

## Assessing a Collaborative Online Environment for Music Composition

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### ABSTRACT

The current pilot study tested the effectiveness of an e-learning environment built to enable students to compose music collaboratively. The participants interacted online by using synchronous and asynchronous resources to develop a project in which they composed a new music piece in collaboration. After the learning sessions, individual semi-structured interviews with the participants were conducted to analyze the participants' perspectives regarding the e-learning environment's functionality, the resources of the e-learning platform, and their overall experience with the e-learning process. Qualitative analyses of forum discussions with respect to metacognitive dimensions, and semi-structured interview transcriptions were performed. The findings showed that the participants successfully completed the composition task in the virtual environment, and that they demonstrated the use of metacognitive processes. Moreover, four themes were apparent in the semi-structured interview transcriptions: Teamwork, the platform, face-to-face/online differences, and strengths/weaknesses. Overall, the participants exhibited an awareness of the potential of the online tools, and the task performed. The results are discussed in consideration of metacognitive processes, and the following aspects that rendered virtual activity effective for learning: The learning environment, the platform, the technological resources, the level of challenge, and the nature of the activity. The possible implications of the findings for research on online collaborative composition are also considered.

### Keywords

E-learning, Online collaborative learning, Asynchronous and synchronous resources, Online music creativity

### Introduction

Several studies in the field of online learning have investigated technical solutions to online learning, and methodological issues related to online learning research, and many ideas for improving learning approaches have been provided (Karvounidis, Chimos, Bersimis & Douligeris, 2014; Ng, 2014; Tseng & Yeh, 2013; Wu & Huang, 2013). In early online learning approaches, an instructional model was used in which online tools were merely considered a means for practice. More recently, however, this instructional model has been updated with more interactive didactic methods based on socio-constructivism, and collaborative activities have been developed. These methods aim to respect the learner's experience, and to stimulate divergent thinking in participants. Prior research has also highlighted relevant aspects of the online learning process related to, for instance, pedagogy, didactic methods, online environments, tools, organization and creativity, and has offered suggestions for designing high-quality learning environments (Biasutti & EL-Deghaidy, 2012; 2014).

The growth of e-learning products has also affected music education, and several music-related tools, and software programs have been developed (Akoumianakis, 2011; Hadjileontiadou, Nikolaidou, Hadjileontiadis & Balafoutas, 2004; Yu, Lai, Tsai & Chang, 2010). Technological advancements have supported the development of e-learning products by providing technological solutions for activities that were previously impossible, such as interacting online in real time to perform, and compose music. The potential of the Internet thus expanded, and one can find through any web search engine thousands of online tools that are now available for music learning. However, many of these online tools have not been evaluated. Thus, the effectiveness of the online tools, and resources needs to be tested, and the pedagogical and didactic approaches to the online learning activities need to be assessed (Seddon & Biasutti, 2009). Moreover, many of the didactic approaches related to the music learning resources available on the Internet are based on an instructional model that involves simple practice, whereas interactive didactic methods based on collaboration are used less often.

The current study presents a project in which participants worked online to collaboratively compose a new piece of music. The learning environment also allowed the participants to interact synchronously, which was a challenging, and complex task. Special software was used to allow more than two participants to interact in real time, and powerful technological solutions were adopted to minimize the latency of the signal. The learning experience was then tested to assess the effectiveness of the online environment.

## **Theoretical background**

In the present study, principles related to collaborative online learning, and online music learning were combined to form the theoretical background.

### **Online collaborative learning**

There is a growing interest in the factors that contribute to the effectiveness of online collaborative activities (Donnelly & Boniface, 2013; Tseng & Yeh, 2013). Prior research has addressed several issues related to online collaboration, such as the strengths and weaknesses of online collaborative activities, the process of collaborative knowledge construction, and the dimensions of metacognition. A positive relationship and collaboration during online activities are relevant factors in online collaboration, since students' satisfaction with online activities is connected with their perceived levels of collaborative learning. The strengths of online collaborative learning include the ability to compare ideas, collaborate, learn from peers, share knowledge, and skills to support other participants, analyze and integrate different points of view, plan in a group, manage the workload, and use an effective platform (Biasutti, 2011). Moreover, crucial factors for building trust for teamwork include individual accountability, familiarity with team members, commitment toward quality work, and team cohesion (Tseng & Yeh, 2013). Positive interdependence (i.e., the perception that participants are linked with others) developed during online activities is also important, as well as aspects such as establishing a positive group environment, and creating a sense of community. Other aspects include technology competence, technology utility, and technology resourcing (Donnelly & Boniface, 2013). Conversely, factors that impede online collaboration include insufficient ability in workload management, different levels of engagement, insufficient coordination and organization, and technical issues (Biasutti, 2011).

Group coordination and dynamics have been addressed in several previous studies. For instance, prior research has examined the process of collaborative knowledge construction, which describes learners' cognitive processes that occur during collaborative learning, with a focus on the exploration of their processes rather than considering the mere products. Collaborative knowledge construction depends on specific social, and cognitive processes, as well as the interaction between these processes. Regarding social interaction, Wu, Hwang, and Kuo (2014) demonstrated that highly interactive students have higher learning achievements than less interactive students, indicating the importance of the social dimension of the learning process, and the importance of interaction among group members for knowledge construction. Furthermore, the discourse among the learners in a group is important during collaborative learning, which relates to the cognitive dimension of learning, and the participants' knowledge construction during collaborative activities. Regarding other online activities, Anderson and Simpson (2004) argued that while discussions in online forums induce basic processes such as the exchange of information, and the investigation of ideas, more articulated processes such as higher-order cognitive skills are not activated. By contrast, Biasutti (2011) has demonstrated that wiki activities can induce higher-order cognitive skills, such as the evaluation of various elements, and subsequent decision making.

