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Music Software in the Compositional Learning Process

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by

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Dedication

To:

Mom

Wife

Son

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Thanks to Dr. David Williams **–** For all of the help during my time at USF

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Abstract

Computer software for music has made a significant impact by affecting the perspective of music making, music creating, music education, music production, and music distribution. This impact continues to evolve as individuals seek new avenues of musical expression. Through the papers included in this document, I seek to explore the range and impact of computer software in music, especially software related to music creativity and composition.

The first paper is a review of literature concerning the effect of software on creative thought, creativity in music, and the influence this has had in musical composition. In this paper I also explore various techniques of composition, including linear and non-linear processes, which make use of the computer and music software.

The second paper is a case study examining the use of music software in a compositional process. In this paper I explore the experiences of the student who was learning to compose music using music software. It offers the perspectives of the students as they developed through each step of the compositional process.

It is important that the reader understand the distinction between composition and improvisation as discussed in these two papers. Simply stated, the act of composing is described as the process of forming, making, creating, or constructing music with various elements, phrases, or sections of music. Composing music is often associated with a skill set that captures inspiration and transforms it into a permanent record. Improvisation is the act of creating and

playing new music without specific forethought or prior preparation. It can also be define as a skill of creating music in a spontaneous, impromptu, or impulsive way.

PAPER 1

LINEAR AND NONLINEAR MUSIC COMPOSITION SOFTWARE

REVIEW OF RELATED LITERATURE

The use of computer software in the performance and creation of music has gained in popularity and common practice over the last 20 years. Digital audio workstations (DAW's), hardware and/or software configurations used for producing, recording, and editing audio files, were dominant mechanisms in use, especially in popular music genres, by the early 2000's. They provided a vehicle not only for generating edited and mastered music, but also for performing electronic music in a live venue (Holmes & Holmes, 2002).

Digital audio workstations followed a time-base or linear format based on a magnetic tape model that was highly sequential. Musicians performing electronic music with the linear format/model found the software restrictive and difficult to use in the expression of creativity - especially in live performances. The inclusion of other hardware technology such as MIDI keyboards (Musical Instrument Digital Interface), digital drum machines, and turntables added possibilities for live music performance and creativity. In spite of these technological additions, the experiences of the performers specializing in electronic music still lacked creative expression (Holmes & Holmes, 2002).

The restrictions of DAW's encountered by many performers provided the impetus to investigate or create other methods that would enable a creative and expressive dialogue between the musician specializing in electronic music, the music technology software, and the audience (Collins & Rincón, 2007). As live electronic music performances evolved, new emerging interactive technologies were created by software designers accentuating a primary objective of supporting creative expression for the live performer (Hook, 2013). One innovation that provided a greater expressive and creative live performance was a software program created by three German software engineers in 1999, called "Ableton Live" (Ableton, 2016; Henke, 2016).

The foundation of "Ableton Live" consists of a software design combining two graphical user interfaces. The first graphical interface is the highly sequential, linear format reflecting the design of prior digital audio workstations (linear). The second interface is an abstract, or nonlinear format created to enhance live performances (Pecko, 2016). Although the two interfaces coexist in the same program, the linear format provides recording and audio editing functions for electronic music, and the nonlinear format has various other functions to aid the electronic music composer. In addition to containing the functions of recording and editing audio, the nonlinear format allows the user to create or compose music in an abstract or random manner. That is, the user is not constrained to a sequential (or linear) method of generating or constructing music.

The nonlinear format provides the electronic music composer and/or performer with a means of achieving greater freedom of creativity and musical expression. Creating music in this way is a more fluid experience than in the linear format. In addition, the nonlinear format provides a substantial increase in the experience of an electronic musical performance and offers an alternative method for improvisation as well as composing electronic music.

Capturing the Essential Distinctions

The essence of the distinct user experience between the two formats (models) pertains to the mental process of musical and procedural thought generation. The linear format, and thus the linear composition software model, structured the elements of the composition process into a hierarchical format that is rooted in chronology. For example, the first thing a user might experience using software oriented around the linear model is the beginning of the song/composition. The beginning is the first component one would experience with respect to time. Then, the user proceeds to the subsequent aspects of the musical product, ultimately finishing the music at the end. (The portion of the song that occurs last with respect to chronology.) We even find a semi-hierarchical model within the chronological base in this type of software model. We might imagine a top-down approach. One where the melodic/primary musical components are established first. Then the harmonic/secondary aspects are added. Then those aspects of the music that are supportive or supplementary. And so goes the compositional process. From left to right; top to bottom.

The problem is that many musicians do not conceive of music in such a formulaic manner. A musician may first have a musical idea or passage in his/her head that he/she feels is an excellent way to end a song without ever having conceived of what might be considered the introductory, head, chorus, bridge, or any other traditional preceding part of the song. He may—and in many cases, does—mentally conceive of the music out of sequence. That is, in a nonlinear manner.

An analogous reference might be writing a paper in a creative writing course. If we give a student some very basic parameters, allowing him/her to conceive of the various components of the writing, the product may emerge in what appears to be a random or abstract manner. Perhaps he first conceives of the type of characters he wishes to write about. Or the type of story. Maybe he decides that he wants his dog to play a key role. And then decides how he would like the story to end. But if we give a student a highly structured, hierarchical set of instructions, and then a computer with a blank document for her to fill with text, the tendency may be to start at the beginning, and proceed from the beginning through to the end. So, a great deal of the user's choice is constrained and facilitated by software that is designed to be—for lack of a better term —friendly to a certain style of compositional process.

Nonlinear description

The nonlinear interface resembles a table with multiple columns and rows resembling a grid of cells. Each column represents a virtual track containing a specific entity such as an instrument, drums, synthesizer, or audio effects or may contain audio or MIDI data. From this interface, the musician can populate the cells with varying musical information that he is creating or composing.

In the nonlinear format, each individual row can perform multiple functions, and any row can be moved in any order with other rows. Additionally, a row can provide time signature and tempo changes. The software offers the ability to play all the cells in each column residing in that row. Executing a row to play during a performance presents the electronic musician with the opportunity to perform the rows sequentially or randomly.

The design of the interface is not restricted to playing only individual rows, but allows the playing of random individual cells. The freedom of playing random cells affords the composer or the performer creative expression during music making or music composition process. The nonlinear interface is a unique design providing real-time creative response to improvisational and compositional ideas.

Historical Background

Some innovations created since the early 1980s are essential to the design and production of the nonlinear composition model as it exists today. These innovations—which include advances in hardware, software, and interactive designs—created a platform for performance and composition of electronic music. The examination of some of these innovations will provide a foundation and a reference point for this paper.

Some of the first innovations are the PC (personal computer), disc drive, audio conversion technology, and software designs. The convergence of these innovations created the foundation of the digital domain. The development and utilization of the PC and its framework of hardware and software operating system provided the environment or digital domain to create and record digitized sound and video information. The invention of the internal disk drive was a crucial component of the computer allowing accessibility in sequential, random, and direct access of the data stored on the drive. This essential piece of hardware enabled the recording of digitized sound and the conception of the electronic musician.

Continued advances in computer technology dominated this span of time with rapid advancements in music recording software and audio digital convertors. These innovations were responsible for the movement of recorded audio from magnetic tape to a digital audio file such as wave, MP3, AIFF, and various other formats. These various formats enabled considerable reductions in the size of the audio files, permitting the storage of audio on digital media.

Increasing the CPU (Computer Processing Unit) processing speed contributed to the enormous improvement in the structure and processing power of the PC. High-speed conversion of video from magnetic tape to a digital format became possible as a result. The increase of CPU speed also permitted an increase of internal data transfer rates facilitating the high speed editing of digitalized audio and video data. Software written during this time established the standard of video and audio editing.

The concept of nonlinear editing of video and audio data began as a foundational framework and later served as the standard for software video and audio editing (Rubin, 1995). Nonlinear editing has been in use in the broadcast and entertainment industry since the late 1990s, and is now the standard for commercial media, film, video, and audio editing. This foundational software and hardware architecture was the platform that the nonlinear composition software model was built upon.

Creating music in computer programs using linear and nonlinear formats is both new and old. The more well-established of the two areas is composing in computer programs using linear models. Composing music in computer programs using nonlinear models is a far more contemporary practice. Consequently, the respective literatures are exclusive (to one format or the other), vary considerably in depth and rigor, and offer little in the way of substantive contributions to theory or practice. This is especially true of educational contexts where instructional pedagogies and practices have been examined.

Since a dearth of applicable empirical research exists, it is necessary to incorporate literatures that are directly and indirectly related. Principally, literatures (including both research and other writings) from the areas of creativity, intuition, musical creativity, music composition, music education and even some aspects of music history are integrated here. Each area sheds some light on various elements at work in the music composition process, and how these elements intersect with computerized music composition and real-time creation.

Creativity

There can be little question that creativity intersects the type of musical composition activities presented here. It falls under what is considered a broad or governing mental phenomenon that heavily influences creation in any domain. Creativity is thought to intersect, in some way, nearly every facet of life. The belief that creativity is a necessity in problem solving, for example, underscores the significance of this capacity in such areas as business, government, science, and education (Gardner, 2007, 2008).

A dense and diverse history of creativity literature suggests a substantial interest in the subject. Research began in the 1950s when Guildford's speech to the American Psychological Association challenged psychologists to pursue research in creativity from a scientific standpoint (Guilford, 1950). This may have marked the beginning of creativity research that has continued even to the current time.

One of the great challenges of researching anything is arriving at a clear and concise definition of the subject being studied. As we see from the following material, defining creativity in a manner worthy of broad consensus has proven difficult. Barron and Harrington (1981) define creativity first, as an achievement that is both socially recognized and novel, and second, as an ability exhibited by an exoteric performance during a critical period, such as an examination or challenge. Simonton (2001) states that creativity has the "capacity to produce ideas that are both originative and adaptive" (p. 2). Amabile (1996) , Csikszentmihalyi (1996), Gardner (1993), Randles (2009) agree that creativity is the act of creating or is the description of a process that produces a finalized result that is both novel and useful. Feldhusen and Goh (1995) define creativity as:

> . . . a parallel construct to intelligence. However, it differs from intelligence in that it is not restricted to cognitive or intellectual functioning or behavior. Instead, it is concerned with a complex mix of motivational conditions, personality factors, environmental conditions, chance factors, and products.

Studies suggest that individuals who exhibit creativity or creative insight contain have skills or abilities that characterize the attributes of creativity (Amabile, 1996; Guilford, 1950). The observation of people employed in creative activities has uncovered, through examination, similar creative traits, and patterns. These traits or patterns represent the foundations of creativity that facilitates the production of novel ideas or solutions to problems. It is through the observation of similar creative patterns or processes, which permitted the examination, identification, and the construction of creativity models (Sawyer, 2006; Webster, 1992).

Theoretical models of creativity

Csikszentmihalyi (1996) and Amabile (1993) maintain that creativity is best expressed as a model consisting of three parts: the domain, the field, and the creative product. For the creative product to be significant to the domain, it must meet two criteria. The product must be: 1) novel and unique, and 2) must be an original and anomalous achievement. The domain represents the discipline, subject area, or sphere of influence that applies to the creative product. The definition of the field can be described as a subset of the domain and expressed as the territory, or specific area of the creative product.

A number of creative models exist in earlier literature. The Wallas Model for the Process of Creativity (Wallas, 1926), Rossman's Creativity Model, (Rossman, 1931), Osborn

Seven Step Model for Creative Thinking, (Osborn, 1953), The Creative Problem Solving (CPS) Model, (Parnes, 1992), A Model for Strategic Planning, (Bandrowski, 1985), and Fritz Process of Creation, (Fritz, 1991), all stand as evidence of the multitude of conceptualizations in which creativity has been framed over the years.

Creative models recognized by cognitive research demonstrate the creative process. Of these, Wallas' model has found support in literature and is identified in divergent disciplines (Wallas, 1926; Webster, 1992). This model describes four stages: 1) preparation, 2) incubation, 3) illumination, and 4) verification (see Figure 3). Each stage is a step toward the creative product. The preparation stage outlines the scope of the problem. The incubation stage is time spent away from the problem to reflect on the current formation of the product. The illumination phase is the moment of the creation of the idea or solution for the problem. The verification stage is the time the idea is tested, verified or put into practice and refined.

Csikszentmihalyi (1996) posits a five-step model including elaboration. The framework for Csikszentmihalyi's model is: 1) preparation, 2) incubation, 3) illumination or insight, 4) verification or evaluation, and 5) elaboration (see Figure 4). The first step, preparation, is the integration with the problem or task. The observation of integration is defined as a state of absorption into the music or art in such a way that the thought processes are focused entirely on that task. The second step, incubation, describes the processing of ideas below the consciousness level. The third step illumination, provides an instant when parts of thoughts come together to make a new whole. It is in this step that musicians and artists realize that something happened to birth a new idea. Verification or evaluation, which is the fourth step, occurs when the creative person evaluates or verifies whether the innovation is worthwhile. Researchers have stipulated that the innovation may be new to the person but not the domain. The last step, elaboration, is defined as a laboriously intensive process that involves processing the details of the innovation (Csikzentmihalyi, 1996).

A renewed research interest in creativity and creative thinking begin in the 1980s (Webster, 1992). While the field of psychology was struggling with the definition of creativity, music researchers continued to search for definitive answers. Influences from psychology research such as multiple intelligence theories and new assessment techniques provided inspiration to music researchers (Gardner, 1985, 1993, 1995, 2000; Guilford, 1967; Torrance, 1968).

Systematic thinking

By the mid-1900s, American economic prosperity had been largely credited to organizational structure within capitalistic enterprises (Kemdall, 1966). It is probably not much of a stretch of the memory to recall some knowledge of Henry Ford's innovative approach to the assembly line in automobile manufacturing. The organizational structure resulted in efficiency and effectiveness in large-scale production. This mechanized systematic approach to industry proved to be key in productivity and profitability, in nearly every sector of American business (Chandler, 1977).

Systematic organizational design, and thinking in a linear systematic manner, had become a common facet of business in the United States, and thus society. So much so that the term "organization men" became a common term used to refer to the individuals who designed, propagated and functioned within bureaucratic systems (Kendall, 1966). Today, the term "systems thinking" still lingers in the business world as a capacity to conceive of operations, structure, regulations, and policy within the framework of systems (Ivancevich & Konopaske, 2013).

However, by the mid-1900s the “organization man”—and his bureaucratic systems and structures—were increasingly regarded as stifling to innovation and information flows (Chandler, 1977). The term began to be associated with rigidity. By the late twentieth century the term characterized an outmoded and nearly irrelevant construct that was more of a liability than an asset. The rapidly changing business climate in the U.S., and around the world, had increased in complexity and competitiveness. Mere efficiency was no longer a significant advantage. Instead, business leaders in this era regarded intuition, or intuitiveness, as an indispensable capacity of management (Peters, Waterman, & Jones, 1982; Rowan, 1986).

Intuition

Like creativity, the concept of intuition faced many initial criticisms that were at least partly attributable to ambiguity. What exactly was intuition? In the minds of many in the business community of the mid- to late twentieth century, the term was associated with emotion-infused gut feelings or hunches that might play a role in decision making. That made the subject seem mysterious and unreliable (Leavitt & Walton, 1975; Mishlove, 1996).

Taking intuition seriously in the business community was heavily dependent on the ability to clearly define, measure, and manage intuition. Intuitive management advocates and consultants sought guidance from what would later become known as neuroscience (e.g., brain scans) as well as creativity research, in the hopes of further understanding intuition. But understanding intuition was not enough to make it manageable. The subject needed to be understood in sensible terms.

In addition to influences from the areas of neuroscience and creativity research, the intuitive capacity was also thought to possibly be a feature of personality style (Akinci & Sadler-Smith, 2012). Even as a trait associated with such things as intelligence or creativity, intuition would need to be studied from a psychological viewpoint. The possible attachment to personality made psychological testing all the more important.

Tests such as the Human Information Processing Survey, the Hermann Brain Dominance Instrument, and the Aptitude Inventory Measurement all examined the intuitive capacity/function in some form (Lussier, 2016). The Myers-Briggs Type Indicator (MBTI) was the most well-known of these. The MBTI was (and is) a measure that identified a personality style or type based on examinees' responses to a battery of written questions. A taxonomy of four categories, organized into scales or lines, was used: extraversion/introversion, thinking/feeling, judging/perceiving, and intuition/sensing. The last category (intuition/sensing) is particularly relevant to this discussion.

