SOUNDSCAPE: A MUSIC COMPOSITION ENVIRONMENT DESIGNED TO FACILITATE COLLABORATIVE CREATIVITY IN THE CLASSROOM

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ABSTRACT

A question that has gained widespread interest is 'how can learning tasks be structured to encourage creative thinking in the classroom?' This paper adopts the stance of drawing upon theories of learning and creativity to encourage creative thinking in the classroom. A number of scholars have suggested that the processes of 'learning' and 'creativity are inextricably linked. Extending upon this, a generative framework is presented which exists as a design support tool for planning creative learning experiences. A demonstration of how this framework can be applied is made through the design of SoundScape – A music composition program designed for school children. This paper reports upon a study using SoundScape within a school with 96 children aged 11. The study focused on two objectives, firstly, identifying any differences in explicitly supporting the creative processes of 'preparation' as opposed to not, and secondly, comparing the outcomes of using real-world metaphors to create music compared to the use of abstract visual representation to specify music.

1. INTRODUCTION

The study reported in this paper focused on facilitating collaborative creativity in a music composition task. In particular, this paper draws together theoretical routes from learning and creativity theory. The study investigated the similarities between the two processes and based upon this a generate framework for creative learning is presented. This framework exists as a design support tool to assist with the design of creative learning experiences within the classroom. In this instance it is applied to the domain of a collaborative music composition task and was used to inform the design of SoundScape. SoundScape was designed to explore the research hypotheses driving the study. The hypotheses focused upon explicitly supporting the preparation phase of the creative processes using music technology and using visual metaphors to specify music. The findings hold a number of implications for the design of meaningful and engaging learning experiences through considering aspects of the creative process.

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2. THEORETICAL BACKGROUND: THE LEARNING PROCESS

2.1 Traditional Perspectives on Learning

Traditional pedagogy concerns itself with the passive absorption of knowledge, which is later tested in examination based scenarios. The underlying assumption of this approach places expectations upon the student to learn and recall knowledge. This is embodied via rote teaching methods [1]. Subsequently, students may respond in ways to meet what they perceive to be the teacher's expectations [2]. Brown *et al* assert that although learning abstract, de-contextualised concepts in the classroom equips students to pass examinations, they may encounter difficulty when applying concepts in authentic practice [3][4]. Secondly, students may rely upon particular features of the classroom context in which the task itself may have become embedded. This differentiates the task from authentic activity in the mind of the student. It is therefore emphasised here that learning should be set in a context appropriate to the concepts to be learned. This view is emphasised by the more contemporary approach of constructivism.

2.2 Social Constructivist Learning Theory

According to the constructivist approach, important aspects of learning are as follows: learning is contextual. Secondly, one needs knowledge to learn. It is not possible to assimilate new knowledge without having a previous knowledge structure. Thirdly, learning is a self-regulated process as every individual learns at a different rate depending on their prior knowledge and experience [5]. Finally, learning is viewed as an individual and social activity in which interactions with others and the external environment are conducive to learning [6][7]. Constructivism emphasizes that students learn by constructing meaning for themselves through active participation within a domain. This approach has a number of advantages. For example, by discussing their experiences with others, shared understandings can be developed [8]. This is especially advantageous in collaborative settings. Many have argued that social interaction is paramount to cognitive development as learning occurs through interacting with others. This enhances the integration of newly acquired concepts into the mental structure of the learner.

2.3 The Constructionist Method of Learning: Learning by Building

Constructionist methods have sought to enhance the learning experience linking creative endeavours to learning. Constructionism can be regarded as an educational method based upon constructivist learning theory [9]. Whereas constructivism advocates that knowledge is constructed in the mind of the individual, constructionism extends upon this, suggesting that an effective way to learn is to build something tangible that exists in the real-world. This is thought to enhance the overall learning experience, making it more meaningful to the student. The emphasis of constructionism is the importance for students to be actively engaged in personally creating a product which is meaningful to themselves and others [9][10].

2.4 The Link between Learning and Creativity

Similarly to learning, creativity also involves the active construction of new ideas and content within the social context of other members of the field. Few scholars have suggested there exists a strong relationship between learning and creativity, however, the similarities between the two appear evidently striking[11][12]. Guilford states that creativity can be considered a sub-type of learning as expressed in the following statement: *"A creative act is an instance of learning…a comprehensive learning theory must take into account both insight and creative activity".* The following section of this paper explores the fundamental models and perspectives on creativity theory and discussed how these models can be aligned with models of learning.