Higher-order cognitive skills involve metacognition and reflection on performed actions, and metacognitive processes have been recognized as a crucial factor for enhancing group coordination, and fostering effective learning. Sharing cognitive experiences is another fundamental aspect of the development of metacognitive skills, allowing participants to control and assess one another's behaviors, cognitive processes, and feelings (Kwon, Hong & Laffey, 2013). Activities such as evaluating group activities, reflecting on the results, and considering approaches to collaboration enhance group coordination and performance. In this way, a group can set realistic goals and select the proper strategy to achieve them. Regarding metacognition, Akyol and Garrison (2011) developed a metacognitive construct with the following three metacognitive dimensions: Knowledge of cognition, monitoring of cognition, and regulation of cognition. Knowledge of cognition refers to the awareness of oneself as a learner and the awareness of one's knowledge, and skills concerning personal cognitive processes. Monitoring of cognition refers to the willingness to reflect upon the learning process, and involves understanding progression, assessing tasks, and making judgments about content validity. Regulation of cognition refers to the interactive aspect of metacognition when students are engaged in providing or asking for help from others to mutually improve their learning experience. This theoretical framework can be used to explore cognitive and metacognitive development, and it was validated by Akyol and Garrison (2011) for assessing metacognition in online discussions.

## **Online music learning**

Several studies, primarily in school settings, have examined the application of information and communication technology (ICT) in music composition (for a review see Biasutti, 2012). Although prior studies in the music domain have focused on the use of technology, they were generally conducted in face-to-face environments. Furthermore, the few studies that were conducted in a virtual environment primarily pertained to instrumental practice rather than music composition. For instance, Seddon and Biasutti (2009) investigated the efficacy of a music e-learning resource for playing improvised blues. A qualitative research approach was adopted that consisted of videotaped observations and semi-structured follow-up interviews. The findings showed that all the participants successfully performed the musical activity in the online setting, and that the online activities facilitated the development of abilities such as planning, organizing, monitoring, and assessing one's competencies. In addition, the following aspects of the e-learning setting were considered helpful: The use of particular topic themes, the synergy between theory and practice, the flexibility of the work schedule, the easy use of the platform, and the full access to essential tools.

## **Summary of the theoretical background**

The reviewed literature indicates several factors that influence the effectiveness of online collaborative learning and metacognitive processing. Regarding online collaborative learning, factors such as the sharing of knowledge and skills, the analysis and integration of different points of view, group planning, workload management, the establishment of trust for teamwork, individual accountability, and commitment toward quality work have been identified. In addition, social aspects such as familiarity with team members, positive interdependence, team cohesion, and a sense of community have been considered. Other aspects of online collaborative learning include technology competence, technology utility, and technology resourcing.

Regarding prior research conducted in the music domain, ICT tools have been considered suitable for facilitating musical creativity, and for enabling online instrumental music learning (Seddon & Biasutti, 2009). Because previous studies on collaborative music composition were primarily conducted in face-to-face environments (Biasutti, 2012), the current study aimed to address this gap in the literature by examining collaborative music composition in a virtual environment. In so doing, the study aimed to identify the successful aspects of the online collaborative activities, and to examine the metacognitive dimensions of online music collaboration.

## **The current research**

### **Research design and questions**

The current research is a pilot study that aimed to test the efficacy of an e-learning environment built to enable participants to collaboratively compose music online. The research design is qualitative: Individual, semi-structured interviews were conducted with the participants after the learning sessions to analyze the participants' perspectives regarding the functionality of the e-learning environment, the resources of the e-learning platform, and their overall experience with the e-learning process. In addition, the forum discussions were analyzed with respect to the metacognitive dimensions. Although the study is exploratory by nature, the following research questions were considered:

- Did the virtual environment enable the participants to compose a satisfactory music piece?
- Did the virtual environment enable the participants to utilize the metacognitive dimensions?
- What were the participants' perspectives regarding composing music through the online learning activity?

## **Method**

### **Participants**

Experienced musicians were involved in the online learning activity. In this way, it was possible to compare previous face-to-face composition experiences with the current online composition experience. The participants ( $n = 3$ )

included the following three musicians: Marco (guitar), Matteo (bass guitar), and Paolo (computer/keyboards/vocals). All the participants were Italian, and had prior experience with formal instrumental music instruction in private music school, and a music conservatory. The participants had approximately twenty years of experience in performing in rock bands, and their ages ranged from 37 to 39 years (mean age 38). The participants are members of the band Reeta Pawone, which was formed in 2001. The music genre performed by the participants was electronic rock, a form of rock music that involves the use of computers, and other electronic instruments to generate sounds. The group has recorded two CDs, and is working on a third. One participant was studying at a university in the northern Italy at the time of the research.

## Equipment

Moodle was used as a platform for the online activities, and an e-learning environment was designed to work both asynchronously and synchronously. The tools that were used for working asynchronously included a database, a blog, a diary set up as a wiki, and several forums for discussing ideas related to composing music, the music content, and technical issues. In addition, the following software was used for the synchronous activities: ooVoo for video and eJAMMING for audio. ooVoo software was adopted because it allows for a real-time video connection of more than two people. However, the audio quality of ooVoo is poor for music making, and for this reason, eJAMMING was used for the audio. A Dropbox database was used to upload, and share the live rehearsals. The participants used PCs with webcams to interact with one another.

