To Know the Way to the Unknown: A Semi-Experimental Study on the Implication of Skills and Knowledge for Creative Processes *in Higher Education*

Mikkel Snorre Wilms Boysen

Abstract—From a theoretical perspective, expertise is generally considered a precondition for creativity. The assumption is that an individual needs to master the common and accepted rules and techniques within a certain knowledge-domain in order to create something new and valuable. However, real life cases, and a limited amount of empirical studies, demonstrate that this assumption may be overly simple. In this article, this question is explored through a number of semi-experimental case studies conducted within the fields of music, technology, and youth culture. The studies indicate that, in various ways, expertise plays an important part in creative processes. However, the case studies also indicate that expertise sometimes leads to an entrenched perspective, in the sense that knowledge and experience may work as a path into the well-known rather than into the unknown. In this article, these issues are explored with reference to different theoretical approaches to creativity and learning, including actor-network theory, the theory of blind variation and selective retention, and Csikszentmihalyi's system model. Finally, some educational aspects and implications of this are discussed.

Keywords—Creativity, education, expertise, technology

I. INTRODUCTION

IN the majority of creativity theory, expertise and practice is considered essential for creative expression [1]-[3]. Empirical implications supporting this assumption are substantial and can, for example, be found in Howard Gardner's biographical study of recognized creative individuals, such as Freud, Einstein, Picasso, Stravinsky, etc. [4]. Furthermore, it is a predominant notion that the individual must practice for at least ten years before being able to produce anything truly original and valuable [5]. For instance, Gardner and Policastro argue that even Mozart, "who was a child prodigy from an early age, had been composing for at least a decade before he could regularly produce works that are considered worthy of inclusion in the repertoire" [6]. A similar conclusion is found in Robert W. Weisberg's biographical study of Mozart, Paul McCartney, and other remarkable artists and scientists [7]. Researchers and theorists preoccupied by creativity from an everyday perspective (little-c creativity) adopt a similar approach to expertise. This is not in the sense that the individual requires ten years of practice,

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but in the sense that creativity relies heavily on expertise. Researchers like Amabile [8] and Craft [9] represent such a perspective.

> *[T]he domain provides a knowledge context within which to be creative. This means that teachers need to be sufficiently knowledgeable of the subject domain to bring learners to the edge of their knowledge, and to enable pupil creativity within the domain.* [10]

Further, pedagogical literature, preoccupied by questions of aesthetics and creativity, present the same basic understanding of the crucial role of expertise [11]-[13]. For instance Malcolm Ross points out that:

> *[The children] need the craftsmanship that will enable them to manipulate media and associated technology with ease and precision; without such skills they must feel themselves inhibited rather than liberated by media. Lacking effective control, they will never be carefree enough to play with media imaginatively or to improvise; both these activities are achieved only after the groundwork has been properly done.* [14]

II. THE GENERAL VIEWPOINT CHALLENGED

The outlined viewpoint, concerning the relationship between expertise and creativity, is challenged in a number of ways. According to several findings, discussed below, expertise might also inhibit creativity.

> *Concerning knowledge, on the one hand, one needs to know enough about a field to move it forward [...]. On the other hand, knowledge about a field can result in a closed and entrenched perspective, confining a person to the way in which he or she has seen problems in the past.* [15]

Several studies imply that expertise sometimes inhibits creativity and flexible thinking. In a statistical investigation conducted by Simonton, the correlation between creativity and formal education was examined [16]. Simonton concluded that people, regarded as creative within a specific domain, are neither highly educated nor uneducated, but rather somewhere in between. Further, French and Sternberg examined relationships between expertise and flexibility and concluded that expertise might, in a certain context, inhibit flexible thinking [17]. Naturally, both of these investigations can be criticized in a number of ways. Simonton might be confusing cause and effect, and the suggestion that flexible thinking

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indicates creative thinking might be questioned. Still, such investigations imply that the relationship between expertise and creativity is not simple or straightforward.

The relation between expertise and creativity seems even more unpredictable when it comes to the fields of music and aesthetics in general. A number of studies have been conducted to examine children's long-term development in terms of creative competence within a variety of aesthetic domains. According to these studies, the early years are characterized by play and freedom, whereas the school years are characterized by conformity [18]-[21]. Gardner suggests that this may be related to the fact that the child gradually becomes more aware of the codes that belong to different domains of knowledge [22]. From this perspective, the adoption of knowledge and skills will inhibit creativity during a certain period of time until the knowledge and skills are learned (or internalized). Subsequently, the child will be able to perform creatively through the use of the domain-specific signs, rules, and forms.

Within the field of digital technology, the main suggested relationship between creativity and expertise seems equally challenged. First of all, the notion that technology might obviate the need for basic skills seems widespread [23]-[26]. Even though such a notion might rely partly on utopian notions [27], there are several studies that indicate that lack of basic skills might not be significant in a creative process incorporating the use of digital technology [28]-[30]. Likewise, a number of studies specifically engaged with music and technology support this suggestion [31]-[37]. Some of them indicate that inexperience might sometimes lead to explorative behavior, whereas expertise might rather lead to less experimentation or even conventional thinking. This point of view is also represented within the fields of music and pedagogics in general [38].

From a theoretical perspective, the relation between expertise and creativity also seem ambiguous. In the majority of creativity models, expertise is explicitly considered a precondition for creativity, e.g. in Amabile's componential model and in Csikszentmihalyi's system-model. However, creativity models might also point in other directions. First, experimentation and explorative behavior are given a key role in many models of creative processes [39]-[42]. Needless to say, it is of course perfectly possible to be explorative as an expert. However, some studies indicate that explorative behavior is more common among novices [43]-[46]. Second, according to the theory of combinatorial creativity, the association (or "bisociation" according to Arthur Koestler) of very different domains/ideas are crucial in a creative process [47]-[49]. In this respect, some studies indicate that the combination of very different domains is more common among novices [50]. Third, according to the theory of blind-variation and selective-retention, creativity relies on some degree of blindness. In this respect, it might be suggested that novices, rather than experts, are more likely to engage in relatively blind processes given the limited amount of knowledge that they possess [51], [52].

III. THE QUESTION ADDRESSED

According to the above, there seems to exist a number of unanswered questions regarding the role of expertise in creative processes that needs further examination. In particular, the dominating viewpoint represented by Csikszentmihalyi and others, appears to be insufficient in order to describe relations between expertise and creativity on a general level.

In this study, presented below, the aim was explicitly to challenge and explore the dominating viewpoint. Therefore, the study was based on fields and domains within which the level of ambiguity seems relatively high. In other words, instead of focusing on the grand old masters and traditions within mathematics or classical music [53], [54], the focus was contemporary music, technology, and youth. Thus, the choice of focus was caused by three hypotheses based partly on empirical evidence and partly on theoretical assumptions, as outlined in the above.

- Music was chosen because it represents a knowledge domain within which rules are constantly bent and negotiated, at least within a number of contemporary musical genres.
- Digital technology was included because it might promote another type of creative process within which the role of expertise is negotiated.
- Youth culture was addressed because this field seems more flexible, changeable, and unstable than adult culture.

It is not assumed these hypotheses are correct in any definitive way. Rather, the hypotheses provided the strategic argument for choosing this specific substantive area. Therefore, as mentioned, the field was specifically chosen in order to explore and challenge general notions about the connection between expertise and creativity. Accordingly, the result of this investigation may not necessarily be relevant to other fields, at least not in simple terms. To summarize, the main question in the study was: *What is the relationship between expertise and creativity within the context of music, technology, and youth culture?*

IV. THE METHODOLOGICAL APPROACH

The relationship between expertise and creativity was explored through a number of semi-experimental case studies within which musical novices, those already experienced and experts composed music via computers. In these case studies, the relation between creativity and expertise was investigated in a deductive, as well as in an inductive manner. On the one hand, the ambition was to isolate expertise as a somewhat independent variable and test different hypotheses. On the other hand, the ambition was to study the field exploratively. Thus, the methodological approach was essentially mixed and included strategies derived from grounded theory, actor-network theory, design-based research, and experimental methodology.

