<td>132</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (2-tailed)

To test the homogeneity of the covariance matrices, Box’s M was used to examine whether the observed covariance matrices of the dependent variables were equal across groups.
As shown in Table 4-23, the significance value of Box’s M was .108, which indicates that the assumptions are met, and the result can be trusted.

Table 4-23. Box’s Test of Equality of Covariance Matrices

<table>
<thead>
<tr>
<th></th>
<th>Box's M</th>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box's M</td>
<td></td>
<td>16.264</td>
<td>1.572</td>
<td>10</td>
<td>.108</td>
</tr>
</tbody>
</table>

Also, Levene’s Test was conducted to check the diagonals of the covariance matrices. As shown in Table 4-24, the results of the Levene’s Test indicated that the equal variance assumption was not violated for any of the variables: Attention $F(1, 130) = 2.419, p = .122$, Relevance $F(1, 130) = .106, p = .745$, Confidence $F(1, 130) = 3.308, p = .071$, and Satisfaction $F(1, 130) = 1.576, p = .212$.

Table 4-24. Levene's Test of Equality of Error Variances

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>2.419</td>
<td>1</td>
<td>130</td>
<td>.122</td>
</tr>
<tr>
<td>Relevance</td>
<td>.106</td>
<td>1</td>
<td>130</td>
<td>.745</td>
</tr>
<tr>
<td>Confidence</td>
<td>3.308</td>
<td>1</td>
<td>130</td>
<td>.071</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>1.576</td>
<td>1</td>
<td>130</td>
<td>.212</td>
</tr>
</tbody>
</table>

*Note.* Tests the null hypothesis that the error variance of the dependent variable is equal across groups. aDesign: Intercept + Instruction

**Multivariate Coefficients for ARCS Measures**

As shown in Table 4-25, the levels of significance for each subscale of student motivation were greater than $p = .05$; Attention $F(1, 130) = 2.256, p = .135$, Relevance $F(1, 130) = .992, p = .321$, Confidence $F(1, 130) = 3.509, p = .063$, and Satisfaction $F(1, 130) = .994, p = .321$. The null hypothesis was accepted; in other words, there were no significant group differences in student motivation. There were generally small effects in the ARCS components, except in Confidence ($d = .326$): Attention ($d = -.260$), Relevance ($d = -.173$), Confidence ($d = .326$), and Satisfaction ($d = -.172$). The partial eta squared also indicated that there was very little variance in the dependent variables. For instance, Attention ($\eta_p^2 = .017$) showed only 1.7% of
variance in the dependent variables (Table 4-25). The results of the analysis implied that significant relationships in student motivation were not found between the traditional web-based and game-based groups.

Table 4-25. Tests of Between-Subjects Effects

<table>
<thead>
<tr>
<th>Source</th>
<th>Dependent Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
<th>Noncent. Parameter</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td>1.066</td>
<td>1</td>
<td>1.066</td>
<td>2.256</td>
<td>.135</td>
<td>.017</td>
<td>2.256</td>
<td>.320</td>
<td></td>
</tr>
<tr>
<td>Relevance</td>
<td>.516b</td>
<td>1</td>
<td>.516</td>
<td>.992</td>
<td>.321</td>
<td>.008</td>
<td>.992</td>
<td>.167</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>1.215c</td>
<td>1</td>
<td>1.215</td>
<td>3.509</td>
<td>.063</td>
<td>.026</td>
<td>3.509</td>
<td>.460</td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>1.152d</td>
<td>1</td>
<td>1.152</td>
<td>.994</td>
<td>.321</td>
<td>.008</td>
<td>.994</td>
<td>.167</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td>1680.830</td>
<td>1</td>
<td>1680.830</td>
<td>3557.059</td>
<td>.000</td>
<td>.965</td>
<td>3557.059</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Relevance</td>
<td>1397.683</td>
<td>1</td>
<td>1397.683</td>
<td>2687.900</td>
<td>.000</td>
<td>.954</td>
<td>2687.900</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>2162.071</td>
<td>1</td>
<td>2162.071</td>
<td>6241.210</td>
<td>.000</td>
<td>.980</td>
<td>6241.210</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>1238.526</td>
<td>1</td>
<td>1238.526</td>
<td>1067.936</td>
<td>.000</td>
<td>.891</td>
<td>1067.936</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Online Groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td>1.066</td>
<td>1</td>
<td>1.066</td>
<td>2.256</td>
<td>.135</td>
<td>.017</td>
<td>2.256</td>
<td>.320</td>
<td></td>
</tr>
<tr>
<td>Relevance</td>
<td>.516b</td>
<td>1</td>
<td>.516</td>
<td>.992</td>
<td>.321</td>
<td>.008</td>
<td>.992</td>
<td>.167</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>1.215c</td>
<td>1</td>
<td>1.215</td>
<td>3.509</td>
<td>.063</td>
<td>.026</td>
<td>3.509</td>
<td>.460</td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>1.152d</td>
<td>1</td>
<td>1.152</td>
<td>.994</td>
<td>.321</td>
<td>.008</td>
<td>.994</td>
<td>.167</td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td>61.429</td>
<td>130</td>
<td>.473</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relevance</td>
<td>67.599</td>
<td>130</td>
<td>.520</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>45.034</td>
<td>130</td>
<td>.346</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>150.766</td>
<td>130</td>
<td>1.160</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td>1743.326</td>
<td>132</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relevance</td>
<td>1465.797</td>
<td>132</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>2208.321</td>
<td>132</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>1390.444</td>
<td>132</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attention</td>
<td>62.496</td>
<td>131</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relevance</td>
<td>68.114</td>
<td>131</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>46.250</td>
<td>131</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>151.918</td>
<td>131</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. R Squared = .017 (Adjusted R Squared = .010)
b. R Squared = .008 (Adjusted R Squared = .000)
c. R Squared = .026 (Adjusted R Squared = .019)
d. R Squared = .008 (Adjusted R Squared = .000)
e. Computed using alpha = .05

124
Summary

The majority of the research participants were females (70.5%), 18-25 years old (96.2%), freshmen and juniors (62.9%), white Caucasian (58.3%), and American (65.9%). Most of the students (92.4%) felt confident about browsing the Internet via computers and mobile phones, and were positive toward online learning (74%) and using digital games for online learning (78.7%). While they were more familiar with text-based learning (57.6%), the most preferred form of online learning materials was video-based learning (58.3%). The majority of the students did not have sufficient knowledge or experience in music education; many students stopped their music education after graduating high school (87%). Even though the students responded that music education was not directly relevant to their major or interest, a third of the students thought learning music would be important for both their academic and personal life success (34.9%). The results of the data analysis showed that the students in the web-based group had higher achievement scores ($M = 18.05, SD = 3.155, N = 66$) than those of the game-based group ($M = 16.92, SD = 2.770, N = 66$). There was a significant effect between the traditional web-based and game-based group in student achievement, and there were moderate treatment effects ($d = .380$) on game-based online instruction. However, there was no significant difference in student motivation (Attention, Relevance, Confidence, and Satisfaction) between the web-based and game-based groups: Attention $F (1, 130) = 2.256, p = .135$, Relevance $F (1, 130) = .992, p = .321$, Confidence $F (1, 130) = 3.509, p = .063$, and Satisfaction $F (1, 130) = .994, p = .321$. Whereas Confidence ($d = .326$) had a medium effect on student motivation, the other three ARCS components showed relatively a small effect on student motivation: Attention ($d = -.260$), Relevance ($d = -.173$), and Satisfaction ($d = -.172$).
Numerous educational institutions have developed diverse and innovative online learning programs for higher education. However, it is challenging to design a sound online learning environment with new technologies wherein students can improve their academic achievement and motivation to learn (Bourgonjon, Valcke, Soetaert, & Schellens, 2010; Vogel et al., 2006). Complex, modern online learning environments require advanced learning technologies and must employ comprehensive instructional methods and effective media in order to support learners in accomplishing their educational goals. While digital games have been considered a potential online learning tool that engage the young, digital generation (Aghababyan, 2014; Bourgonjon et al., 2010; Gee, 2003; Gunter et al., 2008; Kappers, 2009; Liu & Chu, 2010; Liu, Rosenblum, Horton, & Kang, 2014; Martin & Shen, 2014; Perry & Klopfer, 2014; Rouse, 2013; Squire, 2002; Turkay et al., 2014; Wu, Richards, & Saw, 2014; Van Eck, 2006, Yee, 2007), debates are inconclusive regarding whether DGBL significantly improves students’ academic motivation and achievement (Brom et al., 2010; Gunter et al., 2008; Richard, 2014). The effectiveness of DGBL has been tested in various academic fields such as science, math, and language arts (Kappers, 2009; Kebritchi, Hirumi, & Bai, 2010; Liu & Chu, 2010; Proske, Roscoe, & McNamara, 2014; Rouse, 2013). For example, Rouse (2013) investigated “the effects of using educational games in a community college microbiology class” (p.27). Kappers (2012) analyzed complex research questions in regards to educational video games, gender, and motivation in mathematic achievement. Liu and Chu (2010) examined how ubiquitous educational games affect student motivation and achievement in developing English listening and speaking skills. But in fields such as art and music, there is a lack of evidence on how to
design arts-related online courses, such as music appreciation courses, which require more multimedia learning materials for listening.

To fill this gap, this study investigated how two separate online learning environments facilitated with different multimedia affected student motivation and achievement in music appreciation learning. To properly compare a control condition with a treatment condition within the experimental design, an identical web-based online learning course was created by utilizing the same multimedia learning materials as those of the educational music game, *The Young Person’s Guide to the Orchestra®*. This module was designed by applying cognitive multimedia learning theory and multimedia learning principles proposed by Mayer (2104c). The game-based online instruction integrated with the music game was compared to the identical, web-based online instruction. In Chapter 4, this comparative analysis was completed by assessing student motivation and achievement scores derived from 20 pretest/posttest questions and 36 Instructional Materials Motivation Survey (IMMS) questions. Based on the results of the study in Chapter 4, Chapter 5 discusses the findings related to the following research questions:

1. Is there a significant difference in motivation (i.e., Attention, Relevance, Confidence, and Satisfaction) between students who learn music through traditional web-based approaches and students who learn through game-based online instruction?

2. Is there a significant difference in achievement between students who learn music through traditional web-based approaches and students who learn through game-based online instruction?

The results of the statistical data analysis shown in MANOVA and ANCOVA were interpreted based on the cognitive theory of multimedia learning, 15 multimedia learning principles, and ARCS motivation model. The ARCS motivation model (Research Question 1) will be discussed to explain how the students participated and found relevance in, and were confident and satisfied with their multimedia online learning materials. Student achievement
Research Question 2) will be interpreted through the cognitive theory of multimedia learning. The research findings are further expanded by discerning possible implications for both game-based and web-based online music instruction. Fifteen out of 24 multimedia learning principles are analyzed and matched with three instructional goals to clearly define the potential implications of student achievement through online music instruction. The implications for student motivation are discussed in connection with ARCS components. Recommendations are presented concerning applications, strategies, and future research in online multimedia learning environments, which have been found to enhance student motivation and achievement.

**Discussion of Findings**

The primary findings in Chapter 4 are the fundamental outcomes after testing the hypotheses of the two research questions. The first finding is that the level of motivation between the web-based and game-based groups was not different; the web-based and game-based online instruction did promote similar levels of student motivation in Attention, Relevance, Confidence, and Satisfaction. The second research finding was to verify students’ achievement. The results of the study indicated that the control group (web-based group) performed significantly better on academic achievement tests than the treatment group (game-based group). There were no significant effects on the treatment group (game-based group) when controlling for pretest effects. A more comprehensive discussion of these key findings will be presented in this chapter.

**Student Achievement and Cognitive Theory of Multimedia Learning**

Regarding Research Question 2, descriptive analysis and ANCOVA revealed that the traditional web-based online group obtained higher achievement scores than the game-based online group. The two groups of students earned similar pretest scores in the beginning. In fact, the game-based group’s pretest score was slightly better than that of the web-based group. The
instructional design of the web-based online instruction generated more positive impacts on music learning than did the game-based online instruction. This raises several questions regarding which instructional features are effective for the web-based online instruction or less effective for the game-based online instruction. Both the web-based and game-based online instruction were presumably identical in content since they contained many equivalent online learning materials. The equivalent instructional components were given under the same conditions to all students in the research experiment; in other words, the equivalent instructional components might not be the notable factor that affected student achievement. For example, media, which is one of the three instructional components, was an equivalent instructional component; the online instruction was presented using the same delivery media (the same computers in the lab). Thus, this component might not be the major factor that explains the difference in the results regarding student achievement.

Rather, non-equivalent components situated within the two different online learning environments might account for the difference in students’ posttest scores. As shown in Table 5-1, all the non-equivalent instructional components included in the two online instruction types were compared in terms of mode and instructional method.