## Procedure

The task assigned to the participants was to collaboratively compose a new piece of music that could be used for their repertoire within the online environment. No style or genre constraints were imposed. The proposed task is an authentic activity for musicians, and is not an artificial experimental task. This design provided ecological validity to the study, and offered a meaningful and motivating activity for the participants (Kump, Moskaliuk, Dennerlein & Ley, 2013).



Figure 1. The participants while working, and ooVoo screenshot (lower right)

An online tutor was available on the platform. During the virtual work, the participants had to respect the following rules:

- Compose a new piece of music, not a rework of a previous piece of music.

- Perform the work online and in the designed platform only. Do not discuss the new piece of music on the phone or in the presence of another.
- If you are working individually, please take notes and inform the other participants of your work through the platform. Please use the forums and the other tools for these purposes, and consider that you can also upload additional multimedia files to the platform if necessary.
- Keep a weekly diary of the work progress in which all the participants can contribute with their observations. The diary is set up as a wiki tool, so everybody can integrate or modify the text.
- Immediately inform the tutor about any inconvenience or technical problem.



Figure 2. ooVoo images

The participants worked asynchronously on the platform to define general aspects, exchange ideas, and develop the composition process. In addition, the participants interacted synchronously to experiment with their ideas in four real-time sessions of approximately ninety minutes each, as shown in Figures 1 and 2. The online activities took place over a period of approximately two and a half months.

### **The semi-structured interviews**

At the end of the activities, the researcher conducted individual semi-structured interviews with the participants to collect their reflections on the learning experience. Broad questions were proposed to the participants to provide them the opportunity to describe, and assess their experiences. Any further problems raised by the participants were investigated through additional questions. The following questions were proposed:

- How did you collaborate during the online activities?
- What role did the members have during the online activities?
- Please indicate the differences between composing music online, and composing music face-to-face.
- What were the benefits of the online collaborative activities?
- What were the disadvantages of the online collaborative activities?
- What were the most, and least useful tools provided by the online platform?
- In what way were the blogs, diaries, and forums helpful?
- What kind of problems did you have, and how did you resolve them?
- What new perspectives did you develop from collaboratively working online?

The semi-structured interviews were audio recorded and transcribed verbatim for analysis. Before the results are presented, it may be helpful to provide a description of the virtual activities to explain the tasks involved in the online collaborative activities.

### **Description of the online activities**

During the online activities, the participants actively collaborated through experimentation by sharing and discussing ideas, composing and performing music, assessing the composition, and making decisions together. The participants were engaged in a collaborative process in which their ideas were rehearsed and discussed. The work started with listening to music by other rock bands online followed by a discussion. The aim was to draw inspiration from listening to the atmosphere of music by other bands, and to define general aspects of the musical piece to be

composed. The live sessions started with improvisation, which provided a way for the participants to experiment with their ideas, and musical material. Paolo then proposed a backing track facilitated by a computer, and the participants improvised over the backing track. Paolo manipulated the backing track on the computer during live composition sessions, and the other musicians developed their ideas for their tracks. All the video and audio recordings of the live sessions were uploaded on the platform and reviewed by the participants. The participants exchanged ideas on the platform about the improvisations and the musical material developed during the sessions, offering new ideas and discussing other aspects related to the music. The participants then evaluated the various sessions, and collectively decided what to select and how to develop the musical material to be included in the new music piece.

The participants interacted online via the platform among several different forums, a diary (activated within a wiki resource), and a blog. A screenshot of the composition discussion forum is provided in Figure 3.

