SOME FEATURES OF CHILDREN'S COMPOSING IN A COMPUTER-BASED ENVIRONMENT: THE INFLUENCE OF AGE, TASK FAMILIARITY AND FORMAL INSTRUMENTAL MUSIC INSTRUCTION

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Abstract

760 children aged 8 to 12 composed 1,696 short melodies using a computer-based software application. As well as providing an appropriate composing environment, the software maintained a detail event-driven log of all user interactions. Session logs were used as the basis of a detailed behavioural analysis of children's composing processes, exploring the influence of three variables (age, task familiarity and formal instrumental music tuition) on composing processes. Results suggested that older children tended to engage in less exploratory composing behaviour in comparison to younger participants, such as listening to their emerging melodies or trying out different notes. Participants receiving formal instrumental music tuition were far less likely to use the exploratory functions of the software in comparison to their non-expert peers. Older children worked faster than younger children, and were more efficient in their use of the software functions. Increased familiarity with the software was accompanied by greater speed in interaction, regardless of instrumental expertise. Implications for music composition pedagogy and future research in musical creativity are discussed.

Keywords

music technology, composing, children, creativity, software

Introduction

This paper reports the results of an empirical study of children's composing processes while using a software application. The purpose of the study was to examine the relationship between three background variables (age, task familiarity and formal instrumental music tuition) and the choices and actions of children as they composed melodies using a software application. Two of these variables (age and formal instrumental tuition) have been found to have a significant relationship with children's composing behaviour. The third, task familarity, is of particular importance in a technological environment as we might reasonably expect behaviour to change as the user becomes more familiar with the software interface (Lim, Benbasat, & Todd, 1996).

The study differs from other published work in that it takes a very detailed look at a relatively restricted range of behaviour. The task was very specific; compose a short, single line melody. This contrasts with exploration of more open-ended musical tasks, such as improvisation (e.g. Custodero, 2007). Participants worked alone, in contrast with much recent research in the field that has tended to explore the processes of group-based, collaborative composing (MacDonald & Mitchell, 2002). Unlike much of the extant literature, the study used music technology in the form of a computer-based software application. This provided a flexible and supportive framework in which all children could engage, regardless of musical expertise or notational ability (Gall & Breeze, 2005; Nilsson & Folkestad, 2005; Upitis, 1989).

Many recent studies of children's musical creativity have fruitfully employed qualitative approaches to data collection, often focusing on how children experience the task of composition, or how the products of the creative process can or should be evaluated. In contrast, the study reported in this paper employed an objective, behavioural observation approach to data collection (Bakeman, 2000; Bakeman & Quera, 1995). This was in part inspired by earlier work by researchers such as Kratus and Brophy whose observational approach yielded important insights into the composing and improvising behaviours used by children (e.g. Brophy, 2002; Kratus, 1985). It should be emphasised that selecting this method was in recognition of its inherent potential for bringing to the surface particular aspects of the composing process, rather than an ideological rejection of other methods. All have their place, and all are useful in shedding new light on this important topic.

The study builds on the tradition of examining children's composing processes rather than the products of composing (Kratus, 1989, 1991; Upitis, 1997). Studies of this type often characterise composing sessions as involving a sequence of processes that can be placed into some form of order. Kratus, for example, reports finding a clear linear pattern in children's composing of exploration, development and repetition. In many ways, this reflects Wallas's (1926) model of creativity as involving several different stages, each of which should be 'passed through' in order for the creative product to be achieved. This tendency to conceptualise the creative process in music as being divisible into certain 'types' of thinking (reflected in participants' on-task behaviour) has been a significant movement in the music psychology literature, influenced in part by writers such as Webster (1979), Gorder (1980) and Vaughan and Myers (1971) who have developed measures of 'creative thinking' in music based on Guildford's (1967) ideas of convergent and divergent behaviour. This in turn makes the assumption that creative thinking is a distinct dimension of human thought (Torrance, 1966), rather than simply being the use of standard cognitive problem solving and decision making processes for a particular purpose that is culturally situated and therefore considered 'creative'. Few studies have taken an explicitly problem solving approach to investigating creativity in music (though see Berkley, 2004; DeLorenzo, 1989), even though this approach offers significant potential in developing our understanding (albeit at a restricted task level) of how human beings go about producing new musical structures. Indeed, O'Neill and Seddon (2003) argue explicitly that creativity in music cannot be reduced to the level of problem solving. This assumes that problem solving is based on logical processes that are not found in 'creative' acts; however, it is clear from the problem solving literature that logic often plays very little part in human problem solving processes, and that creative acts can legitimately be conceptualised as examples of problem solving behaviours (Brinkman, 1999; McAdams, 2004; Plummeridge, 1980).

