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ABSTRACT

This study explores the way music operates in the mental processing of computer-supported instructional messages, whose other modes are text and graphics. The experiment examined the effect of music on the immediate recall and understanding of three equivalent science lessons delivered by a computer. The objective properties of the music were manipulated to produce feelings that were congruent with the psychological dynamics of the lessons' instructional strategies. This technique sought to enhance achievement by stimulating multiple (triple) encoding in short term memory. It aligned an abstract musical input, which elaborated subjectively on content, with instructional strategy, which is a subjective lesson element. This research, therefore, proposed and tested a variable, Music-Instructional Strategy-Integration (MISI) element, that moderated the instructional treatments. The study also sought subjects' affective evaluations of the lessons accompanied by music as well as their preferences for music in association with academic endeavors. The experimental procedure examined the effects on achievement of three forms of ninth grade lessons on physical science topics, each of which was differently moderated by music or ran in silence. The primary analysis of variance showed no significant statistical results regarding achievement. There was no statistically significant difference in the subjects' rating of the musical patterns, and no relationship between achievement scores and subjects' ratings was found. The subjects were consistent in favoring an association of music with academic activity. The study found that the inclusion of music can stimulate positive student affect toward computer-supported instruction and toward science instruction. It identifies the need for additional research with multiple encoding, and with literal music, which depicts content by becoming one of its objective parts. An appendix lists musical compositions used in the research. (Contains 69 references.) (Author/SWC)

Title:

The Use of Music in the Instructional Design of Multimedia

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The purpose of this study was to explore the way music operated in the mental processing of computer-supported instructional messages, whose other modes were text and graphics. The experiment examined the effect of music on the immediate recall and understanding of three equivalent science lessons delivered by a computer. The objective properties of the music were manipulated to produce feelings that were congruent with the psychological dynamics of the lessons' instructional strategies. This technique sought to enhance achievement by stimulating multiple (triple) encoding in short term memory. It aligned an abstract musical input, which elaborated subjectively on content, with instructional strategy, which is a subjective lesson element. This research, therefore, proposed and tested a variable, labeled MISI (Music-Instructional Strategy-Integration), that moderated the instructional treatments. The study also sought subjects' affective evaluations of the lessons accompanied by music as well as their preferences for music in association with academic endeavors.

The experimental procedure examined the effects on achievement of three forms of ninth grade lessons on physical science topics, each of which was differently moderated by music or ran in silence. This process involved repeated measures of subjects, taken at random from classes of ninth grade students. The investigation employed a Graeco-Latin Square, type GLSFF-3^3 design. This was a fractional factorial design, that evaluated two crossed treatments in the context of three groups of subjects.

The primary analysis of variance showed no significant statistical results regarding achievement. There was no statistically significant difference in the subjects ratings of the musical patterns, and no relationship between achievement scores and subjects' ratings was found. The subjects were consistent in favoring an association of music with academic activity.

This study found that the inclusion of music can stimulate positive student affect toward computer-supported instruction and toward science instruction. It identifies the need for additional research with multiple encoding, and with literal music, which depicts content by becoming one of its objective parts.

Computer-based multimedia is rapidly becoming an important instructional tool (Heinich, Molenda, & Russell, 1993; Schwier & Misanchuk, 1993). Research results document positive learning outcomes associated with the proper instructional use of this media format (Kozma, 1991). Interactive multimedia programs deliver instructional messages through a mix of text and graphics, still and motion images, voice, sound effects, and music. These complex messages are the means through which interactive multimedia presentations gain their considerable power to effectively communicate with learners (Heinich, Molenda, & Russell, 1993).

Little research exists on the use of music to enhance learning in the context of interactive multimedia. This void is not consistent with the universal recognition of music as one of the most powerful forms of human expression. Music is celebrated worldwide for its profound ability to create meaning (Abraham, 1980). Neither is this situation consistent with the steadily improving quality of digitized sound (McKell & McKell, 1994). Most of the research on the instructional use of music in older multimedia formats has concentrated on its affective influence (the feelings it induced) when the music was used as a background context for teaching. These research findings are mixed and inconclusive (McIntyre & Cowell, 1984; Ebisutani & others, 1991; Jaspers, 1991).

Music is regularly listed as one of the standard communication modes for constructing interactive multimedia presentations (e.g., Heinich, Molenda, & Russell, 1993), despite the absence of research-supported guidelines. When guidance is offered about how to insert music into this instructional format, it typically is general and highly subjective (e.g., Burger, 1993). Schwier and Misanchuk (1993) advise that music can be used to "augment" the presentation and to lend "positive emotional texture" (p. 268). The details of the process are left to the intuition of program designers and authors. One cause for this shortcoming is that a grounded, universally accepted understanding of the way music operates in the mental processing of multi-modal messages sent by a multimedia system has not been developed (Kellaris, Cox, & Cox, 1993).

Research has documented a positive impact on learning resulting from additive, dual encoding when linguistic inputs (text/speech) are combined with illustrations (Fleming & Levie, 1993). Rayburn and Tyson (1982) extended additive encoding to a third level when they concluded that music could compliment other images (linguistic and visual) and provide additional information to the brain in the form of auditory images. There has not, however, been any reported research into the use of triple encoding with music.

Hannafin and Hooper (1993) provide an excellent summary of the state of the art for constructing multi-modal messages. They maintain that:

Learning via multi-modal instruction improves when there is sufficient conceptual and temporal overlap between the information presented in each modality (p. 196).

They anchor the above principle of learning in Paivio's (1971) finding concerning the effectiveness of dual encoding. Hannafin and Hooper state that dual encoding depends on the additive effect of encoding mechanisms in short-term memory.

The example given is that of combining text with illustrations, wherein the relevant encoding mechanisms are separate but complementary. The text is said to be a linguistic code form, which is normally (but not necessarily) scanned horizontally. To read text is a visual event, which means that it is a spacial phenomenon. Most people, however, employ a serial protocol in dealing with text. The encoding of illustrations is different. While it too is visual, and therefore also a spacial event, the illustrations are consumed in parallel. An image code form and another variety of encoder are involved in the latter case.

Hannafin and Hooper (1993) identify two conditions governing the effectiveness of multi-modal messages in learning. The first is that multi-modal messages should present information to students in code forms that are congruent. This is consistent with the findings of Kellaris, Cox, and Cox (1993) for persuasive messages in advertising and also with the findings of Boltz, Schulkind, and Kantra (1991) for schematic processing. The text and illustrations of Hannafin and Hooper's example must be redundant, focusing on the same teaching points. These authors warn that non-redundancy may interfere with additive encoding.