<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Example</th>
<th>Web-based Instruction</th>
<th>Game-based Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modes</td>
<td>“Basic communication elements of all instruction: graphics, text, and audio” (Mayer, 2012, p. 313)</td>
<td>Moving images in the game</td>
<td>None</td>
<td>Complex</td>
</tr>
<tr>
<td></td>
<td>Modes are communication vehicles to promote learning (Clark, 2008, p.19-20)</td>
<td>Audio narrations in the game</td>
<td>None</td>
<td>Complex</td>
</tr>
</tbody>
</table>
Table 5.1. Continued

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Example</th>
<th>Web-based Instruction</th>
<th>Game-based Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional</td>
<td>“Instructional components that facilitate learning process of selecting,</td>
<td>Feedback</td>
<td>One-time feedback</td>
<td>Frequent, immediate</td>
</tr>
<tr>
<td>Methods</td>
<td>organizing, and integrating” (Mayer, 2012, p. 313)</td>
<td></td>
<td></td>
<td>feedback</td>
</tr>
<tr>
<td></td>
<td>“Techniques such as examples and practice exercise that lead to learning”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Clark, 2008, p.19-20)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>“a core mechanic to make meaningful choices and explore a space of</td>
<td>Narrative</td>
<td>None</td>
<td>Complex</td>
</tr>
<tr>
<td></td>
<td>“core mechanics represent the essential moment-to-moment activity…”</td>
<td>Narrative</td>
<td>None</td>
<td>Complex</td>
</tr>
<tr>
<td></td>
<td>(Tekinbaş &amp; Zimmerman, 2004, p.389)</td>
<td>Storytelling/</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>“core mechanics create patterns of repeated behavior, the experiential</td>
<td>Narrative</td>
<td>Simple</td>
<td>Complex</td>
</tr>
<tr>
<td></td>
<td>building blocks of play”</td>
<td>Storytelling/</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Tekinbaş &amp; Zimmerman, 2004, p.389)</td>
<td>Exploration</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>“…interacting with and within a representational universe, a space of</td>
<td>Narrative</td>
<td>None</td>
<td>Complex</td>
</tr>
<tr>
<td></td>
<td>possibility with narrative dimensions”</td>
<td>Storytelling/</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Tekinbaş &amp; Zimmerman, 2004, p.378)</td>
<td>Exploration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The common characteristics of the non-equivalent instructional components in the game-based online instruction were more complex than those of the web-based online instruction. As Tekinbaş and Zimmerman (2004) stated, the characteristics of narrative gameplay, moving images, audio narrations, feedback, and narrative gaming mechanics were dynamically...
multifaceted and situated in every gaming scene. For example, when the students played the string instrument sections, they had to explore some parts of a safari where the string instruments had to be assembled to complete the section. Students interacted with numerous moving images and experienced background music and audio narration. They also received frequent and immediate feedback if they answered a question incorrectly. They repeated the game scenes moment-by-moment until they won the game. In the web-based instruction, the same string instrument sections were straightforwardly presented with the essential information based on 15 multimedia learning principles.

The extraneous information presented in the game-based online instruction may have negatively affected student achievement. The cognitive theory of multimedia learning suggests that the most effective way of designing multimedia instructional messages is to consider how the human mind works (Mayer, 2001; Mayer, 2009; Mayer, 2014a; Mayer, 2014b; Mayer, 2014c; Mayer, 2014d; Mayer, 2015c; Mayer & Moreno, 2003; Moreno, 2004; Sorden, 2012). Most of all, reducing extraneous processing is the core concept of the cognitive theory of multimedia learning (Mayer, 2014d). Three assumptions of the cognitive theory of multimedia learning postulate a proper interpretation of the results of the study. Baddeley’s (1992) model of working memory clearly explicates why the students in the web-based online instruction outperformed the students who participated in the game-based online instruction. The limited-capacity assumption theorizes that humans’ information processing has a limited capacity in the working memory (Baddeley, 1992; Mayer, 2014c; Mayer, 2015c). It indicates that extraneous information exceeding the learner’s cognitive capacity may not be properly processed or managed in the system; people can process only small amounts of information that are very transient in each channel for visual or auditory information. The learners in the game-based group might not be
able to hold in working memory the essential information to be completed due to the excessive information from the visual, auditory, or complex exploratory gaming features.

The second assumption is the dual-channel assumption proposed by Paivio. According to Paivio’s (1986) dual coding theory, there are separate channels for auditory and visual information. Learners perform better when the two channels are presented simultaneously since the referential connection between the two channels allows them to construct the new information effectively (Yu, Lai, Tsai, & Chang, 2010). In the game-based instruction, the visual and auditory descriptions were generally referential and simultaneous. However, some visual descriptions of instrument structures (visual information) and corresponding listening examples (auditory information) were separately displayed. Unlike the game-based online instruction, the auditory and visual information was combined and simultaneously presented in the web-based online instruction, applying the dual-coding assumption to help learners understand the new information. In Welch, Howard, and Rush’s (1989) investigation of the development of vocal pitch accuracy, they found that the students who had real-time visual feedback significantly enhanced their vocal pitch accuracy. They indicated that they could find meanings from the visual images and then integrate the information while developing their vocal singing; the students could see and control their voice movements to generate specific visual patterns (Welch, Howard, & Rush, 1989, p. 156). Similarly, Welch, Howard, Himonides, and Brereton (2005) argued that real-time auditory and visual feedback improved the student singers’ behaviors during the lessons. They assumed that a robust multi-sensory feedback system enabled the students to integrate imagery, commentary, and singing information. These studies implied that the learners’ auditory and visual channels propelled the students towards constructing the new information effectively.
This raises an important question regarding the effect of the game-based online instruction. If the working memory system is heavily overloaded by extraneous information, which commonly occurs with narrative exploratory music games, did students in the game-based group improve their academic achievement scores after the pretest? Though the students of the game-based group generally improved their posttest scores after completing their online instruction, the web-based online group showed even more improvement. As shown in the descriptive statistics, they earned a mean score that was 4.81 points higher on the posttest than they did on the pretest. This also shows that the students developed their academic achievement through the game-based online instruction. The second hypothesis for Research Question 2 verified that there was a significant effect of the game-based online music instruction on student achievement after removing the effect of the pretest (covariate). The null hypothesis was rejected since the $p$-value ($p = .006$) was less than .05. It indicated that whereas the web-based group outperformed the game-based group on the posttest, there was also a moderate effect of the game-based online music instruction on student achievement ($d = .380$). These findings imply that the game-based online instruction was still moderately effective on student achievement even if it contained complex gaming features that are considered extraneous cognitive loads needing omission.

Thus, the question remains regarding which factors of the game-based online instruction prove operational as multimedia online learning materials. The active processing assumption rationalizes that people learn better when they engage in a cognitively-active learning process (Mayer, 2014c; Moreno & Durán, 2004). As Moreno and Durán’s (2004) research reported, learners obtained higher scores on transfer and retention tests when they actively organized and integrated information by playing a discovery-based multimedia game. In the same manner, the
learners in the game-based group could actively organize, select, and integrate the new information while exploring new musical instruments. That is to say, the students organized or integrated the new knowledge and information during the game sessions. They constructed new knowledge about musical instruments by comparing and contrasting information while playing the music game. This active-processing aspect of the game might enable them to effectively transfer or retain knowledge from game-based online music instruction.

The discussion of findings not only examined conclusive factors identified in the results of the study, but also postulated potential rationales regarding student achievement within the two different online learning environments by using the cognitive theory of multimedia learning. The game-based online instruction did not surpass the traditional web-based online instruction in terms of student achievement. However, this does not mean that the game-based online instruction impedes the effective cognitive learning process of students. The core mechanics of the game design were segmented, organized, and presented in a way that the learners could actively engage in the learning process. The game-based online instruction effectively applied Gestalt theory to the core game mechanic. As Radocy and Boyle (2003) argued, all music was practiced in the law of proximity and simplicity, especially for novice music learners. Additionally, new information was chunked and organized in a way that the learners could perceive and predict it (Abeles, Hoffer, & Klotman, 1995; Radocy & Boyle, 2003; Richey, Klein & Tracey, 2011). The majority of the music practice in the game-based learning was designed based on these principles. For instance, the gamers practiced distinguishing the similar tone colors, timbres, rhythms, or pitches of the instruments. The students also matched and found the similar pitched or tone colors that represent woodwind instruments. Furthermore, the immediate visual feedback in the game might even enhance student achievement after the posttest. Paney
(2015) reported that undergraduate non-music majors significantly improved their pitch-matching scores after playing a singing video game using visual feedback. This study indicated that using multimodality can generate positive learning outcomes in music learning (Howard, & Rush, 1989; Paney 2015; Welch, Howard, Himonides, & Brereton, 2005). It also implied that specialized instructional design techniques and gaming features would allow for some improvements on the posttest of the game-based group, notwithstanding the excessive information integrated into the game.

**Student Motivation and ARCS Components**

The two different groups’ motivation was analyzed by descriptive statistics and MANOVA. As shown in Chapter 4, while there were no significant differences between the two groups, the mean scores of Attention, Relevance, Confidence, and Satisfaction were slightly different from each other. The total mean scores of the ARCS in the game-based group were .298 points higher than those of the web-based group. The game-based group also had a larger standard deviation, which indicates that the game-based group had much different reactions to the treatment condition (music game). The range and spread of motivation scores became wider after playing the music game. On the other hand, the total standard deviation in the web-based group was lower than those of the game-based group. These scores indicate that their motivation status was closer to the mean score; in other words, students’ reactions to the web-based online instruction were more consistent than the reactions of the students in the game-based group.

When examining the ARCS components in detail, each mean score of the game-based group was also higher than each mean score of the web-based group in terms of Attention, Relevance, and Satisfaction. Apparently, Confidence was the highest motivation subscale in both the game-based group and the web-based group. The overall Confidence also had a medium effect size, compared to the other components such as Attention, Relevance, and Satisfaction. According to
Keller (1987, 2010), Confidence occurs when the learners believe that they will succeed and can control their success by their efforts and abilities. In particular, Confidence affects student achievement and persistence (Keller, 1987; Richey et al., 2011). As shown in Chapter 4, the pretest and posttest scores were correlated to Confidence; the stronger Confidence rates generated higher achievement scores. This indicated that the student group with higher scores in Confidence would have had higher student achievement scores than those of another group. In this study, it was evident that the web-based group was more confident regarding their online instruction, which may have led to higher achievement scores than those of the game-based group. Whereas Confidence was moderately correlated with Attention ($r = .312$), Relevance ($r = .316$), and Satisfaction ($r = .339$), the other three variables were highly correlated to each other. Relevance was strongly correlated to Satisfaction ($r = .749$) and Attention ($r = .591$). Satisfaction ($r = .785$) and Relevance ($r = .591$) were highly correlated to Attention. Satisfaction was strongly correlated to Attention ($r = .785$) and Relevance ($r = .749$). According to Keller (2010), Attention stimulates interest in learning; Relevance is related to the value of the material being learned; Confidence refers to students’ feeling of achievement and success; and the expected result of a positive reward refers to Satisfaction. These ARCS components indicate that students will be highly motivated not only when they are attentive to the online learning materials, but also when the learning materials are relevant to their interest. Students will be motivated with the multimedia online learning environment if these conditions are met. Unlike well-trained music learners, novice music learners become more personally engaged if they know the music (Payne, 1973). Consequently, the students will be attentive and satisfied with their online learning when the relevant online learning materials match with their prior knowledge or experience.
Implications

In this section, pertinent implications will be reviewed as an extension of the discussion of findings. Multimedia learning principles and the ARCS model are adopted to detect the potential implications of how student motivation and achievement function within the two different types of online music instruction. Relevant multimedia learning principles are examined to identify student achievement in the web-based and game-based online music instruction. John Keller’s ARCS components are further examined to discover conceivable assumptions about how student motivation functions within the two different multimedia online learning environments.

Implications of Multimedia Learning Principles for Online Instruction

The fundamental implications of this study are examined based on multimedia learning principles corresponding with three instructional goals: 1) minimizing extraneous processing, 2) managing essential processing, and 3) fostering generative processing. These three cognitive processes (extraneous, essential, and generative processing) are presented to show how meaningful learning has been obtained or not obtained through each kind of online instruction. To be analyzed, web-based and game-based online music instruction were aligned with 15 multimedia principles. Various instructional methods, design features, and multimedia learning materials were evaluated to indicate conceivable assumptions in relation to the results of the study. The different multimedia principles and unique features that were applied to each online instruction type are shown in Table 5-2.
Table 5-2. Multimedia learning principles and three instructional goals (Adopted from Mayer, 2014c, p.63)

<table>
<thead>
<tr>
<th>Goal</th>
<th>The Principles of Multimedia Learning</th>
<th>Web-based online music instruction</th>
<th>Game-based online music instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimize extraneous processing</td>
<td>1) Coherence principles</td>
<td>Unnecessary narration, background music, still images were removed from the original game (e.g., all learning modules).</td>
<td>Not fully applicable. Numerous instructional modes such as background music, audio narrations, still images, and moving images were presented in each section of the game.</td>
</tr>
<tr>
<td></td>
<td>2) Signaling principle</td>
<td>Essential learning subjects were highlighted (e.g., all learning modules).</td>
<td>Some important learning subjects were highlighted.</td>
</tr>
<tr>
<td></td>
<td>3) Redundancy principle</td>
<td>The original spoken texts were removed from corresponding printed texts (e.g., The orchestra and Benjamin Britten sections).</td>
<td>Not fully applicable. Spoken texts with corresponding printed texts were presented in the lessons.</td>
</tr>
<tr>
<td></td>
<td>4) Spatial contiguity principle</td>
<td>Printed texts were placed near corresponding still images (e.g., all learning modules).</td>
<td>Printed texts were placed near corresponding still images.</td>
</tr>
<tr>
<td></td>
<td>5) Temporal principle</td>
<td>Not fully applicable. Qualtrics® does not fully support automatic graphics that the original game had.</td>
<td>Narration and corresponding graphics were presented simultaneously.</td>
</tr>
<tr>
<td>Manage essential processing</td>
<td>6) Segmenting principle</td>
<td>Each learning module was broken into parts based on the core learning subject (e.g., all learning modules).</td>
<td>Each learning module was broken into parts based on the core learning subject.</td>
</tr>
<tr>
<td></td>
<td>7) Pre-training principle</td>
<td>The general descriptions of musical instruments were presented in the beginning of the lessons (e.g., all learning modules).</td>
<td>The general descriptions of musical instruments were presented in the beginning of the lessons.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A brief description of the musical instruments was presented in each animation.</td>
<td>Moving graphics about musical instruments were presented before the main lesson.</td>
</tr>
</tbody>
</table>
### Table 5-2. Continued