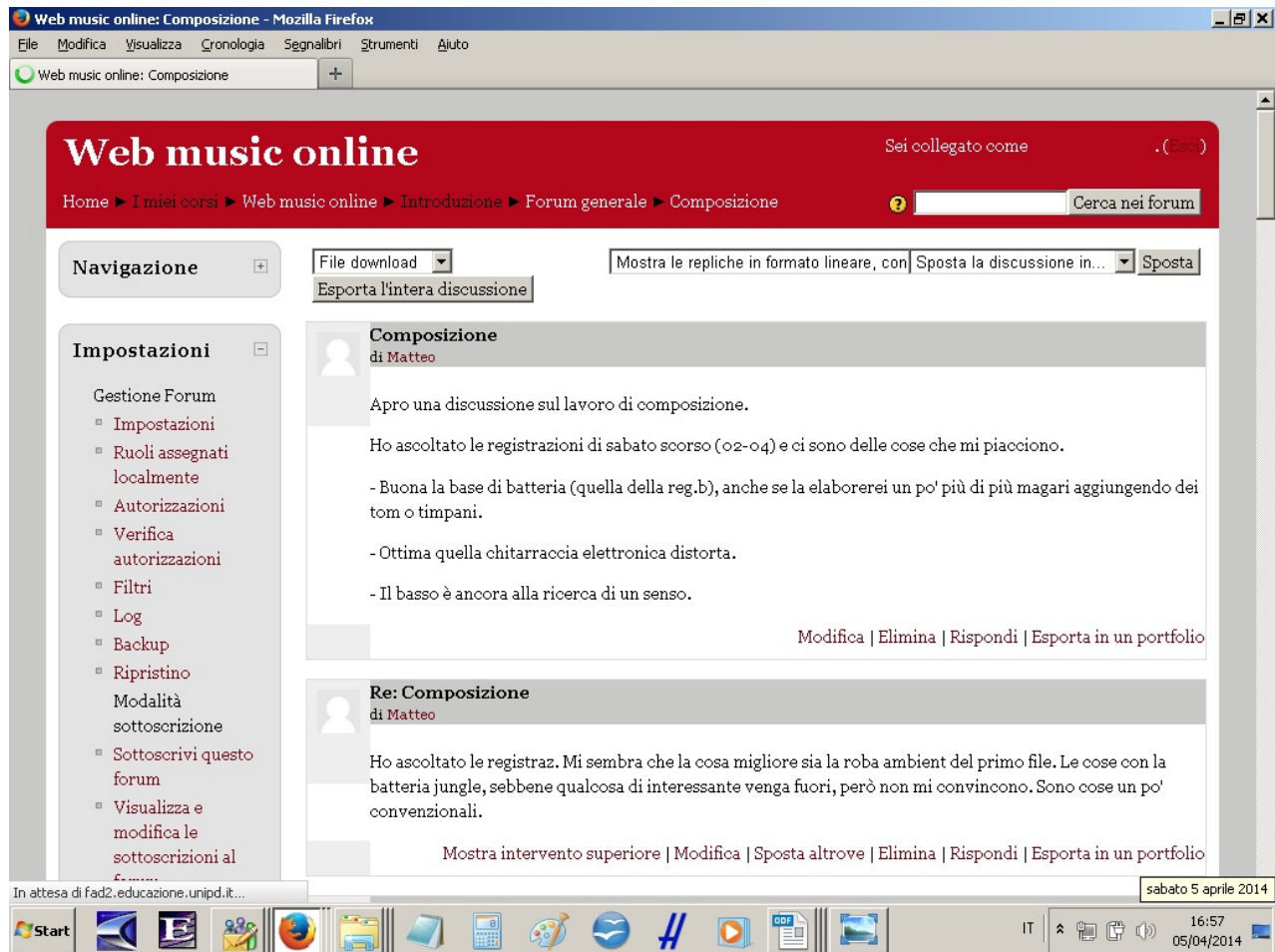


Figure 3. Screenshot of the composition discussion forum

The platform was useful to plan the work, organize virtual meetings, discuss technical issues, develop the composition process, and share feelings. Regarding the forums, the participants established the following seven forums: Listening, software for online performance, session planning, composition, instruments, technical, and events. Although the forums had different names, the topics overlapped because, e.g., composing issues were discussed in both the composing forum, and the listening forum. A detailed description of the online interactions is reported in Table 1.

The final piece was recorded live during the last session. It was constructed with layers of sound, consisting of musical “loops” over which the participants played their instrumental parts. The final piece was not written down in a formal way but was recorded on multi-track software.

*Table 1. The online interactions within the platform*

Online resource	Interventions	Content description
Forum: Listening	59	Links to music by other rock bands for drawing inspiration, and listening to the atmosphere of other music; detailed comments on the music; proposals of demos.
Forum: Software for online performance	7	Characteristics of the software for online performance; passwords; comments on the functionality of the software; and technical problems such as the latency of Internet streaming.
Forum: Session planning	29	Planning of the synchronous (real-time) sessions; appointments for the sessions (synchronous activity); discussions of technical resources; suggestions for improving the organization of the composition activity.
Forum: Composition	20	Comments on and detailed evaluation of the live sessions performed by the group; proposals for selecting and organizing the material; proposals for modifying sounds, and parts of the music piece.
Forum: Instruments	3	The musical instruments that were available for the overall project, and the instruments that the musicians intend to use during individual sessions.
Forum: Technical	11	Discussions about the technical set up and technical problems.
Forum: Events	7	Events and concerts by other rock bands.
Blog	1	Personal feelings.
Diary	12	Descriptions of how the activities proceeded, including personal comments.

## Results

The data consisted of discussions on the forums, transcripts of the semi-structured interviews, and video recordings of the synchronous sessions. For the purposes of this paper, only the forum discussions, and semi-structured interview transcripts were considered.

### **Analysis and results of the forum discussions with respect to the metacognitive dimensions**

The Akyol and Garrison’s (2011) framework has been used to analyze the forum discussions. Accordingly, the analysis focused on the following three metacognitive dimensions described in the theoretical background section: Knowledge of cognition, monitoring of cognition, and regulation of cognition. The coding process was later validated by an independent researcher who separately checked the coding to ensure that the coding actually reflected the metacognitive dimensions considered. The following quotes are coding examples for each of the dimensions of metacognition.

#### *Knowledge of cognition*

...I think, the use of the computer especially when you do electronic music, allows you to create music more focused on the sound rather than music designed to be arranged.

...Conversely, the advantage of the PC is to give you an opportunity to experiment with sounds.

...I would use this tool in the future, at least in the process of composing music, and for preparing the material.

...Music on SoundCloud more and more allows you to break down the song form, to get a sense of sound pieces but without a clear beginning and end.

### *Monitoring of cognition*

...Pleasant creation of a carpet of sounds with a minimal rhythm section.  
...Yes, but we are adding ideas on ideas...  
...Next time, it would be better to do a more analytical job, because improvising goes well, but then you have to synthesize.  
...The rhythm section is still quite rugged.  
...It would be worth considering in detail various parts because the general idea is clear, but we have to arrange it in detail.