The intuition and sensing capacities examined by taking the MBTI were based on Jung's conception of these terms. In his book Psychological Types (1923) he identifies intuition as a type of perception that is beyond the five senses and pertaining to abstractions, imagery, symbolic representations, and even mental conceptualizations (Jung, 1971). By contrast, the idea of sensing was empirical. That is, perceptible through one or more of the senses. Jung's theory suggested that people tend toward a preference for intuition or sensing as a means of engaging the world around them. The sensory individual (one who has an inclination toward the senses) was thought to be more extroverted in personality. The person would more naturally be inclined to external things. Whereas the intuitive individual was thought to be more inwardly focused and likely introverted in personality. Isabel Briggs Myers, the MBTI's creator and developer, indicated that the intuitive person "preferred abstract ideas to concrete facts, potentialities over actualities, future over present, and holistic over sequential decision making" (Myers & Myers, 2010).

In the 1950's the University of California at Berkley's Institute of Personality Assessment and Research—commonly referenced in literature as IPAR—devised a number of mechanisms to study and gain insight into the various facets of the personality. IPAR's early adoption of the MBTI, for use in psychological assessment, was heavily influenced by the revelations of MBTI's intuition scale (Lussier, 2016). While creativity and intuition were distinguished in the minds of IPAR researchers, a degree of correlation had been established between these two areas (Bycroft, 2012).

Harrison Gough Gough (1981) was one of IPAR's researchers who studied the MBTI's utilization in the testing done at the Institute. In his paper, presented at the Fourth Bienniel MBTI Conference at Stanford University, he reported that preference or inclination toward the intuitive form of perception (the introverted personality type) was rare and found in approximately twenty-five percent of the general population. He also indicated that among creative personalities, ninety percent demonstrated preferences or inclinations toward intuitive perception. Creative people (as the studies had defined creative people) seemed to show a fondness for the very forms of perception that defined intuition. Finally, he indicated that people demonstrating a preference for intuitive perception, "favor fantasy and the abstract to factuality and the concrete, like imaginative more than sober-minded people, value possibilities more than probabilities, and prefer theories to facts" (as cited in Lussier, 2016, p. 712).

The Gregorc Style Delineator

The Gregorc Style Delineator (GSD) is a self-report instrument that was designed to identify an individual's primary style/preference of information processing (Benton, 1995). The instrument establishes two dimensions of stylistic variation or preference. These include: 1) perception, and 2) sequence. The perception dimension is separated into an abstract form versus a concrete form, while the sequence dimension is separated into a sequential form versus a random form. Consequently, the GSD may reveal four categories of information processing style or preference: Concrete Sequential, Abstract Sequential, Abstract Random, and Concrete Random.

Individuals who take the GSD rank order ten sets of words. Each word is ranked with a "4" indicating that the term is most descriptive of the individual (self) to a "1" indicating that the term is unlike the respondent, or least descriptive of the individual. Subscale scores on the GSD reveal relative strengths. High scores range from 27-40. Intermediate scores range from 16-26. Low scores range from 10-15.

Although some have questioned the reliability and validity of the GSD (O'Brien, 1990; Reio Jr & Wiswell, 2006) the instrument has been shown to reveal some connectivity to traits measured by the MBTI. For example, Harasym, Leong, Juschka, Lucier, and Lorscheider, (1996) examined 259 nursing students' learning styles, measured by the GSD, and personality traits (as measured by the MBTI), in a search for alignment. Scores from the MBTI and the GSD, as well as from achievement examinations and grade point average were examined. Factor analysis using verimax rotation indicated that the learning style predicted by the GSD corresponded to the traits examined by the MBTI. Individuals showing a preference for the Concrete Sequential learning style on The Gregorc Style Delineator tended to show strengths in the sensing and judging traits from the MBTI. (Recall that sensing from the MBTI was related to an outward-focused, extroverted, personality.) An individual whose GSD style was Concrete

Random tended to demonstrate intuition and perceiving on the MBTI. (Recall that intuition on the MBTI was derived from a capacity thought to be related to creativity.)

Similarly, Drummond and Stoddard (1992) examined the relationship between The Gregorc Style Delineator and The Myers-Briggs Type Indicator, as well as the construct validity of the GSD. The study involved 41 undergraduate students who completed both the GSD and the MBTI. The authors concluded that personality style revealed by the MBTI predicted some of the learning styles indicated by the GSD. Although statistical power and correlations were weak in this study (possibly due to a relatively low number of participants) the results lent some support to the validity of the GSD. The authors indicated that the GSD appeared to measure dimensions that the MBTI measured, but labeled differently.

The Gregorc Style Delineator lends some credibility to the elements of information processing and thinking preferences that govern how individuals function as perceivers and learners. The mere existence of the instrument opens the possibility of highly sequential thinking and learning styles as well as the possibility of holistic or big picture thinking that is less dependent upon highly structured information processing. We need not rely exclusively on the GSD either. It is related to The Gregorc Transaction Ability Inventory, The Kirton Adaption- Innovation Inventory, and The Kolb Learning Style Inventory (Joniak & Isaksen, 1988). These instruments may provide a window into the world of linear and nonlinear composition preference phenomena.

Brain lateralization

Brain lateralization studies emerged in the mid-century. These studies were detailed in specific brain function and suggested that distinct types of information processing occurred more in one hemisphere of the brain than the other (Springer & Deutsch, 1998). The right hemisphere was supposedly the locus of holistic thinking, whereas the left hemisphere was more associated with analytical thinking. Some alignment is evident here. The intuitive capacity or perceptual preference would be localized primarily in the right hemisphere, where the analytical or sequential capacity or preference would be localized primarily in the left hemisphere.

The Herrmann Brain Dominance Instrument (HBDI) was created in the late 1970s by former General Electric training director Ned Herrmann. Like the other instruments identified here, the HBDI was a questionnaire that posed a battery of questions. The purpose if the instrument was to measure hemispheric preference or dominance of individuals (Herrmann, 1988). That Herrmann himself had worked for a large company as the training director is not insignificant. Diagnoses were not the only intended applications of the HBDI. Identification of a preferred or dominant style of cognitive processing was important as a first step toward training the individual to strengthen those faculties associated with their non-dominant hemisphere (Herrmann, 1988). The theory of the instrument's creator was that for comprehensive, efficient, and effective thinking and problem solving, individuals needed to have the ability to utilize the entire brain. This type of whole-brain faculty demanded a capacity for toggling back and forth in the hemispheres of the brain. In Herrmann's later career as an organizational consultant he would go on to stipulate that the full effect and utilization of his instrument, and others like it, should be found in teams and groups of employees and problem solvers within companies. He posited that, as an example, intuitive managers may do well to contemplate new and innovative ideas and approaches, while the more linear-thinking managers would have a critical function in determining the practicality and feasibility of these ideas and approaches (Gorovitz, 1982). The significance of brain lateralization studies such as those using the HBDI is not all- encompassing in this paper. But consider that it is this literature where we encounter the terms linear and non-linear as descriptors of thought processes. Agor (1997) article regarding intellectual capital is an excellent example of the application of such labels, as well as their potential scope and utilization.

Creativity and Intuition: Applications

The preceding sections have served to broadly frame the subject of linear and nonlinear music composition along conceptual and theoretical lines. In these literatures, we find several areas of applicability including: creativity as a broad mental phenomenon influencing thought and action, the intuitive capacity as a related and possibly internal component of creativity (general), personality features derived or informed by intuition, information processing preferences and styles, as well as potential applications of cognitive hemispheric localization that may play substantial roles in linear and non-linear thinking.

Is it possible that The Myers-Briggs Type Indicator, for example, may shed some light on the type of personality style associated with preference for linear or nonlinear composition software? Even the Intuition/Sensing subscale of the MBTI may be partially revealing. How much more applicable may be The Gregorc Style Delineator? Would it be possible that an individual possessing an information processing style of Abstract Random may strongly prefer using nonlinear music composition software? These considerations are especially relevant in the realm of preference, which is not the primary focus of this paper. But we can easily imagine a scenario where the MBTI and/or the GSD could significantly predict preference for either music composition platform.

Success in utilizing music composition software may be illuminated at some future point as well by these literatures. Is it possible that individuals who indicate a preference for left hemispheric functions (as identified in The Herrmann Brain Dominance Instrument) may demonstrate higher levels of proficiency in music composition using the linear music composition software. Success/proficiency is not the foremost aspect of this paper either. Instead, it is primarily oriented around the exact procedures (protocols) student composers utilize as they engage with the software. But the success/ proficiency aspect could easily be defined and treated as a dependent variable in subsequent related research.

Creativity in Music

Randles and Webster (2012) describe creativity in music as:

> The divergent and convergent thought processes, enacted both in solo and in ensemble, that lead to musical products that are both novel and useful, within specific socio-cultural contexts, manifested by way of specific modes of musicianship or combinations of modes that can include but are not limited to the following: improvisation, composition, performance, analysis, and listening.

The authors provide a context-relevant, utility-focused definition. We see that the thought processes that emerge in musical environments (solo or ensemble), that lead to novel and useful musical products generated via improvisation, composition, performance, analysis, and listening (or some combination thereof) defines creativity in music. It is more than a mouthful, but increasingly accepted as a standard of highly creative music and music making. As such, it becomes obvious that generating truly creative music, musical thoughts, or musical products is not done capriciously or absent skill and forethought. For certain, the definition treats the creative aspect of music as an artistic, skill-derived element.

Creative thinking in music

Webster (1990b) states that creative thinking is the thought processes occurring during periods of creativity. During these times, the mind is engaged in deliberate and meticulous thoughts of sound. Webster states that music creativity is "the engagement of the mind in the active, structured process of thinking in sound for the purpose of producing some product that is new for the creator" (Webster, 1990b).

Research involving creative thinking in music is divided into four threads (Webster, 1990b). The first is musical imagination or musical imagery (Kaschub, 1997; Thomas, 1987). The second focuses on theoretical models of the creative process, such as earlier work by Vaughan (1973; 1977), and recent work by Swanwick and Tillman (1986), Kratus (1985, 1989, 1994b, 2001), and Wiggins (2003). The third is research of psychometrics and the design of an assessment instrument that could assess creative aptitude in music (Hickey, 1995; Webster, 1977). The fourth is the observation of creative behavior (Webster, 1990a).

A new (or fifth) thread emerging during the last twenty years pertains to the application of music technology and its corresponding software environment promoting creative thinking. Studies by Folkestad (1996), Hickey (1997), and Seddon and O'Neill (2003) demonstrated the use of music technology as a creative environment to encourage creative music making and musical products. While each research thread adds to our growing agglomeration of knowledge, it furthers the clarification of creative processes, creative thinking, and creative products.

Creativity instruction via music

Can creativity be taught in, or through, music? This question and many like it have led to an inconclusive body of literature. Odena (2012) suggests that creative skill is a capacity that can be developed by participation in musical improvisation, composing, or performance-oriented, action-based, music making activities. Accepting the definition of Randles and Webster's (2012) creativity in music is found in the thought processes that are in play in various musical contexts. So, providing instruction specific to how to create something is different than how to think creatively. By this definition, it may be possible to be engaged in the creation of a musical product, but not engaged in divergent or convergent thought processes that formulate the basis of creativity. Webster himself states that students engaged in exercising creativity skills learn strategies or processes, new ideas, and refinement techniques needed to produce a creative product (Webster, 2002a).

The ambiguity is obvious. It appears that instances may exist where brilliant production of a creative product may be no more than the refined step-by-step assembly or re-employment of a certain set of skills that lead to the completion of the product.

For much of his career, Webster defined musical creativity as, "the engagement of the mind in the active, structured process of thinking in sound for the purpose of producing some product that is new for the creator" (Webster, 2002b, p. 11). The model of the creative thinking process in music that Webster presented in his 2002(b) work suggested that creative thinking in music occurs as a result of divergent thinking as well as convergent thinking. Both are integral processes. As such, composing music, musical improvisation, written analyses of music that was experienced, and producing recordings were all viewed as highly creative musical endeavors.

Suitability of creativity instruction for young people

Webster's creativity research began in 1979 when he investigated the creative music making abilities of 77 high school students in the Rochester, New York area (see Webster, 1979). He specifically investigated improvisation abilities, composition abilities, and analysis. The participants were pre-screened with the Torrance Tests of Creative Thinking (1974) , The Colwell Music Achievement Tests (1970) were used to determine existing abilities in auditory discrimination, melody recognition, pitch recognition, and instrument recognition, and Gordon's Musical Aptitude Profile (1965) was utilized as well. Those students who scored highly in music achievement also scored highly in all criteria measures of music creativity (improvisation, composition, and analysis). The factors of age, grade level, and performance medium, had no significant relationships to any of the criteria measures. I.Q. (intelligence quotient) was significantly related to improvisation. Finally, the three skills proved to be related. High performance in one area was likely to indicate high performance in all three.

At least from the work of Webster, the product driven approach of cultivating musical creativity seems to be a window into stimulating the requisite types of thinking that define creativity. Webster advanced the conception of musical creativity, but also indicated that school music students were capable of being successful in improvisation, composition, and analysis. His studies also indicated that success in these activities is highly related to the existing musical skills students possess.

Moorhead (1941, 1942, 1978) and Pond (1981) also pursued research of musical creativity with young people. This research documented the creativity of young children and the exploration of instrument sounds. Musical instruments from Asia and America allowed the children to explore musical sounds and enabled a creative environment for musical expression and enjoyment. Pond (1981) said, "Everything that I wished to accomplish would relate itself to the ways in which I would observe children taking hold of sound, enjoying it, manipulating it to make sound structures for their use and pleasure" (p. 3). Their research provided grounding for observing musical creativity and examining the creative product.

Improvisation and compositional research are comprehensive observational studies that focus on the creative musical product from the participant. Usually the subjects are children learning to make new sounds with instruments at hand. Children composing, whether it is an improvisation of a motif or a composition of a song is inclusive of the compositional process. Moorhead (1978) and Pond (1981) studies are early examples of this research. They observed the children during their spontaneous music making with the instruments in the school. Moorhead and Pond's approach provided a naturalistic environment to encourage the children with opportunities to compose music. Examining the compositional process during the creation of the product provided opportunities for the understanding of the procedures involved in composing or creating music with students of this age.

Hickey (2001b) study investigated the assessment of fourth and fifth-grade music students’ compositions using Amabile’s consensual assessment technique. In this study, the researcher had previously collected compositions (recordings) that were created by fourth and fifth-graders. These compositions contained the musical products of a process that the researcher had developed to lead young children through a compositional technique. Twelve of the twenty-one compositions she possessed where randomly selected for assessment by sixty-one judges in five groups. The five groups were: professional composers (n = 3), music teachers (n = 17), music theorists (n = 4), 7th grade children (n = 13), and 2nd grade children (n = 24) (p. 238).

Hoyt’s analysis was utilized to generate co-efficient alphas that represented levels of agreement. The professional composers who evaluated the compositions demonstrated the lowest levels of agreement in their evaluations (.04). The teacher group who evaluated the compositions generated moderate levels of agreement in their use of the consensual assessment technique (.64). More interestingly, a subgroup of the teacher group—those who taught general music and choir—exhibited the highest levels of agreement in their evaluations (.81) (p. 240). This study, and much of the work of Hickey, has gained a great deal of notoriety in music education. Similar to Moorhead and Pond in the 1940s, this work affirmed that composition is possible for children (see Pond, 1978).

Creativity in school music programs

Learning is not confined to the formal classroom. However, in the United States it is in the schools where most children and adolescents encounter formal music instruction.

At the primary school levels this is likely to be some form of general music. General music teaching in the U.S. is likely to be guided by the Kodály Method, the Suzuki Method, Orff Schulwerk, or the Dalcroze Approach.

Kodály

Zoltán Kodály viewed music education as highly dependent upon music literacy. So it comes as no surprise that the Kodály Method is driven toward symbolic representation of music. Musical syntax is bolstered by the practice of common musical patterns. Visual representation of rhythm is done with sticks (vertical lines) and connected sticks (to represent divisions such as eighth notes). Students typically sing in accordance with the Kodály Method but playing of recorders is also common around Grade 3 and beyond (Hoffer, 2017).

Suzuki

The Suzuki Method centralizes rote repetition. After hearing a musical example, the student repeats it with as much replicable detail as he/she can recall. In the event of error, the instructor repeats the example giving the student another trial to replicate the example correctly. It should be noted of the Suzuki Method that it is an instrumental pedagogy involving string instruments. Music is memorized. Reading notation is not introduced in Suzuki until fundamental concepts of sound production and technique have been established (Kendall, 1966). Suzuki is the most formulaic of the methods presented here. Much like a one-size-fits-all approach, in Suzuki, one method fits all as well. Without regard for age, students proceed through the same set of lessons and musical content. Finally, Suzuki instruction occurs primarily in one-on-one or small group lessons. Parental attendance is generally required at lessons as well. So while this method remains popular in the U.S.—especially among string players—its direct use is limited in the schools. However, some educators have utilized the fundamental tenets of Suzuki as a platform for teaching elementary level music in other settings (see Suzuki, Mills, & Murphy, 1973).