<table>
<thead>
<tr>
<th>Goal</th>
<th>The Principles of Multimedia Learning</th>
<th>Web-based online music instruction</th>
<th>Game-based online music instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manage essential processing</td>
<td>8) Modality principle</td>
<td>Animations with audio narrations</td>
<td>Not fully applicable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>were separated from the</td>
<td>Printed texts and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>corresponding printed texts</td>
<td>corresponding narrations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(e.g., all learning modules).</td>
<td>were presented together.</td>
</tr>
<tr>
<td>Foster generative processing</td>
<td>9) Multimedia principle</td>
<td>Both words and pictures were used</td>
<td>Both words and pictures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in the lesson, rather than the</td>
<td>were used in the lesson,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>words alone (e.g., all learning</td>
<td>rather than the words</td>
</tr>
<tr>
<td></td>
<td></td>
<td>modules).</td>
<td>alone.</td>
</tr>
<tr>
<td></td>
<td>10) Personalization principle</td>
<td>The words are presented in</td>
<td>The words are presented</td>
</tr>
<tr>
<td></td>
<td></td>
<td>conversational styles (e.g., all</td>
<td>in conversational styles.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>learning modules).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11) Voice principle</td>
<td>Human voices were used for all</td>
<td>Human voices were used for all</td>
</tr>
<tr>
<td></td>
<td></td>
<td>audio narrations (e.g., animations</td>
<td>audio narrations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>clips).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12) Embodiment principle</td>
<td>An on-screen character, a female</td>
<td>An on-screen character,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>teacher, introduced brief learning</td>
<td>a girl named Agelia,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>subjects at the beginning.</td>
<td>appeared in the entire game to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>An on-screen character, a girl</td>
<td>guide learning subjects through</td>
</tr>
<tr>
<td></td>
<td></td>
<td>named Agelia, explained learning</td>
<td>the lesson.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>subjects during a short animation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>in each learning module</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(e.g., string and woodwind family</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>sections).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13) Guided discovery principle</td>
<td>Each exercise in the lesson</td>
<td>Each game session provided the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>provided the learners with text-</td>
<td>learners with frequent hints and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>based hints and feedback before</td>
<td>interactive feedback while</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and after solving problems (e.g.,</td>
<td>playing the game.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>all exercise questions in the</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>learning modules).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14) Self-explanation principle</td>
<td>Exercise questions ask learners to</td>
<td>Not applicable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>explain learning subjects in the</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>lesson (e.g., flute &amp; piccolo and</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>oboe sections).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15) Drawing principle</td>
<td>Exercise questions ask learners to</td>
<td>Not applicable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>draw different sizes of musical</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>instruments (e.g., string family</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>section).</td>
<td></td>
</tr>
</tbody>
</table>
**Game-based online music instruction.** Whereas ten multimedia learning principles were successfully established within the game-based online music instruction, the other six multimedia learning principles were absent from, or misused in, the music game. The six lacking principles are 1) the coherence principle, 2) the signaling principle, 3) the redundancy principle, 4) the modality principle, 5) the self-explanation principle, and 6) the drawing principle. This lack implies that two instructional goals have been apparently unsuccessful in game-based online instruction: minimizing extraneous processing (the coherence principle, the signaling principle, the redundancy principle) and fostering generative processing (the self-explanation principle and the drawing principle).

Mainly, the game-based online instruction did not effectively eliminate extraneous learning materials in certain gaming sections. This might directly cause relatively low student achievement scores on the posttest since it is evident that extraneous information hinders learners’ cognitive process (Clark & Mayer, 2016; Mayer, 2011; Mayer, 2014b; Mayer & Moreno, 2003). For instance, there was excessive information in the music game such as audio, text, moving images, animation, background sound effects, layered narrative storytelling, exploratory adventures, and moment-by-moment frequent feedback. The music learners were forced to process all the incoming information within an hour of gameplay, throughout session-by-session or moment-by-moment interactions. Students’ cognitive capacity may have been overwhelmed so that their working memory could not achieve the essential and generative processing related to the actual music learning. An important implication here is that extraneous processing is not directly initiated from instructional goals or objectives; rather, it is caused by inadequate instructional design (Mayer, 2014c). This indicates that extraneous multimedia learning materials should be eliminated at the instructional design stage to allow sufficient
cognitive capacity for essential and generative processing; it is imperative to minimize unnecessary gaming features and massive audio files to optimally facilitate learning (Clark & Mayer, 2016; Mayer, 2011; Mayer, 2014b; Mayer & Moreno, 2003). To reduce extraneous processing, the missing six multimedia learning principles should be reconsidered for updating game-based online music instruction. First, the coherence principle would improve game-based online instruction; all excessive instructional modes such as background music, audio narrations, still images, and moving images need to be minimized in the game (Fiorella & Mayer, 2014). In the music game, some of the highlighted learning content was not clearly essential material. The essential learning materials should be highlighted by applying the signaling principle (Fiorella & Mayer, 2014; van Gog, 2014). It is also critical to employ the redundancy principle: the printed texts need to be removed from corresponding spoken texts (Fiorella & Mayer, 2014; Kalyuga & Sweller, 2014).

Adding the modality principle is crucial to managing essential processing (Low & Sweller, 2014; Clark & Mayer; 2016; Clark, 2014a; Mayer, 2014c; Mayer & Fiorella, 2014; Mayer, 2014c). It is an especially important principle for game-based online instruction (Clark & Mayer, 2016; Mayer, 2014a). According to the modality principle (Low & Sweller; Mayer, 2014c), students learn better when corresponding texts are presented aurally rather than visually. However, the modality principle was often violated in the game-based online instruction. Whereas many learning materials were narrated in the animations or audio presentations, the corresponding printed texts were mostly adjacent. This somewhat violates the redundancy principle as well, since many of the printed texts were displayed near spoken texts. The complicated instructional design might prevent novice music learners from integrating multiple sources of music-learning materials. The application of the modality principle is especially
important for novice music learners; their working memory system can be easily overloaded due to the great amount of new information to be processed. In this study, 61.4% of the students were at the beginner level. This implies that multimedia online learning materials should be presented based on the modality principle. If all the incoming information is visual, then the learners’ visual working memory will be initially overloaded by the visual images (Mayer & Moreno, 1998; Low & Sweller; Mayer, 2014c). Hence, learners may miss some of the important visual information since they are unable to hold all the incoming visual representations in their working memory at the same time (Mayer & Moreno, 1998). In the same manner, it also implies that music listening examples need to be presented with visual information such as visual feedback or cues. Previous research showed that student achievement in music significantly improved when music examples were presented with corresponding visual images (Howard, & Rush, 1989; Welch, Howard, Himonides, & Brereton, 2005; Paney 2014). If the instructors present massive listening practices with only the auditory channel, learners’ auditory working memories are likely to become overloaded. This music scenario is especially relevant for novice music students. Their working memory may already be overloaded due to the new information, and the overload would become even worse by the auditory-only learning materials. Music learners may miss many listening examples while paying attention to a specific music sample. Thus, the instructors should remove the associated text near animations from the game’s listening materials, rather present the animations with auditory narrations only. If there are numerous new online listening examples, it would be better for them to be presented with visual information, which can be referential with the auditory information. For novice learners, it would be an optimal condition if a small or moderate amount of music learning materials was already familiar.
to them and then was presented with corresponding auditory or visual information at the same
time to avoid purely auditory online presentations.

The final assumption is that students in the game-based online group might not be deeply
engaged in the cognitive learning process since the educational music game omitted some
multimedia learning principles to foster generative processing. The goal of generative processing
is to motivate learners to exert and maintain their effort to comprehend the learning materials at a
certain level (Mayer, 2014c). The guided discovery principle, self-explanation principle, and
drawing principle may improve the existing game mechanics of the music game. Even though
the guided discovery principle was presented in the game, the game’s interactive hints and
feedback were unclear and insufficient to solve problems. Thus, learners might not be motivated
or try to understand the learning materials in an engaged way (Mayer, 2014c). The deficient
instructional design can be upgraded by adopting the guided discovery principle, self-explanation
principle, and drawing principle. It can be enhanced not only by incorporating clear guidance and
comprehensive feedback for the learners, but also by asking them to explain or draw what they
have learned from the lesson (Clark, 2014a; Clark & Mayer, 2016; Mayer, 2014c; de Jong &

In sum, this learning scenario for game-based online music instruction can be explicated
according to the three demands on cognitive capacity proposed by Mayer (2014c). The game-
based online instruction seems to require much extraneous processing from the beginning. First
of all, the majority of the game-based group was at the pre-beginner or beginner level (66.7%),
and stopped their music education after high school (89.4%). The novices in the field of music
would have had high levels of cognitive loads to be processed in general. Additionally, the
inadequate instructional messages in the music game generated even more extraneous processing
for the learners in the beginning. All excessive and complex multimedia learning materials were not properly designed at the instructional design stage. This suggests that the students of the game-based type of online instruction would have had to expend their processing capacity on extraneous processing in the beginning, leaving insufficient cognitive capacity to subsequently proceed forward with essential and generative processing. Not only would there be the potential for students to have missed some essential information, but they may also have been unmotivated to learn. This suggests why the students in the game-based online group achieved relatively lower posttest scores than those of the web-based online group. This learning scenario shows how, eventually, students might be insufficiently motivated for learning even though much research has shown that digital games can improve student motivation to learn.

Web-based online music instruction. All of the following 15 multimedia principles were applied to the web-based online music instruction type: 1) coherence, 2) signaling, 3) redundancy, 4) spatial contiguity, 5) temporal, 6) segmenting, 7) pre-training, 8) modality, 9) multimedia, 10) personalization, 11) voice, 12) embodiment, 13) guided discovery, 14) self-explanation, and 15) drawing principles (Table 5-2). All unnecessary multimedia learning materials that did not support the instructional objectives were removed from the music game at the instructional design stage. The following five multimedia principles were used to eliminate extraneous processing in the web-based online instruction: 1) coherence, 2) signaling, 3) redundancy, 4) spatial contiguity, and 5) temporal. These principles are crucial to minimizing extraneous processing (Mayer, 2014c). The web-based online music instruction was redesigned by using three principles that were not applied in the original music game. For instance, unnecessary narrations, background music, and still images were removed from the original game (coherence principle). Each essential learning subject was highlighted in the learning
modules (signaling principle). The original spoken texts were removed from the corresponding printed texts (redundancy principle). These processes might enable learners to save cognitive capacity for essential processing and generative processing.

Essential processing is crucial since it is directly related to the learning process; complex materials become to-be-learned materials (Mayer, 2014c). In essential processing, learners in the web-based group might easily comprehend complex learning materials. The complex learning materials were redesigned by the other four multimedia learning principles: 1) segmenting, 2) pre-training, 3) modality, and 4) multimedia. These principles facilitate learners in selecting relevant information effectively (Mayer, 2014c). In particular, the modality principle was absent in the game-based online instruction. The modality principle might have produced some positive effects in generating better posttest scores for the web-based online group than those of the game-based group. For example, animations with audio narrations were separated from the corresponding printed texts. This assumes that the students in the web-based online instruction could manage essential processing more efficiently than the learners in the game-based online instruction.

As a result of the relatively efficient extraneous and essential processing above, the students in the web-based online group would have more sufficient cognitive capacity for generative processing than the game-based online group would. Furthermore, the following seven multimedia principles would reinforce student achievement by fostering generative processing: 1) multimedia, 2) personalization, 3) voice, 4) embodiment, 5) guided discovery, 6) self-explanation, and 7) drawing. The goal of generative processing is to make sense of learning materials by organizing incoming information and integrating it with prior knowledge; it is enacted by the learner’s motivation to learn (Mayer, 2014c). Self-explanation and drawing
principles were purposely added onto the web-based online instruction to motivate students by integrating new information with their prior knowledge. For example, web-based online music instruction included exercise questions asking learners to not only explain learning subjects in the lesson (e.g., flute and piccolo and oboe sections), but also to draw different sizes of musical instruments (e.g., string family section). Not only would the process enable them to achieve higher posttest scores than those of the web-based online group, but it could also motivate them to engage in music learning even though there are minimal entertaining or “fun” elements in web-based online instruction, as compared to game-based online instruction.