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TABLE I
A MIXED APPROACH

Research approaches inspired by experimental methodology	Research approaches inspired by qualitative and explorative methodologies (grounded theory, design-based research, actor-network theory)
A number of hypotheses were constructed and tested systematically	An explorative approach to the produced data was applied
A number of hypotheses were constructed and tested systematically	An explorative approach to the produced data was applied
Participants were given specific tasks	The specific tasks were supplemented by processes primarily triggered by the participant's idiosyncratic motivations and visions
The attempt was to isolate 'expertise' as a specific factor	The attempt to isolate 'expertise' as a determinant factor was combined with an open qualitative approach to the participants and their competencies

The case studies consisted of a number of music-technology courses, within which the participants received some basic instructions, and in turn composed music with the use of a computer and musical instruments. Musical novices and experts were recruited and separated into groups according to their level of experience. The music course was conducted in different variations, in different institutions, and with different groups of young people.

The study was divided into three general phases in order to develop, explore, and test hypotheses around expertise and creativity, and yet produce empirical material that was comparable from an experimental point of view. The first phase involved the initial explorative case studies. These studies included 23 students from University College Zealand (UCSJ) between ages 20-25. The second phase included a number of semi-experimental and non-experimental case studies meant for the exploration and development of hypotheses, didactical designs, and data collection methods. These studies included 23 students from the UCSJ (between ages 20-25), the Little School of Holbæk (9th grade), and the School of Tuse (5th grade). The third phase included a number of semi-experimental case studies carried out with a relatively fixed procedure intended for comparison. These studies included 15 participants between ages 19-25 recruited from UCSJ, the School of Rhythmic Music in Vig, and the Royal Academy of Music. The first two phases of the study were mainly flexible and explorative, whereas the last phase of the study was more fixed and deductive (see list of participants in the last phase in Appendix A). All the listed institutions are located in Denmark.

The development of the hypothesis was based on the entire volume of case studies. However, the last and relatively fixed phase constituted the main focus for systematical analysis and is the primary focus of this article.

V. THE MUSIC COURSE

The music course in the third phase consisted of six sessions. In the first five sessions, the participants were given rather closed tasks, and in the final session, the task was rather open ended. In the first five sessions, the participants generally worked in pairs. Each session took approximately one hour. In the last session, the participants worked alone for approximately ten hours.

GarageBand was chosen as the main software. In the first phase of the case studies, other types of software were tested, including Logic and Cubase. However, GarageBand was preferable because it contained different platforms and features that could be used by novices as well as experts. Thus, even though specific technology was chosen, there was still room for the participants' idiosyncratic approach. Most importantly, GarageBand includes loops as well as MIDI. Loops allow the composer to build up music by the use of pre-recorded audio. Thus, novices are able to make music without comprehensive instructions. MIDI, on the other hand, allows the composer to play and design melodies, harmony, and rhythm. Thus, the experts were able to use their musical experience explicitly in the process of composition. The software was supplied by a MIDI keyboard and a microphone. Accordingly, the composer was also able to record different kinds of musical instruments and voices.

VI. DATA COLLECTION

The data collection methods were triangulated in the sense that different approaches were applied. In the first and second phase of the case studies, different data collection methods were tested. The point was to explore which type of data collection produced the most appropriate and subtle empirical material with respect to the key research question. In general, this attempt resulted in an ongoing expansion of data collection methods. Thus, in the final phase of the study, the data was collected through observation, video-observation, screen-recording, interview, GarageBand files, and the musical compositions.

In order to address creativity from a sociological perspective, the study included evaluations conducted by various groups of people. The members of the evaluation groups were recruited according to the following criteria. Firstly, the compositions were evaluated by groups of people similar to the recruited composers in terms of age and location. The assumption is that music may communicate and implement specific codes of meaning that may be understood more directly or completely by members of a specific community [53]-[55]. Secondly, the compositions were evaluated by musical novices as well as experts. Thus, the implications of musical knowledge on creativity were not only investigated through the design of the case studies, but equally through the design of the evaluation. The evaluation was blind in order to avoid the influence of extra-musical issues.

The evaluation was conducted in two steps. Firstly, the evaluation group filled out a questionnaire individually. Secondly, a group discussion was facilitated. The point was to address individual, as well as social constructions, of aesthetic preferences, taste, etc. Furthermore, this procedure enabled a balance between an explorative inductive approach and a deductive approach [56]. The questionnaire was divided into two main sections. In the first section, the point was to generate qualitative data and in the second section the point

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was to generate quantitative data. The evaluation groups included students between ages 19-27 from UCSJ. The students were divided into five evaluation groups that consisted of musical experts, experienced musicians, and novices.

The case studies outlined above were supplemented by interviews with a number of professional musicians, producers, and artists. The professionals were Cæcilie Trier, Sandra Boss, Nicklas Schmidt, Louise Nipper, Jacob Lind-Lauritsen, and Jan Eliasson.

VII. THE STUDY COMPARED TO SIMILAR STUDIES

A number of studies have been conducted in order to investigate questions of creativity, musical technology, and implications of expertise [57]-[61]. Below, two of the most important and relevant studies are presented.

The present study was partly inspired by an investigation of computer based music-making and young people within an institutional context, conducted by Göran Folkestad [62]. Folkestad monitored 14 young people between 13 and 16 years of age over a period of two years. The young people composed music without any specific restrictions or assignments, primarily using the computer. The study included participants both with and without instrumental musical training. It was first and foremost explorative and the discussion of musical competence only played a minor role. Nevertheless, the study indicated no general significant difference between the music of the novices and those experienced [63]. Furthermore, the study implied that people without piano skills were more likely to explore the possibilities provided by the computer equipment [64].

Opposed to Folkestad's longitudinal study, Frederik Seddon and Susan O'Neill conducted a short-term study among 48 young people ages 13 and 14 [65]. Among the participants, 25 had between two and four years' of prior experience of formal music tuition. The rest had no prior experience of instrumental music training. The participants were invited to engage with a computer-based composition task after two 30-minute training sessions. The participants were given three sessions to finish their composition. The study indicates that those musically experienced were less likely to engage in explorative activity compared to the novices [66].

The two studies exemplify pros and cons with respect to different research approaches. Folkestad's qualitative study offers detailed information on the processes of composition. Thus, the long-term period allowed the researcher to study many aspects of creative work. However, the comprehensive amount of empirical material produced over two years promotes an analysis on a macro scale, rather than a micro scale. Further, the limited number of participants might weaken the generalizability of the study. On the other hand, Seddon and O'Neill's short-term study offers information that might also be used on a more quantitative scale, considering the number of people participating. In turn, the limited time for composition might disrupt the attempt to understand creativity as it unfolds in a naturalistic setting. In other words, the external validity may be questioned [67].

The present study differed from the studies described above in a number of ways: (1) The focus is 'creativity' which eventually means that questions of value cannot be ignored (as shown in Section VIII). In the studies referred to above, the compositions' value was not addressed systematically and the evaluation of the musical outcomes was mostly done by the researchers themselves (even though it should be mentioned that Folkestad used two judges in order to triangulate the analysis). In the present study, evaluation groups were used in order to simulate social constructions of creativity. (2) Young people with many years of instrumental music training were recruited. Thus, it is very likely that differences between novices and experts appear more explicit in this study compared to Folkestad's and Seddon and O'Neill's. Further, the notion about the 'ten year rule', presented earlier in this article, is explicitly addressed. (3) In the study, the ambition was to find a balance between in-depth analysis and questions of generalizability. This was done through the different phases, outlined in the above, which included qualitative as well as quantitative investigations. (4) The intention was to find a balance between a long-term and a short-term period of composition. Thus, the participants in this study composed music for approximately 20 hours. (5) Finally, multiple methods of data collection methods were applied. Thus, the birth of a creative idea was investigated from many different perspectives.

