LO-C(L)A(S)P: a Model for Supporting the Development of Learning Objects with Sound Manipulation and Social Resources for Music Education

ABSTRACT

In this paper we describe a model for supporting the development of learning objects that are closer to the music domain and to the student's digital social reality. A case study considering a music education activity, which was created using the proposed model, was conducted with high school students to demonstrate the applicability and benefits of our approach. Results show the importance of considering the proposed model on guiding courseware development for music education. Moreover, it was noticed that students perceive social and sound integrated resources as important elements on their learning process.

Keywords

Music education, learning objects, instructional design, C(L)A(S)P model, social networks, collaborative learning

INTRODUCTION

Music Education presents some specific characteristics such as sound and social interaction that demands reviewing learning environments and new strategies for developing learning content. Sound is a fundamental element for music cognition and for the learning process of a music student (Serafine, 1988). In a questionnaire applied to 24 students from Music degree in a university asking about what resources they’d like to find and use in music learning environments, the majority of the students indicated resources related to video, videoconference, sound recording and score editing (Figure 1). This finding shows that students also want to work with sound manipulation tools in learning environments.

Figure 1 - Tools of the students’ interest in music education activities.
Other characteristic is the related to collaboration. Motivating social interactions between students is considered very important both on general Education (Vygotsky, 1962) and Music Education (Swanwick, 1979), since the process of students exchanging ideas with professors, tutors and each other builds learning.

Common collaborative environments used by students nowadays are the social network’s systems. A study conducted in (Smith and Caruso, 2009) with 30,616 undergraduate American students showed that 90.3% of them spend time every day using digital social network’s environments. In accordance to this fact, 96% of the undergraduate music students reported in the questionnaire we conducted the use of social network’s digital environments as one of the main reasons to use computers and other digital devices. Thus, the use of social network’s systems seems appropriate to be exploited on music education scenario to improve apprentices’ learning performance.

Therefore, it is important to offer sound manipulation resources in learning objects (LO), since students are interested on tools that are closer to the music domain and also that allow interaction. Consequently, it is important to build LO and environments that offer sound manipulation resources integrated to social resources, to help on music student’s learning process.

Problem

When traditional virtual learning environments are used, multimedia and interaction resources are not fully exploited. It is difficult to build educational resources that contain multimedia and rich interaction features. Courseware developers usually apply textual and low fidelity multimedia resources into learning material and use it in the music courses (Frosini, Mitolo, Nesi and Paolucci, 2008). These non-multimedia educational materials can make the student less interested to learning music, since this is a dynamic domain of study and depends on exploration and experimentation of concepts (e.g. play the musical instrument in groups).

When rich and interactive educational objects are used in learning environments, there are, in general, incompatibilities between the pedagogical proposal of the object and the education methodology used by teachers and tutors, which make the music learning process less effective (Alberich-Artal and Sangrà, 2012).

In addition, there is a lack of empiric studies focused on the use of computer as a support element to conduct a better learning on the music domain, like reinforcing collaborative strategies (Nikolaidou, 2012), or a better use of IT tools for music education.

Research Objectives

The learning success is very dependent of an adequate and effective courseware (Valentine, 2002). In accordance with this idea, the main goal of this work is to propose a model that simplifies the development of educational material with collaborative features and sound resources, also making them coherent with a constructivist approach often used by music educators: the C(L)A(S)P Model.

More than just help on the resource development, the proposed model would allow the LO to be closer to the music domain language and its semantic, integrating the pedagogic practice with the courseware production and helping teachers on the development of music educational activities. In agreement with Swanwick (1979), LO built with these directives would allow leading the students to a broader experience, making them to constructively acquire the musical knowledge that is necessary to their education.

We also want to apply the proposed model on the creation of a simple LO, to find out if the characteristics of the resultant material may affect the perception of the students about the LO acceptance, for instance identifying if the LO let students more interested on learning music and on using the it to explore music concepts.

Thus, the hypothesis of this research is defined as: if a model guarantees the development of LO integrating social and music manipulation resources, then the music students will perceive the social-multimedia resources as important characteristics to use the LO in their studies.

RELATED WORKS

In this section, we describe three attempts to organize music learning activities from the literature, focused on the use of multimedia and collaborative resources.

