A Pilot Study Mapping Students' Composing Strategies—Implications for Teaching Computer-Assisted Composition

Abstract

This article presents three in-depth case studies of a computer-assisted composition project in Hong Kong to understand how individual students from varied backgrounds encounter computer-assisted composition. Three higher education students composed short pieces using music technology. Qualitative and quantitative data were collected digitally, through semi-structured interviews, and from students' reflective journals. Comparative analyses of students' composing activities revealed different approaches to composing, and a series of models that reflect the students' varying composing approaches is presented. The findings should help to develop strategies that foster creativity when composing with music technology.

Keywords

Music composition, music technology, computer-assisted composition, composing strategies, creative process.

Over the past two decades, there has been significant interest in research on the use of music technology in the teaching and learning of music. Music technology-based composition is now regarded as a major topic, and has been explored in studies of creativity in music (Williams & Webster, 2005); teaching and learning with music technology (Rudolph, 2005); musical thinking and music technology (Moore, 1989); teaching and learning hardware and software design (Collins, 1992); the use of MIDI in composition (Reese, 1995); the balance of structure and freedom in the compositional process (Ladanyi, 1995); horizontal and vertical approaches to composition (Folkstad, 1996); the autoethnographic approach to composing that combines computers and journaling (MacInnis, 1996); thinking aloud while composing at the computer (Younker, 1997); intrinsic motivation (Cheung, 2001); self-efficacy (Merrick, 2003); pedagogical approaches to multi-media composition (Chen, 2005); pedagogical changes in music education (Burnard, 2007); problem solving in music technology (King & Vickers, 2007); computer-mediated composing among secondary school music students (Kirkman, 2010); and problem-solving strategies and processes in musical composition (Collins & Dunn, 2011). These studies have all demonstrated that music technology-based composition plays a significant role in creativity and music education.

Musical Creativity

Burnard (2007) defined "musical creativity" from the perspectives of phenomenology, psychology, and ethnomusicology. In addition to these three perspectives, this paper also discusses the pedagogical perspective.

Phenomenological Perspective

Phenomenological research stresses experiential learning and tries to grasp all of the subtle variations of lived experience. Conrad (1990) conducted phenomenological analyses of artistic creativity that described the *intention* of the act of creativity. Berliner (1994) elaborated the nature of improvisation in phenomenological analyses of the adult improviser's world of jazz. These studies illustrate that the intention of the student composer is clearly worth observing. This study thus uses music technology as a tool to reveal the relationship between improvisation and composition at different stages of the creative process.

Psychological Perspective

Research from the psychological perspective has drawn comparisons between novice and expert composer**.** Younker and Smith (1996) collected data from both

novice and expert participants and found that whereas experts approached the composing task by considering general strategic factors, novices approached composing with less of an overview and undertook the task on a bar-by-bar basis. More recent research has developed techniques that are suitable for participants from a wide range of ages and musical backgrounds using innovative music technology software to digitally track and compare individual composer processes (e.g., Kirkman, 2010 and Collins & Dunn, 2011). The pilot study reported here uses such work as a basis to observe the thinking process of undergraduate students in a composition task that involved using music technology to compose a piece of music.

Ethnomusicological Perspective

Ethnomusicology looks at the music of specific cultures or subcultures. The ethnomusicological view of musical creativity centres on investigations of distinct forms of cultural actions within a particular culturally specific social context. In certain non-Western practices, there are no clear boundaries for decision-making about which notes to play and the array of possible decisions across the whole field of what we call composing, improvising, performing, and listening (Brinner, 1995). This pilot study compared musicians from various musical backgrounds—a classical/jazz musician, a popular musician and a classical musician—to observe the variation in their creative processes.

Pedagogical Perspective

Odena and Welch (2012) proposed a new generative model of teachers' perceptions of creativity. In their model of teachers' thinking on creativity in music education, teachers draw on their previous experiences such as *musical, teacher education and professional teaching* while simultaneously applying their preconceptions of creativity regarding *pupils, environment, process and product*. The model implies that teacher education and professional teaching have a direct impact on students' thinking about musical creativity and the creative process and product.