VIII. THE DEMARCATION OF CREATIVITY

When investigating the relationship between expertise and creativity we need to find some way to operationalize and define the concept of creativity. In that respect, three complimentary models and conceptualizations are dominating the field of creativity theory and can be found in various shapes and forms in the majority of current literature engaged in analytical discussions [68]-[70]. By applying these models, it might be possible (1) to address different forms of creativity, (2) to include intuitive notions of creativity, (3) to avoid problematic attempts to make strictly objective assessment criteria, and (4) still be able to draw a line between what is creative and what is not. Thus, the three propositions in combination provide a theoretical framework by which questions of demarcation can be handled while still including common notions about creativity.[1]

A. The Three Propositions

Proposition number one: Creativity = novelty + value. This proposition forms a basic starting point, in the sense that most creativity studies, regardless of the type of field and forms of creativity that are explored, implement this specific presupposition. According to this model, creativity is defined by two criteria. On the one hand, the outcome has to be novel,

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[1] It should be noted that the identification and categorization of 'the three propositions' is a result of the author's attempt to systematize the literature review. Accordingly, even though most researchers apply the three propositions in one way or the other, they obviously do not refer to them as 'the three propositions'.

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that is, original and unique. On the other hand, the outcome has to be valuable, that is useful, adaptive, appropriate, and functional [71]. However, the question is, who is to judge whether something is new and valuable and on what grounds? This issue is in general handled by applying the system model (the proposition below).

Proposition number two: Creativity is defined on the basis of three components; the individual person, the domain, and the field. Creativity is present when a group or an individual is producing something which is rooted in a specific knowledge-domain and is considered creative within a social field. In other words, the judgments are conducted by experts within a specific field based on rules and codes provided by the specific knowledge domain. However, the main problem with this model is that behavior normally referred to as 'everyday-creativity', such as children making drawings or regular problem-solving in general, are excluded from the category. Accordingly, this counterintuitive approach is supplied with a proposition about little-c creativity. Thus, 'everyday creativity' is included as a legitimate part of the main category, 'creativity'.

Proposition number three: Creativity is divided into two different categories; big-C creativity and little-c creativity. Big-C creativity refers to artefacts that are considered valuable and novel within the social field, i.e. the social organization of the domain (according to the propositions listed above). Little-c creativity refers to productions considered novel and valuable from the perspective of the creator. Thus, the former propositions are somehow still applied, although little-c creativity is determined on the basis of individual references and judgements instead of social fields and established domains.

In many ways, the three models offer a significant contribution to the field of research in terms of defining and assessing creativity. Still, applying these models results in various epistemological and ontological problems and dilemmas. E.g., proposition number one leads to quite a few problems. Thus, it seems highly counterintuitive that a process is not creative if it does not result in a valuable and original outcome. The problem is related to – or produced by – the fact that creativity normally refers to a product as well as a process, yet still is defined primarily through the quality of the product [72]. Thus, according to Hallam and Ingold, this way of approaching creativity is to 'read it backwards, in terms of its results, instead of forwards, in terms of the moments that gave rise to them' [73]. The challenge with a 'forward reading' of creativity is, however, that the concept becomes problematic to define. If a creative process is not connected to the outcome, but simply defined on the basis of the process, then how do we determine what is and what is not a creative process? The reasoning might lead to the tautology 'a creative process is a process with the characteristic of a creative process'. Accordingly, a 'backward reading' of creativity is applied in this study, even if it partly entails a paradox.

Further, the three propositions seem to entail a focus on the individual in the sense that creativity is essentially connected to single individual achievements. This narrow perspective might be challenged by actor-network theory as described by Bruno Latour, among others.

B. Creativity and Actor-Network Theory

From an actor-network perspective, objects and humans interact in various networks and must accordingly be regarded equally as 'actors' (classified as 'non-human actors', as opposed to 'human actors'). Obviously, the focus on objects offers an interesting perspective on creativity in a technological context [74]-[76]. However, the 'symmetric' approach to objects and humans [77] is not an attempt to humanize the material world. Rather, ANT suggests that human action is not isolated, but, on the contrary, connected to other human and non-human actions in complex networks. Consequently, according to ANT, a creative individual must be treated as a part of a widespread network, constituted by friends, computers, records, software, musicians, etc., instead of being treated as an isolated island.

> *[T]he very word actor directs our attention to a complete dislocation of the action, warning us that it is not a coherent, controlled, well-rounded, and clean-edged affair. By definition action is dislocated. Action is borrowed, distributed, suggested, influenced, dominated, betrayed, translated.* [78]

In light of the above, ANT may lead to a twofold conceptual reduction of individual autonomy. Firstly, by suggesting that non-human actors actually are not just an extension of human will, and, secondly, by suggesting that human action is nothing more than a single link in a long chain of events. Despite this, ANT is not proposing any type of deterministic inspired disqualification of individual autonomy, in the sense that the human actor is still an actor and not just a placeholder [79].

Although ANT is not designed to address technological phenomena in particular, it seems appropriate to apply the theory in regard to digitally-based compositional techniques and cultures: often, contemporary music is basically constructed as a mix between different pre-produced musical fragments. As a consequence, the compositional process is most of all characterized by selection among different fragments and options of combinations. Such a description of the creative matrix differs from conventional notions of an autonomous composer, working primarily alone, producing internally emerged original ideas. Thus, ANT may offer an alternative conceptualization of creativity as it appears in the present study [80], [81].

IX. RESULTS AND DISCUSSION

In the analysis, creativity as a phenomenon is defined and captured by the use of the three main propositions about creativity outlined in the above. First of all, this means that creativity is understood as an individual and a social construction rather than an objective phenomenon. Further, it means that questions about novelty and value play an important role when it comes to the analysis and assessment of the participant's compositions. In the following, the results of the study are discussed according to the three propositions.

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Hence, the musical object and the construction and interpretation of the musical object are investigated simultaneously rather than separately. Needless to say, this might confuse and complicate the examination. Nonetheless, this seems like the most appropriate thing to do according to the theoretical framework presented. In other words, if an objective approach to creativity is put aside, the musical object must be discussed with respect to the individual and social construction of creativity.

A. The Musical Product

The analysis of the musical structure, form, and genre was based on (1) the composer's own description, (2) the description made by the evaluation groups, (3) and, finally, a systematical analysis of the compositions (carried out by the author of this article). In Appendix B and C, the description of the music is shortly summed up. In Appendix B, a general description of the music is presented. In Appendix C, the different compositions are described in terms of musical layers/tracks, sounds, instruments, form, and musical material.

Tables I-IV indicate a number of differences between the novices and the experienced/experts: 1) the experts and the experienced recorded the music using audio recording or MIDI recording. The novices applied loops. 2) The music composed by experts and experienced players is more genre-specific than the music composed by novices. 3) The music composed by novices is more fragmented and eclectic than the music composed by the experts and the experienced. 4) The music composed by experts and experienced players relies more on well-known musical forms than the music composed by novices.

The differences are essential in order to understand the relationship between expertise and various strategies of working. Thus, we will return to the implications of these results throughout the analysis. However, in order to investigate creativity, the musical objects must be valued rather than merely analyzed.

B. The Social Assessment

The assessment carried out by the evaluation groups indicates that both novices and experts are capable of making music that is considered creative. In other words, the novices' compositions were in general not considered better or worse than those of the experienced and the experts' compositions. Nonetheless, there are of course some compositions that were considered particularly excellent by almost all members of the evaluation groups. E.g., the music of the experienced Emil received extraordinarily positive responses. Thus, most of the members in the evaluation groups granted the composition eight, nine, or ten points on a scale from one to ten. Further, the evaluation group described the music with superlatives like, 'exciting effects', 'nice guitar', 'groovy', 'great', 'intriguing sound', 'super intro', 'nice bass', 'beautiful', or 'I would buy a record with this!' Another example is the music of the novice Katrine. The majority of the members of the evaluation groups awarded the music eight or nine points. Further, they described the music with terms like, 'beautiful piano', 'the music told a story', and 'good combination of piano and drums'. In terms of the dominating view on expertise and creativity presented in the introduction, these assessments might be seen as surprising. However, there may well be several reasons for these results.