Orff Schulwerk

Orff Schulwerk, the method devised by Carl Orff and Dorothea Günther is rather popular in U.S. schools. Its focus is on elemental aspects (fundamentals) of music that are simple to understand. Speech rhythms, rhymes, calls, and chants are a part of early instruction in Orff as they teach students to recognize rhythms in everyday life (Hoffer, 2017). Atop the lessons in rhythm, singing is presented. Often in call and response style. Physiological movement is included in Orff as well. Also, improvisation plays an important role in Orff Schulwerk. It is presented in a highly-structured manner where students are allowed choice, but within narrow parameters. As their proficiency and comfort grows, they are offered more choices and fewer restrictions (Orff, 1963, 1973). Orff also includes instrument playing. This is a highly recognizable feature of Orff as the various mallet instruments (sometimes called Orff Instruments) are found in many schools.

Dalcroze

The method of Emile Jaques-Dalcroze contains three primary branches. The first is a focus on physical response to music. Typically called eurhythmics, students of the method are encouraged to spontaneously move to the music they hear. The second branch is solfège. Perhaps the most recognizable feature of solfège is its hand symbols and the fixed do (where C is always do). The third branch of Dalcroze is improvisation. Students learn to improvise first with their voices and on percussion instruments as well (Becknell, 1970, 1990).

Gordon

This section would be incomplete without some mention of Edwin Gordon's contributions to music learning and music education in the U.S. Gordon may be most readily recognized in association with the measurement of music aptitude. His Music Aptitude Profile (Gordon, 1965) is widely known as a reliable measure of stabilized music aptitude. Gordon also contributed the concept of audition. Gordon referenced audition as an inner hearing of music before expression or production of it. He referred to this capacity as being to music what fore-thought is to speech. Eventually his Intermediate Measures of Music Audition (Gordon, 1982) became regarded as a measure of music aptitude as well.

Regarding creativity, Gordon distinguished between musical exploration, creativity, and improvisation (Gordon, 1992). Exploration, Gordon said, was what occurred when we play on an instrument without any conception of what we're doing. By contrast, creativity implies intention, forethought, knowing what we're doing with the music. Gordon contrasted improvisation with creativity by saying that improvisation is creativity with imposed restrictions. In fact, Gordon conceived of a continuum with improvisation (imposed restrictions) on one side, and creativity (no imposed restrictions) on the other. The more restrictions that are imposed on the musician, the more improvisatory the creation. As those restrictions are lifted, the musician begins to move toward increasingly higher levels of creativity.

At least from cursory reviews of some of the most frequently utilized music teaching methods at primary school levels, it does not appear that young students engage in highly creative music activities often. Only in Orff Schulwerk and the Dalcroze Method does improvisation, for example, play an important role. (Albeit among several equally important components.) Composition seems to receive no mention in any of the methods. If any implication can be derived from these it may be that the focus on developing fundamentals of music performance, music reading/comprehension, and an understanding of what Gordon called rhythmic and tonal syntax, occupies the early stages of music instruction (Bluestine, 2000).

Essentially, the fundamentals

It is not clear why improvisatory aspects of music making or composition (even in simple forms) is not present in all the methods. Some part of the answer is probably attributable to their foreign origins. The Kodály Method originated in Hungary. Orff Schulwerk's origins are

German, with the Orff Institute eventually begin founded in Salzburg Austria. The Suzuki Method originated in Japan. And the Dalcroze Method originated in Switzerland. Only Gordon's contributions to Music Learning Theory (see Bluestine, 2000) appear to be rooted in the U.S.

The chronology of the beginnings and development of these methods may shape our understanding as well. Creativity research, and thus, what creativity is and its potential benefits, began in the mid-century. These music teaching methods originated at almost the same time. It was impossible to inform the various key figures of the (now) popular teaching methods about any revelations generated by research. Nevertheless, music education's national standards have included improvisation and composition since their integration into The Goals 2000: Educate America Act (1994). The legislation included National Standards for Arts Education where music's original 9 standards were set in print. Standards #3—"Improvising melodies, variations, and accompaniments," and #4—"composing and arranging music within specified guidelines" (as cited in Mark, 1996, p. 50) were applicable to grades K-4, 5-8, and 9-12. Improvisation and composition are both found as standards at each of the three levels. Even the recent revisions of the national standards have not done away with improvisation and composition.

Creativity: Secondary school level

There is no reason that the music teaching methods previously mentioned, and certainly any of Gordon's contributions, could not be utilized at later (higher) grade levels. This is just not common practice. Surveys have identified that band and chorus are the primary music classes offered in most secondary schools, while jazz/rock ensemble and composition courses represent only 7% of national secondary music curriculum (Abril & Gault, 2008; Williams, 2007). Where improvisation may be sought, it appears that this would be likely in jazz/rock ensemble classes or the like. If the work of Abril and Gault (2008) is accurate, improvisation might be encountered by a small constituency of secondary level students (jazz ensembles are usually smaller than larger concert bands, choirs, or orchestras) in what occupies a small segment of course offerings in the U.S.

The composition courses previously referenced are likely to have a similar profile. They are rare, and when offered are probably pursued by small numbers of students. This is not an effort to say that improvisatory musical skills and experiences are gained exclusively in classes dedicated to them. When music composition or creative music making is offered in secondary schools, it is usually made by the initiative of an individual music educator (Dammers, 2010, 2012). Music theory courses, for example, may play some role in conveying musical composition skills. And perhaps improvisation skills as well. It could also be that music appreciation courses may offer improvisatory opportunities for students despite the possible appearance that the course content would not include it. Some instances of exposure to improvisatory and/or composition instruction could occur in non-class settings such as extra-curricular programs. Finally, improvisation and composition could be carefully woven into the course content of the large musical ensembles that occupy most of the secondary school music curriculum.

Creativity in school music: Summary

The previous sections present research by such authors as Webster, Moorhead, Pond, and Hickey who indicate that creative work such as music improvisation and composition is appropriate for young people. Even elementary school-age children. But most of the music instruction in U.S. schools does not directly address these things. At the primary school levels, a focus on fundamentals and building a repository of tonal and rhythmic comprehension seems to prevail. At the secondary school levels, curricular offerings in music tend to be primarily performance-based ensembles. And perhaps the kind of music making that occurs in such ensembles is satisfactory for creativity instruction. Again, Webster (1990b) states that musical creativity is "the engagement of the mind in the active, structured process of thinking in sound for the purpose of producing some product that is new for the creator" (Webster, 1990a). Does this describe the music making in bands, choirs, and orchestras? Possibly. But consider also that the revised national standards in music distinguish creativity from performance altogether (see National art education Association, 2013). So, where performance (improvised performance possibly being the exception) once might have sufficed as creative music making, it does not appear that this is so readily accepted after the publication of the revised national standards.

Music composition as creativity

Literature suggests that composers integrate creative decision making within the process of composition. Observations of musically trained adults during composition confirm that creative decision making is a crucial component of the compositional process (Davidson & Welsh, 1988; Gardner, 1985, 2011; Paynter, 2000; Sloboda, 1985).

Creative decision-making is also found in children when they are engaged in music making or composition (Barker, 2003). During composition, students use various compositional strategies demonstrating their divergent thinking. While using graphical notations, students displayed numerous compositional strategies to increased creativity while composing.

The new national standards in music define creativity as the “capability or act of conceiving something original/unusual" (National Art Education Association, 2013, p. 20). What is more original and even unusual than the types of music compositions that students might create? This distinction leads to a higher reliance on things like improvisation and composition to align with the creativity component in the new national standards in music. Perhaps now, more than ever before, a greater reliance upon music composition will emerge as music educators seek to work toward these creativity goals. Thus, a new urgency may be developing to provide instructional pedagogies, and a variety of ways of accessing composition for both teachers and students of all ages.

Music Composition in American Schools

Based on all sources, a credible case has been made for the importance of composition in music education. Gamble (1984) captured many of the reasons why when he stated:

> Composition is, I believe, of central importance in music education, for it helps to develop an insight into the very nature of music by involving students in a very intimate way with music and directly confronting them with the problems of making or inventing an expressive and coherent music object (i.e., a composition). In the process of manipulating musical material, in developing, shaping and structuring musical ideas, in forming relationships between ideas, children using imagination, intelligence and feeling. Composing, after all, is thinking in sound (pp. 15-16).

But, how to best approach instruction of composition is a different matter.

Distinguishing composition from improvisation

There is considerable debate over the appropriate methods used in the creation of students' compositional products. And one of the issues that seem to be unresolved is where exactly improvisation stops and compositions begins. Note that Gordon initially raised the idea of a continuum with improvisation on one side and creativity on the other. As time has marched forward, it seems that composition has taken the place of—or become synonymous with—creativity in the metaphorical tug-of-war. But it is obvious that a distinction is necessary to establish pedagogical parameters.

Several studies (Burnard, 2000; Kratus, 1994b; Sloboda, 1985; Webster, 1992) have sought to distinguish the between the creative products of improvisation and composition. Kratus (1994b) states, "I view compositional products as fixed, replicable sequences of pitches and durations, and compositional processes as the fluid thoughts and actions of the composer in generating the product" (p. 116). Wiggins (1992) stated that the musical product is considered a composition if revisions are allowed. Otherwise, the musical product could be identified as improvisation. Wiggins (1992) defines composition as "preplanned performances" and improvisation as "spontaneous performances" (p. 14). Sloboda (1985) speculated that the compositional process differs in respect to the creator's intent for the product. Sloboda's basic belief was that the improviser accepts the first musical product while the composer will create potentially many solutions until one is deemed appropriate and satisfactory for the project.

Perhaps Webster's (1992) version provides the critical distinction. It is the opportunity to hear and reconfigure the music that constitutes composition. Sloboda (1985) seems to align with this. He defines composition as a process that produces musical ideas, applying those musical ideas, and adapting, adjusting, or varying the musical ideas until the discovery of a competent solution. The instruction of composition, then, would entail opportunities to think critically, analyze, and reconfigure a musical product.

Critical thinking/decision-making

If composing is dependent upon critical thinking, the ability to analyze music, thoughtful consideration of appropriateness and potential alternatives, and making suitable decisions, it is well-aligned with the aims of the cognitive domain and highly suitable for inclusion in contemporary education. The cognitive domain is the area of learning and development that pertains to recognition of learned material, recall of prior information, and the development of intellectual abilities and skills (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). Note also that Bloom's taxonomy identifies six hierarchical levels of learning that move from simple to complex. These include: 1) Knowledge, 2) Comprehension, 3) Application, 4) Analysis, 5) Synthesis, and 6) Evaluation (Bloom et al., 1956). Instruction in music composition directly involves every level. Anderson's revised version of Bloom's taxonomy—which consists of: 1) Remembering, 2) Understanding, 3) Applying, 4) Analyzing, 5) Evaluating, and 6) Creating (Anderson, Krathwohl, & Bloom, 2001)—is even more obviously aligned with the kind of learning objectives inherent in music composition.

If any issue related to music composition instruction is not befitting of contemporary educational settings, it may be the assessment of composition quality, and student progress/ improvement. These things, understandably, appear difficult to measure. But research has demonstrated that levels of proficiency in musical understanding (comprehension) and critical thinking are often displayed in children's compositions or musical ideas (Burnard, 1999; Davidson & Scripp, 1988; Wiggins, 1994). Gamble (1984)also found that the effective use of musical ideas and components is directly connected to evolving musical understanding. Freed-Garrod (1999) observed students thinking in sound and demonstrating the competency to produce and evaluate an expressive sound in a musical context. Pachet (2006b) Pachet (2006a), Bamberger (1977), and Kratus (1994a), identified decision-making during composition. Hickey (2001a) study demonstrates that this proficiency content can be evaluated with some reliability.

Composition: What to teach and how

Making a case for composition's inclusion in U.S. schools is not as challenging as it once was. But most music educators are inclined to struggle with determinations of what to teach, as well as precisely how composition should be taught. Pre-service music educators usually enter the music teaching profession with considerable knowledge about the various band, choral, and/or orchestral method books that put instructional processes to print. Knowledge of general music teaching methods is also usually high. This is not the case with methods for teaching music composition. Teachers are then left to explore the various materials available, or revert to their experiences learning music theory. In which case, teaching composition becomes synonymous with teaching music theory.

There is no need to cover the plethora of possibilities as to how this may smash student interest and motivation. But when the only possible avenue for learning things like songwriting, recording, music production, editing, mixing, and many other facets of music that are encountered in composition is constrained to a single line of conventional music theory—beginning with identification of clefs, staves, key signatures, notes, rests, various other symbols, and possibly culminating with short 4-part arrangements built upon conventional (acceptable) chord progression charts—it is not difficult to understand why these courses make up so little of the overall music curriculum in the U.S.

Half of a century has passed since the “Tanglewood Declaration” reiterated Pestalozzian learning theory and called for increasingly higher levels of social relevance in the music learning offered to students in U.S. schools. Byrne, MacDonald, and Carlton (2003) found that when music composition teachers provided engaging and relevant (in the students’ view) tasks, creative quality was better, and the perception of the overall experience was viewed as rich and fulfilling.

Composition processes

Authors have defined the compositional process in various ways. While the components of the process have been demonstrated in a variety of steps or stages, enough similarities have emerged that may indicate common characteristics exist (Wiggins, 2007). Some models show a circular or repetitive design. Others demonstrate a linear design or top-down process that is executed only once. However, the students' creative pathways will usually determine how they will experience the model or create variants of the compositional model. These creative pathways or processes are often dependent on the components used in the compositional environment (e.g., the software and hardware).

Wiggins (1993) defined the compositional process as: 1) perception of the problem structure, 2) searching for musical form, 3) capability to perceive musical opportunities, and 4) level of attention to the compositional task (see Figure 5). Wiggins maintains that children's musical ideas are evaluated against a holistic viewpoint of the final product. From the conclusion of the study, Wiggins proposed that initial decisions made during the beginning stages of composition disclosed an understanding of how the elements of the composition would function in the final product. This is a design feature. It implies the ability to consider the end from the beginning.

Freed-Garrod (1999) study explored peer assessment of music compositions. But a formalized composition process was found to be successful here. Third-grade students were encouraged to collaborate on short compositions and were divided into groups to facilitate the collaboration. The findings indicated that the students achieved improved artistic evaluation methods. Additionally, they acquired an aesthetic awareness of the compositions through collaboration and evaluations of the compositional product.

The compositional process Freed-Gorrod used identified these main processes: 1) exploring (includes improvisation), 2) selecting, 3) practicing, 4) editing, 5) polishing, 6) performing (and sharing), and 6) evaluation (see Figure 6). She maintains that the processes are interrelated in a way that allows execution of the process steps non-sequentially. Some of the steps in the compositional process are recursive such as the exploring step. This was observable when the students in the group made the decision to explore various ideas during the selection process, then the reiteration of the exploration process occurred. Freed-Garrod also indicated that repeating the exploration process is possible if the compositional process is unsuccessful.

Berkley (2001) identified a compositional process similar to Freed-Garrod (1999). Berkley defined the compositional process in four steps: 1) generating and identifying musical ideas, 2) manipulating the ideas, 3) modifying existing ideas and creating new ones, and 4) evaluating and editing the final piece as a whole (see Figure 7).

The first step is similar to step 1 and 2 in Freed-Gorrod's model. This step—generating and identifying musical ideas—can be exploratory in nature. Especially in investigating new musical themes and providing musical ideas. In step 2—the manipulation of ideas—the student can recapitulate musical ideas or themes. During step 3, there is an opportunity to modify or merge ideas, creating new ones. The last step allows the student to evaluate or edit the product holistically.

Emmons (1998) observed the behaviors of his students during the creative process. He speculated that the original observed behaviors might appear linear, but his findings suggested that the process was nonlinear. He concluded with three emergent behaviors. They are: 1) formation, 2) preservation, and 3) revision (see Figure 8). Emmons concluded that the original behaviors of exploration, focus, rehearsal and composition were "interdependent and comprise one group of related behaviors: formation" (Emmons, 1998, p. 49).

Tsisserev (1997) and Savage and Challis (2002) created compositional models from their professional composition experiences. In Tsisserev's study, the students who were engaged in creating or composing experienced four different stages of the compositional process: 1) generating ideas, 2) developing and expanding of ideas, 3) organizing ideas, and 4) expressing ideas (see Figure 9). Tsisserev stated that his focus was on the compositional process not the product. His objective was to create an environment that allowed students to express themselves creatively, without regard for refined, uniform techniques that complied with a standard.

Savage and Challis (2002)adapted a different approach to teaching music and composition using digital technologies. This model represents a linear design that included recursive steps in the process including: 1) starting point, 2) experiment, 3) select, 4) structure, and 5) evaluate/revise (see Figure 10). Students focused on achieving overall task objectives rather than learning a single task within the music software. While this approach is a different method of instructing composition or music making, it was observed that the student will usually learn to perform the necessary tasks within the software by experiencing various options and features of the program. In the process of composing or music making, the student explored various methods of executing functions within the software while enabling the production of musical elements. Interfacing within this software environment, the student experienced the process of composing music within a software program and discovered how to employ features in the music program that aided the compositional process thus creating the compositional product.