Webster (2012) introduced the concept of *revision*, which is the active consideration of new material when faced with the old, with the idea of improving the final product. The concept is based on the notion that the first musical ideas are worthy of change by expanding, extending or otherwise altering them beyond their initial form. *Revision* can take many forms. The role of teachers is to make *revision* a natural part of composing and a part of what we all do to make our work meaningful.

Younker and Smith (1996) showed how novice and expert composers work with

musical ideas by naturally using revision techniques. Folkestad (1996) reported similar behaviour in subjects working with technology. This indicates that students do learn from revision.

According to Reese (2003), "the present use of computers and related technologies in music education, [is] often limited to non-creative skill development" (p. 42). Music technology can open up new horizons of musicality if it fulfil its potential of giving people direct access to creative decision-making with sounds, storage and the instant retrieval of sounds, along with devices to alter and refine previous decisions. This enables "genuine compositional creativity".

Studies such as those of Odena and Welch (2012), Webster (2012), Younker and Smith (1996), Folkestad (1996) and Reese (2003) reveal that teacher education has a direct impact on students' thinking about musical creativity and the importance of music technology at the different stages of composing.

Computer-assisted Composition

Reese (2003) highlighted some of the benefits of software-based composing. Many teachers are energised by the powerful learning that they observe when students use software as "musical crayons" to quickly generate musical ideas. After generating several possible musical fragments, students use the software to help them to "think" as they experiment with changes and additions to the initial patterns or phrases. They can use the standard software features of cutting, copying, pasting and dragging to vary and rearrange these first ideas. Student can easily alter pitch, duration, tempo, tone colour and volume. Over time, students gradually refine and organise their ideas into unified, complete pieces of music, and engage in a compositional process in which a small amount of musical material is generated, transformed and developed into a whole piece. This process closely reflects the recursive nature of the compositional process as described by professional composers. It also shares similarities with the language-writing process of brainstorming, drafting and revising. Software affords an easier entry into this experience than paper and pencil by allowing the direct manipulation of sound and giving immediate feedback to the young composer about musical decisions.

Overall, the technology-supported compositional process enables students to synthesise earlier learning about musical elements, presents them with interesting problems to solve, and helps them "think in sound" and feel the expressiveness of their own creative work. With repeated experiences, early limited efforts develop into

more complex and satisfying pieces as problem solving and creative thinking increase.

Reese's definition of computer-assisted composition includes notation, sequencing and accompaniment software that can be used to create an environment in which students can work with sound. Although these programs were originally developed for use by professional and amateur musicians, music educators have developed strategies to turn them into tools for students to use to compose and improvise. These programs most often use MIDI keyboards, but can be used successfully applied without them. Various modes are available for students to enter and edit musical ideas.

Focus and Research Questions

A way of mapping composing pathways was developed by Burnard and Younker based on students from various backgrounds from the United Kingdom, the United States, Canada and Australia (Burnard & Younker, 2002). In this study, this mapping of composing pathways is re-examined and extended using music technology as a tool for composition among Hong Kong students. Three individual students from an undergraduate program were followed over 12 weeks as case studies to highlight the specific factors associated with the creative process. The students were given three hours of instruction each week in technology and composition and tutorial sessions.

The research questions addressed by the study are as follows.

1. How did the selected participants respond to the computer-assisted composition?
2. What patterns emerged from an analysis of the composing pathways followed by the students in computer-assisted composition?

Method

This study focuses on how music technology can enhance and develop the musical ideas of students during the creative process of computer-assisted composition. MIDI files of the students' compositions were captured and observed through computer-based digital data collection to compare their different musical approaches to the tasks during the creative process. The participants also kept reflective journals during the creative process. The reflective journals were recorded on paper after each lecture and considered two issues: the problems encountered during the creative process and the solutions that the participants employed to solve the problem. Individual semi-structured interviews were conducted after the task was

completed in which each participant was asked 15 open-ended questions. The researcher then observed the MIDI files of the students' approaches to compare the compositional trends in their reflective journals and individual interviews to triangulate the composition pathways.

Sample Selection and Ethical Issues

As a pilot study, the sample size was small, consisting only of three male students. There was no gender discrimination in the research; rather, the three participants were selected primarily based on their varied musical backgrounds. Student A was both a classical and jazz musician. Student B was a popular musician. Student C was a classical musician. Their ages ranged from 20 to 22. The participants signed a consent form to be involved in this pilot study. The connection between the participants and the researcher was a student-teacher relationship.