### *Regulation of cognition*

...Why you do not like the drum at 3' 57"??  
...Drum: First and second parts. Paolo, can you change the sound of the snare? Something more soft,...  
...But, I am more interested in collecting your impressions...  
...I must admit that I did not get your points...  
...Listening to various music pieces with you, I understood that...

## **Analysis and results of the semi-structured interviews**

The transcripts of the semi-structured interviews were analyzed by using an inductive method based on grounded theory. An adaptation of the constant comparative method, which has been successfully used in previous qualitative studies (Biasutti, 2011, 2013), was used. The following five phases were adopted: (1) immersion, in which all the discernibly different behaviors are recognized; (2) categorization, in which categories appear from the discernibly different behaviors; (3) phenomenological reduction, in which themes come out from the categories; (4) triangulation, in which supplementary elements are used to sustain the researchers' interpretations; and (5) interpretation, the final step in which a complete explanation of outcomes is provided in connection with previous research and/or models. In the immersion phase, the transcripts were read several times to acquire a high level of familiarity with the raw data, and then, the discernibly different answers were identified. In the categorization phase, similar behaviors were sorted into similar categories, and 17 distinct categories emerged from the discernibly different answers. Four themes were derived from the 17 categories during the phenomenological reduction phase: teamwork, the platform, face-to-face/online differences, and strengths/weaknesses. A diagrammatic version of the first three phases of analysis for the semi-structured interviews is provided in Figure 4.

Support for the researcher's interpretations of the themes was provided through the process of triangulation. Examination of the semi-structured interview transcripts and forum interactions indicated that the participants independently referred to the researcher's interpretations of the themes. The data supporting the process of triangulation are reported in Table 2.

The coding of the semi-structured interview data was later validated by an independent researcher who separately checked the data coding. The original researcher and the independent researcher discussed any possible disagreements related to the coding. Changes to the original coding were made accordingly. Below, detailed descriptions of the emergent themes are reported.

*Table 2. Supporting quotations for the themes of the semi-structured interviews*

Themes	Supporting quotations	Interpretation
Teamwork	"Performing the instrument for the electronic programming, Paolo has a structural role..." "We have revised the various parts in a sequence that was shared by all of us." "Working in groups is positive for creativity"	These quotations support the interpretation of a teamwork theme because the participants refer to roles and collaboration during the collaborative activities.
Platform	"The most interesting thing was the use of the forum..." "...the diary was used primarily by me,..."	These quotations support the interpretation of a platform theme because the participants evaluated specific aspects of the online



Face-to-face/online differences	<p>“No problem with the platform, it is easy to use”</p> <p>“Certainly, the online work was more flexible.”</p> <p>“The online work was more systematic, better organized.”</p> <p>“Working online made the process followed during the development of the musical material more explicit.”</p>	<p>environment.</p> <p>These quotations support the interpretation of a face-to-face/online differences theme because the participants compared the face-to-face modality with the online activities and processes.</p>
Strengths and weaknesses	<p>“The advantage of working online is the possibility to operate within my own home environment,...”</p> <p>“From the point of view of time, it is a big advantage to work online.”</p> <p>“There were no disadvantages for my part, with the exception of the feeling of a lack of something compared to the normal sessions in a physical place,...”</p>	<p>These quotations support the interpretation of a strengths/weaknesses theme because the participants referred to advantages and disadvantages of the online work.</p>