**Implications for ARCS Components in Online Instruction**

The most important implication is that Confidence may be crucial for students to achieve their academic goals during multimedia learning. As shown in Chapter 4, while the game-based group had generally higher mean scores for ARCS components than those of the web-based group, the mean scores of Confidence in the web-based group were higher and more consistent across the group. Their confidence level was very consistent throughout the online course; they significantly exerted and maintained their learning. Keller (1987, 2010) stated that achievement and persistence are related to Confidence. This statement is aligned with the results of the study in Chapter 4; the pretest and posttest scores were correlated to Confidence. Notably, the posttest scores in the web-based group were strongly correlated to Confidence ($r = .629$). It was evident that the students in the web-based group attained better academic scores and were more confident about online learning. More specifically, the majority of the students in the web-based online group thought the following: that the online lesson was not difficult (92.4%), that there was an adequate amount of information which made it easy to remember important information (63.6%), and that the learning materials were easy to understand (81.8%). These results clearly imply that the easy, comfortable, and adequate level of online music instruction might have made
them consistently confident throughout the entire intervention. This might eventually lead them to accomplish high student achievement scores. For Attention, many of them felt that the web-based online learning did the following: kept their attention (71.2%), was bearable (62.1%), allowed them to learn unexpected information (53%), became bored with the style of writing (68.2%) and found it repetitive (42.4%). However, the game-based group reacted differently regarding the online learning environment. They felt that the game-based learning materials were as follows: eye-catching (62.1%), held their attention (51.5%), and substantial enough to hold their attention (75.8%). Unlike the web-based online learning materials, they perceived that the learning materials were appealing (83.3%), stimulating (60.6%), and presented surprising lessons (54.6%). These findings suggest that students may become less attentive to their online learning if the learning materials are boring and repetitive rather than appealing.

Most of the students in the game-based group thought that they would need music learning even though they did not know most of the music (74.2%). The majority of the students perceived that some stories and pictures were relevant (65.2%), and only 33.3% of the students considered the content of the material irrelevant. In contrast, 51.5% of the students in the web-based group responded that the learning materials were relevant to their learning. Half of the students (52.4%) claimed that completing the lesson was important to them. These findings assume that even though overall motivation was not different between the two groups, the goals of their own learning and the perceived relevance of the learning materials may influence student achievement, as they can integrate new information with their prior knowledge or experience.

**Limitations**

**Time Constraints**

The study has a few limitations. The researcher had to impose several limits to prevent excessive dropouts in the Internet-based experiment. For example, to overcome mortality issues
and time constraints, the study was conducted and examined within an hour instead of over long
time periods such as two to three hours. Since the entire online intervention was designed as a
one-hour session, a full version of the music game was not played in the experiment. All
experiment data were collected from two game sessions of the game’s practice round. The
researcher also recruited a sufficient sample size to prevent unexpected dropouts as well as to
make the research process less complicated or demanding for the participants who were non-
music majors.

**Technological Constraints**

Using Qualtrics® as an online learning platform was extremely important for this
research since the online intervention and research procedures were nicely controlled within the
system by equating the two different conditions. In other words, many extra confounding or
ecological variables were controlled by the system while conducting the research experiment.
However, some technological constraints in Qualtrics® needed to be reported for future research.
The system was originally designed as a developing survey instrument, so the design features for
designing interactive multimedia materials can be limited. For instance, creating interactive
feedback is hard to achieve in the system. Since the Qualtrics® system does not provide the same
timing controls that appear in the full-length version of the narrative game, the researcher chose
the game’s practice round to make an equivalent research setting for both the web-based and
game-based online instruction. For instance, all the research participants in both the online
interventions were able to freely navigate and practice all musical instruments at the touch of a
button. On the other hand, the full length of the game controls each session of the music game;
the gamers were only able to play certain musical instruments after completing gaming tasks
required in the previous round.
Some of the multimedia learning principles (e.g., modality principles) were also unable to be tested within the Qualtrics® system, as the sound system does not support an auto play option for the audio. For example, while the gamers in the game-based online instruction were able to follow a variety of conversational narrations during each gaming session, the learners in the web-based online instruction were able to hear the narrations only when playing the same animations inside each learning module. As a result, one of the modality principles (e.g., having a conversational voice more effective than the others) was achieved within a limited research span.

The Scope of the Learning Subjects

The learning subjects used in the online modules covered only the specific knowledge presented in the educational game, The Young Person’s Guide to the Orchestra®. There were four learning subjects in the online instruction: 1) Benjamin Britten, 2) The Orchestra, 3) The Woodwind Family, and 4) The String Family. To conduct an hour-long research experiment, only two game sections, the woodwind and string families, were selected instead of using a full narrative game consisting of woodwind, string, brass, and percussion instruments. The scope of the music knowledge in the online modules was focused on the general functions of the woodwind and string instruments played in the orchestra as well as a basic knowledge about the orchestra and Benjamin Britten. Thus, other subject areas beyond the primary learning subjects presented in the research were not covered in the online learning modules tested in the research experiment.

The Instructional Design of the Web-Based Online Instruction

Due to the nature of the experimental research design, there were limitations in developing a flexible instructional design for the web-based music instruction. This is because the web-based music instruction precisely followed the basic structure of the educational music game, The Young Person’s Guide to the Orchestra®, to compare two different types of online
instruction without generating biased compounding variables. While this procedure was crucial for designing the web-based instruction to be as equivalent as possible to the game-based online instruction, the various applications of the multimedia design principles were limited when making the web-based online instruction better than the original design of the game. The same multimedia learning materials (texts, audio/visual materials, and animation) were used to eliminate extraneous confounding variables generating biased outcomes that might occur from the different instructional settings.

**Research Conditions for Confounding Variables**

Even though the research chose the strongest experimental research design, which can control for most extraneous confounding variables, some unexpected research conditions (e.g., students’ psychological status) might affect the results of the study. While the research experiment setting was rigorous in the laboratory, there is a possibility that the proposed research design might not be able to control for some extreme research conditions. For example, students’ mood or their physical conditions prior to the research experiment might have impacted their achievement and motivation scores. Therefore, a generalization of the study should be carefully made and take into consideration the potential research conditions.

**A Target Population for Game-Based Learning**

The target population in the research was focused on undergraduates who were non-music majors attending a university in the Southeastern United States. Thus, the student motivation and reactions towards the game-based learning might be limited to the specific target population. For instance, undergraduate engineering majors enrolled in a Northwestern university might have different motivation levels regarding the educational music game, *The Young Person’s Guide to the Orchestra®*. They might like or dislike the music game regardless of the unique design or level since each individual possesses different prior knowledge or
preferences towards playing digital games. Therefore, generalizing student achievement and motivation in this study should be carefully evaluated based on the specific target population that was selected for the research study.

**Delimitations**

There are several delimitations of the study in terms of participants, the digital game (a treatment), research design, the online course, and learning content.

1. The participants in the study were college students who were non-music majors. The learners’ prior knowledge and experience were critical for investigating how different types of multimedia messages should be designed to promote meaningful learning. Therefore, the students who had no prior knowledge and skills for playing music or games were not excluded from the study; rather, they were a central focus in the study. The participants were also active, intelligent, and creative in learning different kinds of academic disciplines outside of their majors. However, the results of the study cannot be generalized beyond the specific context in which the research was implemented. This is because the selected population is a small-scale subset of the general undergraduate population.

2. The web-based and game-based online instruction were designed based on an “educational” music game rather than an “off-the-shelf” commercial music game popular at online stores such as the Apple® app store. As Mayer (2014a) indicated, an educational game used for gaming research should include adequate educational components (Mayer, 2011; Mayer, 2014a). Therefore, the study selected an appropriate educational game that could be used for advanced research. The educational game, *The Young Person’s Guide to the Orchestra®*, was designed by both music educators and professional game designers to contain substantial educational components as well as instructional design features. The instructional elements in the game were critical for developing valuable gaming research. For example, the study was able to pull out important multimedia learning principles from the game such as the pre-training principle, animation principle, personalization principle, voice principle, etc. Commercial games designed for only entertainment purposes do not always include an adequate amount of instructional components to be analyzed unless researchers combine the commercial games with an effective instructional strategy.

3. The study focused on investigating effective online instructional materials that would motivate online learners in the light of the ARCS model. Therefore, common psychological perspectives on motivation and achievement such as intrinsic and extrinsic motivation, self-determination, or perception of competence were not discussed in this study because it is out of the scope of the research purpose. Rather, the learner’s motivation toward instructional materials was investigated focusing on the four main areas of the ARCS model, Attention, Relevance, Confidence, and Satisfaction.

4. The research questions and design were built from the perspective of cognitivism. To answer the research questions, the cognitive theory of multimedia learning was used to investigate
learner’s achievement. It is an appropriate learning theory for examining how individuals in a specific online learning environment would promote their learning outcomes.

5. A music appreciation course is a common type of general music education course that the majority of college students take as a part of their elective course requirements. Many institutes have created new interdisciplinary curricula and instruction in music appreciation courses to bolster students’ academic achievement and motivation. As current educational trends have indicated, modern art education is also moving toward online learning. For this reason, this study focused on online music appreciation instruction, particularly for non-music majors. The learning content in the music course was also chosen considering current teaching and learning trends at the college level. Many college students have participated in or are familiar with college band and orchestra, so the online learning subjects (e.g., woodwind and string families) were selected from the primary knowledge that needed to be learned for their extracurricular activities. The music and game were also selected based on the purpose of the research. The Young Person’s Guide to the Orchestra written by Benjamin Britten is a popular orchestral piece composed to educate the general public. Similarly, the online educational game, The Young Person’s Guide to the Orchestra® was released publicly to foster diverse music appreciation learning experiences for global online communities. Therefore, it was reasonable to base both the web-based and game-based online instruction on the selected learning content and instructional materials.

   The main delimitations came from the nature of the experimental research design that required restricted research conditions. Most of all, it was extremely critical to equate the two different online instructions to analyze all the instructional elements that might influence student motivation and achievement. The web-based online instruction was designed with equivalent instructional modes (e.g., texts, audios, and videos, and animations) and methods so that the researcher could compare the treatment group (a game group) with the conventional group. The two online interventions were also built into Qualtrics® to facilitate the same time allocation and ecological online learning environment. The researcher chose a local game practice round instead of the full narrative game round to make an equivalent research setting for both the web-based and game-based online instruction. This was because the design of the local game round was more equivalent with those of the web-based instruction built into the Qualtrics® system.

   The main learning theory in this research was cognitivism, and the research design, data analysis, and interpretation were developed using cognitive learning perspectives. Cognitivism
was an important theoretical knowledge base for the study. The cognitive perspective provided meaningful implications on how to design cognitively effective online instruction using a new multimedia, such as a game, to promote the students’ motivation and achievement. Even though the proposed experimental research design would not allow for designing creative and flexible online instruction, the research is valuable since there is little evidence-based gaming research in the context of music. However, an extensive generalization far beyond the research context may cause different learning outcomes and practices so that the results of the study might not be fully generalized in all research contexts.

**Recommendations**

**Recommendations for Instructors and Instructional Designers**

Several lessons can be learned through this study. Instructors and instructional designers should pay attention to how people learn, as well as what applications and strategies are appropriate for specific teaching and learning situations. Based on the results of this study, the findings, implications, and subsequent recommendations are revealed in the multimedia learning process, game-based online instruction, and ARCS motivation components. The following are not absolute rules or strategies for instructional design; rather, they are part of a wide range of suggestions and solutions for similar research studies with identical target populations.

**Prospective applications and strategies for multimedia learning.** Successful learning does not occur by randomly selecting a good instructional design practice from various teaching and learning situations; rather, it is achieved by carefully evaluating how people learn. Three goals need to be considered when designing an optimal multimedia online learning environment. As we reviewed in the previous chapters, the cognitive theory of multimedia learning is a central framework for how we designed an effective multimedia online learning environment. Above all, instructors and instructional designers need to understand the three conditions of cognitive
processing, and they should be able to evaluate how learners construct new knowledge with the acknowledgment of our always-limited cognitive capacity. By examining extraneous, essential, and generative processing in advance, teachers and instructional designers can identify which multimedia learning principles are the most appropriate for a specific teaching and learning situation.

First, simplifying music learning materials might be important for non-music majors instead of intensely focusing on only the music curriculum and course schedules. It is recommended that instructional designers plan this strategy at the beginning of the instructional design stage so that learners will have conserved their precious cognitive capacity for actual music learning. To accomplish this strategy, unnecessary instructional modes such as massive texts, audio, videos, or any other complicated multimedia learning materials that are unrelated to the prospective learning goals or objectives need to be curtailed in the beginning. Music instructors may limit the number of music files, control playing times for entire songs, or remove excessive music examples that are not relevant to the learning objectives. If the learners need to practice listening to Mozart’s music, then a good instructional design would let them focus on the music itself, not the fancy images of Mozart, theater costumes, or the theater stages of the performance that can appear in online learning materials. Instructional designers might consider presenting the artistic features of the learning materials in a way that the additional features do not distract the learners, and thus consume their cognitive capacities on irrelevancies.

Second, it is recommended for instructional designers to be aware of the modality principle. Auditory-only or visual-only learning materials may cause a mental overload for learners, since all incoming information may be entered and clustered at only one channel. Thus, instructors and instructional designers might consider presenting multimedia music learning
materials with corresponding visual images so that auditory and visual channels can refer to each other. For instance, music history videos can be presented with spoken texts from a narrator, not displayed with both spoken and printed texts together. Furthermore, the learners are more likely to improve their music learning when music information is presented with visual images. Halpern (1992) stated that learners improved their music learning when the music information was visually presented with a historical background. In addition, the feedback from the visual images might support music learners (Welch, Howard, & Rush, 1989; Paney & Kay, 2015; Paney, 2015; Welch, Howard, Himonides, & Brereton, 2005).