Subjects' Double Identities

The participants were undergraduates at a teaching training institution in Hong Kong. They had a double identity: to gain experience as a student composer and to learn to teach composition with the use of music technology to primary and secondary school students.

Limitations

The scope of the study was three participants from a teacher training institution at the tertiary level in Hong Kong, and thus the results cannot be generalized to the development of all student or professional composers. The software used in the computer lab was the sequencing software *Sonar* and the notational software *Finale* for inputting and printing scores.

Reliability

The detailed analysis of the creative process was studied by a second judge, who is a professional composer with an MM in composition from the Cleveland Institute of Music and a DMA in composition from Ohio State University, USA. The judge has been working for nearly a decade at the teacher-training institution in Hong Kong and teaches composition at the undergraduate and graduate levels.

Working Definitions

In this study, the term *composing* refers to the act of forming or constructing a revised piece over time. A *strategy* is defined as a plan involving significant decision-making processes that govern the overall composition. In Webster's model

(2003) of creative thinking, composition is a dynamic mental process that alternates between divergent (imaginative) thinking and convergent (factual) thinking. Divergent thinking involves generating as many solutions as possible for a specific problem. Convergent thinking involves evaluating the various possibilities and converging on the best solution.

Wallas's Stage Theory (1926)

A view of composing as a time-based process that moves through stages in the creative process from Wallas's Stage Theory (1926) was adopted in the study. The stages refer to the creative operations that take place over time, as illustrated in Table 1.1.

Table 1

Wallas's Stage Theory of the Creative Process (Wallas, 1926, p. 51)

Stage	Nature of Process	Thinking Style
1. Preparation	- Discovering a problem - Seeking and collecting data - Analysing and examining data - Following rules - Association of ideas - Trial and error - Hard work, otherwise no conception can be achieved in the next stage	- Conscious - Logical - Systematic
2. Incubation	- Leaving the problem unfinished - An interval free from conscious thought - Mental relaxation - It takes time	- Unconscious
3. Illumination	- A solution for the problem may present itself - The culmination of a successful train of associations - Less controllable, cannot be influenced by a direct effort of will	- Unconscious
4. Verification	- The validity of the idea is tested - The idea itself is reduced to an exact form	- Conscious - Logical - Systematic

Wallas's Stage Theory can be applied to describe the creative process used by a composer. For example, in the first stage of preparation, the composer may discover a musical idea or issue to work on. The composer will then search for and analyse musical works that are similar to that which he or she would like to compose, in addition to thinking about the kinds of composition techniques that might be used for the piece. At this stage, the composer must employ convergent thinking to search for the most suitable musical examples and composition techniques. This involves consciousness to test ideas and find solutions. Wallas (1926) explained the flow of the four stages as follows.

> In the stage of incubation the composer may have thought consciously for a certain period of time. Perhaps there is a problem that the composer cannot solve; for example, deciding which musical techniques should be used to express specific images or ideas. In such a situation, the composer may leave the musical piece unfinished.
>
> The illumination stage can be the most critical stage in the creative process. After the unconscious incubation stage, a solution to the problem, or a creative idea for the composition, is generated. Nevertheless, the feasibility and the level of creativity is verified by a conscious and objective evaluation process in the verification stage. This takes place when the composer reconsiders the musicality as well as creativity of his or her piece when employing the generated ideas. (pp. 50-53)

These four stages are developmental. However, Wallas (1926) suggests the overlapping of the stages may occur when different problems are explored.

Results

Student A

Background. Student A (20-year-old) is a classical guitarist who formed a rock band called *Devilman* and joined the Hong Kong Guitar Orchestra in 2002, of which he remains a member. While studying music on the music program, he has learned to play different styles of jazz and classical music. He has achieved ABRSM Grade 8 in classical guitar and is a guitarist in the HKIEd Jazz Band.

Findings. Student A began his composition in the F Mixolydian scale. The main melody was played by a trombone. The instrumentation was acoustic bass, string pizzicato, trombone and bongo with polyphonic texture in a through-composed form.