For the purposes of the present study, three independent variables were selected and their relationship with how children completed the composing task explored. These were age, formal instrumental tuition, and task familiarity. Many studies have attempted to investigate not only the processes or stages that characterise children's musical composition, but also the relationship between these characteristics and other independent factors such as participant age, musical expertise and so on. This assumes that factors independent of the creative process itself have some role to play in shaping how people compose. There is significant variation among researchers on the extent to which generalisable patterns of influence can be identified as impacting on composing behaviours. Kratus (1989), for example, found significant differences in the way children at different ages set about completing his creative music task, with younger children being less likely to demonstrate exploratory, developmental and repetitive approaches to composing. Younker (2000), on the other hand, investigated the relationship between participant age and composing strategies and found that there were greater within-group differences than between-group differences, suggesting that variation between her participants might be due to factors other than their age. These findings are broadly supported by Barrett (1996) and Davies (1991).

The role of musical expertise in shaping how participants go about musical problem solving has also been explored in previous research. Seddon and O'Neill (2001, 2006), for example, have suggested that participants receiving formal instrumental instruction will tend to exhibit different behavioural patterns during a composing task than participants who are not, with instrumentalists being less likely to spend time in the ‘exploratory’ phase of composing. This is supported by results from a study by Folkestad et al. (1998), although these authors argued that it is performing experience rather than musical training per se that influences composing strategies. Finally, expertise in composition has also been used as a grouping variable. Hewitt (2002), for example, reported significant differences between non-expert and expert composers in the way they approached a group composition task. Other researchers have reported similar forms of difference between these groups (Colley, Banton, Down, & Pither, 1992). While these findings are important, the influence of task familiarity, as distinct from compositional or musical expertise, has received less attention in the literature. In terms of computer-based composition, increased familiarity with the composing environment can have a significant effect on how the individual engages in the creative process (e.g. Webster, 1989). Research in children’s engagement with computers has suggested that significant differences between how boys and girls perform on problem-solving tasks may be due to differences in the levels of experience each group has with using software (Joiner, Messer, Littleton, & Light, 1996; Light, Littleton, Bale, Joiner, & Messer, 2000).

On the basis of these independent variables having been identified in the literature as having some impact on how children compose, three questions were posed as the basis for the empirical work reported in this paper. First, in the context of a restricted, computer-based melody-writing task, what was the relationship between participant age and the creative process? Second, what impact did formal instrumental tuition have on the creative process? Third, what was the relationship between task familiarity and the creative process?

Methodology

Resources

Many published studies of musical creativity in software environments have relied on observations of participant engagement or post-session video analysis, often supplemented with follow-up interviews or discussion (Hickey, 1995; Mellor, 2000). For the present study it was determined that a computer-based task would better facilitate the accurate logging of participant engagement, with the advantages that (a) the process would be automatic, (b) the log would be accurately time-stamped and comprehensive in terms of capturing all the available functions within the software, and (c) the log would be in an electronic format, suitable for subsequent analysis in an appropriate package or packages. A software application was developed for use in this study, to be used both as a composing environment and as a means of data collection. Figure 1 provides a screenshot of the workspace used by the children in this study.

(Insert Figure 1 about here)

Within the application a range of functions was available to assist the children in their task; a full list of these functions is presented in Figure 2. The third column in the table indicates the code by which each function was labeled for analysis and is referred to subsequently in this paper.

(Insert Figure 2 about here)

As each child composed, the software application maintained a frequency count for each function identified above. In addition, total composing session duration (in seconds) was recorded along with a variety of other variables. Children were asked to self-report on their age, gender, and whether they received specialist instrumental lessons in and out of school.