3. THEORETICAL BACKGROUND: THE CREATIVE PROCESS

3.1 Towards and understanding of the Creative Process

Creativity research originally focused upon stage models of the creative process starting with the work of Poincare in 1913. Poincare describes the creative process as commencing with conscious thought, followed by unconscious work, resulting in 'inspiration' [13]. Based on Poincare's account of the creative process, Wallas formalised the four-stage model of creativity [14]. Wallas defined creativity as a linear four-stage model, progressing through the stages of preparation, incubation, illumination and verification (see figure 1). Preparation concerns immersing one's self in a domain, and developing a curiosity about a particular problem [15]. During this stage, knowledge is consciously accumulated and influences are drawn from previous experience. During the incubation stage, conscious thought pertaining to the problem is rested and left to the unconscious mind [16]. Illumination occurs when one experiences a sudden flash of insight [14]or sudden inspiration [13]. Finally, verification concerns forming judgments pertaining to the creative artefact produced.

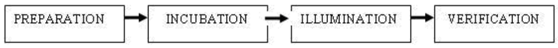

Figure 1. Four stage model of creativity (Wallas, 1926)

Since the proposed model of creativity by Wallas in 1926 there have been many debates and redefinitions of the stages of creativity, however, certain points gain widespread agreement [17]. Firstly, there is a need for preparation for the creative act. Preparation can have a number of aspects, this can involve accumulating existing facts and resources and preparing mentally for the creative process. Second, time is required for the incubation of ideas. Third, the verification of creative thoughts has both a personal and social element. The new work must satisfy the aims of the individual and stand up to evaluation by a wider community.

4. THEORETICAL BACKGROUND: SPECIFYING MUSICAL REPRESENTATIONS

4.1 Children's musical representations

Visual imagery is widely acknowledged as a crucial element of creative thinking [18], therefore it is common sense to incorporate visual imagery into the design of creative learning environments. In relation to music composition software, music has been typically specified using staff notation. However, more recent studies into children's use of musical representations have reported that in some instances staff notation may act as an inhibitor in early music composition owing to the mis-match between the sound properties of music and the visual representation of staff notation [19][20].

Traditional music composition programs have been largely based upon the symbolic functions of traditional staff notation, thus, in some instances excluding those with little to no music experience. Scholars have suggested that alternative forms of graphical notation have proven more effective in studies where the symbols used visually reflect the properties of musical sounds [19]. Symbol systems used in this way do not rely upon retrieval of previously learned meanings as visual elements are matched to auditory elements through readily identifiable representations. This would also allow for musical tones to be represented cross-modally. For example, sounds may be described as 'bright', 'dark', 'harsh', 'soft' etc.

4.2 Children's perceived confidence in music composition

A study conducted by Seddon indicated that children without formal music training appear to lack confidence in composition tasks if they associate their abilities to a lack of formal music training [21]. This is as opposed to higher levels of perceived confidence displayed by those with formal music training [22][23]. In terms of compositional works, results from Seddon's study concluded that students with formal musical training indicated higher preferences for displaying musical expertise such as musical structure within their compositions. Compositions produced by those without formal music training were associated with higher preferences in terms of originality and exploration [21][24][25].

5. A GENERATIVE FRAMEWORK FOR CREATIVE LEARNING

Drawing upon insights from the background motivation, a framework has been developed which represents a distillation of creativity theory focusing upon education. The framework is presented in the form of a generative framework, which exists as a design support tool to assist with the design of lesson support materials and the design of educational technologies. The framework assists the design of creative educational experiences for the classroom by providing scaffolding for supporting materials in terms of the six white component boxes of the framework (see figure 2). Wallas's four-stage model has been adapted as the fundamental basis for this generative framework, with the processes of preparation, generation and evaluation represented laterally across the framework. The vertical dimensions reflect individual (denoted here as personal) and social components of creativity. The social level refers to others, peers and society. Personal levels reflect explicit and tacit levels of thinking.