He first composed using the *Finale* notation software and then imported it into the *Sonar* sequencing software for editing, mixing and panning. For him, the most important element in the piece was rhythm. The inspiration was to express a timeless effect: everything goes wrong, and all of the instruments then play at different beats. The piece was also intended to imitate African drumming. His creative process is illustrated in Figure 1.

Figure 1. Linear pathways exhibited by the classical/jazz guitarist

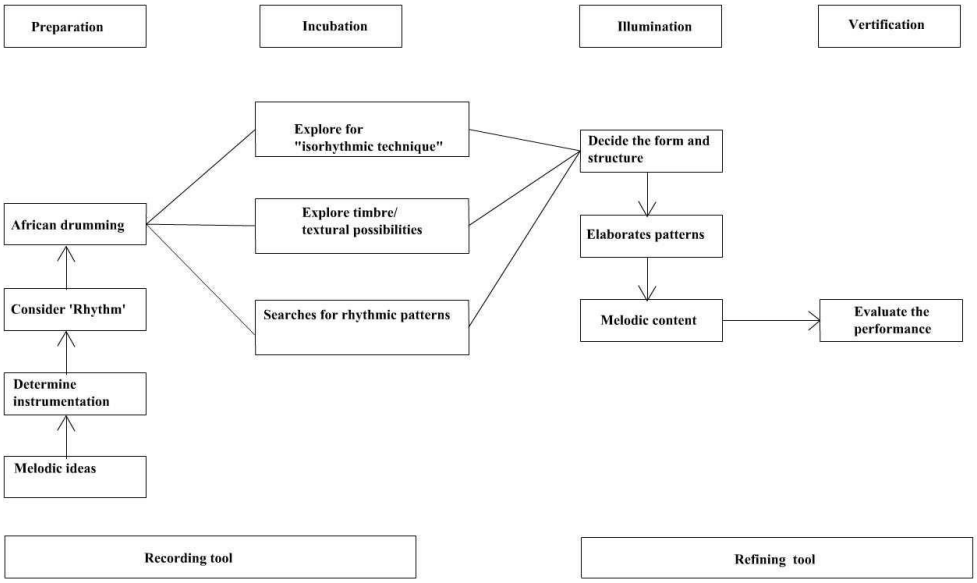


Figure 1 shows the *linear pathway* of the overall creative process of Student A. He displayed minimal movement between divergent and convergent thinking (incubation, illumination and verification). As a result, Student A imposed minimum constraints on his decision-making process.

Student A expressed that it is easier to compose using music technology because he could record the music instantly. He chose the instrumentation initially in his mind, then tried it in the sound module. He found the quantization function useful because it made the music more accurate and the mixing and panning helpful because it made the music more spacious. To summarise, music technology was involved in all four stages of the creative process. However, Student A used music technology as a *recording tool* in the preparation and incubation stages and as a *refining tool* in the illumination and verification stages.

The technology mediated the composing style of Student A. During the incubation stage, the student's MIDI file showed that he used the loop function to