First, as described in the above, the music made by the experienced/experts was often played by themselves on MIDI keyboard or traditional musical instruments, whereas most of the music composed by the novices included loops recorded by others. Thus, it might be suggested that the novices were only partly responsible for their creations, whereas the experienced/experts were fully responsible. The question is essential because it is related to different notions of creativity and different notions of autonomy. Apparently, such questions play an important role from the perspective of the composers that seem to highlight and refer to levels of autonomy during the interviews. E.g., the expert Henrik describes how he preferred not working with loops.

> It reminds me of the time when I worked with eJay, when I was twelve years old. When you could take different boxes with a loop or a melody or something – and put it up in a way that fitted. Then I feel very restricted. That doesn't interest me. It needs to be created by ME. You have to make it yourself – otherwise it is not fun. [82]

Further, questions of autonomy seem to play a vital role for the evaluation groups in the sense that they tried to understand the music as if it was composed unambiguously by a single individual or some sort of coherent group of people. Thus, they primarily used the words 'they' or 'he' when they referred to the composer. However, the question is whether such understanding of creativity is appropriate. On the one hand it seems obvious to suggest that there exists a creative centrum, a sender, a person responsible for the message. On the other hand, this very notion might be somewhat a construction in the sense that novices, experienced people, and experts rely on material, forms, and skills that are extracted from, and connected to, networks.

Second, a reason for the surprising assessment might be related to questions of communication. That is, one might suggest the experts' music is not understood appropriately. However, the members of the evaluation groups represent different musical preferences and different levels of musical competence. Further, the members of the evaluation groups seem to be familiar with the genre and styles that the experienced and the experts adopt, in the sense that they are able to categorize the music relatively unambiguously (see appendix B). Therefore, it seems inappropriate to reject the evaluation groups' assessment per se as strictly a matter of misinterpretation.

Finally, a reason for the discussed evaluation of the compositions could be that expertise sometimes inhibits creativity and lack of expertise sometimes promotes creativity. In the study there appears to be several examples of such relations between expertise and creativity. In the following, this issue will be discussed further.

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C. Originality and Value

During the first two phases of the study, the novices frequently created music that was considered more original than the experts' music, whereas the experts often made music that was considered more qualified in terms of craftsmanship. Thus, a hypothesis was created with regard to originality and craftsmanship. From this perspective, originality was partly produced as a consequence of a lack of competence, and craftsmanship was conversely facilitated by knowledge and experience. Subsequently, this hypothesis became an important part of the study design.

The last phase of the study points in various directions with respect to the outlined hypothesis. Again, there might be several reasons for this. First of all, the novices' application of pre-recorded loops means that the compositions that they made relied partly on other people's musical craftsmanship. Thus, the music of the novices was often interpreted as good craftsmanship by the evaluation groups. Second of all, the musical software provides a specific frame within which common musical rules are maintained. Finally, the experts and the experienced were, of course, not only producing music characterized by craftsmanship, but they were also producing original musical elements.

A final point must be made with regard to originality and value. It might be questioned whether these terms can be separated [83]. According to the group evaluations it seems evident that the two terms are intertwined. Thus, according to the testimonies of the evaluation groups, originality includes an element of value and vice versa. For example, many of the novices attempted to combine all kinds of musical loops in an eclectic manner. Nevertheless, such strategies were not considered original, per se, by the evaluation group. In general, such untraditional combinations of sound was mainly considered original if the result was also considered valuable. Further, levels of craftsmanship seem to be intertwined with levels of originality. Thus, the evaluation groups rarely considered music to be extremely well crafted, but at the same time not original at all. On the other hand, the distinction still seems to be relevant, such as in the case of the expert Cecilie where the evaluation groups explicitly discussed how the music was well done and beautiful, but at the same time traditional and without original ideas or elements.

Plain objectivity is obviously not suggested in the study. However, the music is analyzed by the adoption of the evaluation groups' reflections as well as a musical analysis of the final compositions (see Appendix C). According to the evaluation group, the music made by the novices was much more uncommon than the music made by the experienced/experts, in the sense that genre was mixed and traditions were broken. Further, a musical analysis of the compositions indicates that the novices' music was unconventional in terms of form and structure, whereas the music made by the experienced/experts was much more in line with well-known musical forms (Appendix C). Nevertheless, as described in the above, music that departs from musical norms was not necessarily considered 'original' by the evaluations groups.

D. The Individual Construction of Creativity (Creativity from a Little-C Perspective)

In the designed study, the intention was to identify the most creative elements in the composition from an individual perspective and investigate the events which have taken place leading to these creative ideas. This approach resulted in distinctive differences between the novices and the experienced/experts, a difference that seemingly mirrors the different styles of composition adopted by the participants in general. Many of the novices engaged in working with loops and searching for sounds when the creative moment arose, whereas many of the experienced/experts were involved in different forms of improvisation and experimentation on their musical instrument.

However, this general picture was also challenged. First of all, some of the novices also attempted to play on the MIDI keyboard and some of them were quite satisfied with their performance and the result. The reason for this is not that they considered the self-made melodies the best musical parts, per se, but rather that they accomplished playing the music with their own hands. Accordingly, this has to do with two important issues. Firstly, they considered the musical elements successful because they had learned how to play them during the process. In other words, it is a question of learning and personal development. The playing on the MIDI keyboard was not particularly extraordinary, but it was extraordinary compared to the skills of the novice. Secondly, it is a question of autonomy. The novices felt that they somehow became the genuine creators of the musical element if they played it with their own hands.

In general, accidents and coincidence seem to play a major role. Accordingly, many of the participants described how accidents and coincidence led to the creative ideas they considered most successful. On the other hand, the most successful ideas are also the result of improvisation, reflection, and different forms of experimentation (we will return to that type of process later). However, the amount of accidents and coincidences seem prevalent.

In the light of the above, it is obvious that the composers highlighted specific elements of their composition for several reasons. Thus, it is not only a question of the outcome, but also a question of the relatedness between the outcome and the composer's own horizon and point of departure: sometimes accidents happen that surprise the composer and thus change the composer's perspective. And sometimes the composer manages to do something that he has not been able to do before. Again, the composer's perspective has somehow evolved. In that respect, the stories seem to be related to Boden's and Amabile's interpretation of little-c creativity, in the sense that creativity depends on the relation between creator and creation. This also explains why the participants only highlight musical elements in their composition that they feel responsible for. In other words, even though pre-recorded loops might be highlighted positively by the evaluation groups, the loops are often not highlighted by the composers because they did not feel like the actual creators of these musical elements.

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E. The Presumed Connection between Composer and Audience

The case studies in the second and third phases indicate that the attempt to locate and understand the composer plays an essential role in the way the evaluation groups assessed the music. Frequently the members of the various evaluation groups asked for information about the composers. They regularly wanted to know how the music was made and by whom. Further, they made up various assumptions about the composer and the process of composition that sometimes were presupposed implicitly and sometimes discussed intensively. Thus, notions about the composer seem to play an extraordinary role with respect to the assessment of the music.

Evidently, the discussions about the music appear to be most prominent when the music represented something uncommon that the members of the evaluation group were unable to categorize in any traditional manner. In these situations, they frequently discussed whether the music contained some kind of mistake or whether it was actually intended. During these conversations, the members emphasized that whether or not something is intended highly influences their judgment. Conversely, the music that apparently belongs to a specific tradition is not explicitly discussed. Instead, circumstances related to the creator were implicitly presumed.