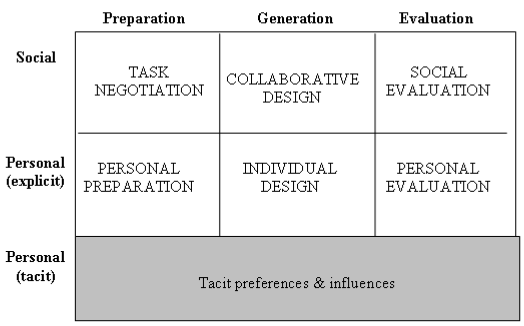

Figure 2. A generative framework for creative learning

With regard to figure 2, the lateral and vertical phases and sub-components of the generative framework are discussed within the following sub sections.

5.1 Lateral process: the preparation process

The processes of preparation, generation and evaluation are recognised herein as three integral concepts of the creative process, in that, every creative act involves the preparation of ideas, whether in the form of tacit influences drawn from the environment, or conscious preparation for the task. Within this process, at the personal level, an individual will develop a curiosity or a desire to create. Once this desire or need has been established, information is consciously accumulated from the external environment and thoughts may be discussed with others on a 'social' level which the individual can reflect upon on a 'personal' level [15]. If working in a collaborative setting, group-wide negotiations of the task will also take place. Inevitably, the way in which an individual prepares for the task will be influenced by their past experiences which may be explicit or tacit [26].

5.2 Lateral process: the generation process

The generation process of the framework encompasses social and personal design. Within this process ideas are generated which can involve interactions and negotiations between the individual and peers in their environment. Additionally, idea generation is assisted partly by a continuous interaction occurring between levels of explicit and tacit thinking [14]. The terminology used in the creativity literature refers to these sub-conscious processes as incubation and illumination. These terms refer to the 'incubation' of ideas where conscious thought pertaining to the problem is rested, and 'illumination' is the point at which creative ideas are realised. A number of scholars suggest that influences from the environment at a 'social' level can trigger creative ideas to progress from tacit to more explicit thoughts at a 'personal' level [16]. Thus, the framework presented here acknowledges the importance of environmental factors upon the creative process, and the importance of allowing time for creative ideas to evolve.

5.3 Lateral process: the evaluation process

The evaluation process concerns reviewing early creative ideas through to evaluating the final artefact. The evaluation process may be conducted by the individual at a personal level, and by the wider community. This represents two dimensions of evaluation, a wide body of literature supports this [27][28]. Although not all creative acts culminate in historically significant acts, the creative individual may wish to verify their work with others residing within the community. This may lead to individual and or societal acceptance of the creative artefact, and in some instances, this may lead to the individual returning to earlier processes of the framework, for example for the refinement of an idea [27]. This is supported by previous studies which extend upon the work of Wallas indicating that a second incubation process may occur after initial illumination, depending on the creative idea or artefact produced [29]. Inevitably, what follows the evaluation process will differ between individuals and scenarios.

5.4 Theoretical assumptions of the framework

The generative framework for creativity attempts to explain concepts and processes involved in creativity. The creative learning process begins with social and individual preparation, and finally ends with social and individual evaluation, and is characterised by three main processes. The framework also acknowledges social and individual elements within the creative process. The framework does not commit to a strict linear route, and it is emphasised here that the creative process is cyclic in nature, this is been supported by aspects reviewed within the theoretical background. The review of creative ideas may result in a need to revise ideas which may result in further preparation, or evaluation or further generation and so on. The framework exists as a design support tool for facilitating creative learning and can be used to guide the design of lesson materials for the classroom and the design of e-learning environments. The framework can be utilised as a design support tool to facilitate creative thinking in the classroom by instantiating the framework. The framework assumes that creativity exists within all, albeit to differing degrees. This view is widely supported by contemporary literature within the domain of creativity [30][31].

6. RESEARCH HYPOTHESES AND PLANNING THE STUDY

Extending upon the theoretical background and the generative framework, two questions were raised. Firstly, what different outcomes may arise when music composition software explicitly supports / does not support the preparation phase of the creative process? Secondly, what different outcomes may arise when real-world metaphors are used to specify music as opposed to using abstract representations? These questions were formulated into the hypotheses to be investigated within this study as follows:

6.1 Hypothesis one:

Explicitly supporting preparation in learning tasks is conducive to creative learning . Learning scenarios which incorporate preparation will:

1. Make the activity more meaningful for the student than those which do not.
2. Make the activity more enjoyable for the student than those which do not.
3. Lead to a greater depth of engagement for the student than those which do not.