Participants

A set of 1,696 melody-writing sessions were completed by children in seven Scottish primary schools Data were collected from 760 participants in the upper three stages of primary school; from P5 (aged 7-8 years, n = 251), P6 (aged 9-10 years, n = 311) and P7 (aged 11-12 years, n = 198). The sample was evenly balanced for gender, and 32% (n = 246) indicated that they currently received formal instrumental music tuition on at least one instrument.

Data collection took place during a series of twenty minute composing periods with groups of around twenty five participants. The composing period followed a ten minute introduction to the software application by the researcher. Children were instructed to 'write one or more melodies that sound good to you'. Within the composing period, participants engaged in one or more melody-writing sessions. Each session produced one completed melody. Composing sessions lasting less than one minute were discarded from the dataset, as were sessions where the participant initiated fewer than ten software events.

Results

Children's interaction with the software application, quantified through their use of the various software functions, was mapped against three dimensions (strategic diversity, rate of activity and function use). The framework was not exhaustive but rather concentrated on three aspects of the compositional process that were believed to be informative and important in the context of previous research. In the analysis, three independent variables were used to explore differences in these dimensions (Figure 3).

Dimension One: The strategic diversity of children's composing processes

As previously described, the computer application provided children with a range of functions they could use as they composed. However, there were relatively few functions that the children were forced to use. 'Strategic diversity' quantified the extent to which the full range of functions within the software application was used by participants.

To calculate the strategic diversity of a composing session the range of available functions within the software was divided into 'core' and 'extension' functions. The core functions were those that the user were obliged to use in order to compose their melody (NOTE, REST, DURATION, ADDNOTE) and one other frequently-used function, PLAYTUNE. Functions classified as extension functions were; TRYSINGLENOTE; STARTAGAIN; DELETENOTE; REJECTNOTE and HEARNOTE. Two of these extension functions were included in the software application to allow children to test and evaluate ideas before committing, an important advantage of a computer-based composing workspace for children.

The score for strategic diversity was therefore based on the total relative frequency of the extension functions (i.e. the proportion of the total functions initiated by the participant that were classified in this way). This variable ranged from 0 to 1.0. The higher the participant's score, the more often they had used extension functions, and therefore demonstrated greater strategic diversity than a participant with a lower score.

Strategic diversity scores had an overall mean of .13 (SD= .11) indicating that, on average, 13% of the functions used by children while composing were outwith the core functions of the software. Measures of central tendency for the 24 experimental groups are shown in Figure 4. Overall, strategic diversity scores decreased as participants became more familiar with the software, from M = .175 in the first melody to M = .07 in the fourth.

(Insert Figure 4 about here)

Strategic diversity scores were subjected to an Age (3) x Instrumentalist Status (2) x Melody Number (4) analysis of variance to test differences between means for significance. The main effect of instrumentalist status yielded an F ratio of

$F(1, 1672) = 7.03$, $p < .01$, indicating that the mean strategic diversity score was significantly lower for children receiving instrumental lessons than for those not receiving lessons. The main effect of age yielded an F ratio of $F(1, 1672) = 4.47$, $p < .05$, indicating that the mean strategic diversity score was significantly lower as age increased. As Levene's Test of Equality of Error Variances indicated non-homogeneity in the data, the Games-Howell test was used as the basis of post-hoc testing of between-group differences. This revealed significant differences between the 7-8 year olds and the 11-12 year olds ($p <.01$), but no significant difference between these groups and the 9-10 year olds. The main effect of melody number yielded an F ratio of $F(1, 1672) = 89.63$, $p < .001$, indicating that strategic diversity scores were significantly lower as melody number increased. Post-hoc testing indicated there were significant differences in strategic diversity scores between all melody numbers except between three and four. There were no significant interaction effects between the independent variables.

Dimension Two: Children's rate of activity of engagement with the software

The second dimension was concerned with the time children spent composing and the resulting melodic output. This dimension allows exploration of the relationship between time 'on task' and the duration and content of the outcome. Three calculations were used to explore different aspects of this dimension.