Davidson and Welsh (1988) noted that novice children composers used smaller elements of music during composition and spent considerable time engaging in sound exploration. Along the lines of similarity in compositional choices, Delorenzo’s (1989) analysis of the compositional process of sixth graders discovered that musical problem solving was a series of choices that disclosed the musical thought processes. The study found that children with similar problem solving skills made similar compositional decisions. These decisions became the framework for the music compositional process.

Composing music via technology

The presence of new technologies has imposed change in much of education and life in general. Music technology is a relatively new field in research, especially as it intersects music composition and musical creativity. Research by Hickey (1997), Folkestad (1996), Webster (1998), Seddon and O’Neill (2003), and Nilsson (Nilsson, 2003; Nilsson & Folkestad, 2005) focused on the application of music technology with a an emphasis on student compositional processes.

Nilsson and Folkestad (2005) provided an opportunity for students to compose and produce a musical product using the computer. The results suggested that the computer sequencer program provided a functionality to transfer knowledge and skill to enhance creative musical ideas. Ruthmann (2007) suggests strategies for musical collaborations with online music programs. Using social networks on the internet could encourage music communities to collaborate and learn music. And Burnard (2007) research provides theoretical constructs to consider, such as "technology as a pedagogic changeagent" (Webster, 2009, p. 426).

Pachet (2006a) study considers a new interactive computer system with some similarity to the Korg Karma workstation (Kay, 2000). The computer developed by Sony Computer Science Laboratories is the first reflexive system to provide a musical dialogue with the user (Addessi, Ferrari, Carlotti, & Pachet, 2006; Addessi & Pachet, 2006). The system, designed as an Interactive Reflexive Musical Systems (IRMSs), incorporates feedback from the computer to the musician (Pachet, 2006b, pp. 360-361). The purpose of the IRMS is to provide focus on the interaction process and not the musical product. The study concluded that the IRMS provides an environment for the gradual learning of musical elements, and a lack of a standard graphical user interface. However, the IRMS does provide the user with the opportunity to focus on creativity without the interruption of the technology.

Remaining Review Sections

Having narrowed the various issues of music creativity down to composition, composition processes for instruction, and the role that technology plays in the process of learning and composing, this review concludes with a presentation of nonlinear music composition, its various facets and features, linear music compositions, and the ways these things are perceived not only by composers and teachers, but also by listeners. This component is situated last in the review as it serves as a type of synthesis of previous literatures. The nonlinear composition software enables nonlinear composition techniques. It is critical to establish what nonlinear music is, the ways it might be composed, and how it is perceived by listeners.

Linear and Nonlinear Music: Including the Listener's Perspective

An easily overlooked—but nevertheless critical—distinction that heavily influences the interpretation of literature's import in the context of this paper pertains to the supposed beholder/ perceiver/end user. To illustrate the need for this section, consider the section on compositional processes that has just been presented. Perhaps some interesting step-wise aspects of musical composition instruction was included. No doubt the value of that material stands to be substantively augmented or diminished based on the primary user/beneficiary of the aspect in question. This is the root of the so what question that is implicitly begged of the components of literature reviews. What is the value of such and such piece of information? The answer, in this context, depends heavily on the eyes through with the issue is being examined.

In the hypothetical music composition processes reference above, several perspectives can be adopted. Consider first the obvious creator/composer perspective. The compositional tactic or process may carry tremendous value as a bona fide technique for generating a certain sound or effect. From the teaching/learning perspective however, the same technique carries different implications. A teacher is faced with questions. Is the manner in which some composer/ researcher generated this sound or effect the optimal way to teach it? Does this offer the most seamless utilization of the computer software? Does the student understand what he/she is doing? Finally, consider the view of the end-user. That is, the listener who experiences a composition. From this perspective, many of the compositional processes, as well as any teaching/learning considerations, are not even perceived much less contemplated.

This toggling between the multiple perspectives has been infrequent throughout the literature section thus far. Heretofore the view of the composer, teacher, and possibly the researcher at times, has been front and center. But the view of the listener is equally important. Especially as it pertains to what is called nonlinear music.

Nonlinear musical compositions: Background

Nonlinear compositional methods can be traced as far back as the late 18th century when Mozart initially explored this concept (Hedges, 1978). In 1792, Mozart conceived of a nonlinear compositional method driven by selecting random numbers. Musikalisches Würfelspiel (Musical Dice Game) was an example of a nonlinear composition. It was created by random dice throws (nonlinear) and performed linearity (Mozart, 1792). Kramer describes Musikalisches Wurfelspiel as a nonlinear minuet observing that "the generation of each event [is] independent of all others" (Kramer, 1981, p. 554).

The beginning of the 20th century was "a time of enormously accelerated stylistic innovation, accompanied by an enormous expansion of technical resources" (Taruskin, 2009, pp. 1-2). This creative environment liberated composers from various musical structures while providing an opportunity for experimentation.

Composers of the 20th century viewed nonlinearity as a structural experimentation of compositional techniques birthed outside of traditional linear composition methods (Kramer & Carl, 2016). Their explorations redefined musical composition by expanding the constructs of the linear composition definition beyond traditional music. The composers' perceptions of nonlinear composition were not a moment of achievement, but one of exploration, great struggle, and discovery.

The construction of nonlinear music uses differential memory relationships to provide connect points for the listener (Snyder, 2000). While nonlinear music lacks linear progressions and hierarchical order, the composer is liberated to exploit similar components displaced at various times to provide for the listener a point of connection or reference to the piece. The resulting structure would resemble more of an interconnected network instead of a series of events in a linear sequence.

Dunn (2008) stated that nonlinear music is a reflection of a complex process. For the musician, that process is dependent on unique methods that enable the production of a nonlinear composition. While the structure of a musical composition is determined by the construction of its components, the product reflects the fabrication and assimilation of thought processes engaged in the experiences of the composer's expression. As the creation of music transforms from linear to nonlinear form, the techniques required to compose nonlinear compositions will increase in complexity.

A number of available techniques have provided various sources for composers applying experimental techniques to the nonlinear composition. These techniques include automatism, probability, chance, and algorithms (James, 2009). While these techniques were applied in a number of compositions, their usefulness has been restrictive due to complexity during application. Composers who examined these techniques did so as experiments to explore alternate methods of composing in a nonlinear manner.

Aleatoric (or aleatory) music was an example of one such alternate method (Brindle & Brindle, 1975). As one of the more controversial developments of contemporary music, aleatory music introduced procedures of chance not only during the composition, but during the performance processes as well (Hoogerwerf, 1976). Aleatory music (Lat. Alea meaning dice game) allowed the composer the freedom to create music using randomly selected musical elements. Within the framework of composition, elements such as pitch, duration, and dynamics were the subject of a draw of a playing card, dice throws, or a coin toss. Other randomizing methods were employed by the composer for the creation and realization of his/her work.

With the aid of the computer, mathematical laws of chance or algorithms were employed as the random source for composition. Computers can be programmed to generate a random number within a specified range while using that number in a decision making processes (Kostka, 2016). For example, Iannis Xenakis used a mathematical formula written in FORTRAN —a computer programming language well-suited to numerical computations--to provide the probability numerical input to his piece “Metatasis.”

To bring about the chance element in performance, the composer may leave certain musical elements or phrases at the discretion of the performer by approximating rather than providing precise notation. This gives the performer a greater role in selecting the various sections of the work to be performed. Some examples of aleatory works are John Cage’s “Music of Changes” for piano, “Concert for Piano and Orchestra” and Karlheinz Stockhausen’s “Klavierstuck X1” (DiMartino, 2016; Henderson & Stacey, 2014).

Aleatory as compositional rebellion

Other composers pursued nonlinear compositions as an alternative to the existing linear structure. Igor Stravinsky's "Symphonies of Wind Instruments" was an earlier example of a multi-sectional nonlinear piece. This piece was a deviant composition from his typical structure that brought a temporary change to his exploration of experimentation (Snyder, 2000).

Stravinsky went beyond static models to develop a technique for composing contemporary pieces in nonlinear time (Kramer, 1986). Another early example of a nonlinear section is "Jardin du Sommeil d'Amour," the sixth movement of Olivier Messiaen's Turanglila Symphonie.

Philip Glass wrote a nonlinear piece in his "Philip Glass: Music in 12 Parts." Part 1 in his composition is described as a nonlinear piece. Riley's "In C," is a departure from a linear model and exemplifies a non-linear composed piece (Carl, 2009; Johnson, 1994). Some additional composers who had successful ventures into nonlinear composition methods during this era were Mahler, Ives, and Debussy (Vickery, 2011).

Evolutionary music

Evolutionary music is music that is subject to external input or variations including interaction with a musician or performer (Brown, 2002). While it involves feedback from a source that will change to the current state from a previous state, it is not restricted to traditional compositional methods. In the late 1990s, electronic music began to shift from linear to nonlinear composition. The musical styles of electronic dance, pop, and video game music were responsible for this transfer (Brown, 2002). Electronic dance music such as techno, and pop music, were considered an alternative to traditional music and constructed using nonlinear composition methods (Campbell, 2014). Due to the construction or format of video games, nonlinear composition became the predominate method of scoring electronic video game music.

Music for video games

A scene of a video game evolves without strict adherence to a time frame or limit for a conclusion. It is, therefore, difficult to compose video game soundtrack linearly. Music composed for this environment must be scored in a way that is dependent on the interactions of the external input or video game player. The composer's reliance on nonlinear and nontraditional compositional techniques to score the soundtrack becomes crucial for a successful and cohesive score for each scene in the video game (Rowe, 2001).

Choices made by the player serve as direction or control in the compositional processes for the score or soundtrack. The extensive use of nonlinear musical components empowers the composer with additional tools to arrange the music for each scene of the game. Components, such as loops, stingers, and one-shots, construct a bridge between the inactive and active scenes in the video game. Choices to be made by the player—who moves through each level of the game—are tracked, presenting the composer with the data and input to arrange the score for each scene in the game. The musical decisions made by the captured input from the player, are coded and programmed into the source code for the video game (Collins, 2008; Phillips, 2014).

The framework used in algorithmic or generative music transforms abstract rules to sounds creating a computational dataflow (Mazurowski, 2012, 2015; Thalmann & Mazzola, 2008). The synthesis, creation, or the composition of music that is based on this type of variable framework is referred to as algorithmic or generative music (Wakefield, 2007). This is not a new means of generating music. Algorithms have been implemented in music as far back as the 1950s, with composers such as Xenakis, Ligeti, and Hiller (Boenn, Brain, De Vos, & Ffitch, 2011; Edwards, 2011; Mazurowski, 2015; Simoni, 2003).

The computer is capable of modeling any process, and will therefore perform the instructions based on the framework built or created by the composer or programmer (de la Puente, Alfonso, & Moreno, 2002; Nierhaus, 2009). The generation of sound by this process is open to the development of explicit process models as they are applied to algorithmic or generative music composition (Polfreman, Loomes, & Wright, 2003).

Using the approach of evolutionary music composition, music can be composed by interactive evolution (Tokui & Iba, 2000), linguistic approach (García Salas, Gelbukh, & Calvo, 2010), spectral modeling (Barroso & Pérez, 2007), harmony search algorithms (Geem & Choi, 2007), and interactive evolutionary computation (Tokui & Iba, 2000). The process model for each composition method differs by the chosen technology utilized, and by the variance of the framework used within each algorithm. However, the driving mechanism of each process model is the final algorithm that is programmed from the framework of the initial design.

Creating artificial composition systems that can successfully achieve a compositional product is contingent on the construction of a musical knowledge database or musical information database that can be utilized within an algorithmic framework. The musical knowledge or musical information database must be constructed as a library of components accessible by the algorithmic framework that is activated by an external stimulus (i.e. the player). From this concept, the musical information accessed by the algorithm will be used in the creation of a music element and the final construction of the compositional product (Bown, Eldridge, & McCormack, 2009; Husbands, Copley, Eldridge, & Mandelis, 2007).

The compositional product is not a creation from a void or vacuum, but from our accumulated experiences, our reactions with culturally relevant structures, and the opportunity of expressing an intrinsic desire to create music (Todd & Werner, 1999). It is the relationship between the composer, whether human or computer, and the compositional product, which must be developed through a progression of evolutionary processes, that the compositional product is conceived, produced, and shared with others.

However, the dichotomy between the duality of systems is simply this; the human composer can evaluate their product to determine the potentiality of a successful composition, while the computer is without an internal evaluation mechanism (Eldridge, 2005). While we create music, we can therefore evaluate our music composition progress and the final product. The computer, through evolutionary algorithms, which are heuristic techniques for solving multi-level musical complexes, will need a supporting evaluation structure to define a computer created compositional product (Drezewski & Tomecki, 2011).

Max/MSP – Programming software to modify music

The Max programming language has its origins in Paris at the Institute de Recherche et Coordination Acoustique/Musique in 1986 (Blum, 2007, p. 18). It was an original design of Miller Puckette to control IRCAM's 4X synthesizer. The language's main advantage is its ability to directory access the audio hardware within the computer. With the updated and more powerful versions of the language, it provides the composer the ability to develop musical ideas and pursue interactive composition (Winkler, 2001, p. 49).

Max is a visual programming language that will allow the user to write modules to modify or create audio sound. With advances made in electronic music compositional software, the introduction of music software programming is another pathway of evolution for electro-acoustic /electronic music experimentation, creation, or composition. As a programming language Max/MSP is different from other programming languages due to its unique graphical interface (Manzo, 2016, p. 2). Max is a high level graphical programming language written in C that uses a graphical rectangle or boxes to represent a basic unit of functionality within the program. The simplicity of this approach gives the musician the opportunity to graphically view the structural progress achieved, while participating in the interaction of the program and the aural evaluation of the musical composition.

The listener and nonlinear music

From the previous sections it becomes obvious that nonlinear music describes a type of music that is not organized in a traditional framework to which listeners are frequently exposed. Composers are autonomous in their pursuit of defining musical parameters that achieve the artistic objective(s) while providing structure for the compositional product. For example, compositions by avant-garde composers are often framed in nonlinear forms or structures. In fact, avant-garde music has come to be almost ubiquitously associated with capricious changes of mood/style (Kamien, 1984). Why would composers do this? Well, probably not out of consideration for the listener. There is most likely something about the selected structure of the music that the composer finds favorable or appealing.

Trained musicians are likely to be associated with this type of composer-centric compositional technique (preference) when considering serialism. Serialism relies on a group of ordered elements (e.g., pitches, rhythms, tone color, dynamics, etc.) to formulate musical compositions. But the complex relationships are often difficult to perceive merely by listening. The actual sound of such music may seem chaotic or random (Kamien, 1984).

The listening experience to such music can be unusual. .Kramer (1988) stated that nonlinear music could induce in a listener a truly extended present while disassociating elements of the past and the future. To the listener, nonlinear music can be more surreal, timeless, and holistic (Rose, 2014). To the composer, creating events in a score that resist the forward progression of music, enabled the composer to frame the composition in nonlinearity (Almen &

Pearsall, 2006; Kramer, 1988; Meelberg, 2006).

Referencing such compositional genres as avant-garde or serialism may overly implicate a highly intellectual approach to composition, as well as refined technique. In the previous sections, aleatoric (chance) music and evolutionary music are introduced to illuminate some non- traditional aspects of nonlinear music and composition. Minimalist music could easily be added. The danger is elevation by association. That is, each of these musical areas is a developed style. This is not to suggest that by utilizing nonlinear composition software, or even composing music in an atypical manner, somehow automatically comports to one of these styles, genres, or techniques. Nor should this possibility be discounted. Some student and amateur composers may, indeed, carefully craft their musical compositions in line with the tenets of any of these styles.

Linear/traditional musical content

The term "traditional" has been used several times in this document to reference typical, common, or seemingly ubiquitous elements of musical form and structure. With regard to Western culture, we can apply the terms linear music or linear music model to traditional music. The terms become synonymous within the four corners of this document.

Linear music is time-based or sequential and thus the listening experience entails successive events while listening to a composition (Kramer, 2015). Copland (1939) proposed that music must contain a beginning, middle, and an end. Copland's assertion was reflective of prevailing thought about musical form and interconnectedness in Western cultures. Seeger (1977) stated that our history of European music clearly demonstrates that our conventional music writing is predominantly linear. He argues that it is the responsibility of the composer to guide the listener through the music and provide the listener with a reference point of the current event within the timeline of the music. From this premise, linear music exists within a temporal continuum created by sequential events (van Elferen & Weinstock, 2015). These sequential events are crucial to the listener because they aid in moving or guiding them through the music.