The second condition is a requirement that each presentation mode within these complex messages appeal to separate encoding mechanisms. To appeal to different encoders in the student's working memory, separate code forms (e.g., text and an illustration) must be used to enhance the formation of meaning. As a counter example, Hannafin and Hooper (1993) caution against an identical presentation of words via both text and speech.

Previous interference studies have shown that human beings are capable of using several different types of encoding mechanisms (Ashcraft, 1989; Leahey & Harris, 1985). Not only are there linguistic (text/speech) and image encoders, but there are sonic, olfactory, kinesiologic, and possibly other combined types of encoders.

It is unknown whether encoding mechanisms combine operations to achieve richer forms of encoding or whether they simply operate in parallel to achieve additive encoding. Although their pattern of operation is not yet clear, encoding mechanisms seem to exist in the limited capacity of short-term memory. Studies in Dual Task Analysis infer some limit to the positive effect of additive encoding (Ashcraft, 1989).

Schwier and Misanchuk (1993) conceive multi-modal instructional messages as consisting of core, supplemental, and peripheral elements. Music is usually inserted as a peripheral element in the mix (Kellaris, 1991), in part because no objective means of relating it to the other messages elements has been developed. Music therefore tends to be relegated to an opening, closing or background for the program. This conception and its inherent design convention seem short-sighted, and they preempt music's full potential to contribute to the presentation.

The nature and artistic tradition of music impedes its use as a tool of technology. Standard practice for dealing with music in education is much more subjective than objective. The educational use of music tends to be mainly intuitive for the following reasons. First, the power of music to create meaning is thought to operate primarily through emotional pathways (Schwier & Misanchuk, 1993; Burger, 1993). Second, music appreciation has typically been approached historically and/or stylistically, in terms of extant compositions. Finally, the objective use of music requires some facility with theory, which is complex and difficult. Music has a special vocabulary and mathematical precision.

The problem with this appropriation of music is that it fosters an incomplete and unscientific approach. It suggests a use of music that is based only on musical genres (e.g., a march versus a dirge) and only by association (e.g., the deep "Dum ... Ba-Dum" from the movie, JAWS, suggests extreme, unseen jeopardy).

This tendency to appropriate music only on the basis of intuition obscures a more technological approach to its use. Music can be selected and inserted into instructional programs more precisely if that insertion is based on its objective properties. There is empirical evidence that music can be manipulated, using its objective properties like tempo, tonality, and texture to produce psychological feelings such as arousal, surprise, and pleasantness (Kellaris & Kent, 1993). Instructional designers, while paying some attention in the past to tempo (e.g., Wakschlag, Dietz, & Zillman, 1982), do not yet take full advantage of this way of applying music to their programs.

Previous reviews of the literature have been narrowly focused. Research is being conducted across a number of disciplines that are important in understanding the effects of music within instructional environments. Also, much of the existing literature is contradictory. Numerous studies have used music as a variable. The most recent studies are finally focusing on distinct properties of music.

Review of the Literature

This analysis of the literature did not locate any reports of research into the use of music as an instructional message element in the context of interactive multimedia. Some textbooks mention this application of music (e.g., Schwier & Misanchuk, 1993), but their coverage is limited.

There is, however, a substantial amount of literature about the use of music in teaching with other media. Most of this material exists either in the form of programmatic essays in magazines and journals or as research reports. The program guides start with the assumption that music can enhance learning. They generally endorse the use of music in education, describe its application in a particular instructional situation, and disclose positive affective responses by students.

The research literature reports mixed findings about the effects of music on instruction. Dr. Dolf Zillman (1994), a noted scholar in the field of communications, interprets the consensus of the literature as follows:

> The evidence concerning the use of music in educational efforts is most discouraging. Surely, as we have shown, music can help to attract children to the educational message (in selected situations). But once they are exposed, the presence of music is detrimental to learning. That's what the experimental research tells us. The findings are very consistent, showing that it is sweet illusion for educators to think that music could further the learning process. Music is a message that **competes** with educational information for attention, and it usually wins the contest.

There is, however, a minority body of evidence together with an even greater amount of teacher intuition that opposes Dr. Zillman's judgment. This subset of the literature supports the counter argument that music can enhance the presentation of educational information.

Such differences of opinion can only mean that a full understanding of the dynamic interaction between music and instruction has not yet been achieved. That conclusion constitutes the need for further study.

Musical Acuity / Intelligence / Academic Achievement

The general connection between musical acuity and intelligence or academic achievement has been the focus of a number of studies. Cary's (1987) review of the pertinent research indicated a definite connection between the exposure of children to music and higher levels of intelligence. This applied also to cognitive skills such as problem solving, risk taking, and creativity. Dryden (1992) demonstrated this linkage in fifth grade students. She documented a positive correlation between students' instruction in music and the development of verbal skills. Hilliard (1993) amassed five case studies profiling the characteristics of creative adolescents. All loved music.

A connection between music and academics has been identified. The exact nature of the relationship has not, however, been determined.

Musical Expression

The expressive power of music has been known since ancient times. Martin Luther, for example, had the highest praise for music. Luther ranked it second only to theology in his hierarchy of God's gifts (Randal, 1986). Other teachers, through the ages, have used music in various ways to make students more - and sometimes less - receptive to learning.

How music operates to express meaning remains a major concern of aesthetic criticism. Expressionists base their understanding in the composer's intentions when creating a work or in the appreciator's feelings when consuming the work. Formalists argue that musical expression derives from the listener's cognitive recognition of the musical elements of the composition melding into a whole. Moderate perspectives urge a synthesis of these affective and rational responses (Behrend, 1989).

Burger (1993) provides guidance for designers about the use of music in multimedia. He categorizes music as literal or abstract. Literal music depicts content by becoming one of its objective parts, i.e., a sound effect such as birds chirping or water rushing. Abstract music elaborates subjectively on content. It operates as a communications device, using emotions (e.g., sadness, love, joy, patriotism, etc.) to embellish the content. Literal music operates on or off screen, conveying proximity or environment. Abstract music operates off screen, stimulating mood and a sense of time, geographic location, association, signature and continuity, and memorability. Burger also introduces elements - melody, harmony, rhythm, instrumentation, musical genres, time signature, tempo, structure, and silence - that can be used to convey meaning. He states that these devices "can imply much more than what is being said and/or portrayed visually" (p. 334).

