ISBN: 978-989-8704-08-5 © 2014

SELF-REGULATION COMPETENCE IN MUSIC EDUCATION

Luca Andrea Ludovico[1] and Giuseppina Rita Mangione[2]
[1]*Laboratorio di Informatica Musicale, Dipartimento di Informatica*
Università degli Studi di Milano, Via Comelico, 39/41 – 20135 Milano (MI) – ITALY
[2]*Università degli Studi di Salerno, Via Giovanni Paolo II, 132 – 84084 Fisciano (SA) – ITALY*

ABSTRACT

This work starts from a systematic review about music education and self-regulation during learning processes. Then the paper identifies those meta-cognitive strategies that music students should adopt during their instrumental practice. The goal is applying such concepts in order to rethink the structure of a didactic e-book for instrumental music education. Thanks to the adoption of the IEEE 1599 standard, the paper outlines a model of active e-book able to improve learners' performances through proper cognitive and multi-modal scaffolds. In the last section the design principles for an implementation will be proposed.

KEYWORDS

Self-regulation, music education, e-book, IEEE 1599 format.

1. INTRODUCTION

Music education for the young, particularly during *early childhood* (between the ages 3 and 8), requires a specific review of course curricula. An integration of multi-modal experiences based on activities such as moving, creating, playing, reflecting (Young, 2003) is required to train a *symbolically fluent child* (Jorgensen, 2002; Barrett, 2009).

The learning environment should be able to represent activity-oriented musical experiences, where students, properly sustained by scaffold elements, are involved in a process of music construction/deconstruction. For example, according to Tomlinson (Tomlinson, 2013), expanding or scaffolding children's early musical experiences and investigations, their engagement in the world of sound, their trans-modal redesign of known literature and song repertoire to communicate new meanings helps children establish strong, confident, vibrant, and creative identities in learning, communication, and performance.

Recent research results emphasized the importance of seeing and hearing children's perspectives, in order to embed children's voices within curricular choices (Griffin, 2009). The path to the music knowledge for young people requires a redefinition to allow them to influence and actively build the course of their studies, namely to negotiate their own pathways by remaking texts. An active interaction in education should engage learning processes for children through complex, authentic communication (Kress, 2004).

Children negotiate their own identities and pathways by remaking interactive texts and representations, catching in this way the essence of the alterations, transformations, musical arrangements and practices (Kress, 2013).

New digital technologies allow to imagine new ways to design and implement educational text, as well as new interaction possibilities. Traditional publications should be reviewed in order to make them usable from different perspectives and along different pathways. In particular, a guided content customization should be provided. Nowadays, the exploration-driven learning environments are particularly relevant for music theory and musical instrument teaching. These frameworks emphasize key ideas such as an interactive and progressive investigation, and the development of an intuitive and creative way of thinking, as reported in (Jorgensen, 2002).

These supports, if properly conceived and redefined, could endorse self-regulatory cognitive and metacognitive strategies. Unfortunately, e-books today have a linear structure with a single path through content, and the lack of choice reduces the possibility to control the learning experience. For the new generation, the innovative e-book has to be flexible, adaptive and dynamic in the order and way in which content is studied.

2. SELF-REGULATION AND MUSIC LEARNING

Education technology, i.e. the research field that investigates how to teach and learn through media, denotes the self-regulation capability as a crucial element to be considered when defining a learning environment (Chang, 2005). As stated in (Järvelä and Järvenoja, 2011) and ([Zimmerman, 2008), self-regulation is fundamental for a successful learning process since it helps students to create their own "method" and strengthen their study skills (Wolters et al., 2011), to apply the best strategies in order to reach their educational goals, to control their performance, and to evaluate their academic progress (de Bruin et al., 2011).

Learning, particularly when related to *conceptually-rich domains* (Azevedo, 2005; McMahon, 2002; Lin, 2001), requires environments which support activities of goal self-regulation, controllable and revisable also in a participatory way (Schunk, 2008). Recent works, such as (Schunk and Zimmerman, 2007), (Graham and Harris) and (Kistner et al., 2010), demonstrated that self-regulated students obtain better results as regards both motor and conceptual performances. Staring at teaching and learning from the self-regulation perspective has great potential in music education, and in instrumental didactics in particular.