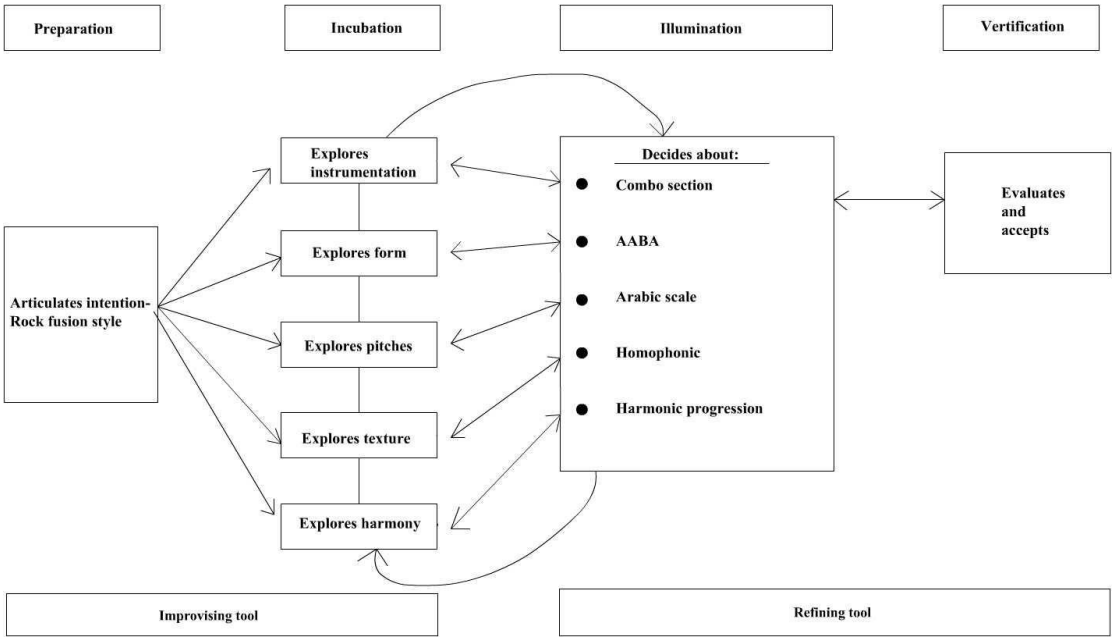
create a repeated rhythmic pattern on one track. After a few days of relaxation, he continued to create another rhythmic pattern that imitated the first track on the second track. His intention was to create an "isorhythmic" effect in the piece.

Student B

Background. Student B (22 years old) plays electric bass guitar and is involved in a band with schoolmates, playing mainly in pop and rock styles. He plays electric bass in the HKIEd Jazz Band.

Findings. Student B began his computer-assisted composition with an Arabic scale in homophonic texture with AABA form. He first composed with the *Finale* notation software in a rock style and then imported it into the *Sonar* sequencing software for editing, mixing and panning. His creative process is illustrated in Figure 2.

Figure 2 Integrated pathway exhibited by the pop/rock bassist



Student B's pathway is labelled an *integrated pathway*. He displayed significantly more movement across and within the four creative thinking stages, particularly between the incubation and illumination stages. His interaction between divergent and convergent thinking was more involved and resulted in a greater number of constraints on the decision-making process.

Student B stated that his inspiration was Arabic music, and had started by

improvising a scale on the MIDI keyboard. For instruments that were more familiar to him, he did not need the assistance of the music technology to know the actual timbre of the instrument. For less familiar instruments, he used the MIDI keyboard to experiment with the sound. He found the quantization function to be effective, especially when applied to the rhythm section. However, he thought that the melody should not be quantized in an exact manner. He emphasised that the mixing and panning function played a vital role in the composition process, and that it would not be a complete work without the final mix. He found that music technology helped to transform his preliminary ideas into the actual sound because it was much better than just thinking about the music in the imagination. To summarise, the role of music technology was again involved in all four stages, and Student B used music technology as an *improvising tool* in the preparation and incubation stages and a *refining tool* in the illumination and verification stages.

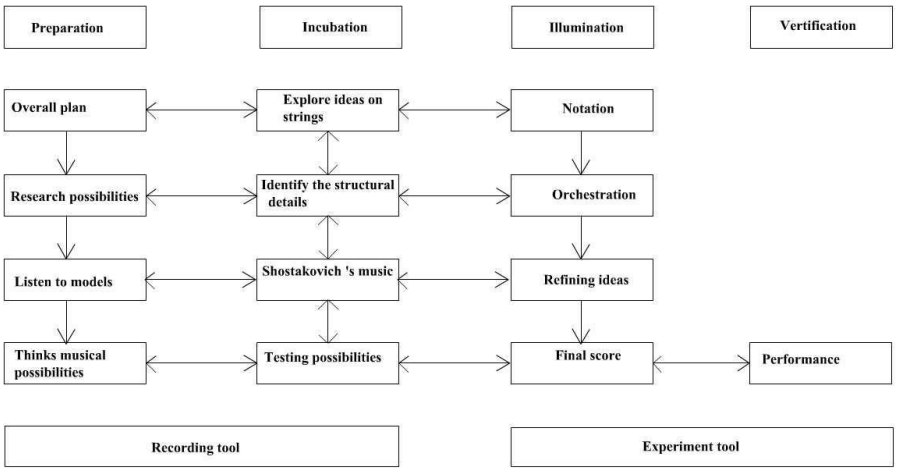
The technology again mediated the composing style of Student B. During the incubation stage, the student's MIDI file showed that he explored the instrumentation first to lay down the instrumental tracks on the file. Afterwards, he put down the markers for different sections to create the overall form of the piece in the conductor track of the sequencing software. After a few days of relaxation, he started to record a harmonic progression with the MIDI keyboard. His intention was to create a "fusion" piece that blended different musical styles.