6.2 Hypothesis two:

The use of visual metaphors based upon real-world objects is an effective way to represent music. Educational programs using visual metaphors to specify music will:

1. Make the activity more meaningful to the student than those which do not.
2. Make the activity more enjoyable for the student than those which do not.
3. Lead to a greater depth of engagement for the student than those which do not.
4. Lead to an increase in student's confidence in a music composition task than those which do not.

6.3 Designing SoundScape

6.3.1 Prototype one: Supporting preparation and using visual metaphors to specify music

Four prototypes of SoundScape were developed to test the research hypotheses. With prototype one, students can select a 'theme' for their composition (see figure 3). Themes that can be selected are: a street, the ocean, a space planet and the jungle. Students select the theme they wish t work with and prepare for the music composition task by specifying their 'composition' objects by associating real-world objects that one might expect to find within the theme to pre-recorded music samples, e.g. if the 'jungle' theme is selected then metaphors might consist of 'lions', tigers', 'monkeys' etc (see figure 4). Students associate the metaphors to the pre-recorded music samples based on qualities they feel are shared between the two.

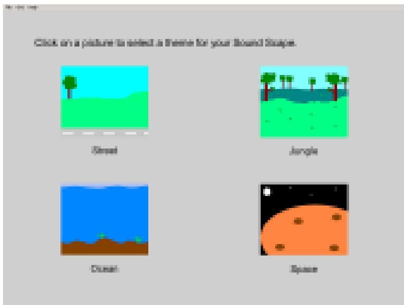

Figure 3. The theme selection environment in SoundScape

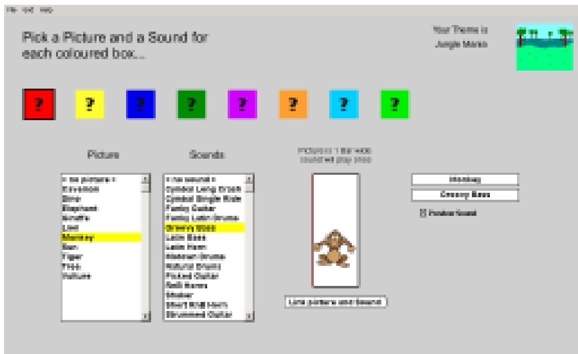

Figure 4. The composition object set up screen in prototype one

After selecting eight composition objects, the students then progress to the main composition environment within SoundScape. To create a composition, students drag and drop the composition objects onto the theme background. There are play, rewind and pause buttons on the interface. As can be seen from figure 5, some bar lines are represented at the interface with some composition objects being one bar in duration, others two. Students manipulate the composition objects to structure their musical work.

Figure 5. The composition environment within Sound-Scape in prototypes one and two

This prototype has been designed to explicitly support the preparation phase of the creative process whilst using visual metaphors to specify music.

6.3.2 Prototype two: not explicitly supporting preparation but using visual metaphors to specify music

Prototype two does not explicitly support preparation and students enter the program at the main composition screen (generation phase of the creative process) and create a composition using pre-specified composition objects (see figure5). The pre-specified composition objects still make use of the visual metaphors associated with the pre-selected composition theme.

6.3.3 Prototype three: explicitly supporting preparation and using abstract representation to specify music

Prototype three uses abstract representation to specify music, similar to those use in off-the-shelf music composition packages such as the E-Jay range. Preparation is explicitly supported within this prototype by allowing students to select eight music samples for use in their compositions (see figure 6). After selecting eight composition objects the students then progress to the main composition area of SoundScape and place the objects on the screen using drag-and-drop functionality (see figure 7).