Perception of music in linear terms

Without regard for the compositional style, genre, or technique used to compose or create the music, the listener will always perceive the musical product in a linear manner in a real-time hearing of it. Music is time-based. It is inconsequential to the listener how the music is structured. It will be perceived as linear (Collins, Hawkins, & Burns, 2013; Kramer, 1988).

For some listeners the separation of a linear conception or expectation and one that is nonlinear is impossible (Kramer, 1988). The creative design used to frame the composition will dictate the musical structure the composer chooses for the compositional product. Although the composer will create or compose the music nonlinearly, the performance of the score will be in a linear timeline. Because of the automatic tendency to cast our conceptions of music's form in a linear manner, subsequent references to the musical product that focus on the listener imply a real-time hearing of the music. The opposite is also true. Discussion of the compositional technique or process implies a view of the music privileged to the composer and possibly the teacher.

Music in the memory

A listener's aural skills consist of both linear and nonlinear capabilities. While the listening process will function as a linear activity, the memory of the music is a nonlinear operation (Kramer, 1988; Kramer, 2015). These two concurrent tasks (linear process and nonlinear operation) are simultaneously in operation during the listening experience. Perhaps the most obvious reference would be the re-introduction of a musical motif that was heard earlier in the piece. But it is the real-time hearing of that motif (again) that conjures the memory. We can easily see a nonlinear application of this in consideration of a mental recall of music one just experienced. Perhaps a catchy motif or lyric comes to mind. This could be followed by the recall of another memorable aspect. Those memories need not occur in a linear manner.

Implications of composition and improvisation in K-12 in education

In viewing the landscape of opportunities for educators to introduce music software into the primary and secondary school system, to be sure there is a plethora of options available that did not exist a decade ago. The innovation of music software offers music educators the ability to participate in creation and music making activities while providing the students with interactive response and the ability to change or modify musical elements that will sound musically pleasing. While the choices are varied there is support for using music software in music education (Dammers, 2010; Nielsen, 2013; Rosen, Schmidt, & Kim, 2013).

While the introduction and the installation of music software in the K-12 classes are usually guided by the teacher/facilitator, it is of course the students who will be engaged in exploring the various options within the program. Children have a propensity of sound exploration (Green, 2008; Pond, 1981). And as they explore the sounds within the program it provides them with feeling of accomplishment and great enthusiasm (Bahman & Maffini, 2008, p. 70; Elliot, 2009, p. 86). The interaction of the student with the music software encourages examination of sonic possibilities while inspiring them to participate in creative and exploratory endeavors (Elliot, 2009, p. 52). Educators usually play an important role in offering resources and guidance in establishing an environment for the development of skill sets for the student composer (Kaschub, Smith, & Reimer, 2009, p. 49). The use of music software is indeed central to the growth of the student in their expression of music creativity and in the development of musicality skills.

In providing opportunities for exploration in a music software class, templates are provided for the educator to employ within the classroom. In appendix 1 of this paper, five Ableton Live templates are supplied for primary school educators to share with their students. They are simple in operation and provide a beginning skill level to encourage sound exploration and engagement in music software technology. Instructions are provided with each template in the form of a PDF. They are representative of some of the types of sounds usually found in a music software environment. The application and exploration of the templates will encourage creative exploration and critical thinking.

Review Summary

If this entire review was to be summarized in only a short amount of page-space it would go something like – the reader is made aware that capacities like creativity and intuition: 1) are present in everyone, 2) are fostered, shaped, and informed by aspects of personality, thinking and learning styles/preferences, and 3) are important for the function of the individual. Naturally these capacities exist wherever people act or carry out their daily lives. They are also prevalent in various domains such as music and art.

There is reason to believe that musical creativity, in the form of music composition, can be developed. Even from early ages. Therefore, it has a place in educational settings. The search for best instructional practices is ongoing and probably dependent upon a number of student and environmental factors. But process-based approaches have been successful. However, flexibility is critical. A one-dimensional, music theory (based on Western Art Music) approach to music composition is likely to limit access to learning opportunities, and possibly fall outside the area of interest of student composers. So the embrace of flexibility must occur not only in musical content (what music is learned, and composed) but also in instructional design and pedagogy (how music is learned and composed). And this opens the typical student composition experience to include nonlinear musical composition and the myriad ways students may choose to go about creating it.

This paper is truly about access and expansion of music composition methods. It will remain as a subject that is open for greater discussion. Wiggins states that, "[all] people are capable of inventing musical ideas" (Wiggins, 2007, p. 465). Indeed, it is these ideas that morph into memorable themes, especially when created by students. However, Berkley (2001) maintains that not all students can compose music. She proposes that compositional instruction requires development of the requisite cognitive and fine motor skills of the different processes and stages of composition (Berkley, 2001). Berkley's definition of the word compose implies traditional methods of composition. Yet in defense of Berkley's viewpoint, several skill sets are required to complete the assignment in her study. The conclusion is inevitable. If students do not have these skill sets, they simply cannot complete those assignments.

Not all students are inclined to pursue traditional methods of composition. However, students may have a desire to create music for personal enjoyment or personal efficacy. Opportunities to engage in creating music, music making, or composing should be available for them to the extent possible, although their methods may not align with traditional techniques used to compose.

REFERENCES

FOR PAPER 1

Ableton. (2016). Ableton - Live [online]. Retrieved from http://ableton.com

Abril, C. R., & Gault, B. M. (2008). The State of Music in Secondary Schools The Principal's Perspective. *Journal of Research in Music Education, 56*(1), 68-81.

Addessi, A. R., Ferrari, L., Carlotti, S., & Pachet, F. (2006). *Young children's musical experiences with a flow machine.* Paper presented at the Proceedings of the 9th International Conference on music perception and cognition.

Addessi, A. R., & Pachet, F. (2006). Young children confronting the Continuator, an interactive reflective musical system. *Musicae Scientiae, 10*(1 suppl), 13-39.

Agor, W. H. (1997). The measurement, use, and development of intellectual capital to increase public sector productivity. *Public Personnel Management, 26*(2), 175-186.

Akinci, C., & Sadler-Smith, E. (2012). Intuition in management research: A historical review. *International Journal of Management Reviews, 14*(1), 104-122.

Almen, B., & Pearsall, E. (2006). *Approaches to Meaning in Music*: Indiana University Press.

Amabile, T. M. (1993). What Does a Theory of Creativity Require? *Psychological Inquiry, 4*(3), 179-181.

Amabile, T. M. (1996). *Creativity in context / Teresa M. Amabile ; with updates by Teresa M. Amabile ... [et al.]*. Boulder, Colo: Westview Press.

Anderson, L., Krathwohl, D. R., & Bloom, B. S. (2001). *A taxonomy for learning, teaching, and assessing: a revision of Bloom's taxonomy of educational objectives*. New York: Longman.

Bahman, S., & Maffini, H. (2008). *Developing Children's Emotional Intelligence*: Bloomsbury Academic.

Bamberger, J. (1977). In search of a tune. In D. Perkins & B. Leondar (Eds.), *The arts and cognition* (pp. 284-319). Baltimore, MD: Johns Hopkins Press.

Bandrowski, J. F. (1985). *Creative planning throughout the organization*. New York: American Management Association.

Barker, A. F. (2003). *Children's musical thinking skills and creative processes during a composition task.* (Ph.D. Dissertation), University of Oklahoma, Norman, OK.

Barron, F., & Harrington, D. M. (1981). Creativity, intelligence, and personality. *Annual Review of Psychology, 32*(1), 439-476.

Barroso, E., & Pérez, A. (2007). Music composition through Spectral Modeling Synthesis and Pure Data. *LINUX AUDIO*, 37.

Becknell, A. F. (1970). *A history of the development of Dalcroze eurhythmics*. Doctoral dissertation. University of Michigan. Ann Arbor, MI.

Becknell, A. F. (1990). The timelessness of Jaques-Dalcroze's approach. In P. Corder (Ed.), *The Eclectic Curriculum in American Music Education: Contributions of Dalcroze, Kodály, and Orff* (pp. 31-36): Music Educators National Conference.

Berkley, R. (2001). Why is teaching composing so challenging? A survey of classroom observation and teachers' opinions. *British Journal of Music Education, 18*(02), 119-138.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives, handbook I: The cognitive domain* (Vol. 19, p. 56): New York: David McKay Co Inc.

Bluestine, E. (2000). *The ways children learn music: An introduction and practical guide to music learning theory*: GIA Publications.

Blum, F. (2007). *Digital Interactive Installations: Programming interactive installations using the software package Max/MSP/Jitter*: Diplom.de.

Boenn, G., Brain, M., De Vos, M., & Ffitch, J. (2011). Automatic music composition using answer set programming. *Theory and practice of logic programming, 11*(2-3), 397-427.

Bown, O., Eldridge, A., & McCormack, J. (2009). Understanding Interaction in Contemporary Digital Music: from instruments to behavioural objects. *Organised Sound, 14*(2), 188-196.

Brindle, R. S., & Brindle, R. S. (1975). *The new music: the avant-garde since 1945*.

Brown, A. R. (2002). *Opportunities for evolutionary music composition*. Paper presented at the Proceedings Australasian Computer Music Conference,, Melborne, Australia.

Burnard, P. (1999). *Into different worlds: children's experience of musical improvisation and composition.* University of Reading.

Burnard, P. (2000). Examining experiential differences between improvisation and composition in children's music-making. *British Journal of Music Education, 17*(03), 227-245. doi:doi:null

Burnard, P. (2007). Reframing creativity and technology: promoting pedagogic change in music education. *Journal of Music, Technology and Education, 1*(1), 37-55.

Bycroft, M. (2012). Psychology, psychologists, and the creativity movement: The lives of method inside and outside the Cold War *Cold War Social Science* (pp. 197-214): Palgrave Macmillan US.

Campbell, M. (2014). *MUSIC2*: Cengage Learning.

Carl, R. (2009). *Terry Rileys In C*: Oxford University Press.

Chandler, A. D. (1977). *The Visible Hand: The Managerial Revolution in American Business*: Harvard University Press.

Collins, K. (2008). *Game Sound: An Introduction to the History, Theory, and Practice of Video Game Music and Sound Design*: MIT Press.

Collins, K., Hawkins, P. S., & Burns, P. L. (2013). *From Pac-Man to Pop Music: Interactive Audio in Games and New Media*: Ashgate Publishing Limited.

Collins, N., & Rincón, J. E. (2007). *The Cambridge Companion to Electronic Music*: Cambridge University Press.

Colwell, R. (1970). The Development of the Music Achievement Test Series. *Bulletin of the Council for Research in Music Education*(22), 57-73.

Copland, A. (1939). *What to Listen for in Music*: New York, McGraw.

Csikszentmihalyi, M. (1996). *Creativity : flow and the psychology of discovery and invention / Mihaly Csikszentmihalyi*: New York : HarperCollinsPublishers, c1996. 1st ed.

Csikzentmihalyi, M. (1996). Creativity: Flow and the Psychology of Discovery and Invention. *Harper-Collins, New York*.

Dammers, R. J. (2010). A Case Study of the Creation of a Technology-based Music Course. *Bulletin of the Council for Research in Music Education*(186), 55-65. doi:10.2307/41110434

Dammers, R. J. (2012). Technology-Based Music Classes in High Schools in the United States. *Bulletin of the Council for Research in Music Education*(194), 73-90. doi:10.5406/bulcouresmusedu.194.0073

Davidson, L., & Scripp, L. (1988). Young children's musical representations: Windows on music cognition. In J. Sloboda (Ed.), *Generative processes in music : the psychology of performance, improvisation, and composition* (pp. 195-230). Oxford England; New York: Clarendon Press; Oxford University Press.

Davidson, L., & Welsh, P. (1988). From collections to structure: the developmental path of tonal thinking. *Generative processes in music: The psychology of performance, improvisation and composition*, 260-285.

de la Puente, A. O., Alfonso, R. S., & Moreno, M. A. (2002). *Automatic composition of music by means of grammatical evolution.* Paper presented at the ACM SIGAPL APL Quote Quad.

DeLorenzo, L. C. (1989). A Field Study of Sixth-Grade Students' Creative Music Problem-Solving Processes. *Journal of Research in Music Education, 37*(3), 188-200. doi:10.2307/3344669

DiMartino, D. (2016). *Music in the 20th Century (4 Vol Set)*: Taylor & Francis.

Drezewski, R., & Tomecki, P. (2011). Evolutionary System Supporting Music Composition *Intelligent Interactive Multimedia Systems and Services* (pp. 29-38): Springer.

Drummond, R. J., & Stoddard, A. H. (1992). Learning style and personality type. *Perceptual and Motor Skills, 75*(1), 99-104.

Dunn, B. M. (2008). *Transforming Conflict Through Music*: Union Institute and University.

Edwards, M. (2011). Algorithmic composition: computational thinking in music. *Communications of the ACM, 54*(7), 58-67.

Eldridge, A. C. (2005). *Extra-Music (ologic) al models for algorithmic composition.* Paper presented at the Workshops on Applications of Evolutionary Computation.

Elliot, D. J. (2009). *Praxial Music Education: Reflections and Dialogues*: Oxford University Press.

Emmons, S. E. (1998). *Analysis of musical creativity in middle school students through composition using computer-assisted instruction: A multiple case study*. (9825697 Ph.D.), University of Rochester, Eastman School of Music, Ann Arbor. Retrieved from http://search.proquest.com/docview/304483874?accountid=14745 http://sfx.fcla.edu/usf?url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:dissertation&genre=dissertations+%26+theses&sid=ProQ:ProQuest+Dissertations+%26+Theses+A%26I&atitle=&title=Analysis+of+musical+creativity+in+middle+school+students+through+composition+using+computer-assisted+instruction%3A+A+multiple+case+study&issn=&date=1998-01-01&volume=&issue=&spage=&au=Emmons%2C+Scott+Everett&isbn=9780591780178&jtitle=&btitle=&rft_id=info:eric/&rft_id=info:doi/ ProQuest Dissertations & Theses A&I database.

Feldhusen, J. F., & Goh, B. E. (1995). Assessing and Accessing Creativity: An Integrative Review of Theory, Research, and Development. *Creativity Research Journal, 8*(3), 231-247. doi:10.1207/s15326934crj0803_3

Folkestad, G. (1996). *Computer based creative music making. Young people's music in the digital age*. Go¨teborg: Acta Universitatis Gothoburgensis.

Freed-Garrod, J. (1999). A Framework for Investigating Self-Described Decisions and Value Judgments for Composing Music: An Illustrative Case Study. *Bulletin of the Council for Research in Music Education*(141), 41-46.

Fritz, R. (1991). *Creating*. New York: Fawcett Columbine

Gamble, T. (1984). Imagination and Understanding in the Music Curriculum Tom Gamble. *British Journal of Music Education, 1*(01), 7-25.

García Salas, H., Gelbukh, A., & Calvo, H. (2010). Music composition based on linguistic approach. *Advances in Artificial Intelligence*, 117-128.

Gardner, H. (1985). *The mind's new science : a history of the cognitive revolution*. New York: Basic Books.

Gardner, H. (1993). *Creating minds : an anatomy of creativity seen through the lives of Freud, Einstein, Picasso, Stravinsky, Eliot, Graham, and Gandhi*. New York: BasicBooks.

Gardner, H. (1995). "Multiple Intelligences" as a Catalyst. *The English Journal, 84*(8), 16-18. doi:10.2307/821182

Gardner, H. (2000). *Intelligence reframed: Multiple intelligences for the 21st century*. New York: Basic Books.

Gardner, H. (2007). *Five minds for the future*. Boston, MA: Harvard Business Press.

Gardner, H. (2008). The Five Minds for the Future. *Schools: Studies in Education, 5*(1/2), 17-24. doi:10.1086/591814

Gardner, H. (2011). *Frames of mind: The theory of multiple intelligences*: Basic books.

Geem, Z. W., & Choi, J.-Y. (2007). *Music composition using harmony search algorithm.* Paper presented at the Workshops on Applications of Evolutionary Computation.

Gordon, E. (1965). *Musical aptitude profile*: Houghton Mifflin.

Gordon, E. (1982). *Intermediate Measures of Music Audiation: A music aptitude test for first, second, third, and fourth grade children*: GIA Publications.

Gordon, E. (1992). *Advanced measures of music audiation*: Gia Publications.

Gorovitz, E. S. (1982). The Creative Brain II: A Revisit with Ned Herrmann. *Training and Development Journal, 36*(12).

Gough, H. G. (1981). *Studies of the Myers-Briggs Type Indicator in a personality assessment research institute*: Isabel Briggs Memorial Library.

Green, L. (2008). *Music, informal learning and the school : a new classroom pedagogy*. Aldershot, Hampshire, England ; Burlington, VT: Ashgate.