Overall Event Rate

Overall Event Rate quantified the number of events (actions within the software environment) that occurred during the composing session and how this compared with other sessions of a similar length. By taking the total number of functions initiated during the session and dividing this by the total session duration (in seconds), it was possible to evaluate whether (for example) a particular session had a large number of functions or a lesser number of functions compared to other sessions.

Overall Event Rate had an overall mean of .25 (SD = .10). It increased with melody number, from M = .22 in melody one to M = .30 in melody four, indicating that participants initiated more events relative to the total time spent composing as they became more confident and familiar with the software. Measures of central tendency for the 24 experimental groups are shown in Figure 5.

(Insert Figure 5 about here)

These scores were subjected to an Age (3) x Instrumentalist Status (2) x Melody Number (4) analysis of variance to test differences between means for significance. The main effect of instrumentalist status yielded an F ratio of $F(1, 1672) = 19.01$, $p < .001$, indicating that the relative number of events per composing session was significantly lower for children receiving instrumental lessons than for those not receiving lessons. The main effect of age yielded an F ratio of $F(1, 1672) = 63.80$, $p < .001$, indicating that the relative number of events per composing session was significantly lower as age increased. Post-hoc testing (Games Howell) revealed significant differences between all three age groups ($p < .001$). The main effect of melody number yielded an F ratio of $F(1, 1672) = 52.49$, $p < .001$, indicating that overall event rate was significantly lower as melody number increased. Post-hoc testing indicated there were significant differences in the relative number of events per composing session between melody one and the remainder ($p < .001$), but no significant differences among the remaining melodies. A significant interaction effect was identified between instrumentalist status and age, yielding an F ratio of $F(1, 1672) = 3.26$, $p < .05$. There were no significant interaction effects between the remaining independent variables.

Event to Melody Duration

Event to Melody Duration (M= .07, SD=.06) scored the number of events that had been initiated within the software relative to the overall duration of the resulting melody. This was calculated by dividing melody length in beats by session duration in seconds. A higher score would indicate a longer melody for the same session duration.

Measures of central tendency for the 24 experimental groups are shown in Figure 6.

(Insert Figure 6 about here)

Event to Melody Duration scores were subjected to an Age (3) x Instrumentalist Status (2) x Melody Number (4) analysis of variance to test differences between means for significance. There was no significant effect found for instrumentalist status or for age. The main effect of melody number yielded an F ratio of $F(1, 1672) = 69.88$, $p < .001$, indicating that ETM was significantly higher as melody number increased. Post-hoc testing (Games Howell) indicated there were significant differences in EM between melody one and the remainder ($p < .001$), between melody two and the remainder ($p < .005$), but no significant difference between melodies three and four. There were no significant interaction effects between the independent variables. Although no overall effect was found for age, the difference for ETM between the 9-10 and the 11-12 age groups was significant ($p <.05$).

Event to Result

The Event to Result measure (M= .31, SD=.21) quantified the melodic output of each composing session relative to the number of events that had been initiated to create that output. The ETR was calculated by dividing the total duration of the melody (in beats) by the total number of functions initiated.

Measures of central tendency for the 24 experimental groups are shown in Figure 7.

(Insert Figure 7 about here)

These scores were subjected to an Age (3) x Instrumentalist Status (2) x Melody number (4) analysis of variance to test differences between means for significance. Significant effects were found for all three independent variables. The main effect of age yielded an F ratio of $F(2, 1672) = 31.5$, $p < .0001$, indicating that event to result scores were significantly lower as age increased. Post-hoc tests (Games Howell) identified significant differences between each of the three age levels ($p < .001$). The main effect of instrumentalist status yielded an F ratio of $F(1, 1672) = 5.8$, $p < .01$, indicating that event to result scores were significantly lower if the child was receiving formal instrumental music tuition.

Finally, the main effect of melody number yielded an F ratio of $F(3, 1672) = 30.6$, $p < .0001$, indicating that event to result scores were significantly higher as melody number increased. Post-hoc tests identified significant differences between all levels of melody number ($p < .01$), with the exception of melodies three and four where the difference was not statistically significant. A significant interaction effect was observed between age and instrumentalist status, yielding an F ration of $F(2, 1672) = 3.01$, $p < .05$). No other significant interaction effects between the independent variables were identified.