The VEMUS platform (Tambouratzis, Perifanos, Voulgari, Askenfelt, Granqvist, Hansen, Orlarey, Fober and Letz, 2008) is an environment focused on providing resources to support students’ performance through self-practicing. It offers tools to
allow hearing reference performances, recording student’s performance and automatic assessing them. Although the authors specify the architecture of the platform, which organize the way music activities are developed and used, there is no concern about LO developing.

In (Wen, 2010), Internet is proposed as a learning environment for music, since it provides multimedia content that may be individually and collaboratively explored. However, the focus of the work was on the learning strategy, and it lacks a specification of how to build LO for music education.

A survey was conducted in (Wei and Young, 2011) in order to detect which Web 2.0 resources the digital natives population of students wants to work with on learning environments for music. The authors noticed that students seem to somewhat agree with the use of Youtube, social networks, pod-casting and search engine resources, on this order respectively. However, the authors didn’t propose any model to develop LO based on their findings.

Despite the good educational results noticed by all these works, they are not concerned about measuring the music student acceptance of the proposed platforms and strategies.

THEORETICAL BACKGROUND

In this section, we briefly present some concepts used in this paper.

Learning Objects

The educational material used in learning environments may be created using one or more learning objects. According to Wiley (2002), learning object is any digital resource that can be reused to support the learning process. They may be large or small resources, depending on the size of their contents, and also can be combined together building other learning objects (Wiley, 2002).

Collaborative Learning

The main idea of collaborative learning is to encourage students to work together, making themselves responsible for their own learning. In this situation, the knowledge is built through explanations, debates, rationale argumentation, which provoke exchanges of experiences among all participants (Castro and Menezes, 2011). The dialog among students is fundamental in collaborative learning. It is the dialog that allows to share ideas and to consolidate complementary points of view.

According to Crook (1994), one of the benefits Information Technology brings to Education is the support for learning styles, such as collaborative learning. A model that uses the philosophy of collaborative learning is the C(L)A(S)P Model.

The C(L)A(S)P Model

The C(L)A(S)P model (Swanwick, 1979) is a constructivist model for music education. It emphasizes five parameters that are crucial to learning music: C – Composition, A – Audition, P – Performance, (L) - Literature and (S) – Skill Acquisition. Composition (C) can be performed through learning activities and practices that encourage music extemporization and creation. Audition (A) is related to hearing music with varied aesthetic, cultures and periods. The parameter Performance (P) is addressed in the practice of a musical instrument, involving interpretation and specific skills.

The parameter Literature ((L)) introduces the historical and theoretical context of music compositions and periods, besides the musicological analysis. The parameter Skill ((S)) refers to the development of abilities that are necessary to a musician, such as ear and rhythmic training, group practice and specific knowledge that are necessary for a particular instrument.

The music teacher must favor the main parameters (C, A and P) in the educational activities, over parameters (L) and (S). However, (L) and (S) must also be present in the learning activities because they aid mastering the main parameters. Swanwick (1979) proposes that the parameters C(L)A(S)P must be linked by the teacher in the educational activities.

In addition to the hierarchical division of the parameters C, A and P over (L) and (S), respectively called Category I and Category II, there is a third category that must be taught in an musical activity: the interaction among the participants. This interaction occurs through the exercise of collaboration between students and teachers during the proposed activities.

We believe that C(L)A(S)P model is adequate for being applied to computer supported music education due the possibilities of interaction and multimedia manipulation that computers offer in addition to social network’s systems already used by the students.
THE LO-C(L)A(S)P MODEL

To support the development of LO for music education and address the problem of creating social-multimedia objects to this domain, we proposed a model called LO-C(L)A(S)P. It focuses on guiding courseware developers to build collaborative and multimedia learning objects for music education. It is based on C(L)A(S)P model, which allows courseware developers to think since the beginning in musical and collaborative aspects. In this section we describe this model and show how to create a LO according to it.

The Big Picture

Figure 2 presents a schematic representation of the LO-C(L)A(S)P model.