According to the system model, this outlined tendency makes sense. If domain specific rules are followed, the members of the social field might interpret the artefact in a relatively straightforward way. However, if the rules are broken, the social field must decide how and in what way the peculiar artefact might fit into the domain. If the sender intentionally breaks the rule of the domain, the artefact's possible inclusion in the domain must be considered. If the sender does not know the rules of the domain or simply does not know how to handle them, then the artefact can be ignored and cast away.

According to the above, the evaluation groups seemed, in general, to implicitly presume that they somehow understand the music, the intentions, and the composer responsible for the message. This assumption may be questioned. First, the listener and the composer did not emphasize the same musical details when they described the most prominent and successful musical elements in the compositions (see Appendix D). Second, they often imagined things about the composition process that were incorrect. Naturally, this does not prove that their interpretation of the music is out of sync with the composer's intentions. Nevertheless, it implies that communication is not a straightforward process even though the audience may orient their judgments on the notion that a certain kind of straightforwardness exists.

Naturally, the communication that takes place in the case studies represents a connection between sender and receiver that can be categorized as relatively weak according to network theory [84]. Thus, the receivers were not familiar with the senders' music and they did not know anything about the senders' age, gender, and background. Conversely, in a naturalistic setting the audience will interact with the artist in different ways and the connection between sender and receiver will be stronger. Nonetheless, there are reasons to believe that people in a natural setting also partly base their judgment on questionable assumptions about the composer and the process of composition [85].

F. Sighted and Blind Processes

In Section IX E, creativity was discussed according to the three propositions outlined. Consequently, the attempt has been to identify the presence of creativity. This discussion forms the basis upon which an examination of different types of processes can take place. In the following, the creative processes observed in the case studies are discussed with respect to different levels of expertise. The focus of the investigation is different strategies of composing and how experience is adopted in the creative process.

One of the most striking differences between the novices and the experienced/experts was how they implemented plans and strategies in the compositional work. The experienced/experts were working with specific strategies. They were basing their composition on a particular musical form and structure and they were relying on a specific order of work. Conversely, the novices worked without a specific plan or they implemented a plan that appeared to be less specific.

The distinctions between novices and experienced/experts are e.g. evident with regard to the musical form. In the interview, the participants were asked to draw or write down the form according to their own interpretation. The experienced/experts were in general describing well-known musical structures. Thus, Christian described the form as something like intro-A-B-C-B-outro; Laura describes her music as following an A-B-A form; Martin divides his music into the sections of intro-A-bridge-B-A-bridge-B-C-solo-A-bridge-B-C; and Cecilie describes the music according to an A-B-A form.
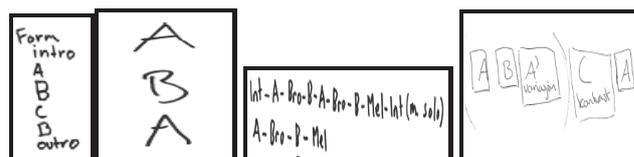

Fig. 1 Musical forms written down by Christian, Laura, Martin, and Cecilie

The well-defined sectional structure appears to be further reinforced when examining the screenshots of the participant's final compositions (see below, from the left, Christian, Laura, Martin, and Cecilie). Thus, the screenshots reveal that the music is typically divided into different sections that are repeated several times throughout the composition according to common musical norms [86]-[89].

Conversely, the music composed by novices seems less easy to define. Thus, most of the novices simply argued that their composition could not be described according to any type of well-defined form. The music as it appears in GarageBand supports this description in the sense that (1) many different loops are applied; (2) the loops were not repeated more than

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two or three times and often they were not repeated at all; and (3) the music was constantly developing and not returning to previously introduced motifs.

Fig. 2 The musical form as it appears on the screenshot: Christian, Laura, Martin, and Cecilie

Fig. 3 The music of the novices as it appears on the screenshot: Julie, Katrine, Steffen and Trine

In light of the analyzed data, it seems obvious that the experienced/experts relied on their former experiences and knowledge. They followed specific procedures, which they knew would lead them in a specific direction. 'I always start with the drums' said Christian. 'I always begin with the melody' said Henrik. Thus, because of their experience they were basing the work on a specific line of order.

It seems reasonable to relate the level of planning with Amabile's discussion of algorithmic and heuristic processes [90]. According to this distinction, the experienced/experts apparently implement different type of algorithms. In other words, they follow various rules. Conversely, the novices were not following specific rules, at least not compared to the experienced musicians and experts. First of all, they had no former experience that could help guide them in a specific direction. Second of all, they had not been given any specific manual that they could follow. From this point of view, the novices in these case studies are essentially different from the novices described by Dreyfus and Dreyfus that typically follows a kind of manual [91]. Naturally, one may suggest that the rules are represented by the software that the novices applied [92]-[95]. Nonetheless, it seems the novices were experimenting, rather than implementing, specific plans or rules. In other words, even though musical rules were retained through the musical software, the novice was not following plans or strategies imposed by themselves, at least not compared to the experienced musicians and the experts. In the following, the implication of these different strategies is discussed in the light of the theory of blind-variation and selective-retention.

G.Blind-Variation and Selective-Retention

The essence of creativity might be understood according to a systematic view on creativity represented by Weisberg and Gabora, among others, or a more chaotic view on creativity represented by Simonton and the theory of blind-variation and

selective-retention [96], [97]. In that respect, the study seems to support both perspectives on creativity. Thus, the study underpins notions about creativity understood as blind-variation and selective-retention as well as creativity understood as a relatively systematic and sighted process.

First of all, accidents play an important role in the creative processes. In the study, accidents were found in all the phases of the enquiry and were often acknowledged by the participants as a crucial element of the creative process. The accidents were blind in the sense that they were not in any way part of an intended or foreseen action. In many cases, the participants rejected or adjusted the mistake. Yet, in some cases, the mistake was selected and retained. Further, the participants often experimented without knowing exactly what would come out of the trial. This type of action might be understood as partly blind and partly sighted. The action was blind because the creator did not know the end-result. Yet, the action was sighted in the sense that the experiment was intended. In some cases it seems as if the creator was basing the experiment on well-known structures, e.g. when the experts improvised on the instrument. They did not know exactly how it would sound, but they had a pretty good idea. In other cases, the creator tended to form experiments that would intentionally move them from known to unknown areas. For example, they intentionally played strange sequences of harmonies that they did not know the sound of in advance or combined intentionally different loops that resulted in an unpredictable outcome.

According to the above, there seems to exist a continuum from completely blind processes to completely sighted ones. Thus, an interesting question might be, at which end of the spectra does creativity reside? This investigation implies that some sort of blind processes are crucial in terms of creativity. In particular, the fact that accidents played a vital role in the investigated cases indicates that creative processes benefit from the presence of unforeseen events. Furthermore, it seems like plans and strategies sometimes hinder creativity, in the sense that they lead to results that are considered conventional by the evaluation groups.

Naturally, from an ANT perspective, a process will not be blind, but rather influenced by different human and non-human actors in a network. Thus, even if the human actor does something relatively blind in the process of composition, sightedness might be represented by the non-human actors involved. However, it seems reasonable to also focus on the degree of sightedness from the composer's point of view.

H.The Role of Reflection and Intuition

According to Dreyfus and Dreyfus, human behavior might be categorized as either reflexive and conscious or intuitive and unconscious [98]. Similar notions are suggested, in different versions by scholars like Donald Schön [99] and Polanyi & Prosch [100]. In the case study, the role of intuition and reflection are related to different types of composition strategies in various ways. Thus, reflection and intuition may hardly be associated in any definitive way with specific types of outcomes and processes. Further, the distinction appears to

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be problematic in the sense that hand, mind, intuition, and reflection seem partly intertwined [101], [102]. Nevertheless, it still makes sense to draw a distinction based on these terms as long as the categorization is not understood to be too absolute.