Dimension Three: Children's use of the various software functions as they composed

This dimension was intended to quantify the kinds of functions children used as they composed within the software environment. Three calculations were used for analysis.

Use of 'Discrete Functions'

First, the relative frequencies of each of the discrete software functions were calculated for the sample as a whole, by taking the total number of occurrences of each function and dividing by the total number of functions for that composing session. This quantified seven separate elements, each representing the frequency of one available function within the software environment (Figure 8)

(Insert Figure 8 about here)

No significant differences were identified when the frequency of discrete functions was analysed. To explore trends in frequency of use, a visual inspection of the data relating to the frequency with which specific functions in the software were used was undertaken.

(Insert Figure 9 about here)

As can be observed in Figure 9, function frequency was quite stable and did not appear to be related to user age or instrumentalist status. It is interesting to note the decrease in the use of the 'hear note' function as user age increased, suggesting that older children relied less on this function than the younger participants.

In terms of instrumentalist status there was no obvious difference in how participants who did and did not receive formal instrumental tuition utilised functions in the software that allowed them to hear individual notes, or entire melodies.

(Insert Figure 10 about here)

Figure 10 indicates the frequency of function use according to melody number. Again, it was evident that the use of the 'hear note' function decreased as participants became more experienced at completing the task. Frequencies of the other functions remained fairly constant.

Use of 'Process Functions'

This subscale measured the relative frequency of what were termed 'process' functions, as compared with the total number of functions initiated during a composing session. Functions in this category were; HEARNOTE, TRYSINGLENOTE, PLAYTUNE, REJECTNOTE, DELETETUNE, DELETENOTE and ADDNOTE. Process functions were therefore actions within the software that allowed children to 'build' their melody; they were decision-making events.

The Process Function score (M = .41, SD = .10) for each composing session indicated the proportion of the session that comprised these types of functions. A score of 0.5 would indicate that 50% of the child's interaction with the software had been process-based, as opposed to playing notes on the keyboard, selecting durations and rests, and other types of functions that did not actively move the composition forward.

Measures of central tendency for the 24 experimental groups are shown in Figure 11.

(Insert Figure 11 about here)

Process Function scores were subjected to an Age (3) x Instrumentalist Status (2) x Melody number (4) analysis of variance to test differences between means for significance. Significant effects were found for all three independent variables. The main effect of age yielded an F ratio of $F(2, 1672) = 3.2$, $p < .05$, indicating that the use of process functions decreased significantly as age increased (M = .42 for the 7-8 year olds and for the 9-10 year olds, M = .40 for the 11-12 year olds). Post-hoc tests (Games Howell) confirmed that there was no difference between the 7-8 year olds and the 9-10 year, but that the difference between these groups and the 11-12 year olds were significant. The main effect of instrumentalist status yielded an F ratio of $F(1, 1672) = 6.74$, $p < .01$, indicating that the use of process functions was significantly lower if the participant was receiving instrumental lessons (M = .40 compared with M = .42 for non-instrumentalists).

Finally, the main effect of melody number yielded an F ratio of $F(3, 1672) = 25.69$, $p < .0001$, indicating that the use of process functions decreased significantly as melody number increased. Post-hoc tests identified that the use of process functions in composing the first melody was significantly different from the remaining melodies. However, the difference between melodies two, three and four were not significant. No significant interaction effects were identified between the three independent variables.

Use of 'Evaluative Functions'

As the name suggests, the Evaluative Function score measured the extent to which the participant had used evaluative functions rather than decision-making functions. The aim was to further divided process-based functions into two separate categories, the balance between which would be of interest to researchers. Evaluative functions were considered to have occurred when the child used any of three functions within the software environment that allowed then to test or evaluate a solution to the melody-writing task. Three functions (HEARNOTE, TRYSINGLENOTE and PLAYTUNE) were coded in this way, with the remainder of the process functions being classified as decision-making.