The scholarly concern with such aesthetic expression extends back to the 1800's (e.g., Gurney, 1880; Gundlach, 1935; Rigg, 1937; Watson, 1942; Holbrook & Bertges, 1981). Gurney explained this expressive power of music as early as 1880 in the following way:

> {T}he power of music to suggest external objects and events and intellectual conceptions ... may take place in two ways. First, the actual sounds and motions of the music may perceptibly resemble actual sounds and motion of other things ... The second way in which images of external facts may be suggested by music is by general qualities ... {T}he same calm and steady musical flow which might suggest a quiet succession of waves has naturally an expression of tranquillity {sic} corresponding to the same idea (p. 349-50).

A good example of classical music's ability to produce sound effects is found in Grofe's Grand Canyon Suite. One hears in this work a credible musical image of a donkey's "clopping" along a canyon trail and also a vivid representation of a thunder storm. There are similar musical dynamics in Prokofiev's Peter and the Wolf and in Saint Saens' Carnival of the Animals.

Good examples of classical music's power to express the content's general qualities are Wagner's Tristan und Isolde of love and passion; Smetana's Ma Vlast of patriotism; Holst's The Planets (Mars) of militarism; Berlioz's Requiem (2nd Movement - Dies Irae) of fear; Stravinsky's Rite of Spring of sexuality; Mahler's Resurrection Symphony of transcendence; Beethoven's Ninth Symphony of joy; Verdi's Stabat Mater of lament, etc. Other types of music are equally capable of such expression.

Human Response

Humans respond both physically and mentally to music. The physical response has been documented in studies of efforts to combat text anxiety. Such efforts have produced mixed results. These experiments usually measure and report the impact which music can have on pulse rate, blood pressure, skin chemistry, etc. (e.g., Blanchard, 1979; Moseley, 1990).

How humans respond mentally to the stimulus properties of music is varied and complex. There are both affective and cognitive responses to music, which are conditioned by individual differences (Rayburn & Tyson, 1982). Irish (1993) found that when adults have free choice of words to respond to music, their affective and cognitive responses are personal and idiosyncratic. There were, however, consistent patterns of response in and between individuals with similar education and experience. Personality traits also affect reactions to music (Lewis, 1991).

Paris's (1993) recent study is but one example of the powerful impact of music in the affective domain. She found significant results when assessing the effects on fifth graders of stimulating music as compared to sedative music. Such effects can be time sensitive. Brentar an associates (1994) found an inverted U-shaped relationship between frequency of exposure to rock and popular songs and the affective response of undergraduates toward the songs.

The traditional view has favored an affective response (feelings, emotions) over a cognitive response (empirical factual knowledge processing and problem solving) to music (e.g., Schwier & Misanchuk, 1993). Hylnka (1980), writing about the favorable implications of general film music for television and other instructional films, drew the conclusion that only affective learning is influenced by music. Recognizing the difficulty of dealing experimentally with aesthetics, Price (1986) proposed a precise, professional vocabulary on affective responses in the field of music.

There is evidence of music's ability to affect cognitive processes. Bickel (1992) presented a means of investigating the cognitive component of music listeners' responses through analysis of their verbal reports. She found that seventh and eighth graders often presented creative metaphors, described unique perspectives on the listening experience, displayed personal idiosyncrasies, found overall unifiers, and invented unique listening tools.

The most publicized, contemporary work on the impact of music directly on cognitive operations is that of Frances Rauscher (1993). She reported finding, in two, similar experiments with different audiences, that exposure to music enhances specific spatial reasoning skills, without necessarily invoking emotions.

Dr. Rauscher's musical treatment (Mozart - a sonata for pianos) was administered to the sample prior to the reasoning task, not concomitantly with it. Her data showed that this musical score acted, physiologically, to prime the same neural net that was involved in the problem solving exercise. She found also that this beneficial effect of music was not permanent. It dissipated within fifteen minutes.

Other information concerning music and the brain is contained in a database (Music and Brain), which is accessible over the Internet. This database offers references to scholarly articles, books, conference proceedings, theses, reprints on music history, education, psychology, and the physiology of hearing and making music.

There is evidence that students, whose mental operations favor the right hemisphere of the brain, are more appreciative of music. Zalanawski (1990) analyzed this tendency. She reported results from a mixed sample of undergraduates, who responded both verbally and visually to a musical selection. Those with a right brain orientation showed greater appreciation as measured by attention, understanding, and enjoyment scores.

It is, however, an oversimplification to portray aesthetic appreciation and creativity solely in the right hemisphere and rationality only on the left side. Levy, as early as 1983, concluded that:

> The two hemispheres differ in their perceptual roles, but both sides are involved in the creation and appreciation of art and music. Both hemispheres are involved in thinking, logic, and reasoning. The right hemisphere seems to play a special role in emotion, e.g., humor. If students are emotionally engaged, both sides of the brain will participate in the educational process regardless of the subject matter. (p. 68).

There is additional support for the notion that both hemispheres of the brain are engaged by music (MacKinnon, 1981; Merrion, 1988; Piro, 1989).

There has been consideration of the connection between music and thinking. Marek (1993), using music to induce moods, found no significant effect on memory. Stratton and Zalanowski (1985) got mixed results when they tested paired associate memory with imagery and repetition instructions with and without background music.

Instructional Uses

Studies concerned with the effect of music on student achievement have typically examined specific settings, student populations, and/or subject matter. These often overlap. These studies have generally assessed student behavior when different types of music were presented to students during instruction. The range of types of music used with instruction has been very wide. It includes rock, classical, easy-listening, and has even been extended to rap (Anderson, 1993).

<u>Setting</u>

Teachers have long been concerned with the creation of a setting conducive to learning. A holistic approach to teaching means appealing simultaneously to the student's physical, emotional, and cognitive domains. The relatively recent discoveries about brain functioning have encouraged this approach.

A program of this type is Lozanov's "Suggestive Accelerated Learning Technique" (SALT). To foster holistic learning, SALT uses music only as a general context. The music is selected by genres and applied as sonic mass (Kellaris, Cox, & Cox, 1993) simply to envelop the instruction. Its purpose is to set a mood, induce relaxation, and to be broadly suggestive. The hope is that music will operate as a catalyst for learning because it increases receptivity in the brain.

SALT gained a substantial following and has been the subject of considerable experimentation (Schuster & Gritton, 1986). There is a sizable body of literature pertaining to this method, much of which deals with music. The pertinent experimental results with SALT, however, are mixed and inconclusive. For example, Cullen (1986) reports significant gains from the use of accelerated learning in language instruction. Conversely, Confer-Owens (1992) found that SALT made no difference in teaching study skills to under-prepared college freshmen. Moon (1985) used a meta-analysis to show that relaxation techniques had only a small positive effect on cognitive academic variables.