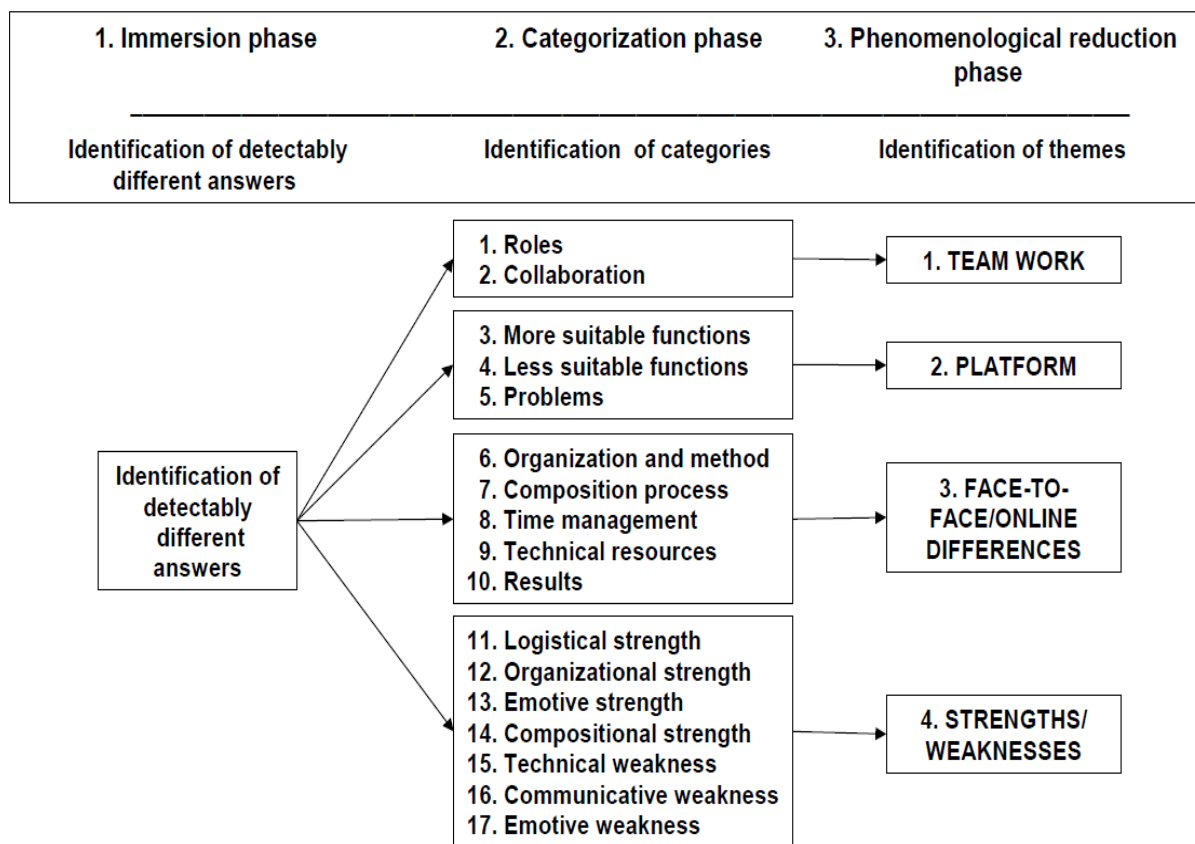


Figure 4. Diagram of the three phases of analysis for the interview data

### Teamwork

The participants considered teamwork to be essential during the online activities, and the coding process revealed the following categories: roles and collaboration. Regarding roles, the participants acknowledged that they have particular roles in making music, and each participant had his/her own specialty. Paolo uses a computer, and his role is to define the structural part of the piece and to design the backing track, while Matteo and Marco focus more on the sound and the music phrases to be arranged onto the backing track. Matteo is more proactive than Marco in composing the music, while Marco focuses more on the sound effects of the guitar. According to Matteo,

“Performing the instrument for the electronic programming, Paolo has a structural role. The construction of the music piece then revolves around the various proposals and ideas. I think Paolo and myself were more proactive, while Marco was less purposeful because he spends more time on the sounds.”

Collaboration was a key aspect at all stages of the online activities from the generation of ideas to the composition of the music. The collaboration developed through virtual discussions and activities, and the participants exchanged ideas and shared decisions in a democratic setting, “Together we contributed to the production of the musical material... (Paolo).” “The arrangements were developed following a series of discussions between the three of us in relation to the material produced with the improvisation... (Marco).” In addition, the collaboration involved sharing ideas and principles, “The samples produced during improvisation were then reprocessed...on the basis of exchanged impressions in the forum after listening (Paolo).” “We have revised the various parts in a sequence that was shared by all of us... (Paolo).” These quotes highlight the collaboration that occurred during the online activities, and the creative learning environment that was established. The discussions enabled the participants to clarify their thoughts, and to make relevant decisions when composing the music piece. The participants were considered equals, and the virtual learning environment facilitated egalitarian participation, as reported by Paolo, “The online situation has permitted a more horizontal process, and less binding to the original proposal.”

### *Platform*

The platform was deemed functional, and several useful tools for the online work were highlighted by the participants. The related categories included more suitable functions, less suitable functions, and problems.

The discussion forum and the database used for uploading the session recordings were considered to be the more suitable functions of the platform. The forum gave continuity to the composition process, as reported by Paolo, “The most interesting thing was the use of the forum that gave me a sense of continuity while working, which is lost in a face-to-face situation. Face-to-face, when we finish the sessions, “we pull the plug,” and everyone reworks the material on his own.” Thus, the forum constituted a tool that helped the participants share their opinions, and more explicitly reflect on the process. The platform further strengthened the sense of community through practice based on collaborative work. Sharing recordings was important because it enabled the participants to listen, and identify fragments for potential revision.

The participants identified the diary as a less suitable function of the platform. Specifically, the diary was not considered particularly useful for articulating the work, as reported by Matteo, “Well, the diary was used primarily by me, then, seeing that the others were not very attracted to this thing...I have not used it a lot.”

Regarding problems, the encountered issues were mostly technical, e.g., related to the availability of broadband Internet, as a very powerful connection was required for the synchronous sessions.

### *Face-to-face/online differences*

The participants shared their opinions regarding face-to-face versus online interaction for composing music. Specific aspects of the online work, for instance, related to the organization of the work and work method, the composition process, time management, technical resources, and the achieved results, emerged.

Regarding the organization of the work and work method, it was reported that working online is more systematic than working face-to-face. As Paolo stated, “The online work was more systematic, better organized.”

Regarding the composition process, the participants stated that it closely resembled face-to-face collaboration with respect to the basic operations, although there were differences in the overall process. Moreover, the basic principles that were followed to compose the music piece and the efforts to produce the musical material were considered to be similar in between two different settings, “I think we set up the online work more or less like the one we set up face-to-face, where a large part of the exchange of opinions, ideas and suggestions is via email, SMS, or phone. Here, we have been working exclusively online (Marco).” However, it was reported that the online tools facilitated the comprehensive composition process, and the development of a metacognitive dimension. As Paolo asserted, “Working online made the process followed during the development of the musical material more explicit.” This

statement demonstrates that the online environment enhanced the participants' reflection on, and awareness of the performed task.