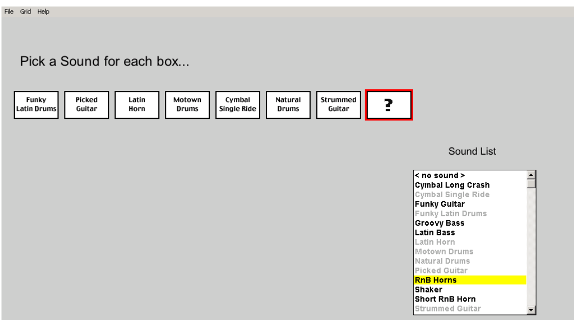

Figure 6. The composition object set up screen in prototype three

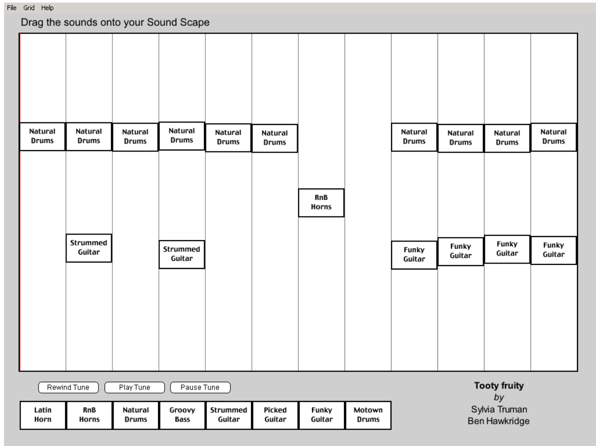

Figure 7. The composition environment within Sound-Scape in prototypes three and four

6.3.4 Prototype four: not explicitly supporting preparation and using abstract representations to specify music

Prototype four does not explicitly support preparation, so the students do not select composition objects to use, rather, they enter the task on the main composition screen (the generation phase of the creative process). Here they use pre-define composition objects to create their composition using the abstract representation to specify music (see figure 7).

6.4 Experimental conditions

In order to investigate the research hypotheses, each prototype was assigned to one of four experimental conditions as shown in table 1. Ninety six school children participated with this study, all eleven years of age. Twenty four participants were allocated to each condition, with twelve pairs of students in each. The study was conducted over a month and with one pair of students at a time to allow participants to work free from distraction.

6.5 Exploring student's level of perceived confidence with the composition task

Before being introduced to the composition task, students were individually provided with a sheet of paper an A3 sheet of paper containing the question "who makes music". This was used to elicit attitudinal responses towards the following:

1. Who the individual participant perceived to have the ability to create a piece of music.

2. What skills the individual participant perceived as necessary to create music.

This was administered prior to and after using Sound-Scape so that any changes in the participant's opinions relating to the above could be compared. This was used to provide an indicator of individual student's level of perceived confidence when approaching the task of musical composition.

6.6 Arranging groups to explore the research hypotheses using the four SoundScape prototypes

Prior to interacting with SoundScape, students were instructed: *"working as a pair, create a piece of music using SoundScape. There is no right or wrong way of carrying out the task. Spend as long as you feel is necessary on your composition until you feel you have completed it.*

Condition	SS Prototype	Preparation Support	Musical Spec	No. of Students	No. of pairs
V-P	One	Yes	Metaphor	24	12
V-NP	Two	No	Metaphor	24	12
NV-P	Three	Yes	Abstract	24	12
NV-NP	Four	No	Abstract	24	12

Table 1. Experimental conditions used in the study

Data was collected during the participant's composition session both by the program and observational behaviour analysis. The A3 sheet of paper was represented after their session with SoundScape and students were asked to add anything they felt they wanted to. Outcomes of the study are now discussed in terms of: time on task, manipulation of composition objects used, points of pairwise discussion and student's level of perceived confidence with the composition task.

7. RESEARCH FINDINGS AND DISCUSSION

Outcomes of the study were compared across all four conditions in terms of the time spent on the composition task, the number of composition objects moved, the number of musical bars used, the number of the eight available composition objects used,, the number of individual discussion points made about individual sounds, the number of individual comments made about individual pictures, the number of individual comments made about mappings (i.e. the association between the music samples and visual metaphors used), and the student's level of perceived confidence with the task.

7.1 Time on task

Results indicate that those working within preparation conditions V-P and NV-P spent significantly longer on the task than those in non-preparation conditions V-NP and NV-NP, $(F\ (1, 48) = 39.734,\ p < 0.01)$. Findings also indicate that those working with visual metaphors to specify music (i.e. groups V-P and V-NP) spent significantly longer on the task than those using abstract representations to specify music (i.e. NV-P and NV-NP), $(F\ (1, 48) = 4.494,\ p < 0.05)$.

7.2 Composition object manipulations

7.2.1 Number of composition objects moved

Results indicate that those using visual metaphors moved significantly more objects than those using abstract representations to specify music $(F\ (1, 48) = 10.483,\ p < 0.05)$. No significant differences were identified between preparation and non-preparation conditions.

7.2.2 Number of musical bars used

Those using visual metaphors to specify music (i.e. V-P and V-NP) used significantly more musical bars than those using abstract representations to specify music (i.e. NV-P and NV-NP), $(F(1, 48) = 10.547,\ p < 0.05)$. No significant differences were identified when comparing preparation and non-preparation conditions.