There are other studies of music as a favorable context for academic productivity. A typical example is Kellogg's (1982) finding that many successful technical writers regularly work with background music. He surveyed one hundred twenty seven engineering professors about their academic productivity and writing habits. Multiple regression analysis revealed that background music was among the tools used. While this study does not deal with instruction, it may have implications for the use of music in non-traditional learning environments.

<u>Student Type</u>

Studies have been done with specific populations of learners. The major groupings have been of regular students versus those with special needs. Regular students have been further subdivided according to age/grade level (e.g., Davidson & Powell, 1986); by sex and perceptual type (e.g., Rayburn & Tyson, 1982); and by geography (e.g., Eaton, 1985; Talabi, 1986; Hicks, 1987).

A typical experiment with normal students was run by Davidson and Powell (1986). They observed twenty six students in the fifth grade over a four month period to determine the effect of easy-listening background music on on-task-performance (O-T-P). Time series analysis indicated a significant increase in O-T-P for male subjects and for the total class.

Music has been used in a wide variety of special education situations. The relevant literature is a blend of programmatic guides and reports of experiments. The former are generally favorable while the latter report mixed experimental results. Studies done with this population typically used a background music treatment and measured variables such as stress levels, hyper-activity, anxiety, psychomotor skills, and cognitive achievement.

An example of one such study was reported by Kleckley (1989). He used two different populations, learning disabled high school students and secondary remedial students. The study involved a three week unit on the Constitution which was followed by four parallel quizzes. Background music was provided during alternate testing sessions. Kleckley found significant variations for the learning disabled group in the form of lower stress levels and higher test scores with background music.

Subject

Studies using music during instruction have been done with a wide range of subject matter, again with mixed results. Music has been widely used in teaching language. Studies have also included: mathematics, spelling, writing, vocabulary, reading, social studies, history, and multicultural education. This group of studies have generally measured achievement and/or affect.

There are more references to the use of music in teaching language than any other subject. Several experiments connect music to verbal learning. Peters (1993) observed that music seemed to encourage verbal auditory learning among second graders. Pietrick (1988) found no significant changes in attitudes of sixth graders regarding the effects of music and art in remedial language arts development.

Music has been used in teaching several science subjects. Beauchamp (1989) included a musical factor in his comparison of the effects of slide plus tape presentations in biology. He found significant differences among four treatment groups in the degree of affective response and cognitive achievement. Among his conclusions was that music - more so than visuals - prompted long range positive affective responses.

Smith and Davidson (1991) reported a study of the effects of music listening on student achievement. The subjects were seventh-graders, who were independently learning astronomy. There were no significant achievement differences among students who learned while listening to rock, classical, easy-listening, or no music at all.

Literature Reviews Within Education

There have been a number of literature reviews regarding the use of music for instructional purposes since 1984. Two of these pertain to particular groups, which are exceptional and at-risk students. A third is more general. All of these reviews conclude that the research results which they considered are mixed and inconclusive. Each cites the need for further investigation.

McIntyre and Cowell (1984) reviewed the research concerning the effects of music on academic performance and behaviors of exceptional students. They found that such studies pertained primarily to achievement in mathematics, reading, and the ability to attend to study materials. McIntyre and Cowell also discovered that the research concerning behaviors of exceptional students concentrated on task-related behavior, unacceptable behavior, interpersonal conflicts, motor activity rate, relaxation, and attention span. They concluded that the findings regarding the effects of music on studying, mathematics, reading performance, activity rate, and social behavior are unclear and often contradictory. They call for more research in this area.

A second literature review, performed by Ebisutani and associates (1991), focused on at-risk students. These reviewers considered the effect of music on the reading, oral language, and writing abilities of marginal students. The intention of the analysis was to identify and describe how music should be used in classrooms to facilitate language development. Ebisutani et al. considered three types of publications, theoretical works, research reports, and essays of practical classroom applications. They drew two conclusions. First, they decided that the research results were mixed and inconclusive. The evidence did not suggest to them that music has the potential for producing a positive effect on reading rate and writing fluency. Second, they found that the theories used to justify the use of music in reading and language arts activities are not firmly grounded in any research. Accordingly, these investigators joined in the call for further study, pressing for examination of the critical variables involved in music's effects on the literary development of students.

A review of the literature performed by Jaspers (1991) deals with music as a component of instructional materials. Observing the scarcity of literature on the use of music in audiovisual productions and its implications for their design, this review concentrates on the relationship between music and emotion. It also links music and cognition, but to a lesser extent.

Jaspers' (1991) study considered music to be a form of nonverbal communication (cf. Hylnka, 1980). His review discusses the learning outcomes of music in the affective and cognitive domains, including its emotional and structural aspects. Jaspers concludes that:

> {T}here appears to be no absolute need for music as a component in an instructional programme. Music is, however, one out of a set of effective means to evoke a desired emotional state in the viewer/listener, or to comment on information conveyed, or to line out certain aspects of the structure of the problem (p. 51).

He goes on to suggest that:

> by manipulating musical variables such as tempo, modality, {and} rhythm, the designer of the audio-visual programme may try to reach more emotional ends, and by manipulating the easy to recognize musical elements such as melody and instrumentation, he can manipulate the more cognitive and structural ends (p. 51).

No evidence has been found that indicates experimentation by Jaspers to test this conclusion.

Other Europeans are reported to be studying the educational use of music including Brosius of the University of Mainz in Germany and Broeckmann at the University of Klagenfurt in Austria (Zillman, 1994). In a German article addressing the musical dimension of education, Dietrich and Wermelskirchen (1990) explore how musical events educate by examining the debate between emotional and cognitive responses to music.

The evidence and opinion to date, concerning the use of music to enhance educational efforts can only be seen as inconclusive and discouraging. The presence of music is thought by some to be non-essential in instructional programs, as was concluded by Jaspers. Others are even more critical, pointing out that some applications of music can be disruptive, (e g., Hannafin & Hooper, 1993). Such interpretations are based on the well documented distraction effect of music. These studies begin with Fendrick's work (1937) and continue until recently, (e.g., Zuk & Danner, 1986).

The studies reported on to this point, have one thing in common. They have generally used music only as background, comparing instructional treatments with background music to instructional treatments without music. The only way that some studies attempted to manipulate the music was by the type of music, thereby altering the tempo, rhythm, and/or harmony which can alter moods or affective responses. One additional variation to the use of music in these instructional studies has been where background music has accompanied test-taking.