Working online also increased the flexibility of the work, and facilitated time management. As Matteo reported, "There was definitely better time management due to the fact that everyone needed to make fewer trips with equipment, tools, etc."

The technical resources and technology involved in working online were deemed to be more developed than those in a face-to-face setting because the online setting required a fast Internet connection to minimize the latency of the signal transmission during the synchronous sessions. As Paolo stated, "Good communication requires a telecommunications system that can offer a good capacity for data transmission. For the rest, it does not require additional technical resources than those used in face-to-face situations."

With regard to the achieved results, the participants expressed satisfaction with the work performed. As Marco noted, "I am personally satisfied both with the music piece, and with the online experience....The music piece is a bit different from what we have composed so far, more ambient, almost as a kind of soundtrack....Interestingly, the music offers good suggestions on what to experiment with in the coming months." Matteo, however, encountered difficulties in making aesthetic comparisons between the composed piece, and their previous pieces, "It is difficult to compare this music piece with the previous ones...; we should make others in this way, and then you could make a comparison with those made previously in a face-to-face situation....Anyway, I am pleased with the finished composition, and also with the experience. Results fully achieved."

#### *Strengths/weaknesses*

The participants indicated that the online process entailed logistical, organizational, emotive, and compositional strengths, as well as technical, communicative, and emotive weaknesses.

Regarding the logistical strength of the online process, Paolo stated that "the advantage of working online is the possibility to operate within my own home environment, without having to move my equipment." Regarding resources, Marco remarked about "the opportunity to have a whole range of instruments and materials that you may not have in an external rehearsal because they are at your home, and not in the rehearsal room." Similarly, Matteo recognized "the opportunity to have access at any time to the archives, and your instruments. Because we do not have a dedicated rehearsal room, at the end of each session, we must move all the stuff. This is the reason that many times we do not bring with us things that maybe could have been useful during the session."

In discussing the organization of the online process, the participants unanimously expressed the advantage of being able to individually manage their time, "Surely the possibility to optimize time, and space (Matteo);" "the possibility to make the most use of your time (no movement, no downtime) (Marco);" "the possibility to work without space-temporal or practical constraints."

Regarding the emotive strength of the online process, Marco reported that a more comfortable situation occurred by rehearsing at home, "working at home, I have developed a greater feeling of tranquility."

Regarding the composition process, the participants noted that working online was more reflexive than working face-to-face. Indeed, the online environment affected the overall composition process by facilitating the stylistic elaboration of the material, as reported by Matteo, "The impression is that there is a continuity of style while composing online." Moreover, the participants developed a more logical approach to composing music based on systematic reflection. As Paolo reported, "I had the feeling of working in an arranged, perhaps even more logical way: improvisation, discussion, and processing." The online collaborative work further opened several operational perspectives. For example, Paolo stated that "there is the possibility of enlarging in a theoretically infinite way the possibility of exchanging, and processing the musical material....From a compositional point of view, this was a new perspective that opened an exciting new dimension for me." In addition, Matteo reported that "having a virtual interaction opens a new window for creativity development; this is very positive."

The technical disadvantages that were noted in the online collaborative process included some latency in the signal transmission online. Such latency created an aerial effect that was appreciated by participants. However, it was not possible to work on very precise rhythmical solutions within such circumstances. As Matteo asserted, "...while in a situation like this one, where maybe you have even a little latency, you cannot be very precise, although the program works very well,...but you may be stimulated to work on the atmosphere of the music....I mean, it developed better...Face-to-face..., you have more possibilities to use the rhythm than here...." Another technical disadvantage related to the audio volume, which could not be as loud in the online sessions as in face-to-face sessions, and this lack of power influenced the participants' feelings associated with the music. As Matteo reported, "Concerning the rhythm, for example, in a face-to-face situation, you feel it more, because the sound comes out more aggressively since you have a more powerful amplifier in front of you."

Regarding communicative disadvantages, Marco noted an aspect of visual communication, "Sometimes, it was difficult to interact visually or gesturally. In addition, when listening to what was done previously, it was sometimes hard to understand when the other participants were listening or when they were interacting with the music, perhaps re-improvising on ideas already expressed."

Regarding the emotive weakness of the online process, Paolo reported feeling a lack of physical presence during the online sessions, "There were no disadvantages for my part, with the exception of the feeling of a lack of something compared to the normal sessions in a physical place, at least for the performance aspects."

Regarding how to improve online collaborative work, the participants identified the systematic nature of the work, "We must be more systematic during the elaboration of the material; some ideas are often left out too quickly. However, this is also related to a compromise between the need to produce the material, and the time available (Paolo)."

## **Discussion**

Regarding the first research question, the online environment was considered effective because the participants were able to compose a new piece. Moreover, the participants positively evaluated the experience, and the new music piece, indicating that collaborative composition activities can be performed in virtual environments. This result extends findings reported by previous research regarding the use of ICT for composing music.