Student C

Background. Student C (21 years old) was a viola trainee at the Music Office. During this period, he joined many orchestras, such as the Hong Kong Youth Strings and the Hong Kong Youth Symphonic Orchestra. He also performed at the joint concert of the Lincoln Youth Symphony Orchestra (USA) and the Hong Kong Youth Strings. He studied on the music program and participated in the String Quartet at the HKIEd. Later, he furthered his studies at the University of Newcastle in Australia.

Findings. Student C began the composition in E minor for orchestra with a 16-measure theme played by strings. The piece was composed with contrapuntal texture in ternary form. He first started with the *Finale* notation software and then imported the work into the *Sonar* sequencing software for editing, mixing and panning. He started with the melody and took inspiration from Shostakovich's music. His creative process is illustrated in Figure 3.

Figure 3. Self-regulated pathway exhibited by the classical violinist



Student C demonstrated an approach to composing that was based on modelling a specific stylistic convention. He emphasised the preparatory activities before formal decision-making, and spent much time in the exploration stage. The preparatory activities included listening to models of compositions and researching the possibilities in applying compositional techniques (the incubation stage). Refining and editing the ideas was an important aspect in the illumination stage. By imposing boundaries and limiting the compositional options, he set a *self-regulated pathway* by working within a chosen musical language, and explored beyond this by thinking in sound.

Student C stated that it is easier to compose using the computer because he could hear the actual sound instantly. He spent a significant amount of time on the orchestration. The mixing and panning function was helpful to balance the sound of the virtual orchestra. He observed that the sound of a chord played by the MIDI seemed to have less dissonance than the sound played by acoustic instruments. He commented that the instruments in the sound module could be more humanised and the composing software should contain both sequencing and notation functions. He revised the orchestration by adding and subtracting instruments in the software to find the best orchestral sound. Student C used music technology as a *recording tool* in the preparation and incubation stages and an *experimental tool* in the illumination and

verification stages.

The technology mediated the composing style of Student C. During the incubation stage, the student's MIDI file shown that he had started to record the cello part as the melodic motif for the string section. After a few days of relaxation, he brought in some listening references, such as Shostakovich's music, and recorded the violin part and the viola part on top of the cello part. He listened to the instant playback from the samples as his first draft. During the illumination stage, he mentioned that he would like to refine the music with more detailed articulation and dynamic marking using the notation software to create a printed orchestral score.

Discussion

The strategies and the movement between and across creative thinking stages varied among the students. Figure 1 shows that student A used a *linear pathway* with limited shifts between stages. Figure 2 shows that Student B used an integrated pathway, with a composing strategy characterised by the interaction of the incubation (finding), illumination (focusing) and verification (fixing) stages. Figure 3 shows that Student C was self-regulated with increased movement across the stages. The differences in approaches are clearly linked to the relative constraint and freedom of the creative process.

The formal instruction in composition did not appear to affect the students' ability to think divergently and convergently. Composing requires students to use strategies to find and focus on musical ideas, and to manage, memorise and think in sound. Computer-assisted composition allows musical ideas to be easily saved so that the composer can move on to the next stage or edit ideas as desired. When a musical idea appears, but does not fit into the musical context, the composer may find ways to amend it. The balance between constraints and freedom becomes crucial for students in the composing process. The different creative uses of the sequencing software in this study suggest that students' needs differ with the degree of constraint or freedom that they impose on the creative process.