First of all, reflection seems to be connected to the creation of master plans, e.g. regarding choice of genre, instruments applied, etc. In other words, the participants seemed to be reflexive about the frame of reference within which the composition was formed as well as procedural issues concerning the process of composition. Such plans are sometimes associated with the confirmation of musical norms and sometimes the opposite. Hence, the composers sometimes made explicit decisions in order to break with traditional norms and sometimes made explicit decisions to follow musical norms. Accordingly, reflexive thinking might be used proactively to stay within a specific musical norm as well as move beyond a specific musical norm.

However, reflexive thinking was often intentionally rejected by the participants. Many of the participants explicitly tried not to think, because thinking from their point of view often destroys the creative process. In such situations, the participants associated thinking with the sighted reliance on rules and norms instead of the reliance on feeling, sense, and intuition. Further, deliberate thinking might be understood as slow and effortful, whereas intuition might be understood as fast and effortless [103], [104]. Accordingly, the participants' behavior might be explained by such reasons.

However, the rejection of deliberate thinking seems to entail very different scenarios. The main proportion of the novices rejected reflexive thinking in order to do something blind or unintended, in the sense that they listened to and combined various different loops. Thus, reflexive thinking seemed to be replaced by some kind of blindness. Often such blind processes seem to involve the breakdown of musical norms. Conversely, the main proportion of the experienced musicians and experts rejected thinking in order to 'think with their hands', 'follow musical instinct', 'work intuitively', etc. The question is whether such process is characterized by the implication of norms and rules, or not.

I. The Connection between Intuition and the Unknown

Based on the case studies it seems like intuition leads to musical outcomes that are not norm breaking, but rather the opposite. In other words, intuition does not seem to entail remote associations [105] or any other type of process or outcome that are associated with the breaking of norms. The participants were first and foremost working within specific traditional frames when they were working intuitively, e.g. when they were 'doing something with their hands'. However, this is also a rather bold conclusion that needs to be questioned. First of all, creativity may be characterized as something that is novel in a specifically appropriate way (see discussion above). Accordingly, it is not just the amount of novelty that defines the level of creativity. As Klausen emphasizes, the music of Mozart is considered creative even though it is following musical traditions to a high degree

[106]. Thus, novelty might still be there, only in a less explicit way. Therefore, it may be wrong to argue that intuition does not lead to novelty per se, but only that it does not lead to a very explicit breaking with norms.

Secondly, one might argue that intuition plays another role among professional artists than the experts investigated in the case studies. Thus, based on Dreyfus and Dreyfus's model of skills acquisition, one might suggest that the comprehensive amount of expertise and experience enables these artists to act intuitively in a unique way [107]. However, the interviews with professional artists in this study hardly support such a suggestion. E.g., the professional composer Nicklas Schmidt described how he makes reflective decisions in order to move away from common routines and produce something novel. Further, the composer Sandra Boss explained how she designs musical settings specifically in order to promote accidents. Thus, in these cases, it seems like reflective thinking rather than intuition is the key to novelty. Essentially, intuition seems to promote appropriateness.

It should be mentioned that the relationship between intuition and creativity is not actually addressed explicitly by Dreyfus and Dreyfus [108]. In an interview, Hubert Dreyfus explains this methodological choice:

We don't know how to deal with innovation, because coming up with something new doesn't fit our model. Our model says all skills are based on seeing similarity of the situation to something you have already been in. How people can come up with something brilliant and new we don't have a story about (Hubert Dreyfus interviewed by Flyvbjerg, [109]).

Accordingly, Hubert Dreyfus apparently seems to support the suggestion that intuition primarily leads to something known rather than something unknown.

J. The Location of Creativity

The main tradition within the field of creativity is to focus on an individual or a limited group of individuals when creativity is addressed. However, it might be argued that creativity is a phenomenon that essentially happens within networks rather than within single individuals. Thus, the ambition is to include both human and non-human actors in the analysis and interpretation of creative processes. In turn, this problematizes the attempt to propose some differences between the participants as single subjects. First of all, this means that the composition strategy discussed in the above might also be related to the non-human actors involved.

The interface of GarageBand is partly based on sample technology that invites the composer to mix different genres and to build up a dense musical texture [110]-[112]. In other words, the composers might be influenced by the affordances offered by the software [113], [114]. This perspective might be supported by the fact that the majority of novices in all phases of the study composed eclectic music. In other words, the eclectic composing strategy might be a result of the musical software rather than a result of the level of the novices' expertise. However, the entire volume of case studies only partly supports such a suggestion, in the sense that

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experienced musicians and experts that worked with loops in the first session of the music course produced both eclectic music and genre-specific music. Accordingly, the eclectic outcomes are the result of many parameters, including the level of the composer's expertise and the type of software applied: that is, the mechanism is multi-causal.

According to the above and the result of the study in general, it is important to stress that the interaction between human and non-human actors does not appear to be constant or stable. The interaction might take many forms. First of all, the user is not determined by the non-human actor and vice versa. Second of all, there does not seem to exist a constant balanced relation between the composer and the material. In other words, the user might sometimes force the non-human actor in specific directions, whereas in other situations the non-human actor seems to be forcing the human actor in a specific way. In the following the role of the two main non-human actors in the case studies are addressed: the computer and the musical instrument.

K. The Instrument and the Computer

As described in the above, the main proportion of the experienced/experts in the case studies applied instruments, whereas the majority of the novices applied loops. The different non-human actors seemingly entail different types of processes. When the experienced/experts were playing instruments, they seemed to follow well-known musical norms. That is, they improvised or experimented with harmonies and notes that were related to traditional scales, rhythms, and harmonies. Hence, even though they experimented, they did not in general try out completely unusual ideas. Conversely, the novices' interactions with the computer moved in another direction. On the one hand, the software only allows specific norm-based musical outcomes in terms of harmony and rhythm [115]. On the other hand, the computer permits and invites the combination of many different types of musical samples, including a broad spectrum of different genres. Thus, the novices' compositions often represented eclectic unusual combinations and yet traditional musical structures in terms of rhythm and harmony.

L. The Mind and the Computer

It seems evident that the interaction between computer and composer differ from the interaction between instrument and composer. The differences depend on which template of GarageBand is applied. Thus, working with MIDI recording and MIDI keyboard resembles working with a musical instrument, whereas working with loops and effects departs essentially from playing a traditional instrument. The differences between working with loops and instruments seem crucial in terms of the creative processes.

Firstly, the feedback mechanism is basically different. When working with loops the feedback is delayed. Conversely, when working with a musical instrument the audio feedback appears immediately. The implications of this difference seem essential in terms of the creative process. Thus, when working with loops, the room for reflection is reinforced because the composer has extra time to reflect upon the result of his actions. Further, the strategy of composing that includes the blending of loops means that the composer can hardly predict the outcome of their actions, at least not in any definitive way.

Secondly, the actions are not connected to automated skills related to instrument play. Thus, the composer is not guided by musical procedural knowledge [116]-[119]. In the investigation, this circumstance seems to facilitate processes in which the composer experiments with musical versions that seem relatively far from traditional musical norms. It seems obvious to suggest that such experiments are partly reinforced by the disconnection of automated instrumental skills.

X. CONCLUSIONS

The relation between expertise and creativity is not in any way predetermined, unambiguous, or stable. The level of creativity depends on many parameters. Expertise is only one of them. And expertise might promote creativity as well as the opposite. Yet, the main object of this study has been to investigate the complex relationship between creativity and expertise. Obviously, the answer to this question is not possible to break down into a few words or sentences. Still, in the following the important findings are tentatively summarized.

Expertise might lead to an entrenched perspective, in the sense that knowledge and experience may work as a path into the well-known rather than into the unknown. This limited perspective may be caused by sighted reflective processes, including master plans, strategies, choices of form, and choices of genre. Further, intuitive thinking and tacit knowledge that depends on routines, former knowledge, and automated skills may reinforce this limited perspective. However, when the expert moves into unknown territories, reflective thinking seems to be the main dynamic factor, rather than intuition.