Guilford, J. P. (1950). Creativity. *American Psychologist, 5*(9), 444-454. doi:10.1037/h0063487

Guilford, J. P. (1967). Creativity: Yesterday, Today and Tomorrow. *The Journal of Creative Behavior, 1*(1), 3-14. doi:10.1002/j.2162-6057.1967.tb00002.x

Harasym, P., Leong, E., Juschka, B., Lucier, G., & Lorscheider, F. (1996). Relationship between Myers-Briggs type indicator and Gregorc style delineator. *Perceptual and Motor Skills, 82*(3_suppl), 1203-1210.

Hedges, S. A. (1978). Dice Music in the Eighteenth Century. *Music & Letters, 59*(2), 180-187.

Heise, M. (1994). Goals 2000: Educate America Act: The Federalization and Legislation of Educational Policy. *Fordham L. Rev., 63*, 345.

Henderson, L., & Stacey, L. (2014). *Encyclopedia of Music in the 20th Century*: Taylor & Francis.

Henke, R. (2016). Ableton Live - How it all began. Retrieved from http://roberthenke.com/technology/ableton_live.html

Herrmann, N. E. D. (1988). The creative brain: Lake Lure, NC: Brain Books.

Hickey, M. (1995). *Qualitative and quantitative relationships between children's creative musical thinking processes and products*.

Hickey, M. (1997). The Computer as a Tool in Creative Music Making. *Research Studies in Music Education, 8*(1), 56-70. doi:10.1177/1321103x9700800106

Hickey, M. (2001a). An Application of Amabile's Consensual Assessment Technique for Rating the Creativity of Children's Musical Compositions. *Journal of Research in Music Education, 49*(3), 234-244. doi:10.2307/3345709

Hickey, M. (2001b). Creativity in the Music Classroom. *Music Educators Journal, 88*(1), 17-18. doi:10.2307/3399771

Hoffer, C. (2017). *Introduction to music education*: Waveland Press.

Holmes, T. B., & Holmes, T. (2002). *Electronic and Experimental Music: Pioneers in Technology and Composition*: Routledge.

Hoogerwerf, F. W. (1976). Cage Contra Stravinsky, or Delineating the Aleatory Aesthetic. *International Review of the Aesthetics and Sociology of Music*, 235-247.

Hook, J. (2013). *Interaction Design for Live Performance.* (PhD Doctoral dissertation), Newcastle University School of Computer Science Retrieved from https://books.google.com/books?id=xcntAQAAQBAJ

Husbands, P., Copley, P., Eldridge, A., & Mandelis, J. (2007). An Introduction to Evolutionary Computing for Musicians. In E. R. Miranda & J. A. Biles (Eds.), *Evolutionary Computer Music* (pp. 1-27): Springer London.

Ivancevich, J. M., & Konopaske, R. (2013). *Human resource management*. New York, NY: McGraw-Hill Irwin.

James, A. (2009). *Constraining Chance: Georges Perec and the Oulipo*: Northwestern University Press.

Johnson, T. A. (1994). Minimalism: Aesthetic, Style, or Technique? *The Musical Quarterly, 78*(4), 742-773.

Joniak, A. J., & Isaksen, S. G. (1988). The Gregorc Style Delineator: Internal consistency and its relationship to Kirton's adaptive-innovative distinction. *Educational and psychological measurement, 48*(4), 1043-1049.

Jung, C. G. (1923). Psychological types: or the psychology of individuation.

Jung, C. G. (1971). Psychological types, volume 6 of The collected works of CG Jung. *Princeton University Press, 18*, 169-170.

Kamien, R. (1984). *Music: An Appreciation*: McGraw-Hill.

Kaschub, M. (1997). Exercising the Musical Imagination. *Music Educators Journal, 84*(3), 26-32. doi:10.2307/3399053

Kaschub, M., Smith, J., & Reimer, B. (2009). *Minds on Music: Composition for Creative and Critical Thinking*: R&L Education.

Kay, S. (2000). *The Korg Karma music workstation*. Tokyo: Korg, Inc.

Kendall, J. D. (1966). *Talent, education and Suzuki: what the American music educator should know about Shinichi Suzuki* (Vol. 1): Music Educators NationalConference.

Kostka, S. (2016). *Materials and Techniques of Post Tonal Music*: Taylor & Francis.

Kramer, J. D. (1981). New Temporalities in Music. *Critical Inquiry, 7*(3), 539-556.

Kramer, J. D. (1986). Discontinuity and Proportion in the Music of Stravinsky. *Confronting Stravinsky: Man, Musician, and Modernist*, 174-194.

Kramer, J. D. (1988). The Time of Music New Meanings, New Temporalities, New Listening Strategies.

Kramer, J. D. (2015). *Time in Contemporary Musical Thought*: Routledge.

Kramer, J. D., & Carl, R. (2016). *Postmodern Music, Postmodern Listening*: Bloomsbury Publishing.

Kratus, J. (1985). *Rhythm, melody, motive and phrase characteristics of original songs by children aged five to thirteen*. Unpublished doctoral dissertation. Northwestern University. Evanston, IL.

Kratus, J. (1989). A Time Analysis of the Compositional Processes Used by Children Ages 7 to 11. *Journal of Research in Music Education, 37*(1), 5-20.

Kratus, J. (1994a). Relationships Among Children's Music Audiation and Their Compositional Processes and Products. *Journal of Research in Music Education, 42*(2), 115-130. doi:10.2307/3345496

Kratus, J. (1994b). *The ways children compose.* Paper presented at the Musical connections: Tradition and change.

Kratus, J. (2001). Effect of Available Tonality and Pitch Options on Children's Compositional Processes and Products. *Journal of Research in Music Education, 49*(4), 294-306. doi:10.2307/3345613

Leavitt, C., & Walton, J. (1975). Development of a scale for innovativeness. *ACR North American Advances*.

Lussier, K. (2016). Managing Intuition. *Business History Review, 90*(4), 708-718.

Manzo, V. J. (2016). *Max/MSP/Jitter for Music: A Practical Guide to Developing Interactive Music Systems for Education and More*: Oxford University Press.

Mark, M. L. (1996). *Contemporary Music Education*: Schirmer Books.

Mazurowski, Ł. (2012). *Computer models for algorithmic music composition.* Paper presented at the Computer Science and Information Systems (FedCSIS), 2012 Federated Conference on.

Mazurowski, Ł. (2015). Algorithmic composition transformational-generative system for background music generation. *Przegląd Elektrotechniczny, 91*, 112-117.

Meelberg, V. (2006). *New Sounds, New Stories: Narrativity in Contemporary Music*: Amsterdam University Press.

Mishlove, J. (1996). What is Intuition? *Intuition at Work: Pathways to Unlimited Possibilities*.

Moorhead, G. E., & Pond, D. (1941). *Music of young children*: Pillsbury Foundation for Advancement of Music Education.

Moorhead, G. E., & Pond, D. (1942). *Music for Young Children*: Pillsbury Foundation for the Advancement of Music Education.

Moorhead, G. E., & Pond, D. (1978). *Music of Young Children*. Santa Barbara, CA: Pillsbury Foundation for Advancement of Music.

Mozart, W. A. (1792). Musikalisches Würfelspiel [Mozart's Dice Game] K. 294d. Nikolaus Simrock.

Myers, I., & Myers, P. (2010). *Gifts differing: Understanding personality type*: Nicholas Brealey Publishing.

National Art Education Association. (2013). National Coalition for Core Arts Standards. *Retrieved December, 23*, 2013.

Nielsen, L. D. (2013). Developing musical creativity: Student and teacher perceptions of a high school music technology curriculum. *UPDATE: Applications of Research in Music Education, 31*(2), 54-62.

Nierhaus, G. (2009). *Algorithmic composition: paradigms of automated music generation*: Springer Science & Business Media.

Nilsson, B. (2003). I can always make another one!'' Young musicians creating music with digital tools, *. S. Leong (Ed.) Musicianship in the 21st century: issues, trends and possibilities (Sydney,Australian Music Centre).*

Nilsson, B., & Folkestad, G. (2005). Children's practice of computer-based composition. *Music Education Research, 7*(1), 21-37. doi:10.1080/14613800500042042

O'Brien, T. P. (1990). Construct validation of the Gregorc Style Delineator: An application of LISREL 7. *Educational and psychological measurement, 50*(3), 631-636.

Odena, O. (2012). Perspectives on musical creativity: where next? *Musical creativity*, 201-213.

Orff, C. (1963). The Schulwerk: Its origin and aims. *Music Educators Journal, 49*(5), 69-74.

Orff, C. (1973). *Orff Schulwerk, Past and Future*: American Orff-Schulwerk Association.

Osborn, A. F. (1953). *Applied imagination*. New York: New York: Charles Scribner.

Pachet, F. (2006a). 18 Creativity studies and musical interaction. *Musical creativity*, 347.

Pachet, F. (2006b). Enhancing individual creativity with interactive musical reflexive systems. In I. Deliège & G. Wiggins (Eds.), *Musical creativity* (pp. 359-375). New York: Psychology Press.

Parnes, S. J. (1992). *Source book for creative problem-solving: A fifty year digest of proven innovation processes*. Buffalo, NY: Creative Education Foundation Press.

Paynter, J. (2000). Making progress with composing. *British Journal of Music Education, 17*(1), 5-31.

Pecko, S. (2016, January 27). What advantages does Ableton Live have over Logic Pro. Retrieved from https://www.quora.com/What-advantages-does-Ableton-Live-have-over-Logic-Pro-for-music-producers-and-vice-versa

Peters, T. J., Waterman, R. H., & Jones, I. (1982). In search of excellence: Lessons from America's best-run companies.

Phillips, W. (2014). *A Composer's Guide to Game Music*: MIT Press.

Polfreman, R., Loomes, M., & Wright, R. (2003). *Physically inspired interactive music machines-making contemporary composition accessible?* Paper presented at the Advanced Learning Technologies, 2003. Proceedings. The 3rd IEEE International Conference on.

Pond, D. (1981). A Composer's Study of Young Children's Innate Musicality. *Bulletin of the Council for Research in Music Education*(68), 1-12. doi:10.2307/41162300

Randles, C. (2009). Student composers' expressed meaning of composition with regard to culture. *Music Education Research International, 3*, 42-53.

Randles, C., & Webster, P. (2012). *Creativity in Music Teaching and Learning*. Journal Article. Unpublished Work.

Reio Jr, T. G., & Wiswell, A. K. (2006). An examination of the factor structure and construct validity of the Gregorc Style Delineator. *Educational and psychological measurement, 66*(3), 489-501.

Rose, G. J. (2014). *Between Couch and Piano: Psychoanalysis, Music, Art and Neuroscience*: Taylor & Francis.

Rosen, D., Schmidt, E. M., & Kim, Y. E. (2013). *Utilizing music technology as a model for creativity development in K-12 education.* Paper presented at the Proceedings of the 9th ACM Conference on Creativity & Cognition.

Rossman, J. (1931). The psychology of the inventor. Washington DC: Inventor's Publishing.

Rowan, R. (1986). *The Intuitive Manager*: Little, Brown.

Rowe, R. (2001). *Machine Musicianship*: MIT Press.

Rubin, M. (1995). *Nonlinear : a guide to digital film and video editing / by Michael Rubin* (3rd ed. ed.). Gainesville, Fla: Triad Pub. Co.

Ruthmann, A. (2007). The Composers' Workshop: An Approach to Composing in the Classroom. *Music Educators Journal, 93*(4), 38-43. doi:10.1177/002743210709300416

Savage, J., & Challis, M. (2002). A digital arts curriculum? Practical ways forward. *Music Education Research, 4*(1), 7-23.

Sawyer, R. K. (2006). *Explaining creativity : the science of human innovation / R. Keith Sawyer*. Oxford ; New York: Oxford University Press.

Seddon, F. A., & O'Neill, S. A. (2003). Creative Thinking Processes in Adolescent Computer-based Composition: an analysis of strategies adopted and the influence of instrumental music training. *Music Education Research, 5*(2), 125-137. doi:10.1080/1461380032000085513

Seeger, C. (1977). *Studies in Musicology, 1935-1975*: University of California Press.

Simoni, M. (2003). Algorithmic composition: a gentle introduction to music composition using common LISP and common music. *SPO Scholarly Monograph Series*.

Simonton, D. K. (2001). The Psychology of Creativity: A Historical Perspective: Green College Lecture Series on The Nature of Creativity: History Biology, and Socio-Cultural Dimensions, University of British Columbia.

Sloboda, J. A. (1985). *The musical mind : the cognitive psychology of music*. Oxford: Clarendon.

Snyder, B. (2000). *Music and Memory: An Introduction*: Bradford Books.

Springer, S. P., & Deutsch, G. (1998). *Left brain, right brain: Perspectives from cognitive neuroscience*: WH Freeman/Times Books/Henry Holt & Co.

Suzuki, S., Mills, E., & Murphy, T. C. (1973). *The Suzuki concept: An introduction to a successful method for early music education*: Diablo Press, Incorporated.

Swanwick, K., & Tillman, J. (1986). The Sequence of Musical Development: A Study of Children's Composition. *British Journal of Music Education, 3*(03), 305-339. doi:10.1017/S0265051700000814

Taruskin, R. (2009). *Music in the Early Twentieth Century: The Oxford History of Western Music*: Oxford University Press.

Thalmann, F., & Mazzola, G. (2008). *The BigBang Rubette: gestural Music Composition with Rubato Composer.* Paper presented at the ICMC.

Thomas, H. (1987). Encouraging the musical imagination through composition. *Music Educators Journal, 73*(5), 27-30. doi:10.2307/3397919

Todd, P. M., & Werner, G. M. (1999). Frankensteinian methods for evolutionary music. *Musical networks: parallel distributed perception and performace*, 313-340.

Tokui, N., & Iba, H. (2000). *Music composition with interactive evolutionary computation.* Paper presented at the Proceedings of the 3rd international conference on generative art.

Torrance, E. (1974). The Torrance tests of creative thinking-TTCT Manual and Scoring Guide: Verbal test A, figural test. *Lexington, KY: Ginn*.

Torrance, E. P. (1968). *Norms-technical manual: Torrance tests of creative thinking*. Bensenville: Scholoastic Testing Service.

Tsisserev, A. (1997). *An ethnography of secondary school student composition in music: A study of personal involvement within the compositional process*. Unpublished doctoral dissertation. University of British Colombia. Canada.

van Elferen, I., & Weinstock, J. A. (2015). *Goth Music: From Sound to Subculture*: Taylor & Francis.

Vaughan, M. M. (1973). Cultivating Creative Behavior: Energy Levels and the Process of Creativity. *Music Educators Journal*, 35-37.

Vaughan, M. M. (1977). Musical Creativity: Its Cultivation and Measurement. *Bulletin of the Council for Research in Music Education*(50), 72-77. doi:10.2307/40317450

Vickery, L. (2011). *The Evaluation of Nonlinear Musical Structures*. Paper presented at the The Third Totally Huge New Music Festival Conference, Perth Western Australia. http://ro.ecu.edu.au/cgi/viewcontent.cgi?article=1352&context=ecuworks2011

Wakefield, D. W. (2007). *Vessel: A Platform for Computer Music Composition, Interleaving Sample-Accurate Synthesis and Control.* (Masters of Arts), University of California, Santa Barbara.

Wallas, G. (1926). *The art of thought*. New York: Harcourt, Brace and Company.

Webster, P. (1977). *A factor of intellect approach to creative thinking in music.* (doctoral dissertation), Eastman School of Music, University of Rochester, Rochester, NY.

Webster, P. (1979). Relationship between Creative Behavior in Music and Selected Variables as Measured in High School Students. *Journal of Research in Music Education, 27*(4), 227-242.

Webster, P. (1990a). Creative Thinking in Music. *Music Educators Journal, 76*(9), 21. doi:10.2307/3401072

Webster, P. (1990b). Creativity as Creative Thinking. *Music Educators Journal, 76*(9), 22-28. doi:10.2307/3401073

Webster, P. (1992). Research on creative thinking in music: The assessment literature. In R. Colwell (Ed.), *Handbook of Research on Music Teaching and Learning: a project of the Music Educators National Conference* (pp. 266-280). Oxford, New York: Oxford University Press.

Webster, P. (1998). Young Children and Music Technology. *Research Studies in Music Education, 11*(1), 61-76.

Webster, P. (2002). *Creative thinking and music education: encouraging students to make aesthetic decisions.* Paper presented at the Proceedings of the 10th Anniversary European Society for the Cognitive Sciences of Music, Musical Creativity Conference. Liege: University of Liege.

Webster, P. (2009). Children as creative thinkers in music. In L. Hallam, I. Cross, & M. Thaut (Eds.), *The Oxford handbook ofmusic psychology* (pp. 421-428). New York: Oxford University Press.