Interdisciplinary Studies

Research on the use of music to enhance instruction continues. Significant work is also being done outside the discipline of education. The relationship of music to various settings, audience categories and behaviors, and varieties of subject matter is still being studied. There is a new concern, however, with the mechanics of communication, cognition, and the objective properties of music. Hylnka (1980) suggested a theoretical basis and some practical guidelines for using music in multimedia productions, based on a critical review of the behavioral research on film music. His theoretical perspective was non-verbal and multiple channel communication.

Seidman (1981) studied the role of music in motion pictures to suggest ways that educators might use music to improve the effectiveness of their instructional films. Seidman reviewed several studies showing that tempo, modality, rhythm, and harmony interact with audience characteristics to alter moods and thus shape their response to presentations. Seidman was not optimistic that musical accompaniment to media productions would improve student performance on achievement tests or enhance learning and retention of cognitive content. He did, however, suggest that both affective and cognitive interpretations of these productions are influenced by such "sonic scenery" which the musical score creates (p. 51).

Rayburn and Tyson (1982) investigated the effect of background music with lecture tapes, filmstrips, and films in teaching freshman psychology concepts. They compared media, visual or non-visual (haptic), and male and female learners. Treatment conditions included music during presentation, during both presentation and testing, or no music. The administration of the treatments - three music conditions crossed with three media types in the context of three groups, constituted a Graeco-Latin Square, type GLSFF 3 design. Results using difference scores by sex showed no effect except when film was the medium of instruction. Film was a better medium of instruction for women. Results using difference scores by perceptual type showed no effect except when lecture tape was the medium of instruction. With the music at presentation condition, visuals improved but haptics did not. Both visuals and non-visuals improved more when background music was present not only during the instruction but continued during the test. Rayburn and Tyson drew the conclusion that, "music may serve as an auditory image, which provides additional information to the brain just as Paivio's visual images seem to do" (p. 21).

Rayburn and Tyson's (1982) hypotheses were rooted in the distraction effect of music and in the widely held assumption that males are more visual than females. They predicted that when music was added to media presentations with both visual and verbal elements, the visually oriented subjects, i.e., males, would score lower. Conversely, the haptically oriented subjects, i.e., females, were expected to score higher. They also anticipated that the same background music added to a lecture presentation would lower the scores of the visuals and would not affect the scores of the haptics. These hypotheses were not supported by the data. The test scores of both visuals and haptics improved when the music was continued through the test. The insertion of the music in this research was imprecise (only background music was used). Also, neither the media type nor the lesson content were equivalent which are necessary when using their chosen research design.

Wakshlag, Reitz, and Zillman (1982) manipulated the tempo of music in an educational television program to study its impact on attention gaining and information acquisition. Their findings offer a mixed endorsement of music. What is of importance is their experimental technique of manipulating the musical input according to one of its objective properties. Later, Reitz (1984) found that background music's major value as an attentional device in educational television appears to be its ability to bring viewers back to the screen once their gaze has drifted away.

Boltz, Schulkind, & Kantra (1991) assessed the effects of background music on the remembering of filmed events in order to better understand schematic processing, a cognitive process. They employed a factorial design, in which sixty students in an introductory psychology course were randomly assigned to two groups. The subjects were presented with a series of filmed episodes in which the mood of the background music was either congruent or incongruent with the episode's outcome. For one group, the music always foreshadowed the ending of an episode. For the other, the music always accompanied the final outcome. A control group saw the same filmed episodes with no music. They found that recall was significantly enhanced when the mood of accompanying music was congruent with the mood of the scene's outcome. They also found that mood-incongruent music was more effective (memorable) for the foreshadowing treatment. Data from a cued-recognition task showed that music could provide effective retrieval cues for recognizing the scene it had originally accompanied. In addition, music with positive affect consistently produced higher levels of performance than did negative ones.

Kellaris (1991), Kellaris, Cox and Cox (1993), and Kellaris and Kent (1993) have conducted a multi-dimensional investigation into the effect of background music on ad processing. Kellaris (1991) and Kellaris, Cox and Cox (1993), proposed and tested a contingency variable, entitled "Music-Message-Congruency." This construct refers to, "the congruency of meanings communicated non-verbally by music and verbally by the ad copy". The experimental results indicate that, "increasing audience attention to music enhances message reception when the music evokes message-congruent versus incongruent thoughts" (Kellaris, Cox & Cox, 1993, p.51).

Kellaris and Kent (1993) performed an exploratory investigation of responses elicited by music varying in tempo, tonality, and texture. Three dimensions of human feelings - arousal, surprise, and pleasantness - emerged from the responses measured. They reported their findings as follows:

> Pleasure was influenced by the interactions of both tempo and tonality with texture. Faster speeds and more consonant keys increased the pleasantness of classical, but not Pop, music. Arousal was influenced by the interaction of tempo with texture. Faster speeds produced greater arousal among subjects exposed to Pop, but not classical, music. Feelings of surprise were influenced by tonality such that less consonant keys, i.e., atonal relative to minor, minor relative to major, were rated more surprising.

The stimulus property of music to create the feeling of arousal also has advocates as an accelerated learning technique with hyperactive and disabled students (Applegate & Hamm, 1985; Windwer, 1981).

Analysis of the literature confirms the suspicion that there is as yet no grounded, universally accepted understanding of the way music operates in the mental processing of multi-modal instructional messages. Furthermore, there is little evidence of new research into the issue as it regards interactive multimedia instruction. Past evidence about the impact of music on learning, in any format, is inadequate and inconclusive. The older research findings are certainly mixed. Consequently, many interpret the data in an entirely negative way. They underscore the powerful distracting properties of music, and they favor a minimal use of music in educational programs.

The practical advice which is often given to designers concerning the use of music in their instructional products is meager. It sometimes carries a warning that the wrong kind of music can sabotage the lesson. The best practical advice about the most effective use of music seems to exist in the discipline of advertising.

The human response to the stimulus properties of music is complex and difficult to understand. That process continues to be the source of debate about the balance of affective versus cognitive operations.

The question about a more effective use of music in educational communications continues to be asked and the body of literature on the issue is growing. Research is being conducted internationally and in academic disciplines beyond education, e.g., psychology (brain research), communications (film studies), and in advertising. Among the growing number of reports about positive effects of music on learning, cognition, or affective response, are at least nine works (Hylnka, 1980; Seidman, 1981; Wakshlag, Reitz, & Zillman, 1982; Reitz, 1984; Kellaris, 1991; Boltz, Schulkind, & Kantra, 1991; Jaspers, 1991; Kellaris, Cox, & Cox, 1993; Kellaris & Kent, 1993). Such work is launching a new trend in the way music is applied in instructional design. Each of these works involves inserting music into the instruction or message according to its objective properties.