Expertise is important in a creative process for several reasons. Firstly, expertise provides a comprehensive amount of knowledge and knowhow that may be combined or developed in many different ways leading to many different results. Secondly, expertise provides the tools by which specific goals can be reached. Thirdly, expertise provides techniques that may help in the meeting of the requirements of value and craftsmanship. Finally, expertise provides competences in order to form a creative product according to the codes and signs within specific knowledge domains.

Lack of expertise, on the other hand, enables blind experimentation that may lead to unexpected results. However, the lack of expertise might also inhibit creativity, in the sense that expertise, as mentioned, is crucial in a creative process. First of all, a blind process needs to happen within relatively sighted processes. Straight blindness without purpose leads to no creativity. In other words, blindness has to be implemented in processes that are partly sighted, and this sightedness relies on some kind of expertise. Secondly, the selection of blind variations and the subsequent honing depend on expertise.

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Digital technology may influence the relation between expertise and creativity in several ways. Firstly, digital technology may provide some of the necessary expertise that the novices do not own. However, from a little-c perspective such procedures may not necessarily be seen as creative because little-c creativity apparently includes a kind of explicit autonomy. Secondly, digital technology might be productive in terms of providing a platform upon which partly blinded processes can be practiced. Further, digital technology seems to reinforce time for reflection that may lead to the unknown instead of the well-known.

The study indicates that creative processes rely on some degree of blindness. This notion is reinforced by the fact that mistakes seem to occupy a crucial part of creative processes. This finding may result in provocative conclusions regarding the relationship between creativity and expertise. Most importantly, the creator's total control seems to be an obstacle in creative processes, in the sense that total control hardly makes room for mistakes. Thus, lack of competence may promote creativity, in the sense that this can be related to lack of control. However, experts might intentionally put themselves in situations within which control is minimized in order to promote blindness.

Creative processes are addressed in the study partly as an individual phenomenon and partly as a phenomenon unfolded in networks. According to the approach inspired by actor-network theory, the autonomy of creative processes may be questioned, in that the human actors are connected to other human actors and non-human actors. Thus, the creative humans depend on digital technology as well as musical instruments. However, this relationship is by no means stable. Sometimes, the subject's autonomy seems to be prevalent, and on other occasions the impact of the non-human actor seems to be dominant. From the composer's own perspective, the reliance on musical software is associated with a lack of autonomy, whereas the reliance on musical instruments is associated with high autonomy. Hence, even though digital software allows the novices to produce music considered creative by other people, the novices themselves do not necessarily agree with this in that they do not feel that they have contributed to the process in a creative way. In other words, they do not feel as though they are the genuine creator. However, this notion about different levels of autonomy might not be appropriate in that the use of traditional musical instruments also entails dependence on other human and non-human actors.

XI. Future Research and Educational Implications

In the study, the relationship between expertise and creativity is examined within a specific field and partly within a laboratory setting. Thus, the findings formulated in the article are based upon a specific type of empirical material that may not be applicable with respect to other fields and may not be equally valid outside an experimental setting. Consequently, in order to produce theory with general implications, the findings needs to be pursued, examined and elaborated within other fields and by the use of other methodological approaches. Accordingly, further research may primarily include investigation of the findings reached in this study. From this perspective, three issues appear to be most significant and obvious to pursue.

First of all, the complex construction of creativity comprised by the different phases of creation and evaluation needs to be examined further. In this article, the construction of creativity is attempted through various perspectives in order to link individual processes of creation with subsequent evaluations conducted by other people. This strategy entails interesting findings regarding the apparently limited connection between little-c and big-C creativity and the questionable connection between sender and receiver. However, this finding may be partly caused by the adopted laboratory setting. Hence, it seems relevant to investigate this issue further within a natural setting, e.g. among professional artists and their audience.

Next, the role of mistakes in creative processes seems surprisingly prominent in the examined case studies. This finding entails a number of questions appropriate for further research. For example, it might be relevant to investigate whether mistakes occupy a particularly prominent role within a digital context. Further it might be interesting to investigate the relationship between control and creativity. In the case studies, control seems connected to reproduction rather than production. However, some of the interviews conducted in the study with professional artists and former students of the Academy of Music clearly indicated that total control may function as the road to creativity. For example, Cæcilie Trier described total control as an unambiguous advantage in a creative process. Further, Jacob Lind-Lauritsen described how professional musicians develop a specific personal and unique way of playing that may be compared to a specific way of talking. Hence, in such cases control seems connected to uniqueness and creativity. Yet, this is not the result of the analyzed case studies, which primarily included amateurs. It would be relevant to investigate these questions among professional musicians.

Finally, pedagogical and educational implications of the study's main findings need to be pursued. Essentially, the study leads to didactical questions, such as: how is it possible to learn without adopting an entrenched perspective? How can notions of personal autonomy be addressed, if the perspective of actor-network and distributed creativity is applied? What is the role of the teacher if only a limited amount of skills need to be learned? How can creativity be facilitated and assessed in education, if creativity is basically a social construction? And finally, how is it possible to promote creativity systematically, if creative processes are partly blind? In other words, if the way to the unknown is unknown, how then is it possible to teach students the way to the unknown?

The questions asked are not necessarily novel or neglected. Ericsson attempts to demonstrate how an entrenched perspective can be avoided through reflective practice [120]. A number of studies, textbooks, and coaching concepts try to unfold how blind and sighted processes can be facilitated in and outside an educational context [121]. Attempts are made

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in order to fully understand the implications of the distributed aspects of creativity [122]. On the other hand, field studies continuously indicate that the facilitation of creativity in education is subject to a number of paradoxes and dilemmas that relate to the outlined questions [123]. In this respect, the application of digital software seems to affect and enhance the discussed challenges significantly. Thus, teachers are apparently continuously trying to figure out how to assess and facilitate creativity in education, how to know what the students need to learn in order to be creative in the age of digital technology, and how to handle the distributed aspects of creativity from a didactical perspective [124]. Therefore, it seems essential to further investigate pedagogical implications and potentials in light of new knowledge and insights about the multifaceted and ambivalent roads to creativity.

APPENDIX

TABLE I
THE PARTICIPANTS AND THEIR MUSICAL EXPERIENCE

	Age	Years of experience	Study	Listens to…	Music in the family
Katrine	21	0	Social Education, UCSJ	Rock music, HIM, Nickelback, Skillet	Nothing significant
Trine	24	0	Social Education, UCSJ	Many genres, Walk of the Earth	Nothing significant
Steffen	21	0	Social Education, UCSJ	Many genres, Rock, Metal	Nothing significant
Casper	22	Computermusic: 2 years	Social Education, UCSJ	Electronic music, LMFAO, David Guetta, and Dada life, *Cry Baby* by Cee Lo Green	Nothing significant
Julie	22	0	Social Education, UCSJ	Pop, A&B, Rap, LOC, Suspect, Mads Langer, Volbeat	Sister plays piano
Emil	20	Guitar: 5 years Computermusic: 2 years Gymnasium music-level A	School of Music, Vig	Coldplay, Tina Dickow, Psychedelic Rock	Mom, dad, and brother play a bit
Jonas Vig	23	Piano: 8 years Violin: 1 year Bass: 1 year Computer: has studied computer science at the university	School of Music, Vig	Rock, Pop, Folk, Heavy Metal, Symphonic Metal, Power Metal,Trash Metal, Dubstep, Electronica, Nightwish, Metallica, Simon and Garfunkl	Father plays guitar, concerts Brother plays piano
Christian	19	Guitar: 6 years Computer music: 4 years Gymnasium music-level A	School of Music, Vig	Rock, Funk, Hip Hop, Beastie Boys	Mom and dad play guitar and drums. Little brother plays piano
Laura	22	Piano: 5 years	School of Music, Vig	Jeff Buckley, Susanne Sundfør, CocoRosie	Nothing significant
Martin	19	Guitar: 6 years	School of Music, Vig	The Beatles, Bob Dylan, Bruce Springsteen, Pulp.	Mom and sister sing in choirs
Mikkel	22	Violin: 2 years Guitar: 10 years Computermusic: 8 years	Social Education, UCSJ	Blues, Jazz, Techno, Gorillaz, Massive Attack, Joe Satriani	Mom and both brothers play instruments
Henrik	24	Piano: 4 years Guitar: 7 years Drums: 7 years	Social Education, UCSJ	Electronic music, Heavy Metal, Metalcore, Melodic Heavy Metal, rock from the seventies, Avicii, Culture Beat, Electric Light Orchestra, Haddaway, Black Sabatth, and The Who.	Both parents play the piano
Jonas	25	Piano: 14 years	Social Eeducation, UCSJ	Rock, Classical Music, Dance, Rock music from the eighties, 'Rock with Hammond Organ', Deep Purple, Heavy Metal	Mom and both brothers play instruments
Cecilie	22	Piano: 15 years Gymnasium music-level A	School of Music, Vig	Bill Evans, Esperanza Spalding, Thomas Dybdahl, Jarle Bernhoft. Faure's requiem, Debussy.	Father plays the flute in classical orchestra. Elder sister plays piano.
Kristian	23	Piano: 15 years	The Royal Academy of Music	Many different genres, Jazz, Pop, Electro, Aleatoric Music, Steve Reich, Stockhausen	Elder brother is a teacher at the Royal Academy of Music. Sister is a singer and a student at the royal Academy of Music.