Webster, P. (2012). Key research in music technology and music teaching and learning. *Journal of Music, Technology and Education, 4*(2-3), 115-130. doi:10.1386/jmte.4.2-3.115_1

Wiggins, J. (1992). *The nature of children's musical learning in the context of a music classroom*. Unpublished doctoral dissertation. University of Illinois at Urbana-Champaign.

Wiggins, J. (1993). *The nature of children's musical learning in the context of a music classroom.* (Ed.D. 9305731), University of Illinois at Urbana-Champaign, United States -- Illinois. Retrieved from http://search.proquest.com/docview/304059946?accountid=14745 ProQuest Dissertations & Theses (PQDT); ProQuest Dissertations & Theses A&I database.

Wiggins, J. (1994). Children's Strategies for Solving Compositional Problems with Peers. *Journal of Research in Music Education, 42*(3), 232-252. doi:10.2307/3345702

Wiggins, J. (2003). A frame for understanding children's compositional processes. In M. Hickey (Ed.), *Why and how to teach music composition: A new horizon for music education* (pp. 141-167). Reston, VA: MENC.

Wiggins, J. (2007). Compositional Process in Music. In L. Bresler (Ed.), *International handbook of research in arts education* (Vol. 16, pp. 453-476): Springer Netherlands.

Williams, D. B. (2007). *Reaching the "other 80%:" Using technology to engage "non-traditional music students" in creative activities.* Paper presented at the Presentation at the Tanglewood II Technology and Music Education Symposium, Minneapolis, MN: University of Minnesota.

Winkler, T. (2001). *Composing Interactive Music: Techniques and Ideas Using Max*: MIT Press.

Appendix

Listed below is the link for the Ableton templates mentioned previously in the paper. These templates are for primary school students. They represent a starting point of sound exploration. The instructions for the templates are listed below and are listed in the download file.

Ableton version 10 is required to operate these templates.

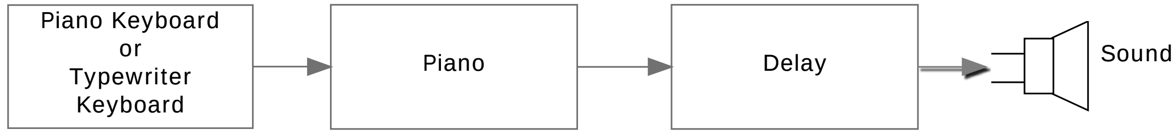
https://www.dropbox.com/l/scl/AABQqODicq10v4oQ1PhLT7MXY5cAKCsOfb8

Eight-Note Delay

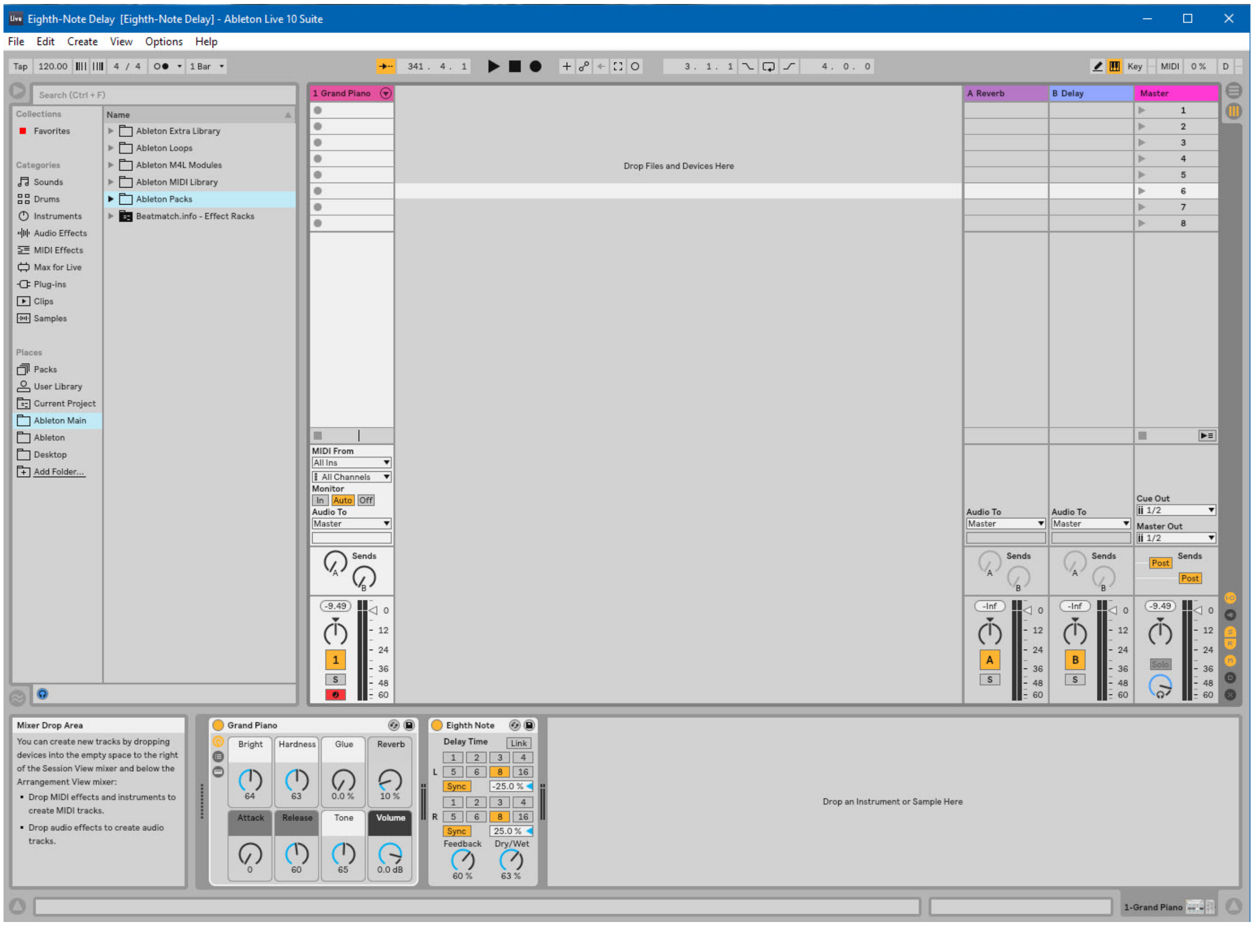
The eighth-note delay is an audio delay based upon an eighth-note. The delay module requires some type of sound as a source for the production of the delay sound.

The template is set up to receive MIDI in from a piano keyboard, or from the typewriter keyboard. The keys on the row of A through L are represented as the white keys on the piano.

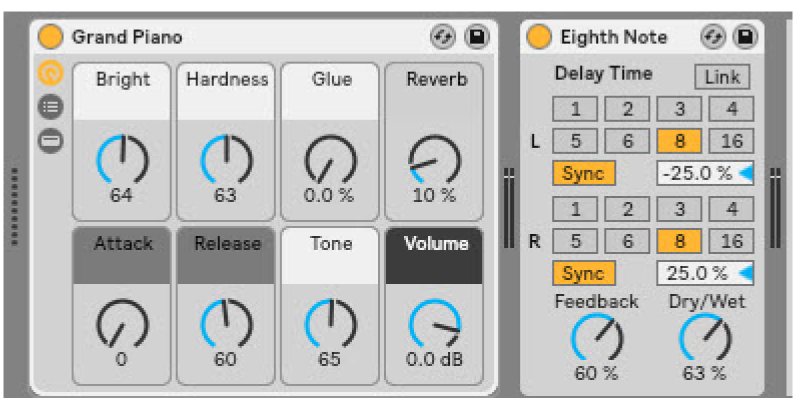
By pressing a key (MIDI or letter), a MIDI signal is sent from the keyboard to the piano causing the piano to play. The piano sound is routed to the delay unit for processing. A graphic of the flow of the process follows.



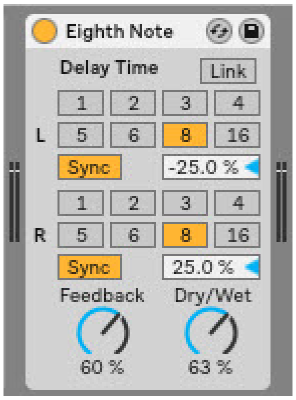
Delay Signal Flow



The view of the screen with the Grand Piano Instrument and the Eight-Note Delay



The piano instrument and the Delay Module



Eighth-Note Delay Module

Before you start:

The eighth-note delay is simple to use but has some very advanced features. A list of avenues to explore is listed below. To reverse any of the actions you did while you are exploring, execute an undo (Cntl+Z). To begin, make sure the computer MIDI keyboard is on. Press the record button to arm the track. Then press a key A-L on your typewriter keyboard.

Things to try:

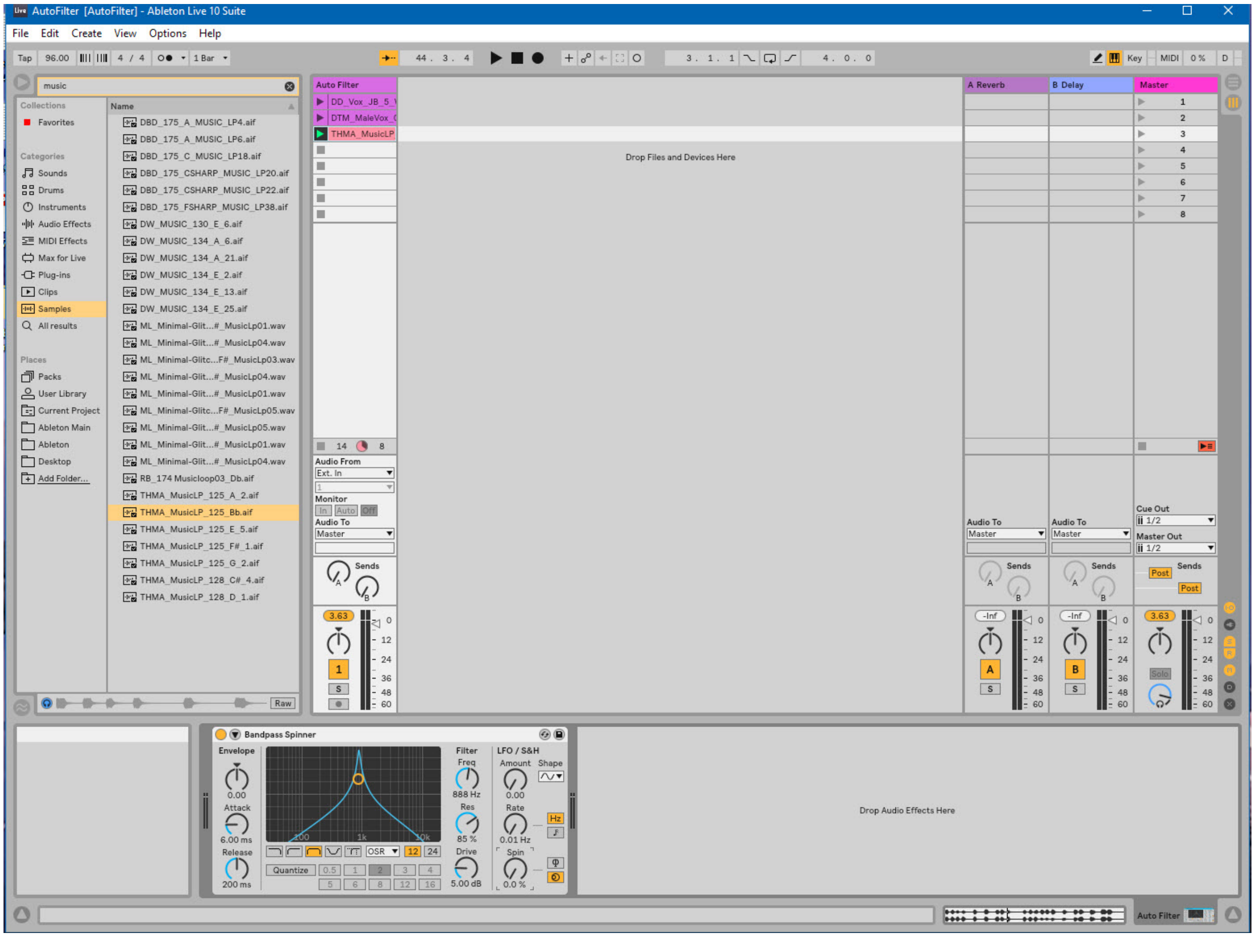
1. Change the delay on the left (top) note to 16 while you are exploring. Each of the numbered squares represents a delay time in 16th notes.
2. To hear the piano only, turn the dry/wet knob to 0.0%. Then gradually increase it to 80% to merge the two sounds.
3. Try to change the sound of the piano by moving the Reverb to 80% and changing the tone to 85%.

AutoFilter

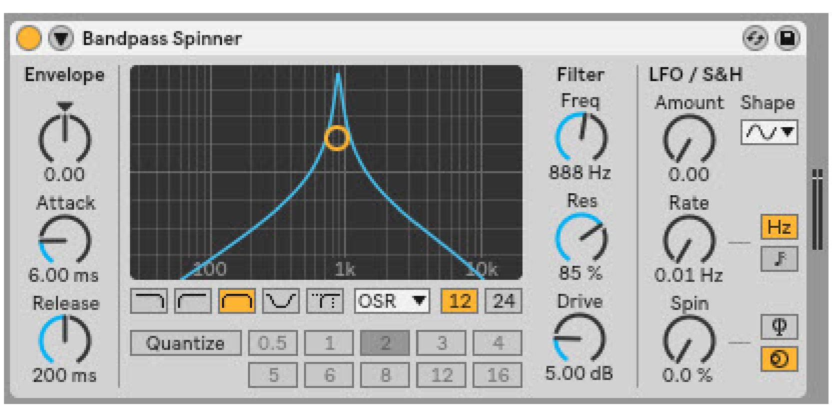
The AutoFilter is a passive equalizer that is configured to sweep across the audio sound spectrum. It requires a sound source which can be a sampled sound or recorded music.

The template contains three samples. One is a female vocal singing, "Well, well, well." The next sample is a male voice saying, "A revolution in music." The third sample is a short audio clip of electronic music. There are triangles located on each graphic clip of the audio sample. To start the audio clip, press the triangle located on the clip. A graphical representation of the function of the AutoFilter process follows.

AutoFilter Signal Flow



The view of the screen with the three samples and the AutoFilter



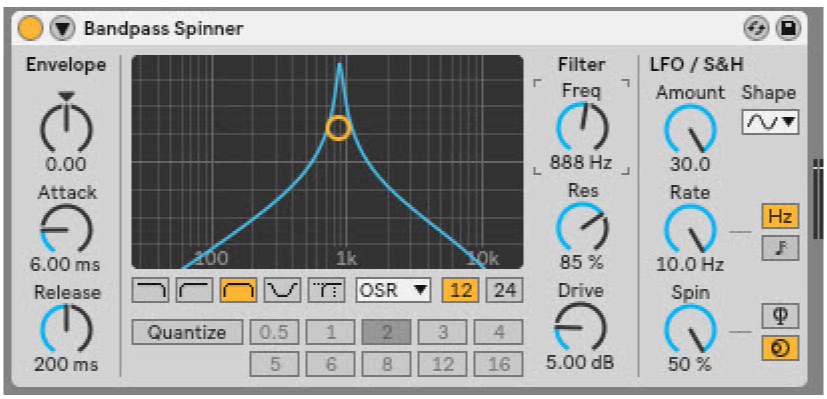
Close-up of the AutoFilter

Before you start:

A list of things to try is listed below. Press play on one of the three samples before you start to explore the AutoFilter. To reverse any of the actions you did while you are exploring, execute an undo (Cntl+Z). Press the record button to arm the track and record your own sample.

Things to try:

1. Change the **Freq** dial right below **Filter**. The filter will sweep across the audio band, from low to high frequency.
2. Another way to do this is to click on the orange circle in the view screen. You can move it left and right to show the effects of engaging the filter.