Studies are beginning to deal with the integration of music into the mechanics of communications messages. This technique breaks with the past practice of using background music throughout the lesson and expecting it to function as a contextual catalyst for learning. It is, therefore, becoming popular to use elements of music in experiments as moderating variables, which embellish the treatment variables. This practice has shown some positive results (Kellaris, Cox, & Cox, 1993).

The present study was designed to assess a procedure for integrating music into multimedia instruction to enhance learning. This procedure had three components. First, it employed multi-modal messages, which attempted to foster triple encoding in short term memory. These multi-modal messages were constructed of three congruent code forms. Text, illustrations, and music were the codes that were used because each is processed in a different encoder in short term memory. Second, the procedure managed the musical input using the objective properties of music. Third, the procedure linked the musical input to instructional strategy as the means of achieving redundancy among the code forms.

This research proposed and tested a variable, labeled Music-Instructional Strategy-Integration (MISI), that moderated the instructional treatments. The study anticipated that the beneficial impact of music in multimedia instruction is directly related to the extent that the music enhances psychological operation of the lessons' instructional strategies.

The intention of MISI was to systematically leverage music's ability to elicit feelings of arousal, surprise, and pleasantness through manipulation of its objective properties of tempo, tonality, and texture (Kellaris & Kent, 1993). MISI linked this ability of music to two standard instructional strategies that evoke these same feelings. The operational strategies were affective orientation and cognitive dissonance. The first involves arousal, and the second entails surprise and pleasantness when the dissonance is reconciled (Hannafin & Hooper, 1993). These two strategies guided construction of the text and graphics portions of the treatment lessons.

Three physical science lessons were designed for delivery by a multimedia computer. Two patterns of music were produced for each lesson. The first pattern caused the affective impact of the musical selections to be congruent with the psychological dynamics of the instructional strategies. This arrangement was intended to moderate the treatment to enhance achievement. The second pattern caused the affective impact of the musical selections to be incongruent with the psychological dynamics of the instructional strategies. Conversely, this arrangement was intended to moderate the treatment to retard achievement. Each lesson was also delivered with no music or silence.

Method

Subjects

Subjects were 48 ninth grade students from a high school in a middle-class socioeconomic metropolitan area. They were enrolled in a physical science class that used very little multimedia. All of the subjects were on a regular academic track.

Materials

A single multimedia computer was used to present the treatment lessons. An audio tape player, with detachable speakers was also used. The computer, monitor, and speakers were situated either near the end of a large conference room table or on a classroom counter for comfortable subject access (seated) to the presentations. This equipment performed flawlessly throughout the experiment. All settings were void of major distractions.

Three lessons on physical science topics, designed especially for this investigation were installed on the computer. One lesson was about energy, another was about machines, and the third concerned physical forces. They concentrated on comparing the contrasting types of energy, machines, and physical forces and on measurement within each of the categories.

The lessons were designed using the instructional strategies of affective orientation and cognitive dissonance. This was accomplished under the direct guidance of the teacher who hosted the final phase of the experiment. She is a practicing classroom teacher, who regularly presents these topics to her ninth grade class. Every effort was made to structure the lessons to be equivalent in form and rigor. The lessons were also formatively evaluated by several of the teachers whose students participated in the pilot studies.

The visual elements of the lesson presentations were developed using PowerPoint (Microsoft, 1992). Each lesson was cast in its own, unique screen design to distinguish it and to combat student boredom. The base screen design ("wizard") for each lesson was chosen for its clean, uncluttered appearance, vivid colors, and contrast. The lessons were presented in the "slide show" mode. Each lesson ran for approximately 7.5 minutes. The transition between screens was a standard, quick cut through black. The parts of the lessons were divided roughly into thirds. The first one-third of the screens accomplished affective orientation. The second third established dissonance by lifting up discrepant events. The remaining screens provided reconciliation by explaining away the dissonance.

All screens contained two main visual elements, which were text and still graphics. The graphics were obtained from PowerPoint's (Microsoft, 1992) clip art file. The words appeared on the left side of the screens, and the graphics were on the right. Screens were timed on the basis of the number of words they contained. Short messages of up to four words appeared for seconds. The time for longer messages was extended for one second per additional two words. All of the subjects, during the pilot studies, reported having enough time to read all screens. A major effort was made to reduce formal language.

Two sets of the lessons were accompanied alternately by music. The third set ran in silence. The musical accompaniment was simulated using the audio tape player rather than internal to the software. This was done to achieve control and precision. The use of an audio tape player provided a sure control for coordination of the musical passages with the set of screens it was intended to support. It also allowed the addition of a production value. Through the use of the volume control, the music was faded in and out at the transition between sets of screens. The music was played at the #2 volume setting as was recommended during the pilot studies. A suggestion was also made during the pilot studies that the audio tape player not be readily visible for fear of calling attention to the music and its manipulation. This recommendation was followed, and the player was relocated in the final phase of the experiment to be less noticeable.

The music accompanying each of the lessons was unique and tailored to that lesson. Each sound track contained three strains of classical music, based on the advice of experts in the field. Classical music was used throughout for uniformity and because of its unfamiliarity to the subjects. Classical music is highly ordered, and its use added an extra dimension of control to this moderating variable.

Table 2 presents the works from which the music accompanying each of the lesson parts were drawn. The full titles of the recordings are in Appendix A.

Table 2

Musical Selections by Lesson

Lesson	Congruent	Incongruent
Energy	Beethoven-Egmont	Gorecki-Sym.#3
	Berg-Chamber Music	Bach-Sinfonia
	Elgar-P&C March #4	Albinoni-Adagio
Forces	Beethoven-Fidelio	Holst-Venus
	Berg-Concerto	Elgar-Nimrod
	Tchaikovsky-March Slav	Albinoni-Adagio

Machines	Rossini-Barber of Sev. Berg-Chamber Music Holst-Jupiter	Vivaldi-Largo Bach-Air Marcello-Adagio

Experimental Design

This study used repeated measures of subjects' immediate recall and understanding of lesson content together with their effectiveness rating of the lessons supported by music. A Graeco-Latin Square, type GLSFF 3^3 design (Kirk, 1982) was employed to obtain repeated measures. This is a fractional factorial design, evaluating varieties of two crossed treatments (visual lesson presentations and music) on individuals drawn at random from classes and separated into three groups. This design is best represented by a cube with 27 cells. Only three of the cells on each of the levels contained scores. Each cell containing scores occupies a unique position within the cube in terms of rows and columns.

The treatment effects are both between and within subjects. The design assumes that the fixed effects are the treatments and that the blocks are random effects. It also assumes no interaction effects.