Music technology has a direct impact as a tool during the creative process of music composition. When different strategies emerge, the role of music technology as a functional tool varies with composition strategy. Student A used music technology as a *recording tool* in the preparation and incubation stages and a *refining tool* in the illumination and verification stages in a *linear pathway.* Student B used music technology as an *improvising tool* in the preparation and incubation stages and a

refining tool in the illumination and verification stages in an *integrated pathway*. Student C used music technology as a *recording tool* in the preparation and incubation stages and an *experimental tool* in the illumination and verification stages. Clearly, music technology can be used as *refining tool, improvising tool or experimental tool* in the illumination and verification stages. Its use as a *refining tool* concurs with the finding of Webster (2012) of the importance of *revision*, or the active consideration of new material in the face of old with the idea of improving the final product. The use of music technology as an *improvising tool* concurs with Berliner (1994) ideas about the nature of improvisation in phenomenological analyses. By using music technology as both a recording tool and improvising tool, the relationship between improvisation and composition becomes more obscure. Using music technology as an *experimental tool* concurs with the finding of Brinner (1995) from an ethnomusicological perspective that there are no clear boundaries in decision-making about which notes to play and the array of possible decisions across the field composing, improvising, performing and listening.

For those working in the field of music education at any level, from schools to universities, and in particular those working to develop music composition skills in learners, the findings may be especially useful. When school teachers or composition teachers understand the different stages and thinking styles of students during the creative process of composition, they will find it easier to provide feedback and guidance after each creative stage, and can use tools such as sequencing software as a complement. For example, a student may become stuck in the middle of a composition when using a MIDI keyboard as an *improvising tool* in the preparation and incubation stage. The teacher can then assist him or her to use a *refining tool* in the illumination and verification stages following an *integrated pathway*. Alternatively, a student may use notation software to input his or her music using the software as a recording tool in the preparation and incubation stages and think that the work is finished. The teacher can then direct the student to enter the illumination and verification stages by using sequencing software as a *refining tool* to edit the score into a professional production with a final mix with different timbres of instruments.

Model Application—A Pedagogy of Computer-assisted Composition

Create "Sound Objects" Rather Than "Notational Symbols"

In the creative process of computer-assisted composition in this study, the students paid more attention to "sound objects" than notational symbols. Paytner (2000) stressed that the word "composing" means positioning things together, and

describes the phenomenon as a person putting sounds together and being pleased with the results enough to remember them. The benefits of computers are that students can save their music in MIDI/audio file as "real sounds" rather than "notation". Musicians think of "creating sound" more than "creating notation".

Teaching Musical Style

In this study, the students stated in the individual interviews that the teaching of musical style is crucial. Although students may have some previous musical background, music teachers can provide more musical examples as scores and recordings to give students a comprehensive musical understanding of a particular style in which they would like to compose. Bennett (1976) suggested that the fostering of experience in music composition has important education considerations. Developing germinal and internal musical ideas relies heavily on long-term memory and past experience. Students thus cannot be expected to compose in a style or medium that is unfamiliar to them. The teaching of musical style is thus recommended in music composition programs, whether taught with or without the use of music technology.

Direct Experience to the Students

The creative process model suggests that students must be made conscious of the various aspects and operations inherent in producing a creative product. Students need guidance and practice in monitoring their own creative musical behaviour. This means that students must be given the opportunity to hear their compositions in both draft and final form. Computer-assisted composition provides an environment in which students can hear their compositions instantly. This enhances the creative process, particularly for students who have little musical training. By allowing students to directly experience the results of their composition through the medium of a computer, significant music learning takes place as musical ideas are tried, amended and refined.

Computer-based Creative Music Environments

Computer-based creative music environments are now frequently employed in general music classrooms where music education emphasises non-skill-based learning in composition and performance. These programs are capable of reducing the skill-based nature of the creative musical process. From the educational perspective, composition may allow for the development of aspects of musicality that are not directly dependent on performance and musical literacy skills.

Conclusion

The findings from the three case studies cannot be generalised to the development of all student or professional composers. However, the insights generated may be useful for music teachers, student composers and music software developers to understand the relationship between decision making, problem solving and the creative process in the use of music technology as a recording tool, refining tool or improvising tool. The findings suggest that students must be allowed to follow their own compositional approaches to experiment and explore a variety of musical possibilities during the creative process. This result provides a theoretical basis for further research to understand the role of music technology as a tool to develop creative thinking and musical thinking.

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