7.2.3 Number of the available eight composition objects used

Wit regard to the number of the eight available composition objects used, those using visual metaphors to specify music (i.e. V-P and V-NP) used significantly more of the eight available composition objects than those using abstract representations to specify music (i.e. NV-P and NV-NP), $(F(1, 48) = 7.333,\ p < 0.01)$. When comparing preparation and non-preparation conditions, those working within the preparation conditions used significantly more of the eight available objects than those in conditions in which preparation was not explicitly supported $(F\ (1, 48) = 5.794,\ p < 0.05)$.

7.3 Pair wise discussion points

7.3.1 Discussions on individual sounds

In terms of the discussion points that took place within the pairs as students worked on their composition together, results indicate that those using abstract representations to specify music (i.e. NV-P and VN-NP) made significantly more comments about individual sounds than those using visual-metaphors to specify music (i.e. V-P and V-NP), $(F\ (1, 48) = 6.305,\ p < 0.05)$. No significant differences were identified when comparing sound discussion points across preparation and non-preparation conditions.

7.3.2 Discussions on individual pictures

With regard to discussion points concerning individual pictures (for groups using visual metaphors to specify music)m those within the preparation condition V-P made significantly more comments about individual pictures than participants within the non-preparation conditions V-NP, $(t\ (22) = 2.732,\ p < 0.05)$.

7.3.3 Discussions on individual 'mappings'

With regard to the mapping discussion points (for groups using visual metaphors to specify music), those in the preparation condition V-P made significantly more mapping comments than those within the non-preparation condition V-NP, $(t\ (22) = 3.815,\ p < 0.01)$. The overall findings are summarized in table 2.

Outcome	Task Support	Representation
Time on Task	Those in preparation conditions spent longer on the task	Those in visual metaphor conditions spent longer on the task.
No. of objects moved	No significant differences.	Those in visual metaphor conditions moved more composition objects.
No. of bars used	No significant differences.	Those in the visual metaphor conditions used more of the musical bars.
No. of eight objects used	Those in preparation conditions used more of the eight objects	Those in visual metaphor conditions used more of the eight objects.
No of sound discussion points	No significant differences	Those in abstract representation conditions made more comments about sounds.
No. of picture discussion points	Those in the preparation condition made more picture comments.	N/A
No. of mapping discussion points	Those in the preparation conditions made more mapping comments	N/A

Table 2. A comparison of overall findings form the study

7.4 Student's perceived level of confidence with the composition task

In response to the question "who makes music" handed to participants on an A3 sheet of paper prior to their interaction with SoundScape, participants named types / groups of people who they felt made music. These types were:

- Anyone
- Composers
- Record producers
- Recording artists / pop stars
- People who can play musical instruments
- People who can read music.

The responses were analysed across all conditions. Findings indicate that at time 1, 63% of participants from V-NP stated that "anyone" could make music, V-P and NV-NP conditions made the least number of comments concerning this at 50% of participants in both conditions. A large number of comments were made overall concerning musical skills such as playing an instrument and reading music across all conditions. Participants from V-P and V-NP conditions made more comments about musical skills. Following their interaction with SoundScape, participants were asked to add any comments they felt necessary to their A3 sheet. A change in responses was noted in the participant's opinions following participant's exposure to SoundScape, with a higher number of participants from all four conditions commenting that "anyone" can make music. Other responses made after interaction also related to the question 'who makes music', with an emphasis on musical skills decreasing across all conditions. This is especially noticeable in the changes of opinion concerning skills initially perceived as prerequisites to music composition.

8. CONCLUSIONS

In answer the original question posed by this paper *"how can learning tasks be structured to encourage creative thinking in the classroom?"* This study has sought to provide a solution to this via the presentation of a generative framework. The design of educational technologies, including music composition technologies can e guided by this framework. This paper has also demonstrated the application of this framework through the design of SoundScape, a children's creative music composition environment. SoundScape was used as a vehicle to test two research hypotheses, the first focusing upon the effects of providing explicit support for the preparation phase of the creative process using music technology as opposed to not, and, secondly, focusing upon the effects of using visual metaphors to specify music as opposed to abstract representations. Findings from the study indicated that preparation is a crucial element of the creative process and that support preparation in music composition can assist to encourage creative thinking in children's music composition. Outcomes also suggest that the use of visual imagery to specify music is also a useful too for learning, especially where the imagery used is consistent with real-world artifacts.

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