The UEF score (M = .39, SD = .21) for each session reflected the proportion of process events that comprised evaluative, as opposed to decision making, types of functions. An score of 0.5 would indicate that 50% of process functions contained HEARNOTE, TRYSINGLENOTE and PLAYTUNE events. Thus, it was possible to evaluate both the frequency of evaluative and of decision-making type events using this calculation. Measures of central tendency for the 24 experimental groups are shown in Figure 12.

(Insert Figure 12 about here)

Evaluative Function scores were subjected to an Age (3) x Instrumentalist Status (2) x Melody number (4) analysis of variance to test differences between means for significance. Significant effects were found for the three independent variables. The main effect of age yielded an F ratio of $F(2, 1669) = 4.52$, $p < .01$, indicating that the use of evaluative functions decreased significantly as age increased. Post-hoc tests (Games Howell) confirmed significant differences between the 7-8 year olds and the other groups. The difference between the 9-10 and the 11-12 year olds was not significant. The main effect of instrumentalist status yielded an F ratio of $F (1, 1669) = 5.26$, $p < .05$, indicating that the use of evaluative functions was significantly lower if the participant was receiving formal instrumental tuition ($M = .16$ compared with $M = .18$ for the non instrumentalists).

Finally, the main effect of melody number yielded an F ratio of $F (3, 1669) = 79.1$, $p < .0001$, indicating that the use of evaluative functions decreased significantly as melody number increased. Post-hoc tests identified significant differences in most cases, with the exception of between melodies three and four. A significant interaction effect ($F(6, 1669) = 2.37$, $p < .05$) was found for age x instrumentalist status x melody number.

Discussion

The focus of this study was on the role of three factors previously identified in the literature as being significant in explaining observed differences in how children compose and how they interact with software environments; age, formal instrumental tuition and task familiarity.

In terms of compositional approaches and methods, older children tended to engage in less exploratory composing behaviour in comparison to younger participants, such as listening to their emerging melodies or trying out different notes. Similarly, children who received instrumental tuition were far less likely to use the exploratory functions of the software in comparison to their non-expert peers. For all groups, the range of actions used in the composing process grew more restricted as they became familiar with the software application.

Analysis of the rate at which children composed suggested that older children tended to initiate more functions within the same space of time, compared with younger children. Children receiving instrumental lessons tended to exhibit higher rates of activity when compared with non-expert participants. As participants became more experienced in using the software they tended to engage in more rapid engagement with it, suggesting an increased technological competence independent of age or musical expertise.

The amount of time children spent composing relative to melodic length of their compositions was fairly consistent. As participants became more expert in using the software they tended to compose longer melodies. Older participants tended to use fewer functions to create melodies of equivalent length, compared with younger children. Instrumental tuition was a factor in the behavioural activity of some age groups, but this finding did not apply to all age groups.

The framework distinguished between ‘process’ and ‘choice’ operations, and there was a consistency decrease in the use of process functions as age increased, irrespective of instrumental expertise. Familiarity with the software application did not appear to have any significant relationship with the use of process and choice functions. The data suggested that children tended to use fewer evaluative functions in comparison to their use of decision-making functions. When this trend was broken down by instrumentalist status, however, some increase in the use of evaluative functions was identified for the small number of 12 year olds in the sample. Use of evaluative functions decreased as children became more familiar with the software. Their behaviour was concentrated more consistently on decision-making rather than evaluating.

The empirical work reported here employed a behaviour observational approach, designed to quantify how children composed a short melody using a software application. The method was based on an assumption that physical behaviour, in this case initiating actions within the software, reflects underlying cognitive processes. The benefit of the method is that it allowed for a precise quantification of action. Behavioural observation methods do not however provide any direct information about the composing process. They simply reflect physical actions. It is impossible to evaluate, for example, the degree of consideration given to a particular action; did the child think about clicking a particular button, or did they just 'do it'? These methods are purely quantitative, and seek to generalise findings across the sample population. There is little room for consideration of the individual, or their experience of composing music.