Figure 2 - The LO-C(L)A(S)P Model

The model considers the creation of a repository of resources (C(L)A(S)P resources or atomic LO) that are categorized according to the C(L)A(S)P parameters. It is allowed to categorize one resource on more than one category at the same time. Some examples of resources are: an audio playback tool (A), a score editor tool (C, A and (L)), video recording tool (A, P and (S)) and so on. These resources can be combined into LO that are more complex (LO based on C(L)A(S)P). Then, these complex LO can be used in the development of music education activities.

In order to provide interaction features, related to the Category III of the C(L)A(S)P model, the repository also contains the social resources. As shown on Figure 2, the resources that are classified in this category communicate with existing social networks, e.g. Facebook, requiring or sending social information such as data about a user or his friends, news feed, like button etc.

Some Developed C(L)A(S)P Resources

Ten resources that were developed according to the LO-C(L)A(S)P model are showed and categorized in Figure 3, numbered in red from #1 to #10.

Before we describe these resources, it is important to address a common element - the sound source - that links all resources that handle sound. Three different types of sound sources could be considered: synthetized, obtained from audio input (e.g. microphone) or retrieved from an audio file. In the repository, the resources must share one or more sound sources in order to synchronize their use and data with all running LO. Sound sources are not shown in Figure 3 since they are not resources directly handled but they depend on a C(L)A(S)P object to be used.

Despite the three types of sound sources, we considered only the synthetized sound source in this paper, in order to simplify the comprehension of the sound manipulation concepts used in LO-C(L)A(S)P model. The basic element for the creation of
the synthetized sound is the oscillator, which is a source who oscillates in a determined frequency, producing a sound. Then, it is possible to apply some effects and to combine different sounds, producing new ones. The oscillator acts as a unity of sound for the resources described in this paper.

Figure 3 - C(L)A(S)P resources available in the example repository

The oscilloscope (resource #1) shows an animated sound wave corresponding to the frequency generated by the oscillator. It is categorized as a ((L))iterature resource because of its theoretical function (to exhibit the sound wave according to the sound that is produced by the sound source).

The resource #2 is a diatonic note switcher that allows choosing one of the diatonic system notes – C, D, E, F, G, A and B. On choosing a diatonic note, the resource changes the oscillator to the frequency that corresponds to the chosen note. It is categorized as a (C)omposition resource because it allows the creation of melodies with successive switches, and also as an (A)udition resource, since it allows the student to listen the selected note.

The resource #3 is called pitch control. The pitch is how we perceive the frequency of the sounds. The student can use the pitch control to freely change the sound frequency. Similarly to resource #2, the pitch control is categorized as a (C)omposition and an (A)udition resource.

The resource #4 is a frequency display, which allows showing the oscillator frequency in a given moment. It is categorized as a ((L))iterature resource, since the frequency information is a theoretic data of the generated sound.

The recording control is represented by resource #5. It is composed of buttons that start, stop or clear the recording. Recording implies on capturing audio information from the oscillators and transforming them into the Wave audio format (.wav). It is categorized as a (C)omposition resource.

The resource #6 is a sound emission control for the oscillator. It is composed of two buttons: one to start sound emission and other to stop it. It is categorized as a (C)omposition and an (A)udition resource, because it allows the alternation between silence and sound that can be used by musicians on their compositions and also be appreciated by students.

The resource #7 allows recorded files to be downloaded or sent to the teacher. It is considered as an (A)udition resource, since it allows the audio file playback.

Three resources (#8, #9 and #10) were developed as Category III representatives. They communicate with Facebook social network environment, sending and receiving social information. The resource #8 allows students to post comments about a specific music education activity using the Facebook comment feature. The resource #9 allows students to “like” a musical
activity or to recommend it to a friend through the Facebook sharing feature. Finally, the resource #10 allows recorded audio files to be shared on Facebook. Since it is possible to listen the shared music study, it is also categorized as an (A)udition resource.

Resources presented on this section are only examples of the sound and social functionalities. The goal was to show enough resources to explain the building process of the LO that was used on the case study. However, it is possible to build a high variety of sound manipulation and social resources, linked to one or more sound sources and connected to other social network’s environments.

An Example of Learning Object

In order to demonstrate the use of the LO-C(L)A(S)P model on the process of creating a music education activity, a LO was developed. The learning objective was to understand the pitch parameter of the sound. Figure 4 shows a screenshot of this LO.