Regarding the second research question, the results showed that the participants engaged in metacognitive processing during the online composition activities. The online work proceeded at a metacognitive level, and the participants were stimulated to reflect on their actions, and decisions. As noted in Matteo's diary, "The work goes on, and we are now mastering the technological resources; therefore, we focus on creativity." This quote provides evidence that the online learning activities stimulated the development of higher-order cognitive abilities in the participants, which is consistent with previous findings reported by Biasutti (2011), and Lin and Jou (2013). In addition, the metacognitive analysis conducted with the framework developed by Akyol and Garrison (2011) provided evidence that the participants reflected on their knowledge, evaluated the progress of the activities, and regulated their cognitive resources based on the roles of their bandmates. These findings are in line with Akyol and Garrison's (2011) results regarding the distinct metacognitive dimensions. The online learning activities also stimulated cognitive processes in the participants, as they made aesthetic evaluations, synthesized different perspectives, and developed critical thinking skills. This result is consistent with the findings of Tseng and Yeh (2013), who reported that processes associated with teamwork can promote critical thinking skills in students. In the current research, the participants reported that the online environment allowed them to develop an even more logical approach to music composition based on orderly reflection than the face-to-face setting, as the online environment allowed them to organize their activities, and supported them in composing the music piece in a sequential fashion.

Regarding the third research question, the participants identified components relevant to the online composition experience. These included teamwork, the platform, face-to-face/online differences, and strengths/weaknesses. The platform was considered useful for planning the work, organizing online meetings, discussing technical issues, developing the composition process, and sharing feelings. Indeed, collaboration and teamwork were considered key components of the online work (Donnelly & Boniface, 2013; Tseng & Yeh, 2013). Other comments related to the

organization of the work and work method, time management, and technical resources. The participants also noted strengths and weaknesses of the online experience. These strengths and weaknesses can be exploited to provide guidelines on how to utilize online tools more efficiently to support future research projects involving composing music in an e-learning setting.

The findings of the present study contribute to a better understanding of the usefulness of collaborative online environments and resources, and reveal certain aspects of the virtual setting that render online collaborative activities efficacious for learning. These aspects include the opportunity for collaboration, the dynamics of the group, and the use of appropriate technology (Biasutti, 2011). In addition, in line with Tseng and Yeh's (2013) findings, other aspects, such as individual accountability, familiarity with team members, commitment toward quality work, and team cohesion, were found to affect the online collaboration process. Overall, several factors affected the online collaboration process, including the learning environment, the platform, the technology resources, the level of challenge, and the nature of the activity.

The learning environment was important for the online collaboration process because it was simple yet effective, and because it offered the participants an opportunity to collaboratively work online. The participants interacted continuously while composing a piece of music, showing commitment to the task.

The platform provided support for the online collaboration process and facilitated collaborative work and actions such as sharing during listening situations, as well as discussing and developing a cooperative decision process. The platform fostered a sense of community based on cooperation and collaboration, as reported by Donnelly and Boniface (2013). The participants felt reflective, and actively engaged in the composition process, demonstrating commitment and responsibility (Tseng & Yeh, 2013).

Regarding technological resources, the software programs that were used for the synchronous sessions performed satisfactorily, and full access to necessary resources was a key aspect of the effectiveness of the online activities for composing music. Indeed, previous studies have demonstrated that adequate technical solutions are crucial for achieving high-quality results (Valentín, et al., 2013).

The participants noted the challenge of the activities, and they were actively engaged in performing the activities. As Matteo noted, "Working online is a new and exciting experience...; performing online is particularly challenging and compelling for its employment of technology." This quote demonstrates that the online activities were considered challenging, and that they effectively stimulated the involvement of all the participants, as occurred in the study by Seddon and Biasutti (2009).

With regard to the nature of the activity, the assigned task — to collaboratively compose a music piece regardless of style or genre constraints — was simple and useful, and allowed the participants to interact naturally in the virtual environment. The task was an authentic activity for musicians, and the use of authentic activities is crucial for facilitating collaboration within virtual settings. The nature of the learning environment was also important, as online activities should be performed in a realistic setting (Kump et al., 2013). The authenticity of the activities strengthened the ecological validity of the study, and stimulated the involvement of the participants. Moreover, the open-ended nature of the task facilitated the development of collaborative work, motivating the participants to achieve at least a functional level of cooperation. The flexible work schedule was another relevant aspect, as it allowed the participants to feel more comfortable in making decisions about the work activities, which is consistent with Seddon and Biasutti's (2009) results. Other elements such as constant interaction, deep involvement, and collaboration among the participants were crucial for rendering the online activities effective, as reported by Tseng and Yeh (2013). In addition, Anderson and Simpson (2004), and Seddon and Biasutti (2009) have reported similar findings, highlighting the effects of the instructional design on the interactions among participants.

## **Conclusions and future work**

There are several limitations to the current study. The results must be considered in relation to the study's exploratory nature because only one music group was involved. Because of the limited number of participants, it was not

possible to include quantitative methods, so only qualitative methods were used. The findings provide some insights into a possible methodology for evaluating the online tools within a virtual setting. However, the generalizability of the results is limited by the study's methodological design. In the future, it would be interesting to design a study with a larger number of participants to increase the validity of the results. Another limitation pertains to the assessment of the final product, which was not evaluated by external experts. The music piece was only evaluated by participants, who were satisfied with the final output.

The results of this study have implications for research on online music composition, and suggest the need for further research on the nature of the processes involved in online music composition. The virtual environment used in the study was effective for fostering online music composition, and could be applied to develop online music composition projects involving participants from different parts of the world. Regarding the technical implications of the findings, the synchronous resources were important tools for developing ideas through improvisation, and they allowed participants to collaboratively compose their music piece. In further research, it would be interesting to expand the use of asynchronous software for collaborative online music composition in wiki environments, and to evaluate their effectiveness. In addition, other music genres, such as contemporary and electronic music, could be considered.

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