As such, observational approaches leave little room for consideration of the experience of composing from the perspective of the individual. Composing is reduced to a set of mechanistic actions. Other researchers have attempted to give more attention to 'individuality' of composing (e.g. Burnard, 2004), though in doing so the actual process of composition (i.e. how children proceed at the macro level through a composing task) has perhaps been less intensively explored. I would suggest that future research needs to combine these approaches if our understanding of children's composing is to be extended.

The design of the study, and the analytical framework used post data collection, exhibit several limitations. Perhaps most importantly, given that age-related differences were suspected to be important in how children engage in musical composition, the study was not longitudinal in design. Therefore, those age-related differences that were identified should be treated with some caution, and subjected to further empirical study. Concerning the analytical framework, it was intended to measure features of children's compositional process that were believed to be most important. However, many other aspects of their composing could have been included in the framework. Again, future analysis and development could provide a broader and more sophisticated methodology for identifying patterns and differences in the data (for example, in the area of probability).

For music educators, research findings in the area of composition should have a practical application. However, given the variety of approaches that researchers have used to investigate the topic, it is somewhat difficult to identify or quantify what impact the findings of separate studies can or should have on the structure and delivery of classroom activities. The present study has confirmed one compelling finding from previous work, namely that children proceed through the creative process in quite different ways, even where the task is consistent. They appear to develop their own intuitive methods for completing creative tasks, and these may be influenced by a wide range of factors external to the creative process itself. From the perspective of developing the kinds of skills necessary for effective composition, the freedom to explore outwith set patterns of behaviour allows the child the opportunity to develop skills and abilities in creative work. Computer-based approaches to composition are, of course, especially powerful in that they allow children freedom from conventional apparatus of composing, such as notation, keyboard skills and so on. The computer can provide audio feedback for the child at the click of the mouse, and this has been previously identified as one of the compelling reasons for increasing the amount of ICT within music classrooms. However, it was observed in the present study that children tended to use these evaluative functions infrequently in their composing. Perhaps greater teacher-led encouragement to use such functionality would improve the quality of the experience and the outcome.

I would suggest that studies of this kind, which place all the emphasis on the process of composition and not on the quality of the outcomes of that process, remind classroom music teachers that learning is an exploratory process. In a climate that is predominantly concerned with assessment, it is too easy to get caught up in 'finishing' the work and checking that it meets certain standards, rather than focusing on providing children with the chance to play, explore and experiment with sound, thereby developing the evaluative, perceptive and manipulative skills necessary to truly intentionally create with sound. On the other hand, teaching methods that focus on being ‘creative’ without taking account of whether the outcome is of value may be equally meaningless. A balance should be sought between the creativity that is embedded within the teaching process and the creativity that is exemplified in the outcomes/ products of that process.

Empirical investigation of creativity in music, especially relating to composing or improvising, is a hugely problematic area. Researchers face problems of definition, task development, process and outcome evaluation, and the relationship between internal cognitive activity and external behaviour during the composing process. There is a clear link between the creative process and the creative product, but to what extent should researchers be concerned with that relationship? Does a low-quality outcome (however defined, another problematic area!) mean that the process itself has been flawed, or is less worthy of investigation? Certain types of music, for example aleatoric and improvised music, do not reflect the kinds of careful, considered and deliberate compositional behaviours most commonly associated with composition, yet are held by many to be equally ‘creative’. In the study reported here, there was no attempt to relate process with product. This was a deliberate strategy, but future research might seek to explore this relationship further.

Any research in a field as wide and undefined as musical creativity is bound to be rather unsatisfactory. Where we look for patterns, we find that composers work individually and idiomatically, and often inconsistently even between projects. We still struggle to gather data on the underlying cognitive processes involved in creativity and, even if we could access these, it is questionable what usefulness they would be. Using a range of methods, as has been the case in the field to date, is advantageous in that many different facets of children’s composing have been explored. A lack of consistent tasks, cohorts and methodologies does, however, make generalisation and theorisation difficult. Behavioural research, which attempts through direct observation and quantification of behaviour, is useful in detecting how individuals engage in composing, but does not tell us why or what they are thinking. Explorations of the impact of age or expertise differences are useful in exploring how children's composing processes may change as a result of other factors, but we lack a theoretical framework to explain the findings of this study, or any other, that identifies age or stage related differences in compositional processes.

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