As Payne (1973) reported, novice music learners may be more engaged in their music appreciation learning when they are familiar with the music. It is suggested that instructors and instructional designers organize all multimedia learning materials not only to make sense to learners, but also to encourage them to integrate the materials with their prior knowledge. In other words, instructors and instructional designers might consider reorganizing the learning materials according to the learners’ views to motivate them to learn. For example, for non-music major students who love rock music, but do not know about classical music, music instructors may describe the structure of orchestral music by comparing it with the similar structure of rock music. When multimedia learning materials are explained in the learner’s own words or views, these materials are more likely to be attractive to them; as a result, they may motivate learners to pursue and maintain the learning process. Overall, each student retains different levels of cognitive capacity, prior knowledge, and experience. It would be imperative to carefully review their unique characteristics when designing multimedia instructional messages.

**Prospective applications and strategies for game-based online instruction.** There are three recommendations for game-based online learning in music. The multimedia online music
materials need to be organized and aligned without losing the desired learning outcomes (Mayer, 2011; Clark & Mayer, 2016). To use a digital game for online learning, it is recommended that instructors and instructional designers set up precise and clear instructional objectives and goals within specific subject areas that reinforce both achievement and motivation (Zeigler, 1974). Since many modern digital games include complex gaming features, the primary learning goal can be easily lost during gameplay. In particular, explanatory narrative games like The Young Person’s Guide to the Orchestra® tend to layer great amounts of storytelling in the game. In this case, knowing the clear goal would be imperative when planning to use a narrative game for online music learning since narrative games contain complex gaming elements including core mechanics, goals, conflict, and uncertainty (Salen & Zimmerman, 2004). If music instructors plan to adopt a narrative game into their online learning, they would need to pay attention to the goal of the game. The gaming goal is a fundamental building block of narrative game design, which guides and supports learners’ progress (Salen & Zimmerman, 2004). Clearly, it is recommended for instructional designers to avoid massively open-ended, unstructured, and exploratory narrative games for learning, since they may cause extraneous cognitive processing, which prevents learners from proceeding to essential and generative processing by limiting their cognitive capacity (Clark & Mayer, 2016).

Second, feedback is the most highlighted and successful gaming element for learning. Cameron and Dwyer (2005) stated that feedback guides “the learning process and provide[s] students with a sense of satisfaction and/or accomplishment” (p. 224). In their research, 300 undergraduates completed three types of instructional units: 1) questions without feedback, 2) questions with knowledge of response feedback, and 3) questions with elaborative feedback. The results of the study indicated that the student group that received elaborative feedback improved
their achievement the most. They stated that games without elaborative feedback are not an effective strategy for learning. Moreno and Mayer (2005) and Leemkuil (2006) also concluded that elaborative feedback is more important than simple response feedback for stimulating learning. The common finding of this research is that the use of feedback in the game promotes a positive effect on learning and transfer (De Jong, 2011). It indicates that instructors and instructional designers may consider providing sufficient feedback that can be used as reference information to support learning. Importantly, exploratory or elaborative feedback would be more beneficial than a simple knowledge response (Cameron & Dwyer, 2005; Leemkuil, 2006; Moreno & Mayer, 2005).

Different kinds of elaborative or explanatory feedback can be used for online music learning. Paney and Kay (2015) tested a singing game called SingingCoach. Their study showed that the participants improved their pitch-matching based on immediate and concurrent feedback. These are particularly important in music education since the majority of music learning requires immediate feedback as part of the lesson. In this case, digital games can be used as a convenient and alternative online learning tool for music education when music teachers cannot formally attend the class, or they have a relatively short game in class (Paney & Kay, 2015). Similarly, visual feedback and cues are recommended to promote student achievement for music learning (Howard, & Rush, 1989; Welch, Howard, Himonides, & Brereton, 2005; Paney 2014).

**Prospective applications and strategies for ARCS components.** The ARCS components require essential strategies. According to Keller (2010), there are three categories in the Attention subscale: perceptual arousal, inquiry arousal, and variability (Keller, 2010). As presented in Chapter 4, the characteristics of music appreciation learning are greatly appealing to the learner’s emotions and interests. According to Zeigler (1974), the primary goal of music
education is to encourage informed and interested audiences. In that sense, perceptual arousal would be the first step to motivate online learners in music education. Music instructors and instructional designers should carefully create specific learning events or guidance that closely appeals to the learner’s emotions. Payne (1980) stated that the emotional appeals of music were less strong with well-trained listeners. If the learners are well-trained musicians or in the upper levels of music learning, familiar music would be less appealing to the listeners (Payne, 1980). On the other hand, novice learners become personally engaged in music learning when they are familiar with the music (Payne, 1973). This suggests that music listening examples need to be carefully selected for novice learners.

Another practical design tip is that instructional designers can practice some variation in the online music appreciation course. Unlike when using a face-to-face format, online instructors can practice changing narrators or speakers of the audio or video recordings. Many students in the research experiment expressed that there was a great amount of repetition and that the same patterns of instructional methods were not appealing. By avoiding the same patterns or repetitive features, instructional designers or game designers may improve the quality of the online learning.

To achieve relevance, the primary key is to know whether the online learning materials support what learners need or their personal goals. Well-designed online learning, if irrelevant, would still decrease the learner’s motivation. Music instructors or instructional designers may encourage learners by recalling their initial goals or objectives in the middle of the music lesson.

The third step is to make the learners confident. According to Keller (1987), true confidence comes from one’s ability and effort to be successful, not from luck or difficult tasks. Since Confidence is closely related to achievement and persistence (Keller, 1987, 2010),
instructional designers may consider this a special condition that stimulates learning. For example, instructors may set up very realistic and achievable goals as a reward. Also, instructors can slowly increase the difficulty level of the task so that they keep learners persistent as well as make them reach a high level of learning by providing sufficient feedback.

Keller (1987, 2010) suggested three important strategies for Satisfaction: unexpected rewards, positive outcomes, and frequent reinforcement. Most of all, immediate feedback might be crucial for an online music appreciation course since music learning has been traditionally practiced in a face-to-face format with frequent immediate feedback. For instance, many forms of music learning require immediate feedback after music listening or performance. If students play wrong musical notes, the music teacher immediately points them out and shows the students how to play the correct pitch. Research has also reported how computer games or computer software programs could improve student involvement and achievement (Welch, Howard, & Rush, 1989; Paney & Kay, 2015; Paney, 2015; Shi-Jer, Yuan-Chang, Yi-Zhen, Ru-Chu, & Wei-Yuan, 2011; Welch, Howard, Himonides, & Brereton, 2005). Since online instructors do not always contact the learners at the individual level, it is recommended that the instructors and instructional designers design the online music instruction to be more communicative and interactive by using immediate and concurrent feedback (Paney & Kay, 2015; Paney, 2015; Welch, Howard, Himonides, & Brereton, 2005; Welch, Howard, & Rush, 1989).

**Recommendations for Future Research**

Future research can be completed in various ways. To begin with, researchers can explore the other two game sessions in *The Young Person’s Guide to the Orchestra®*. Since this study used only two game sessions, the string and woodwind instruments, additional research can be expanded with the other two game sessions on brass and percussion instruments. Furthermore, various online learning environments in different music areas such as performance or
composition can be included in future research. Second, the duration of the research can be executed differently. The student achievement and motivation in this study was investigated over an hour-long online lesson so that the results of the study could be concluded based on short-term online learning. To investigate more broad and dynamic online learning environments, it would be beneficial to research weekly-based or semester-based online courses. It would also be meaningful to compare the game-based online learning environment with a face-to-face format. In particular, collaborative online learning environments integrated with the sociocultural learning theory would be supportive and substantial as an extension. In this context, a mixed-method approach may generate rich interpretations of learners’ behaviors on gaming and the multimedia learning environment.

This study focused only on learner motivation and achievement; however, the roles of instructors and feedback issues in the online learning environment need to be addressed in future research because they are critical for encouraging online students to be motivated and active. Lastly, the educational game, The Young Person’s Guide to the Orchestra®, is a 2D digital game. There are a variety of digital games and futuristic technologies such as 3D or virtual reality that can be utilized within multimedia online learning environments. It is worthwhile to investigate these new technologies, testing with the cognitive theory of multimedia learning and multimedia learning principles.

Conclusions

This study compared two different online learning environments in terms of student motivation and achievement. Web-based and game-based online instruction were compared to investigate whether students’ achievement and motivation were different within each instruction condition. The conceptual framework was made based on Mayer’s (2014c) cognitive theory of multimedia learning and the ARCS model developed by John Keller (2010). One hundred and
thirty-two undergraduates participated in a one-hour, online learning experiment, and they were randomly assigned to either the control group or the treatment group. The students’ motivation and achievement in music appreciation learning were measured by 20 achievement questions and the IMMS motivation survey. The collected data were analyzed using MANOVA and ANCOVA. The results of the study showed that the web-based online group attained better student achievement scores than those of the game-based online group. The game-based online instruction did not outperform the web-based online instruction mainly because it was unable to eliminate extraneous cognitive processing and prioritize learners’ cognitive capacities for essential and generative processing. There was no difference in student motivation between the web-based and game-based online groups. However, the study revealed that confidence was critical to improving student achievement in the multimedia online learning environment. It is also important to note that generalized assumptions about this study should be carefully made since its results are based on a very specific online learning context, including a unique timeline and target population. For instance, this research investigated one-hour online music instruction based on a specific target population, which consisted of undergraduates who were non-music majors attending a Southeastern public university.

In sum, there are no absolute rules or principles for optimal instructional design; however, this study of game-based online music instruction provided concrete evidence not only on how to improve the multimedia online learning environment in the field of music, but also how to design motivating multimedia learning environments wherein learners accomplish their educational goals. Nevertheless, we know the online learning environment is always alive and evolving; thus, we need to be more creative and innovative when designing sound online learning environments for higher education.
### APPENDIX A
### INSTRUCTIONAL MOTIVATION MATERIAL SURVEY (IMMS)

**Attention**

<table>
<thead>
<tr>
<th>Item</th>
<th>Not true</th>
<th>Slightly true</th>
<th>Moderately true</th>
<th>Mostly true</th>
<th>Very true</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. There was something interesting at the beginning of this lesson that got my attention.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. These materials are eye-catching.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. The quality of the writing helped to hold my attention.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. This lesson is so abstract that it was hard to keep my attention on it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. The pages of this lesson look dry and unappealing.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. The way the information is arranged on the pages helped keep my attention.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. This lesson has things that stimulated my curiosity.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. The amount of repetition in this lesson caused me to get bored sometimes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. I learned some things that were surprising or unexpected</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. The variety of reading passages, exercises, illustrations, etc., helped keep my attention on the lesson.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. The style of writing is boring.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. There are so many words on each page that it is irritating.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relevance</td>
<td>Not true</td>
<td>Slightly true</td>
<td>Moderately true</td>
<td>Mostly true</td>
<td>Very true</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>----------</td>
<td>---------------</td>
<td>-----------------</td>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td>1. It is clear to me how the content of this material is related to things I already know.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. There were stories, pictures, or examples that showed me how this material could be important to some people.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Completing this lesson successfully was important to me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. The content of this material is relevant to my interests.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. There are explanations or examples of how people use the knowledge in this lesson.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. The content and style of writing in this lesson convey the impression that its content is worth knowing.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. This lesson was not relevant to my needs because I already knew most of it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I could relate the content of this lesson to things I have seen, done, or thought about in my own life.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. The content of this lesson will be useful to me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Confidence

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not true</th>
<th>Slightly true</th>
<th>Moderately true</th>
<th>Mostly true</th>
<th>Very true</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. When I first looked at this lesson, I had the impression that it would be easy for me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. This material was more difficult to understand than I would like for it to be.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. After reading the introductory information, I felt confident that I knew what I was supposed to learn from this lesson.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Many of the pages had so much information that it was hard to pick out and remember the important points.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. As I worked on this lesson, I was confident that I could learn the content.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. The exercises in this lesson were too difficult.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. After working on this lesson for awhile, I was confident that I would be able to pass a test on it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I could not really understand quite a bit of the material in this lesson.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. The good organization of the content helped me be confident that I would learn this material.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>Not true</td>
<td>Slightly true</td>
<td>Moderately true</td>
<td>Mostly true</td>
<td>Very true</td>
</tr>
<tr>
<td>--------------</td>
<td>---------</td>
<td>---------------</td>
<td>-----------------</td>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td>1. Completing the exercises in this lesson gave me a satisfying feeling of accomplishment.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>2. I enjoyed this lesson so much that I would like to know more about this topic.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>3. I really enjoyed studying this lesson.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>4. The wording of feedback after the exercises, or of other comments in this lesson, helped me feel rewarded for my effort.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>5. It felt good to successfully complete this lesson.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>6. It was a pleasure to work on such a well-designed lesson.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>O</td>
</tr>
</tbody>
</table>
APPENDIX B
20 ACHIEVEMENT QUESTIONS

The following questions are designed to test your previous knowledge and information relating to the "Orchestra." A total of 20 questions are given to you. Please choose the best answer for each question.

Which one of the following musical pieces is originally written by Benjamin Britten to educate people about the musical instruments in the symphony orchestra?

- The Young Person’s Guide to the Orchestra
- Symphonie Fantastique
- Eroica
- Jupiter
- The Lord of the Rings

What is the name of the composer who loved to write music throughout his childhood and wrote some of the most well-known music pieces such as Ceremony of Carols, War Requiem, and the operas Peter Grimes and Billy Budd.