Dependent Measures

There were three types of dependent measures in this study. These measures included a posttest performance for each lesson, a subjective evaluation (rating) of the interaction of music in each lesson, and a survey of student preferences.

Subjects were given a paper and pencil test on lesson content immediately following each presentation. The first part of the test contained 16 true/false, multiple choice, and fill-in-the-blank types of questions. The order of the questions was arranged so that their sequence did not parallel the lesson presentation. The alpha coefficients for the tests used in the study were as follows: Energy test = .70; Physical Forces test = .66; and Machines test = .68.

Each test also contained a second section where the subjects subjectively evaluated the interaction of the music and the lesson. The subjects were asked to indicate whether they felt that the music, when present, made the content of the lessons more or less understandable. A rating scale with a range of 1 (less) to 10 (more) was provided.

Following the last quiz, the subjects were asked to complete a survey. It measured subjects' preferences for music by type, music's presence in their academic pursuits, multimedia science lessons, and favorite type of science class.

Procedure

Several pilot studies were run in preparation for the formal experiment. Pilot studies were conducted at five sites during the spring and early fall to formatively evaluate the components of the experiment. Two of the pilot studies involved a full administration of the experiment. Three others had special purposes involving equating the lessons and achievement tests together with ensuring the reliability of the instruments.

The final, formal phase of the experiment required 3 days to administer. Little discussion was needed with subjects in order to initiate the experiment. They simply were told that they would view three science lessons and would take a quiz following each. To enhance their motivation, the subjects were told by their teacher that their scores on the tests would constitute a daily grade.

A random selection of the beginning cell yielded the machines lesson moderated by incongruent music. With this starting point located, the GLSFF 3^3 design mandated the following order of treatment administrations to the respective groups. The treatments for Group One were the machines lesson with incongruent music, forces with no music, and energy with congruent music. Group Two received the lessons in the order of forces with congruent music, energy with incongruent music, and machines with no music. The scenario for the third group was the energy lesson with no music, machines with congruent music, and forces with incongruent music. This scenario is shown in Figure 1.

Figure 1. Administration of the treatments

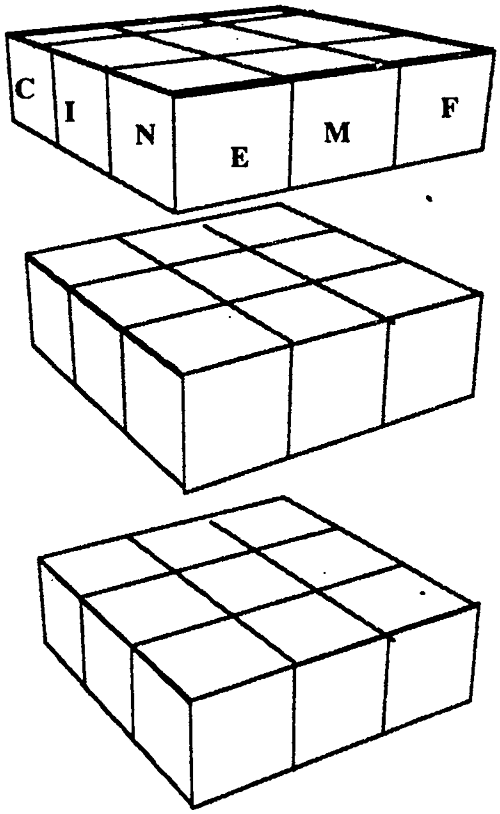

Figure 1. Viewed from top to bottom, the shaded cells contain scores for Groups 1, 2, and 3. The lessons are shown on the right face of the cube (E = energy, M = machines, F = physical force). The musical patterns are shown on the left face of the cube (C = congruent, I = incongruent, N = no music).

Results

Posttest Performance

The summary tables which follow organize the data for use in the analysis of variance required by the GLSFF 3^3 design. Table 3 presents, by group, the number of test items answered correctly in relationship to the lessons.

Table 3

Group Scores by Lesson

Group	Machines	Forces	Energy	Total
1	150	135	146	431
2	148	149	165	462
3	152	146	165	463
Total	450	430	476	

Table 4 presents, by musical pattern, the number of test items answered correctly during each administration of the treatments. It profiles the effect of the musical patterns across the sequence of treatments.

Table 4

Group Scores by Musical Pattern

Pattern	Treatment 1	Treatment 2	Treatment 3	Total
Incongruent	150	165	146	461
Congruent	149	152	146	447
No Music	165	135	148	448
Total	464	452	440	

Table 5 presents group performance in the context of all treatment components, where:

a_i = lesson; $_i$ = 0, machines;
= 1, forces;
= 2, energy;

b_i = group; $_i$ = 0, group 1;
= 1, group 2;
= 2, group 3;

c_i = music; $_i$ = 0, incongruent;
= 1, no music;
= 2, congruent;

Table 5
Total Number of Items Correct in Each Treatment Component

$a_0b_0c_0$	$a_1b_1c_2$	$a_2b_2c_1$
150	135	146
$a_1b_0c_1$	$a_2b_1c_0$	$a_0b_2c_2$
149	165	148
$a_2b_0c_2$	$a_0b_1c_1$	$a_1b_2c_0$
165	152	146

Tables 6, 7, and 8 contain, by group, the totals of items answered correctly on the achievement tests, the sample means, and standard deviations for each treatment component. The data are organized according to major treatment (lesson) juxtaposed with its moderating variable (musical pattern).

Table 6

Group 1: Items Correct, Mean Scores, and Standard Deviations

Lesson	Musical Treatment	Items Correct	Mean	SD
Machines	Incongruent	150	9.38	2.47
Forces	None	135	8.44	2.49
Energy	Congruent	146	9.13	3.67

Table 7

Group 2: Items Correct, Mean Scores, and Standard Deviations

Lesson	Musical Treatment	Items Correct	Mean	SD
Forces	Congruent	149	9.31	2.05
Energy	Incongruent	165	10.31	2.71
Machines	None	148	9.25	2.59

Table 8

Group 3: Items Correct, Mean Scores, and Standard Deviations

Lesson	Musical Treatment	Items Correct	Mean	SD
Energy	None	165	10.31	2.93
Machines	Congruent	152	9.50	1.62
Forces	Incongruent	146	9.13	2.64

The ANOVA prescribed (Kirk, 1982) was calculated to test for statistical significance of the effects of the forms of the independent variable, the forms of the moderating variable, and the other factors impacting the treatments, i.e., the groups and the order of treatment administration/repeated measures. The summary for the ANOVA is shown in Table 9. The factors A, B, and C represent respectively the lessons, the order factor, and the musical patterns. No factor produced a statistically significant effect.