![Screenshot of a complex learning object](image)

Figure 4 - Screenshot of a complex learning object

Nine of the ten resources were used in the development of the LO. In order to use a resource from the repository, it is enough to copy the HTML code responsible for showing the resource manageable components and paste it on the body of the desired LO code, also written in HTML. Therefore, the LO developer doesn’t need to worry about calling internal JavaScript procedures of sound manipulation and social functions, or with the code for correct operation of the resource or even with images and visual formatting elements. Consequently, the LO development becomes easier. The resources were organized in four different areas.

The first area is located on the top-right part of the LO, where there are the resources for “like” and recommend the activity. In the second area, the two types of frequency control and the frequency display were added. The third area shows the oscilloscope, which varies according to the frequency chosen by the student using the controllers of previous area. Finally, the recording controls, the recording download and share buttons were grouped together on the forth area.

The LO described on this section is an example of a learning object that integrates the C, A, (L) and Interaction parameters, and it is coherent with the C(L)A(S)P model. An example of another LO with the available resources would be an object that could use more than one pitch controller. In this case, the LO would have two sound sources and, consequently, two
simultaneous sounds would be generated. So, the student could combine both sounds and study how to harmonize them. It illustrates the reuse possibility of the resources on the creation of a different LO.

**CASE STUDY**

To verify if music students perceive sound and social resources as relevant elements in a music LO, we used the LO developed according the LO-C(L)A(S)P Model in a case study. In this section, we address both the case study description and its results.

**Case Study Description**

The developed LO was used in a case study with 23 high school students in a basic music education class. The participants’ average age was about 15 years old.

The unit of analysis was the individual performance of the students’ music education activity using the developed LO plus the comment resource. The activity objective was to explore the concept of the sound pitch parameter. The learning objective was to understand that the higher the pitch, more acute is the resulting sound and narrower is the sound wave on the oscilloscope, and vice-versa.

Students used the LO during an entire week. Moreover, they were encouraged to post a comment, through the comment resource, explaining their understandings about the studied subject.

All students’ actions on the LO were monitored and recorded through automatized logs. The data for analysis were collected from these logs and from the student’s posted comments. Moreover, 13 students were interviewed. Due to the homogeneity of the participants – given by the common age, same generation, similar classes and knowledge – from the eleventh interview it was verified that the answers stopped giving us new information about the students’ perceptions. It means that a saturation point was achieved, which implies that the number of interviews was already enough (Guest, Arwen and Laura, 2006). From that point on, we’ve just conducted the already scheduled interviews, resulting on 13 interviews.

This research was registered on the school’s ethic research committee and duly authorized by the institution, by the students and their parents.

**Results**

The results were analyzed over three perspectives: (i) learning objective, (ii) quantitative and (iii) qualitative.

**Learning Objective Analysis**

An analysis of the 23 posted comments showed that the majority of the students tried to compare the manipulation of the pitch controllers with the variation of the sound wave drawn by the oscilloscope, understanding that more acute pitches have narrower sound waves. Only two students seemed to partially confuse the pitch concept with the intensity one, which represents the volume of the sound. But even these two students wrote partially correct comments about the pitch concept. Therefore, we considered that the majority of the students understood the concept.

**Quantitative Analysis**

Considering the manipulation of any resource as an action, the student that executed the lowest amount of actions but correctly commented about the concept was the base for comparison. He executed 36 actions on the process of understanding the pitch concept. 4 students (17%) made less than 36 actions and none of them posted comments about their findings. On the other side, 18 students (78%) made more than 36 actions and only 3 of them didn’t post comments. Among these 18 students, 7 have executed a number of actions between 40 and 100, 9 between 100 and 200 and 2 of them more than 200 actions. It seems to show that the majority of the students continued to use the LO even after a possible understanding of the pitch concept. The most used resource was the diatonic note switcher.

**Qualitative Analysis**

Through the qualitative analysis, we tried to verify the validity of our hypothesis. Data collected from the interviews showed four main concepts that may have influenced the use of the LO by the students: (i) learning opportunities, (ii) social influence, (iii) ease of use and (iv) hedonic motivation.
The first concept is the perceived learning opportunities. It can be defined as the degree a student believes the usage of LO can offer opportunities to learn the subject (Bourgonjon, Valcke, Soetaert and Schelles, 2010).