- Schubert
- Beethoven
- Britten
- Mozart
- Bach

Which instrument group would be placed in front of the orchestra stage (the red section)?

- Singers
- Percussion
- String
- Brass
- Woodwind

Which of the following families is NOT included in an orchestra?

- Brass
- String
- Percussion
- Singers
- Woodwind
Which one of these musical instruments is a part of the woodwind family?

- Trumpet - Tuba
- Woodblock - Whip
- Clarinet - Oboe
- Harp - Violin
- Piano - Xylophone

Which two musical instruments are played by blowing across the mouthpiece?

- Flute – Oboe
- Clarinet – Piccolo
- Clarinet – Oboe
- Flute – Piccolo
- Bassoon – Piccolo

What is the musical instrument that can make the highest pitch?

What is the woodwind instrument that can make the lowest pitch?

- Flute
- Oboe
- Piccolo
- Bassoon
- Clarinet
Which two instruments use the “Reed” to play sound?

- Flute – Trumpet
- Piccolo – Harp
- Clarinet – Viola
- Oboe – Clarinet
- Flute – Piccolo

Which one of these instruments is a smaller version of the flute?

- Oboe
- Piccolo
- Trumpet
- Clarinet
- Bassoon

Which statement is true if you want to make the lowest pitch by playing the clarinet?

- The player should close the first two holes of the clarinet
- The player should open the second hole of the clarinet
- The player should open all the holes of the clarinet
- The player should close all the holes of the clarinet
- The player should open the third hole of the clarinet

Which musical instrument’s tube is bent in two due to its size?

- Trumpet
- Bassoon
- Oboe
- Flute
- Clarinet
Which of these musical instruments is a part of the string family?

- Tuba
- Viola
- Timpani
- Trumpet
- Xylophone

What is the name of this instrument below, which has longest and thickest strings making the lowest pitches?

- Cello
- Double Bass
- Viola
- Violin
- Harp

Which one of these statements is TRUE concerning the Harp?

- Fifty strings are arranged in order from longest to shortest
- The longest strings make the lowest pitches
- The longest strings make the highest pitches
- A bow is used to play the harp
- Pedals are placed at the top of the harp

Which one of these instruments is a larger version of the Violin and is also held in the same manner?

- Cello
- Double Bass
- Viola
- Guitar
- Harp
Arrange these string instruments from the highest pitches to the lowest pitches.

- Viola - Cello - Violin - Double Bass
- Violin - Viola - Cello - Double Bass
- Cello - Viola - Violin - Double Bass
- Double Bass - Cello - Violin - Viola
- Double Bass - Violin - Viola - Cello

What is a big common feature among the violin, viola, cello, and double bass?

- Violin, viola, cello, and double bass use a bow to play sound
- Each instrument has the same size hollow wooden box with five strings
- Musicians sit on a chair and hold each instrument between their knees
- Musicians play each instrument by holding it on their left shoulder under the chin
- Each instrument has a pedal at the bottom to play different pitches

Which one of these statements is NOT true concerning the violin and viola?

- The bridge in the middle of the wooden hollow box makes vibrated sound and the hollow bodies of the instruments amplify the sound
- Both violin and viola are held on the player's left shoulder under the chin
- Different pitches can be played by pressing down on the strings with the fingers of the left hand on the fingerboard
- The player can play 'pizzicato' by moving a bow back and forth across the strings
- The player uses a bow to play 'arco' by moving back and forth across the strings

Which one of these statements is NOT true concerning cello and double bass?

- While cello can only be played by sitting on a chair, double bass can be played by either standing or sitting on a stool.
- A metal spike called an end-pin is attached to the bottom and sticks into the floor
- The strings of the cello and double bass have much thicker strings that make lower pitches than those of violin and viola
- A higher pitch can be played when pressing down on the part of string closer to the scroll
- A higher pitch can be played when pressing down on the part of string closer to the bridge
Attribution for the images:

1. Flute
The image was created by Powerhouse Museum - Powerhouse Museum, Australia, CC BY-SA 2.5, https://commons.wikimedia.org/w/index.php?curid=37950231

2. Piccolo

3. Oboe
The image was created by Aquazer from fi, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=1993236

4. Clarinet
The image was created by Clarinet.jpg:Ratigan at fr.wikipedia, and it was the same file as Mezzofortist uploaded here. Later versions were uploaded by Luna04, lunity at fr.wikipedia.
This is a cropped version of lunity's version. derivative work: Finemann (Clarinet.jpg) [Copyrighted free use], from Wikimedia Commons

5. Bassoon
The image was created by Gregory F. Maxwell <gmaxwell@gmail.com> PGP:0x80413BFA (By uploader) [GFDL 1.2 (http://www.gnu.org/licenses/old-licenses/fdl-1.2.html)], via Wikimedia Commons

6. Double Bass
The image was created by User:AndrewKepert [GFDL (http://www.gnu.org/copyleft/fdl.html) or CC-BY-SA-3.0 (http://creativecommons.org/licenses/by-sa/3.0/)], via Wikimedia Commons
APPENDIX C
WEB-BASED ONLINE MUSIC INSTRUCTION

An Instruction to the Orchestra
(Web-Based Online Music Instruction)

College of Education
University of Florida

Note: All audio and visual materials in this lesson were either used by special permission of the copyright owner or the researcher followed fair-use rules required by copyright law in using them. Any audio recordings produced by Naxos of America were not used in this research.
WAIVER OF CONSENT

University of Florida, Department of Education:
2423 Norman Hall, PO BOX 117048, Gainesville, FL 32611

Name of Investigator(s):
YoungJu Kang (Principal Investigator), Albert D. Ritzhaupt (Faculty Mentor)

Title of Project:
A Comparative Study of Game-Based Online Instruction in Music Appreciation: An Analysis of Student Motivation and Achievement.

Request to Participate in Research:
We would like to invite you to participate in a web-based online intervention. The online intervention is part of a research study whose purpose is to examine how game-based online instruction affects student motivation and achievement in the process of learning music. This research should take about one hour to complete.

We are asking you to participate in this study because you are a UF student and 18 years or older. You must be at least 18 years old to take this online intervention.

The decision to participate in this research project is voluntary. You do not have to participate and you can refuse to answer any question. Even if you have already begun the web-based online intervention, you can stop at any time.

There are no foreseeable risks or discomforts to you for taking part in this study.

Depending on your class, there will be extra credit being offered as an incentive for participating. However, the extra credit will not exceed 1% of overall grade, and there are no benefits to you other than to further research.

Your part in this study is anonymous to the researchers. However, because of the nature of web-based research, it is possible that respondents could be identified by the IP address or other electronic record associated with the response. Neither the researcher nor anyone involved with this research will be capturing those data. Any reports or publications based on this research will use only group data and will not identify you or any individual as being affiliated with this project. In addition, there are no direct benefits to the researcher for participating in the study.
If you have any questions regarding electronic privacy, please feel free to contact Rob Adams, UF’s Chief Information Security Officer via phone at 352-273-1344 or via email at security@ufl.edu.

If you have any questions about this study, please feel free to contact YoungJu Kang, College of Education, University of Florida, Gainesville, FL 32608. Tel: 646.472.9306, Email: yk470@ufl.edu, the person mainly responsible for the research. You can also contact Dr. Albert D. Ritzhaupt, College of Education, University of Florida, 2423 Norman Hall (Office: G518), PO BOX 117048, Gainesville, FL 32611, Tel: 352.273.4180, Email: aritzhaupt@coe.ufl.edu, the Faculty Mentor.

If you have any questions regarding your rights as a research participant, please contact the UF IRB-02 at 352-392-0433 or irb2@ufl.edu. You may call anonymously if you wish.
This study has been reviewed and approved by the University of Florida Institutional Review Board (# 201602000).

By clicking on the accepted button below you are indicating that you consent to participate in this study.

Thank you very much for your time and support.

Kang, YoungJu
Introduction

Welcome to online music lecture at the University of Florida! This brief instruction will provide you with basic information on how to you complete the project. There are four key steps to succeed at the research project.

**Step 1:** To begin with, please complete the basic information about yourself (e.g., your major). A 10-minute pretest will be given to you after the short demographic survey.

**Step 2:** Complete your online lecture by using a specific online learning material integrated in the online lecture. You will need to review all the knowledge and information for approximately 30 minutes. You can browse through each learning content by clicking the arrow key.

**Step 3:** A 10-minute post-test will be given to you in order to test the learned materials after the online lecture. All test questions are based on the knowledge and contents you have learned in the lecture.

**Step 4:** You will need to complete the IMMS (Instructional Materials Motivation Survey) questionnaire for the final step. Please complete all survey questions within 10 minutes and submit them accordingly.

If you have understood and finished the instruction, please click the following arrow button to move forward to the next step. Should you need any further assistance before starting your online lecture, please do not hesitate to contact me at yk470@ufl.edu.
Section 1: Background Information
This section will ask you about your background information in relation to gender, ethnicity, education, and major. Select the answers that best describe yourself.

What is your gender?

- Female
- Male

Which category best describes your age group?

- 18-20
- 21-25
- 26-29
- 30-35
- 35 or older

Which race/ethnicity best describes you?

- American Indian or Alaskan Native
- Asian / Pacific Islander
- Black or African American
- Hispanic American
- White / Caucasian
- Multiple ethnicity / Other (please specify)

What is your nationality? (please specify)


What is your educational classification?

- Freshman
- Sophomore
- Junior
- Senior
- Other

Previous  Next
Section 2: Knowledge and Experience about Technology and Online Learning

In this section, you will need to recall your previous knowledge and experiences about online learning. Please click the best answers that describe yourself.

Are you confident about browsing the Internet from your computer or mobile phone?

- Not at all confident
- Slightly confident
- Moderately confident
- Very confident
- Extremely confident

How many online courses have you taken before?

- None
- 1-2
- 3-5
- 6-10
- More than 10 courses

Which of these multimedia online learning materials are you most familiar with?

- Text-based learning
- Audio-based learning
- Video-based learning
- Game-based learning
- Others (please specify)

What is your favorite multimedia online learning material?

- Text-based learning
- Audio-based learning
- Video-based learning
- Game-based learning
- Others (please specify)
**Agreement/Disagreement Status**

Strongly Disagree = 1, Disagree = 2, Neither nor Disagree = 3, Agree = 4, Strongly Agree = 5

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A fully online course is useful for accessing my grades and multimedia learning materials.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2. A fully online course is effective because it is flexible and interactive while providing new knowledge and information.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>3. A fully online course makes me uncomfortable due to the learning environment.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>4. A fully online course makes me feel challenged because online learning technologies are complicated.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Section 3: Knowledge and Experience about Digital Games
This section will ask you about your previous knowledge and experience in relation to digital games. Please answer what your favorite digital games and simulations are.

How many hours do you play digital games per week?

- None
- 1-2 hours
- 3-5 hours
- 5-8 hours
- Other (please specify)

Agreement/Disagreement Status

Strongly Disagree = 1, Disagree = 2, Neither nor Disagree = 3, Agree = 4, Strongly Agree = 5

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Digital games and simulations can be used in a regular curriculum and instruction.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2. I would like to use digital games and simulations to improve my online learning experience.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>3. I often use digital games as online learning materials.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Section 4: Knowledge and Experience about Music Learning
This section will ask you about your previous knowledge and experience in relation to music education. Please choose the answer that best describes yourself.

When was the last music learning experience that you had?
- Preschool
- Elementary School
- Middle School
- High School
- Informal learning outside of school

What kinds of instruments can you play? (Please specify)

Have you participated in a high school band or orchestra?
- Yes
- No
- Other (please specify)

I consider myself as a musician:
- Pre-Beginner Level
- Beginner Level
- Intermediate Level
- Upper Intermediate Level
- Professional Level

Agreement/Disagreement Status
Strongly Disagree = 1, Disagree = 2, Neither nor Disagree = 3, Agree = 4, Strongly Agree = 5

1. I can read and play musical scores.

2. Learning music is important for both my academic and personal life success.
The following questions are designed to test your previous knowledge and information relating to the "Orchestra." A total of 20 questions are given to you. Please choose the best answer for each question.

Which one of the following musical pieces is originally written by Benjamin Britten to educate people about the musical instruments in the symphony orchestra?

- The Young Person's Guide to the Orchestra
- Symphonie Fantastique
- Eroica
- Jupiter
- The Lord of the Rings

What is the name of the composer who loved to write music throughout his childhood and wrote some of the most well-known music pieces such as Ceremony of Carols, War Requiem, and the operas Peter Grimes and Billy Budd?

- Schubert
- Beethoven
- Britten
- Mozart
- Bach

Which instrument group would be placed in front of the orchestra stage (the red section)?

- Singers
- Percussion
- String
- Brass
- Woodwind

Which of the following families is NOT included in an orchestra?

- Brass
- String
- Percussion
- Singers
- Woodwind
Which one of these musical instruments is a part of the woodwind family?

- Trumpet - Tuba
- Woodblock - Whip
- Clarinet - Oboe
- Harp - Violin
- Piano - Xylophone

Which two musical instruments are played by blowing across the mouthpiece?

- Flute – Oboe
- Clarinet – Piccolo
- Clarinet – Oboe
- Flute – Piccolo
- Bassoon – Piccolo

What is the musical instrument that can make the highest pitch?

- Flute
- Oboe
- Piccolo
- Bassoon
- Clarinet

What is the woodwind instrument that can make the lowest pitch?

- Flute
- Oboe
- Piccolo
- Bassoon
- Clarinet
Which two instruments use the "Reed" to play sound?