Table 9
Computations for Type GLSFF 3^3 Design

Source	*df*	*MS*	*F*
Between blocks	47	528.667	0.027
Groups	2	13.792	
Blocks w groups	45	514.974	
Within blocks	96	510.333	
A	2	22.166	0.046
B	2	5.999	0.013
C	2	2.542	0.005
Residual	0	0.000	0.000
ABC X blocks w. groups	90	479.625	
Total	143	1039.000	

Subject Ratings

Students subjectively evaluated the interaction of the music and the lesson for both the congruent-music and incongruent-music treatments, by indicating on a 10 point scale whether they felt that the music, when present, made the content of the lessons more or less understandable. The t-test for nonindependent samples was run on the rating arrays for each group and for the total sample. There were no statistically significant differences in the subjects' ratings of these two musical patterns. In each case, the observed ratio was less than the t-value required to reject the null hypothesis.

Table 10 compares the ratings by group and for the total sample of the two musical patterns. Means, standard deviations and the t-value for these relationships are shown.

Table 10
Results of the t-tests

	n	Congruent		Incongruent		t
		X	SD	X	SD	
Group 1	16	5.81	2.23	5.38	2.16	-1.21
Group 2	16	4.88	2.16	4.81	2.93	0.12
Group 3	16	5.25	2.05	4.44	2.90	2.09
Total Sample	48	5.31	2.14	5.21	2.76	0.38

Table 11 compares the relationships between subject achievement scores and the associated ratings for each group and for the sample as a whole. In each case, the observed correlation coefficient was less than that required to reject the null hypothesis.

Table 11
Correlation of Ratings with Achievement Scores on Different Musical Patterns

Rating	Achievement	
	Incongruent	Congruent
Group 1		
Incongruent	-.17	
Congruent		-.14
Group 2		
Incongruent	.32	
Congruent		.14
Group 3		
Incongruent	.08	
Congruent		.00
Total Sample		
Incongruent	.09	
Congruent		-.04

Student Preferences

Individual student preferences were collected using a survey which included questions about music, science lessons and multimedia. The results indicated that the students generally study in the presence of music (77%). That was consistent with the report by 81% of the subjects that the musical patterns used in this experiment did not distract them. The failure of patterns of classical music to exercise a strong distraction effect is probably due to the high preference ratings given by the subjects to rap (40%), pop (17%), and light rock (14.5%). These are all forceful forms. % of the subjects of a liking for science lessons delivered in the fashion of this experiment. A large percentage (77%) of the students indicated that they liked the science lessons delivered this way and 73% indicated that they would take more science courses if they were delivered using multimedia.

Discussion

The purpose of this study was to assess the impact of music as an aid to learning. It attempted to enhance achievement by stimulating triple encoding in short term memory by aligning an abstract musical input, which elaborated subjectively on content (Burger,1993), with instructional strategy, a subjective lesson element. This research tested music in the role of a moderating variable, labeled Music-Instructional Strategy-Integration (MISI). The rationale for this moderating variable was to integrate abstract music with instructional strategy, a subjective lesson element, on the basis of psychological feelings. Participants viewed three multimedia science lessons that were designed using the instructional strategies of affective orientation and cognitive dissonance. Musical selections accompanied the lessons and were either congruent or incongruent with the psychological dynamics of the instructional strategies. Lessons were also delivered without music. The study assessed immediate recall and understanding of the lessons, students' subjective evaluation (rating) of the interaction of music in each lesson, and student preferences concerning music, science, and multimedia instruction.

The high MISI condition (music congruent with instructional strategy) was expected to enhance student achievement based on recent studies concerning the use of music in advertising (Kellaris, 1991; Kellaris, Cox & Cox, 1993; Kellaris & Kent, 1993) and in psychology (Boltz, Schulkind, & Kantra, 1991). A second expectation was for the low MISI condition to retard achievement compared to the no music condition. We did not find a statistically significant difference between the three conditions - high MISI, low MISI, or no music. This finding is also not in agreement with the research which regards music as a distraction (Zillman, 1994).

Students' rated the interaction of music in each lesson by answering the question "Did the music make the material in this lesson more or less understandable?" using a ten-point scale. Students were expected to find the incongruent music distracting and to therefore think that the music made the lesson less understandable in the lessons with low MISI. It was also expected that students would think that the music made the lesson more understandable in the lessons with high MISI. These expectations were not fulfilled based on the statistical analysis. This finding is, however, consistent with student performance on the achievement tests and may provide an explanation for our results.

This study ratified the popular notion that ninth grade students prefer instruction with a musical ingredient. It also found that students believe that music adds to lesson effectiveness and that the inclusion of music can stimulate positive student affect toward computer-supported science instruction.

There are several possible explanations for why the insertion of music which was congruent with the psychological operation of the lessons' instructional strategies did not improve performance. One consideration in this study was the choice of classical music. We purposefully chose music that was not familiar to these students. Familiar music could possibly be more distracting and might carry an affective association. The results from the students' subjective ratings of the music, however, showed that they may not have distinguished between the congruent and incongruent treatments. The use of classical music with this particular group of subjects may have acted similar to background music.

The failure of this technique to produce a significant effect could suggest that multiple encoding is an objective, content specific phenomenon, not under the influence of subjective lesson attributes. This study suggests, therefore, the need for a similar investigation of multiple encoding using only literal music. Literal music depicts content by becoming one of its objective parts as in a sound effect (Burger, 1993).

In designing this experiment, we purposely used a simple dissemination strategy rather than embellishing the lessons with components that are known to improve performance, (e.g. practice, feedback, interactivity). We did this in an attempt to avoid a "no significant difference" finding due to a ceiling effect. It is possible, however, that the efficiency of the instructional design employed and the impact of the visual elements for these lessons fully executed the psychology of the instructional strategies so that no room was left for the music to contribute to those psychological dynamics. This study suggests the need for further experimentation with music as an agent in dual encoding where the music is associated with only one other message element such as text. A related but different explanation is the possibility of a novelty effect associated with multimedia delivered instruction. These students were not used to this delivery mode in their classroom. The uniqueness of these lessons together with the short length of the lessons, may have held their attention more than if it were a common or lengthier occurrence.

This investigation clearly demonstrated that adolescents prefer to have music present in their academic activities and may be more interested in science courses which utilize the use of multimedia. This finding together with the mixed results of research about the best way to integrate music into instruction strongly suggests the need for further studies.

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APPENDIX A

Musical Compositions

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