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TABLE II
THE COMPOSITIONS ACCORDING TO THE COMPOSERS: THE EVALUATION GROUPS AND THE AUTHOR

The music described by the composers	The music described by the evaluation group	The music described by the author
Katrine	Piano music with noisy drums in the middle	Classical music, Pop, wild drums, relaxation music	Piano pop
Trine	Something wild	Pop/Jazz/electronic/Funk	Jazz/Soul
Steffen	A mix of different genres	Many genres and instruments, Daft Punk, music from the eighties	Mix of many genres structured horizontally
Casper	Electronic music	Electronic music and piano	Electronic Pop/Dance
Julie	A mix of different genres	Many genres and instruments	Eclectic mix of pieces of sounds and genres
Emil	Psychedelic Rock and Electronic music	Electronic rock, beat (and many styles)	Symphonic Electro-rock
Jonas Vig	Electronic music	Electronic pop/videogame	Electronic playful music – videogame-music
Christian	Hip hop – rap music	Hip hop – rap music	Hip Hop and Rap
Laura	Happy pop	Happy music with piano and drums	Melodic happy pop
Martin	Country	Country/Folk	Country/Folk
Mikkel	Jazz	Funk, Jazz, jam	Funk, traditional jazz
Henrik	Electronic music	Electronic/Techno	Electronic/Dance
Jonas	Blues	Jazz/Blues	Traditional Blues
Cecilie	Traditional classical music	Classical Music	Baroque music
Kristian	Minimalistic, controlled improvisation, inspired by John Cage, Steve Reich, and Stockhausen	Electronic, psychedelic, Silent Goa, spacy	Minimalistic elitist electronic music

TABLE III
A SHORT CHARACTERISTIC OF THE COMPOSITIONS

	Number of tracks	Instruments	Form	Type of music material
Katrine	8	Piano, drums 1, drums 2 strings 1, percussion, strings 2, synth	Unclear – maybe ABA'	Sampled Loops MIDI loops
Trine	9	Drums 1, shaker, horn section 1, synth guitar, electric bass, electric bass 2, synth, drums 2, horn section 2	Unclear – like an intro	Sampled Loops
Steffen	16	Horn section, bass, shaker, drums 1, drums 2, drums 3, electric bass, electric guitar, electric bass 2, synth 1, acoustic guitar, Banja, synth 2, drums 4, shaker, piano	Unclear – different layers succeed each other – like a DJ turning up and down the layers	Loops
Casper	5	Piano, synth 1, strings synth 2 bass, drums	Unclear – ABA' form repetitive	MIDI keyboard
Julie	13	Guitar 1, guitar 2, drums 1, drums 2, vocal 1, electric guitar, sound effect, drums 3, drums 4, drums 5, vocal 2, bells, pistol shut	Unclear – not repetitive – not sectional – every sample is only used one or two times	Loops
Emil	10	Clap, bass drum, piano, flute, guitar, synth 1, synth 2, drums 1, drums 2, horns	Unclear – ambient – repetitive structure	Recorded guitar MIDI Keyboard Loops
Jonas Vig	8	Trumpet section, bass 1, synth bass, drums, bass 2, synth guitar, tenor sax, alto sax	Intro-A-A	MIDI keyboard
Christian	7	Drums, bass, guitar, vocal 1, vocal 2, vocal 3, vocal 4	Verse-chorus-verse-chorus (sectional)	Recorded Bass Recorded Guitar Recorded Vocal Loops
Laura	11	Bass, drums 1, drums 2, synth 1, strings 1, strings 2, synth 2, Piano, Drums 3, clap, drumbass	Intro-AABBAABB-Outro	MIDI keyboard
Martin	10	Vocal 1, vocal 2, vocal 3, guitar 1, drums, guitar 2, guitar 3, guitar 4, guitar 5, bass	Intro-verse-bridge-chorus-verse-bridge-chorus- solo-verse-bridge-chorus-outro	Recorded guitar Recorded vocal Loops
Mikkel	14	Drums 1, bass 1, recorded guitar 1, recorded guitar 2, drums 2, bass 2, trumpet section, violin 1, guitar, violin 2, violin 3, organ, strings, piano,	Divided into five clearly defined sections A-B-C-D-A	MIDI keyboard Recorded guitar MIDI keyboard Samples
Henrik	10	Grand piano 1, grand piano 2, guitar sound, drums 1, drums 2, synth. 1, synth 2, synth 3, synth 4. bass	A-B-A	MIDI
Jonas	5	Electric organ, electric guitar, electric bass, drums 1, drums 2	Twelve-bar blues form ABCA	MIDI keyboard Loops
Cecilie	8	Tuba, Cello, Viola 1, Clarinet, Viola 2, bassoon, string section, bass section, string section 2	A-B (Baroque music, ostinato)	MIDI keyboard
Kristian	5	Synth 1, synth 2, synth 3, drums, vocal	Repetitive rhythmical structure supplied with vocal sections	MIDI Recorded vocal

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TABLE IV
RELATIONSHIP BETWEEN THE COMPOSER'S ASSESSMENT AND THE EVALUATION GROUPS'

	The elements preferred by the composers themselves	The elements preferred by the evaluation group	Correlation
Katrine	Piano-loops The drums in the middle section	The piano The drums in the middle section	A lot
Trine	A short guitar motive in the intro	Bass Horn Intro	None
Steffen	The overlap between different sections The horn intro The transformed piano-loop	The horn intro The bass The 'sound'	Some
Casper	The piano The moonbeam theme and sound	Piano Beat The development from piano to beats	Some
Julie	The combination of the two loops 'guns and stars' in the intro	Drums Chimes in the intro Guitar in the intro	Some
Emil	The horns in the middle section	The voice The combination of acoustic and electronic sounds The transformation of the music between the different sections	None
Jonas (Vig)	The guitar melody	The guitar The bass The keyboard and the horn/guitar	Some
Christian	The bass	The guitar The bass The melody The lyrics	Some
Laura	The beats (particular the clap) leading up to the second A-section The melody introduced in the second A-section	Drums Piano The section leading up to the second A-section The clap	Some
Martin	The song in general The choirs	The drums The guitar in the beginning	None
Mikkel	Horn solo and contra bass The string motive	The bass The combination of the different sections The musical dialog between the instruments	Some
Henrik	The grand piano theme	The guitar	None
Jonas	The guitar improvisation	Drums The organ theme	None
Cecilie	The transition from section A to B	The transition from section A to B The first part The interplay between the instruments	Some
Kristian	The piano improvisation	The keyboard (piano) The bass The voice	Some

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