- Flute – Trumpet
- Piccolo – Harp
- Clarinet – Viola
- Oboe – Clarinet
- Flute – Piccolo

Which one of these instruments is a smaller version of the flute?

- Oboe
- Piccolo
- Trumpet
- Clarinet
- Bassoon

Which statement is true if you want to make the lowest pitch by playing the clarinet?

- The player should close the first two holes of the clarinet
- The player should open the second hole of the clarinet
- The player should open all the holes of the clarinet
- The player should close all the holes of the clarinet
- The player should open the third hole of the clarinet

Which musical instrument’s tube is bent in two due to its size?

- Trumpet
- Bassoon
- Oboe
- Flute
- Clarinet
Which of these musical instruments is a part of the string family?

- Tuba
- Viola
- Timpani
- Trumpet
- Xylophone

What is the name of this instrument below, which has longest and thickest strings making the lowest pitches?

- Cello
- Double Bass
- Viola
- Violin
- Harp

Which one of these statements is TRUE concerning the Harp?

- Fifty strings are arranged in order from longest to shortest
- The longest strings make the lowest pitches
- The longest strings make the highest pitches
- A bow is used to play the harp
- Pedals are placed at the top of the harp

Which one of these instruments is a larger version of the Violin and is also held in the same manner?

- Cello
- Double Bass
- Viola
- Guitar
- Harp
Arrange these string instruments from the highest pitches to the lowest pitches.

- Viola - Cello - Violin - Double Bass
- Violin - Viola - Cello - Double Bass
- Cello - Viola - Violin - Double Bass
- Double Bass - Cello - Violin - Viola
- Double Bass - Violin - Viola - Cello

What is a big common feature among the violin, viola, cello, and double bass?

- Violin, viola, cello, and double bass use a bow to play sound
- Each instrument has the same size hollow wooden box with five strings
- Musicians sit on a chair and hold each instrument between their knees
- Musicians play each instrument by holding it on their left shoulder under the chin
- Each instrument has a pedal at the bottom to play different pitches

Which one of these statements is NOT true concerning the violin and viola?

- The bridge in the middle of the wooden hollow box makes vibrated sound and the hollow bodies of the instruments amplify the sound
- Both violin and viola are held on the player's left shoulder under the chin
- Different pitches can be played by pressing down on the strings with the fingers of the left hand on the fingerboard
- The player can play ‘pizzicato’ by moving a bow back and forth across the strings
- The player uses a bow to play ‘arco’ by moving back and forth across the strings

Which one of these statements is NOT true concerning cello and double bass?

- While cello can only be played by sitting on a chair, double bass can be played by either standing or sitting on a stool.
- A metal spike called an end-pin is attached to the bottom and sticks into the floor
- The strings of the cello and double bass have much thicker strings that make lower pitches than those of violin and viola
- A higher pitch can be played when pressing down on the part of string closer to the scroll
- A higher pitch can be played when pressing down on the part of string closer to the bridge
Attribution for the images:

1. Flute
The image was created by Powerhouse Museum - Powerhouse Museum, Australia, CC BY-SA 2.5, [https://commons.wikimedia.org/w/index.php?curid=37950231](https://commons.wikimedia.org/w/index.php?curid=37950231)

2. Piccolo
The image was created by User:Cæsura - Image taken by User:Cæsura using a Hewlett Packard 315 digital camera., Public Domain, [https://commons.wikimedia.org/w/index.php?curid=366131](https://commons.wikimedia.org/w/index.php?curid=366131)

3. Oboe
The image was created by Aquazer from fi, CC BY-SA 3.0, [https://commons.wikimedia.org/w/index.php?curid=1993236](https://commons.wikimedia.org/w/index.php?curid=1993236)

4. Clarinet
The image was created by Clarinet.jpg:Ratigan at fr.wikipedia, and it was the same file as Mezzofortist uploaded here. Later versions were uploaded by Luna04, lunity at fr.wikipedia. This is a cropped version of lunity's version. derivative work: Finemann (Clarinet.jpg) [Copyrighted free use], from Wikimedia Commons

5. Bassoon
The image was created by Gregory F. Maxwell <gmaxwell@gmail.com> PGP:0xB0413BFA (By uploader) [GFDL 1.2 (http://www.gnu.org/licenses/old-licenses/fdl-1.2.html)], via Wikimedia Commons

6. Double Bass
The image was created by User:AndrewKepert [GFDL (http://www.gnu.org/copyleft/fdl.html) or CC-BY-SA-3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons
Good Job! You have just finished your pretest. Click the "Start My Online Lecture" button to begin.
An Instruction to the Orchestra:

“The Young Person’s Guide to the Orchestra”
by Benjamin Britten
Welcome to the music appreciation class at the University of Florida! In this course, you will learn about music through listening examples in each chapter. A cue sign, which looks like a small hand (see Example 1), will play 'Themes,' 'Variation,' and 'Fugue' in the listening example. Please follow the cue sign while listening to the music you play.

Example 1. A cue sign

Now, we are about to learn about Benjamin Britten, a British composer who wrote the famous orchestra piece, "the Young Person's Guide to the Orchestra." So, what is the "Orchestra"? Let's figure it out together! Please click the next button to start the first chapter.

Music Reference
The "Orchestra" was performed by the YouTube Symphony Orchestra. The original music can be accessed at the following link, https://www.youtube.com/watch?v=3HhTMJ2bek0&index=9&list=PLxGkvEhGyzaFPMvRBHgWfVtatuoe

**Notes: Images without attribution were derived from the game link, the Young Person's guide to the Orchestra (http://listeningadventures.carnegiehall.org/game.aspx). Copyright permission was attained for all the images from the game link."
The Young Person's Guide to the Orchestra
In 1945, the famous composer Benjamin Britten was asked by the British Ministry of Education to write a piece of music that would teach children about the instruments in the symphony orchestra. The music was to go with a movie called Instruments of the Orchestra. With or without the movie, Britten's music has become a classic. Not only is it a favorite way to learn about instruments, but it is also a great piece of music to listen to.

The Life and Times of Benjamin Britten
One of England's most famous composers, Benjamin Britten, was born on November 22, 1913. Britten first fell in love with music listening to his mother, who was a singer. By the age of 5, he was already composing. Throughout his childhood, he loved to write music (often writing before breakfast!). He also loved math and playing cricket.

Image Attribution: According to information on the photograph, it was originally taken by photographer Hans Wild for High Fidelity magazine (published in the United States).
[Public domain], via Wikimedia Commons

When he was only 11 years old, a famous composer named Frank Bridge started working with Britten. Bridge taught the young composer many of the composing skills he would use later in life. Britten wrote some of the most well-known pieces of the twentieth century. They include The Young Person's Guide to the Orchestra, Ceremony of Carols, War Requiem, and the operas Peter Grimes and Billy Budd.

Unlike some famous composers, Britten was lucky enough to be highly respected during his lifetime. He won many awards, including a medal from the United States Library of Congress. Benjamin Britten died on December 4, 1976, just days after his 63rd birthday.
The Orchestra
The word orchestra comes from the ancient Greek word orchestra. The word originally referred to the area in front of the stage in a Greek theater used for dancing and signing. Later, musicians played in this spot. Over time, the word's meaning changed to refer mainly to the instruments and musicians. Today, an orchestra is made up of four different groups, or families, of instruments: the woodwinds, the strings, the brass, and the percussion.

Example 1. Orchestra Layout
In this lesson, we will study the **woodwind family**. The woodwind family is composed of five instruments: the **piccolo**, the **flute**, the **oboe**, the **clarinet**, and the **bassoon**. The pitch ranges of the woodwinds are all different. Let's closely look at the instruments!

Please click and play each listening examples while learning woodwind family section!

**Music References:**
1. "Pitch Ranges of Woodwind," "Theme," and "Fuga" were performed by Fountain Chamber Music Society. The original music can be accessed at the following link, [http://listeningadventures.carnegiehall.org/game.aspx](http://listeningadventures.carnegiehall.org/game.aspx)

2. "Woodwind Family" and "Variation" were performed by the YouTube Symphony Orchestra. The original music can be accessed at the following link, [https://www.youtube.com/watch?v=3HhTMJ2bek0&index=9&list=PLSxGkvEyHrGYzaFPMvRBBHgwFVtatuKoee](https://www.youtube.com/watch?v=3HhTMJ2bek0&index=9&list=PLSxGkvEyHrGYzaFPMvRBBHgwFVtatuKoee)

**Notes: Images without attribution were derived from the game link, the Young Person's guide to the Orchestra ([http://listeningadventures.carnegiehall.org/game.aspx](http://listeningadventures.carnegiehall.org/game.aspx)). Copyright permission was attained for all the images from the game link.
The Woodwind Family
In his Young Person's Guide to the Orchestra, Benjamin Britten introduces five members of the woodwind family – the **piccolo**, the **flute**, the **oboe**, the **clarinet**, and the **bassoon**. These instruments were called woodwinds because at one time they were made from wooden tubes.

Today, the flute and piccolo are usually made of metal. To help remember the other half of the family name, think of how the woodwinds are played. You blow your breath, or "wind," into a mouthpiece. This causes the tube to vibrate and sound to come out.

Example 1. Woodwind Family
Pitch Ranges of Woodwind
The bigger the instrument, the lower the sound, or pitch. The largest woodwind here is the bassoon, which plays the lowest pitches, followed by the clarinet. The oboe and the flute can play roughly the same pitches, but neither one of them can play as high as the piccolo or as low as the bassoon!

Please play the example of the pitch ranges of woodwinds below. Do you hear any pitch differences?

Example 2. Pitch Ranges of Woodwinds
Exercise
Please recall the five instruments that are composed of the woodwind family first. What are the five instruments? Complete your answer by dragging each instrument in the box.

Hint: Please think about the musical instruments sound like wind blowing!

<table>
<thead>
<tr>
<th>Items</th>
<th>Woodwind Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bassoon</td>
<td></td>
</tr>
<tr>
<td>Piccolo</td>
<td></td>
</tr>
<tr>
<td>Woodblock</td>
<td></td>
</tr>
<tr>
<td>Clarinet</td>
<td></td>
</tr>
<tr>
<td>Oboe</td>
<td></td>
</tr>
<tr>
<td>Cello</td>
<td></td>
</tr>
<tr>
<td>Flute</td>
<td></td>
</tr>
<tr>
<td>Xylophone</td>
<td></td>
</tr>
</tbody>
</table>
Correct Answer

Woodwind Family

1. Flute
2. Piccolo
3. Oboe
4. Clarinet
5. Bassoon

Percussion Family

1. Woodblock
2. Xylophone

String Family

1. Cello
Flute & Piccolo
The flute is easy to spot! It has a shiny silver-colored tube (sometimes it’s even gold!) that is about two feet long. You hold the flute to your right side and blow across a mouthpiece on the side of the tube to make sounds. To change the pitches, you press keys that open and close holes along the tube.

Example 1. Flute

Example 2. Piccolo
The Mouthpiece
When you blow into the mouthpiece of a flute, don’t blow too hard! Think about how you would blow across the top of an empty bottle to make a sound. When you blow, the air is caught by the edge of the hole. This makes the air in the tube (or bottle) move and (you guessed it!) vibrate.
Exercise 1
When you consider the sizes of the flute and piccolo, why does the piccolo make a higher pitch than the flute? Please write down your answer and review them with information presented this lesson.

Exercise 2
Please click each audio example below and identify the correct instrument. Can you distinguish the sound between the flute and piccolo?

Hint: The piccolo's sound are sharp and brilliant like birds signing!

1) Play the instrument A
2) Play the instrument B
3) Play the instrument C
4) Play the instrument D
Correct Answer 1

Since the piccolo has a smaller size than the flute, the piccolo can make a higher pitch than the flute.

Correct Answer 2

Instrument A - Flute
Instrument B - Piccolo
Instrument C - Piccolo
Instrument D - Flute
Oboe

The oboe is made from a dark wood, but it gets its shiny glitter from all its silver-colored keys. You press these keys to make different pitches. To play the oboe, hold it straight in front of you, point it down and blow into its double reed.

Example 5. Oboe
The Reeds
The double reed starts out as a single piece of cane (a type of grass) that you fold in half and cut in two. This creates two pieces of cane of the same size. The pieces are bound with string to a metal tube attached to a piece of cork that fits into the top of the instrument. When you blow, the reeds vibrate (of course!) and make sound (sound familiar?). Oboe players spend lots of time cutting and shaping the reeds so they sound just right!

Example 6. Oboe Reed
Exercise 1
What makes the oboe’s sound very unique and different when compared to other instruments, especially the flute and piccolo? Please review the lesson to find your answer.

Hint: A piece of cork is a part of the oboe’s reed!

Exercise 2
Which one is the oboe’s reed? Please choose the correct answer.
Correct Answer 1

Unlike the flute and piccolo, its double reed makes a unique sound and tone color. Even though the clarinet and bassoon also use reeds to make musical sounds, the sizes and shapes of the reeds are totally different from those of the oboe.

Correct Answer 2

The answer is A. 'B' is a bassoon reed and 'C' is a saxophone reed.

A. Oboe Reed  B. Bassoon Reed  C. Saxophone Reed
Clarinet
The clarinet looks a lot like the oboe, with the same color, silver keys, and almost the same size, but it has a bigger bell shape at one end. Instead of a double reed, the clarinet has a mouthpiece to which you attach a single, wider reed. When you blow into the mouthpiece the reed moves very quickly (vibrates!). The vibrations travel into the tube, and (ta-da!) sound comes out!