As we could notice, the majority of the interviewed students perceived the sound manipulation resources associated to the resource of sound wave visualization (promoted by the oscilloscope) as the characteristics that best offered learning opportunities. According to them, the understanding of sound parameters was facilitated by the experience of freely modifying and visualizing sound. Some of them already had studied the pitch concept but reported that had not understood it before the use of the LO. Therefore, this finding seems to fit in our hypothetical position, showing that the students perceived the sound resources as important elements in their learning process.

The second concept, social influence, can be defined as the degree in which an individual believe that other people think it is important to him to use a specific technology (Venkatesh, Morris, Davis and Davis, 2003). Adapting this construct to the context of music education, we understand the social influence as the student perception about how his colleagues think it is important to him to use learning objects in music education.

We noticed through the quantitative analysis that the social resources provided in the case study activities were not really used by the students. The recommendation given by the teacher to post a comment with the understanding of each concept was the main reason for the students to use the social resources. Only one student shared her musical studies in Facebook and “liked” musical activities and comments of her colleagues by her own will.

However, from the interviews, we could identify that sharing objects in Facebook seems to be quite related to what the students think their friends on the social network will like, i.e., to what their friends would think important to share. When asked if they would share musical studies recorded through the LO, the students indicated they would share the musical studies if they thought someone would be interested on the material.

Therefore, we identified that the social influence acts on the use of social resources provided by the LO-C(L)A(S)P model, such as sharing. We also noticed the use of social resources may be conditioned to the perception of social influence of each student. Thus, we believe that in a context where all friends are working with similar interests, such as in a study group, the students will perceive the social resources as important elements of the LO.

The third concept, ease of use, can be understood as the perceived degree of how easy it is to use the technology (Venkatesh et al., 2003).

From the interviews, we noticed that some of the students perceived the integration with the Facebook and commented that it was easier to understand how to use the available social resources due to this characteristic. Moreover, they said that the sound resources were easy to use and also that they would not use the LO if it was hard to handle. Hence, we can conclude that the students perceived sound and social resources as important elements by the ease of use perspective.

The last observed concept was the hedonic motivation. It can be defined as the perception of pleasure or fun derived from the use of some technology (Venkatesh, Thong and Xu, 2012).

From the interviews, many students perceived the manipulation of sound resources as a fun activity. In addition, many students said that they would recommend the LO to friends so they could learn music concepts in a funnier way. Thus, this finding seems to indicate that sound resources are perceived as important elements, by the hedonic motivation perspective.

CONCLUSIONS

This work shows the importance of using a model that focuses on the integration of social and musical features, and also guides courseware development for music education. The proposed LO-C(L)A(S)P model makes the categorization of music education resources easier, closer to the semantic of the music domain and also helps the content-maker on developing LO that are more coherent to the C(L)A(S)P model. Moreover, it ensures the use of resources that are closer to the basic needs of music pupils: sound and interaction. These characteristics assist both teacher and student on successful music education activities.

It is also important to highlight that the students understood the studied concept. According to motivational aspects, the use of the LO-C(L)A(S)P resources by the majority of students more than what would be necessary for their understanding seems to show that they motivate students to explore more the LO.

Furthermore, according to the qualitative analysis, it was possible to notice that the use of sound manipulation resources integrated with social ones influenced in the students’ perception of the learning opportunities provided by the LO. In addition, it was also possible to notice that social and musical resources, provided by the use of the LO-C(L)A(S)P model, positively affected students’ perception about ease of use and hedonic motivation. However, the use of social resources
deserves a special treatment. According to the social influence perception, the students would be more comfortable to use social features, such as content sharing and “like”, in controlled environments where the participants have the same interest, like study groups.

Thus, we may conclude that the integration of musical and social elements were seen by apprentices as important characteristic to their learning performance, which seems to confirm our hypothesis.

Future works may consider the development of a virtual learning environment that, together with the LO-C(L)A(S)P model, can offer more resources that are interesting (and important) to music education students, such as other sound sources manipulation, sound and score editing, and performance video recording. Likewise, they may also consider another interaction resources, such as real-time collaborative activities, audio and video instant communication and groups of interest for content sharing.

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