Close-up of AutoFilter with Spin engaged

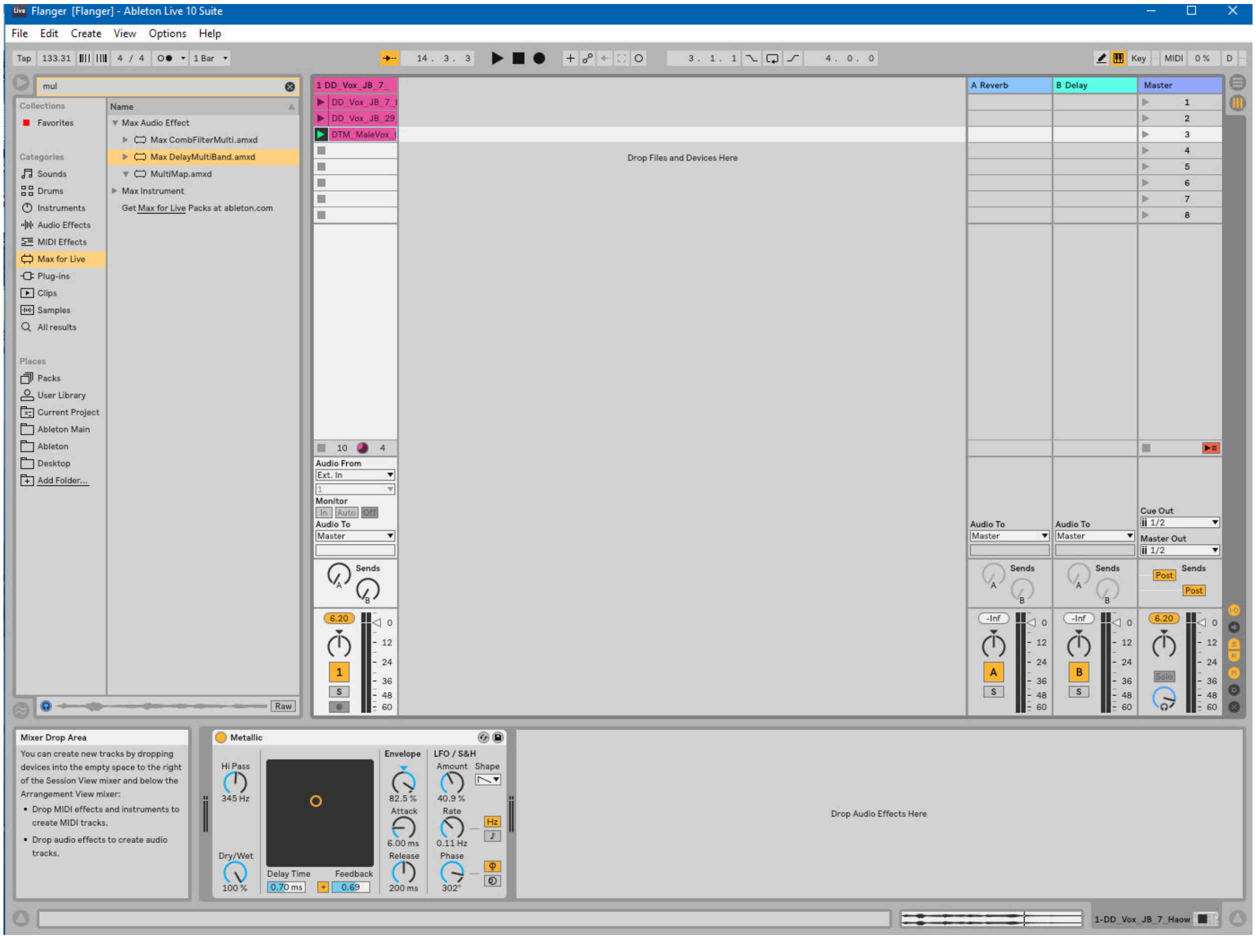
3. The **Spin** knob starts an LFO stutter effect with the sound source that is leaving the filter.
4. Change the **Spin** knob to achieve various sounds.
5. Change the **LFO Amount** knob to change the sound.
6. The **Rate** knob can be changed to achieve the stutter effect.

Flanger Effect

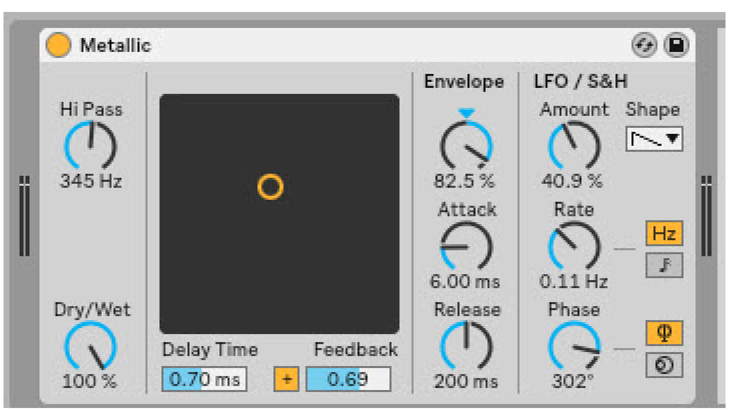
The Flanger is an audio effect that gives the sound source a metallic sound. It creates a cyclically varying phase shift to the original sound. It is necessary to use a sound source as input, which can be a sampled or recorded sound.

The template contains three samples. One is a female vocal singing, “Ho.” The second clip is a female voice saying, “Hey.” The last sample is a male voice saying, “A revolution in music.” There are triangles located on each graphic clip of audio samples. To start the audio clip, press the triangle located on the clip. A graphical representative of the function of the Flanger process follows.

Flanger Signal Flow



The view of the screen with the three samples and the Flanger



Close-up of the Flanger

Before you start:

Press play on one of the three samples before you start to explore the Flanger. To reverse any of the actions you did while you are exploring, execute an undo (Cntl+Z). Press the record button to arm the track and record your own sample.

Things to try:

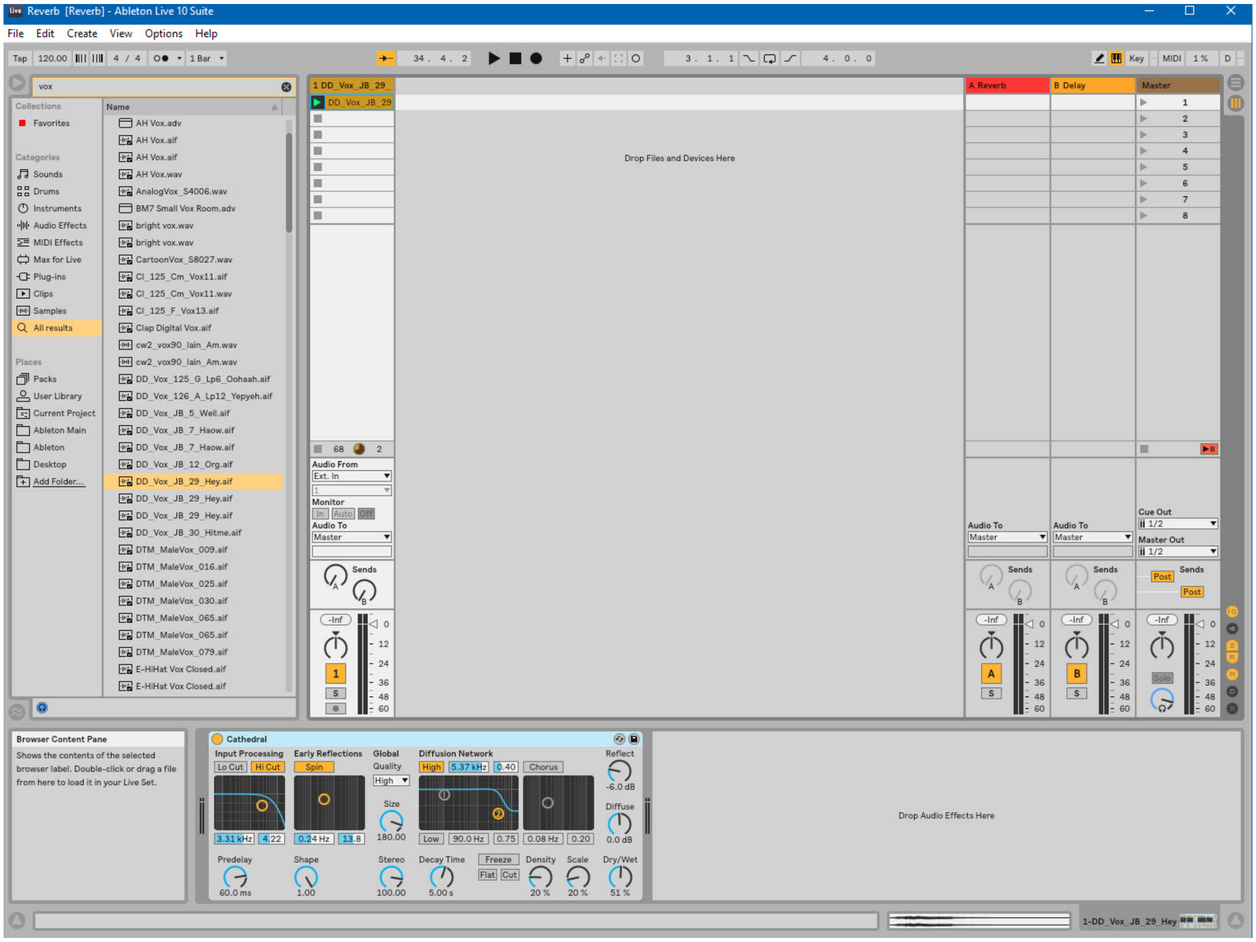
1. Click on the orange circle in the view screen. You can move it left and right to show the effects of the filter.
2. Change the **Hi Pass** dial while the filter is engaged.
3. For a maximum effect of the Flanger, place the circle in the top right corner.

Reverb Effect

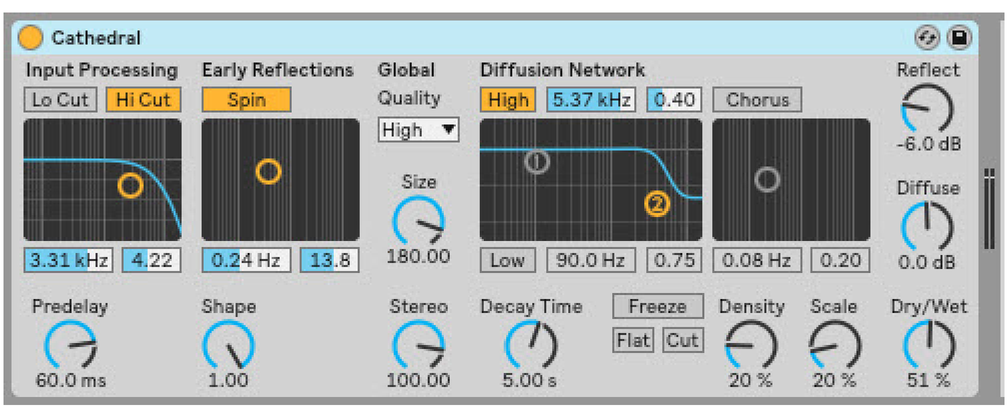
The Reverb module is an audio effect that gives the sound dept as if it is in a hall or large space. It creates space around the sound source and causes the original source to sound large or full. It requires a sound source as input, which can be a recorded or sampled sound.

The template contains one sample of a female vocal saying, "Hey." There is a triangle located on graphic clip of audio sample. To start the audio clip, press the triangle located on the clip. A graphical representative of the Reverb process follows.

Reverb Signal Flow



The view of the screen with one samples and the Reverb module



Close-up of the Reverb module

Before you start:

Press play on the sample before you start to explore the Reverb module. To reverse any of the actions you did while you are exploring, execute an undo (Cntl+Z). Press the record button to arm the track and record your own sample.

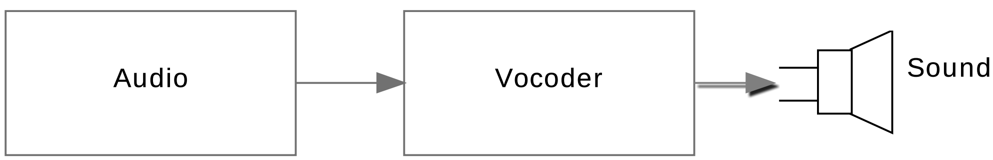
Things to try:

1. Change the **Dry/Wet** knob to demonstrate the difference with Reverb and without it.
2. Click on **Chorus** button. Click on the orange circle in the **Chorus** display. You can move it left and right to show the chorus effects.
3. Change the **Decay Time** dial while the Reverb is engaged. It will change the time and echo effect of the reverb.

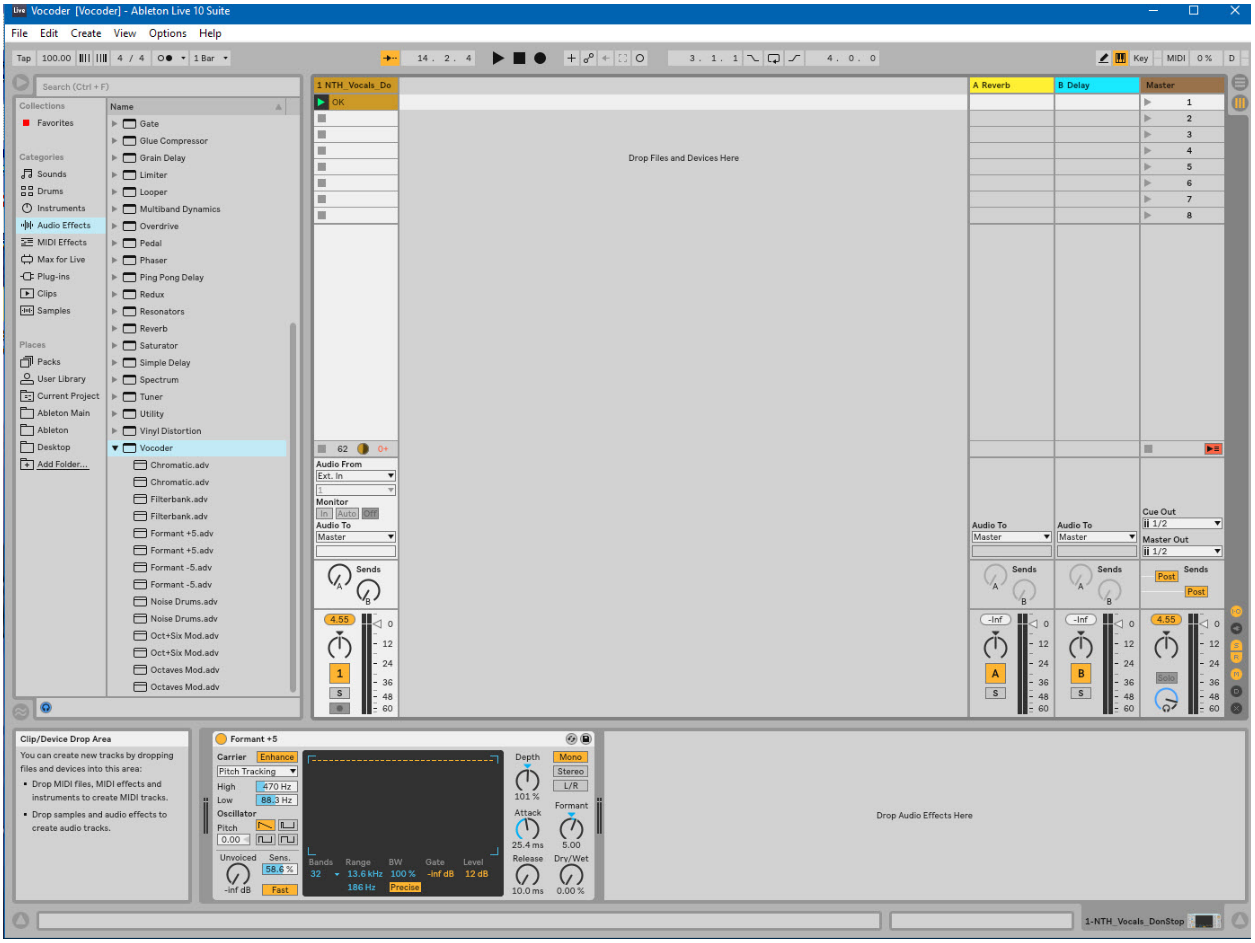
Vocoder Effect

The vocoder module is an audio effect that sounds similar to synthesized audio. It is often used to create robotic sounds or voices. It requires a sound source as input, which can be a sampled or recorded sound.

The template contains one sample of a male vocal saying, “OK.” There is a triangle located on graphic clip of audio sample. To start the audio clip, press the triangle located on the clip. A graphical representative of the Vocoder process follows.



Vocoder Signal Flow



The view of the screen with one samples and the Vocoder module

Close-up of the Vocoder module

Before you start:

Press play button on the sample clip before you start to explore the Vocoder module. To reverse any of the actions you did while you are exploring, execute an undo (Cntl+Z). Press the record button to arm the track and record your own sample.

Things to try:

1. Change the **Dry/Wet** knob to demonstrate the difference with Vocoder and without it.
2. Change the **Depth** knob. You can hear the variations in the sound.
3. Change th**e Formant** knob. It will change the pitch of the sound.

PAPER 2

Using music software in the compositional process: A case study of electronic music composition

Links for the paper 2

The original paper is on Journal of Music, Technology, and Education, website.

The original paper weblink:

http://www.ingentaconnect.com/content/intellect/jmte/2013/00000005/00000003/art00003

A secondary link is provided if the first one is unsuccessful:

DOI: https://doi.org/10.1386/jmte.5.3.257_1