Example 7. Clarinet
Holes
Like all woodwind instruments, you change pitches on the clarinet by pressing keys that open and close holes in the tube. The more holes you cover, the lower the pitch. Why? Think of it as making the tube "longer." No, the tube doesn't actually grow longer, but the more holes you cover, the longer the length of tube the air has to travel before it can escape. When fewer holes are covered, the air has less tubing to travel to escape. This is like making the tube shorter, and the pitch higher.

Example 8. Holes
Exercise
Select the image below that would make the lowest pitch while playing the clarinet. Please draw the clarinet's holes for the lowest pitches on your own, and then find the correct answer in the images below.

Hint: Think about making the tube "longer" for the lowest pitch.

(*Note: Black = Closed, White = Open)
Correct Answer

The performer can change pitches on the clarinet by covering holes in the tube; the more holes you cover, the lower the pitch! The answer is B.

Attribution for the image:
All clarinet images in the exercise question were created by Mr. Eberhard Frost, and the image can be freely used by users in the sense of open source (Mr. Eberhard Frost, eberhard.frost@fkw350.de, Friedrichsgaber Weg 350, 22846 Norderstedt, Germany).
Bassoon
The bassoon is often made of maple. As the longest woodwind instrument in Britten’s guide, it plays the lowest pitches. Like the oboe, the bassoon uses a double reed. But because of the bassoon’s big size and the way it is held, the reed is attached to the end of a bent metal tube called a crook.

Example 9. Bassoon
Bassoon Size

The bassoon is almost 8 feet long. (That’s four times the size of the oboe!) It’s so big that it comes in four parts that fit together. Because it is so big, the tube is bent in two so that a player can hold it and play it. Even with the bend, the instrument is so long that the musician has to hold it off to the side to play it!

Example 10. Bassoon Size
Exercise
Please explain the bassoon's parts based on the lesson. Which one is the top, middle, and bottom part? Construct the structure of the bassoon by dragging each bassoon part and placing them in order from top to bottom.

Hint: Think about the name and shape of each bassoon part (e.g., Bell joint).
Correct Answer

Figure 1. Bassoon Parts
We will review the **string family** in this lesson. The string family is composed of five instruments: the **violin, viola, cello, bass,** and **harp.** As the names indicate, all instruments use **string** to make sounds.

Please click and play each listening examples while learning string family section!

**Music Reference:**
1. "Pitch Ranges of Strings," "Theme," and "Fuga" were performed by Fountain Chamber Music Society. The original music can be accessed at the following link, http://listeningadventures.carnegiehall.org/game.aspx

2. "String Family" and "Variation" were performed by YouTube Symphony Orchestra. The original music can be accessed at the following the link, https://www.youtube.com/watch?v=3HhTMJ2bek0&index=9&list=PLSxGkvEyhHyGyzaFPmVRBHgWfVetatukoee

**Notes:** Images without attribution were derived from the game link, the Young Person’s guide to the Orchestra (http://listeningadventures.carnegiehall.org/game.aspx). Copyright permission was attained for all the images from the game link.
The String Family

Instrument in the string family all have (you guessed it) strings! Family members include the violin, the viola, the cello, and the double bass. These instruments all have one big feature in common: each is made of a hollow wooden box with four string stretched across it. When you pluck these strings with your fingers or move a bow across them, the strings move and vibrate, making sounds. One string family member looks very different. It is the harp with 47 (yes, 47!) strings. You play them by plucking them.

Example 1. The String Family
Pitch Ranges of Strings
Of the four string instruments that are similarly shaped, the double bass plays the lowest pitches. Know why? Right! It's the biggest instrument in the family. (Are you starting to see a pattern?) The violin is the smallest string instrument, so it plays the highest pitches. The cello and viola play pitches in between. The harp, with its 47 strings, can play almost all of the pitches that the other string instruments can play.

Example 1. Pitch Ranges of Strings
Exercise
Please recall the violin, viola, cello, bass, and harp. Can you think about what the differences are? Complete your answer by dragging the instruments that are a part of the string family in the box.

Hint: The string instruments make sounds by using strings.
Correct Answer

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>String Family</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Violin</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Viola</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Cello</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>String Bass</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Harp</td>
</tr>
</tbody>
</table>
Violin
The violin is the smallest string instrument in Benjamin Britten's guide. To play it, you hold the large part under your chin on your left shoulder. The fingers of your left hand move along the fingerboard, pressing down on the strings. This allows you to produce different pitches. Your right hand is busy at the same time. It holds a bow or plucks the strings to get the vibrations started.

Example 1. Violin
Styles of Play
There are lots of different kinds of bows in the world. Bows on your sneakers. Bow-and-arrow bows. String players use a different kind of bow. It’s a straight wooden stick with hairs from a horse’s tail stretched from one end to the other. The bow’s horsehair is moved back and forth across the strings like a saw. This technique is called arco or bowing. It gets the strings to vibrate and the instrument to sound. Sometimes players don’t use the bow. They pluck the strings with their fingers, like a guitar. This is called pizzicato.

Example 2. Styles of Play
Exercise
Please listen to the following sound and identify the specific pattern of the violin sound. Draw or mark the 'Arco' and 'Pizzicato' symbols while the sound example is playing. Which one is the correct order of the 'Arco' and 'Pizzicato'? 

Hint: Think about the sound characteristic when bowing or plucking strings.
Correct Answer

The pattern of the violin sound is in the following order. The answer is B:
Viola
The viola is a slightly larger version of the violin, so it plays slightly lower pitches. Like the violin, the viola is held on the player’s left shoulder under the chin. You hold the bow with your right hand and change pitches by using the fingers of your left hand to press the strings in different places on the fingerboard.

Example 1. Viola
Parts of the Viola
Like the violin, the cello, and the double bass, the viola is made from a pear—shaped hollow wooden box. Four strings are stretched across the box and up the fingerboard. The strings are held in place by pegs at the top of the fingerboard and by a tailpiece at the bottom of the box. In the middle of the box, the strings are held off the box by the bridge. This allows them to vibrate when they are played. The string instruments' hollow bodies amplify the sound, making it louder.

Example 2. Parts of the Viola
Exercise
The following figure shows the names of the viola parts. How would you describe the sizes of the 'Scroll', 'Finger board', 'Sound Post', and 'Tail Piece' when comparing to those of the violin and cello?

Hint: The structures of the violin and the viola are the same. How about the sizes?

Figure 1. Viola Parts

Attribution for the Image:
The image, "Viola or violin" was created by Hel-hama (Own work) [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons

○ Its scroll, finger board, sound post, and tail piece are smaller than those of the violin.
○ Its scroll, finger board, sound post, and tail piece are bigger than those of the violin.
○ Its scroll, finger board, sound post, and tail piece are bigger than those of the cello.
○ Its scroll, finger board, sound post, and tail piece are the same as those of the violin and cello.
Correct Answer

B. Its scroll, finger board, sound post, and tail piece are bigger than those of the violin.

Attribution for the Image:
The image, *Viola-Violin* was created by User:Frinck51 (Own work) [GFDL (http://www.gnu.org/copyleft/fdl.html) or CC-BY-SA-3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons
Cello
The cello is a bigger version of the viola. It has much thicker strings and can produce lower pitches. To play the cello, you sit on a chair and hold the cello between your knees. (It is much too big and heavy to hold under your chin!) A metal spike called an end-pin is attached to the cello’s bottom and sticks into the floor, keeping the cello in place.

Example 1. Cello
Fingerboard
To change pitches on the cello (and other string instruments), you press your left fingers onto the strings in different places up and down the fingerboard. When you press down on the part of the string closer to the bridge, you shorten the part of the string that vibrates. This makes a higher pitch. When you press down on the part of the string that is closer to the scroll, you lengthen the part of string that vibrates, and the pitches are lower. String players practice for many years to learn exactly where to place their fingers to produce just the right pitches. They practice so much, they get calluses on their fingertips!

Example 2. Fingerboard
Exercise
Please recall the "Fingerboard" part in the lesson and explain your answer the question below.

Hint: Which number would make the cello string being longer or shorter?

Question 1> The image below shows a musician playing different pitches on the fingerboard of the cello. Which number would make the highest pitch on the fingerboard?

![Image of cello fingerboard with numbers 1, 2, 3, 4]

Attribution for the image:
The image title is "First Position (Closed)" created by Ms. Deryn Cullen. The Cello Companion Blog (or thecellocompanion.info) owns its copyright.

- 1
- 2
- 3
- 4
Correct Answer

When you press down on the part of the string closest to the bridge, you shorten the part of the string that vibrates. This makes a higher pitch. Therefore, the correct answer is D.

![Diagram of strings and notes]

Attribution for the image:
The image title is "First Position (Closed - G String)" created by Ms. Deryn Cullen. The Cello Companion Blog (or thecellocompanion.info) owns its copyright.
Bass
The double bass or string bass is the largest of the string instruments. Like the others, it has a scroll at the top, four strings, four pegs, a fingerboard, a bridge, and a tailpiece. But its shape is slightly different. It has sloped "shoulders" and a flat back.

Example 1. Bass
String Bass Size

The double bass is so large that a player either has to stand or sit on a very tall stool to play it. Because its strings are the longest and thickest, it plays the lowest pitches.

Example 2. String Bass Size
Exercise
Please freely play each sound in the question and explain the characteristic of the sound. Which note makes the lowest and heaviest sound?

Hint: The string bass has the lowest pitches!

Question 1> Which one is the sound of the string bass?
Correct Answer

The string bass (or double bass) makes the lowest and heaviest sound rather than those of other string instruments such as violin, viola, and cello. The answer is D.
Harp

The harp is not always part of the orchestra, but many composers like to add it. It looks very different from the string instruments we’ve talked about so far. The harp has a graceful, curved neck to which the strings are attached. You never use a bow to play the harp. You always pluck the strings, sometimes plucking many at one time!

Example 1. Harp
Harp Strings
The harp's 47 strings are arranged in order from long to short. The longest strings make the lowest pitches, and the shortest strings make the highest. The strings on the harp are tuned to the same pitches as the white keys on the piano. In order to play the "black key" pitches, you press the pedals found at the bottom of the harp. These pedals make the strings slightly longer or shorter. This causes them to make either slightly lower or slightly higher pitches.

Example 2. Harp Strings
Exercise
Please carefully listen to the four notes in the item and explain the characteristic of each note. To complete the exercise, drag the correct answer in order.

Hint: Please review the sound quality of each note. This question is challenging!

Question 1> Please listen to the four notes below and stack them in the box from the highest to lowest pitch.

<table>
<thead>
<tr>
<th>Items</th>
<th>The notes from the highest to lowest pitches.</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Note D" /></td>
<td></td>
</tr>
</tbody>
</table>

4 / 4
Correct Answer

The longest strings make the lowest pitches, and the shortest strings make the highest.

The notes from the highest to lowest pitches.

1. Note B
2. Note D
3. Note A
4. Note C
Good job! You have just finished your online lecture for "An Introduction to the Orchestra." Now, you are ready to take the 10-minute test. You can review your online lecture again before taking your test. Remember, once you start your test, you will need to finish your test within 10 minutes. If you are ready to take your test, click "Start My Test".
APPENDIX D
GAME-BASED ONLINE MUSIC INSTRUCTION

The Young Person’s Guide to the Orchestra:
Game Link: http://listeningadventures.carnegiehall.org

Note: All audio and visual materials in this lesson were either used by special permission of the copyright owner or the researcher followed fair-use rules required by copyright law in using them. Any audio recordings produced by Naxos of America were not used in this research.
Now you are about to start your music game. Please read the following game instructions before you start your game:

1. Once you enter the game please click the icon: "Practice Round."

2. All the information you need to learn will be placed in the book icon: "look it up!"

3. Please read and practice ONLY the sections "Benjamin Britten," "Orchestra," "Woodwind Family," and "String Family" in the "Table of Contents."

4. You can select and play your practice games in the required sections by hovering over and clicking the gray dots in the "Safari Map." The "look it up!" icon will appear in the left corner of your screen so that you can review each music lesson while playing your game.

5. If you want to return to the table of contents, please click the red bookmark.

6. Please click the "Start My Game" button below when you are ready.
Please remember you will need to come BACK to THIS SiTE to complete your post-test and survey.

To start your game, please click Here!
Good job! You have just finished your online lecture for "An Introduction to the Orchestra."

Now, you are ready to take the 10-minute test. You can review your online lecture again before taking your test. Remember, once you start your test, you will need to finish your test within 10 minutes. If you are ready to take your test, click "Start My Test".
LIST OF REFERENCES


256


BIOGRAPHICAL SKETCH

YoungJu Kang is an active researcher, instructional designer, multimedia online learning developer, and musician. She earned a B.A. and an M.A. in music at Sangmyung University in Seoul, South Korea. In the United States, she expanded her academic career in connection with business and technology to be an innovative leader in the field. After completing an M.A. in music technology from New York University and an M.A. in music business at the University of Miami, she received a Ph.D. in curriculum and instruction with a speciality in educational technology from the University of Florida. As a creative instructional designer who supports the arts and technology, not only has she designed numerous online learning courses for higher education, but she also has been involved in multimedia arts and music education projects in the United States, Europe, and Asia. Her special interests are Instructional Design for Online Education, Arts and Technology Integration, and Computer Game-based Virtual Learning Environments for all educational levels.