Practising a musical instrument presents many challenges. For instance, students are required to practice over a long period of time, to focus on their goal, to face the threats typical of a competitive learning environment, to gather feedbacks in order to improve their performance, to overcome insecurity, to develop a psychological and behavioural toolkit against pressure and problems (Martin, 2008).

Music education experiences a high drop-out rate caused by students' sense of failure. Works such as (McPherson and Renwick, 2001) and (Pitts and Davidson, 2000) show that young music students are not methodical in their learning process. Like any other theoretical or practical discipline, music learning requires a good self-regulation attitude. Most indications come from a longitudinal research that investigated the evolution of 157 children practising a musical instrument between the ages 7 and 20 (McPherson and Renwick, 2011). Research results highlight the importance of self-regulation theory as a tool to support music knowledge and skill acquisition.

In order to gain ability to play a music instrument, the young student has to learn and apply a number of behaviours aiming at improving his/her own performances, such as: managing and planning exercise activity, promptly reacting to his/her performance or to external feedbacks (e.g. when practising in an ensemble),modifying and adapting strategies, adequately setting the environment, asking for help when needed, in order to access useful resources for learning.

Music mastering occurs when *ad hoc* scaffolds are provided to the learner, helping him/her to adopt self-regulated mechanisms to monitor and control performances (McPherson and Zimmerman, 2011).

With respect to other research areas about learning, only now the one related to instrumental practice is beginning to consider and apply the *self-enhancing cycle*, a key concept of the self-regulation learning theory. About self-regulation techniques young music students can adopt, the model by Zimmerman and Campillo (Zimmerman and Campillo, 2003) has been recently applied to the self-regulated problem-solving process. Three cyclical macro-phases are identified (McPherson and Renwick, 2011), as shown in figure 1. A detailed analysis of self-regulation cycle is fundamental to identify the proper scaffolds for active music e-books, as discussed in Section V.

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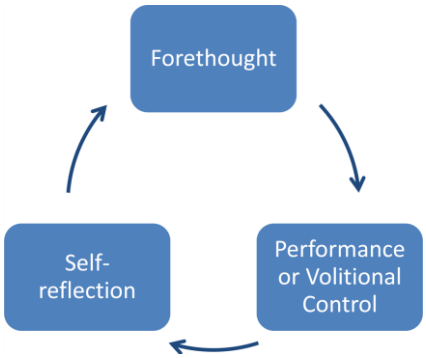

Figure 1. Cyclical phases of self-regulation.

2.1 Forethought

This phase is based on *task analysis* (goal setting and strategic planning) and *management of self-motivation beliefs* (self-efficacy, outcome expectation, intrinsic motivation) (McPherson, 2005). By autonomously defining medium- and long-term goals students can fix their own performance standards and become more motivated. Self-confident students are more effective in their learning efforts and do not give up when they have to face difficulties. Young musicians have to apply strategic learning behaviours (strategic planning) by identifying the most appropriate methods to accomplish a given task, without losing sight of the defined goals. An example of strategic planning for a musician is to stop performing warm up material from the printed score, and start playing the memorized text. Other strategies include hand annotations written on the score, or well-known techniques of *sight reading* (McPherson and Renwick, 2001).

The idea of self-efficacy is fundamental for a musician (Bandura et al., 1999), and it implies the self-recognition of being a good instrumentalist. This opinion interacts with the outcome expectations (Graabraek Nielsen, 2008), thus affecting the continuation of musical studies. Self-efficacy drives students to evaluate their performance not only on the basis of external rewards but also for the intrinsic motivation of personal satisfaction (Zimmerman, 2002).

2.2 Performance or Volitional Control

We can recognize two processes that students can apply to improve their performance: *self-control* (self-instruction, imagery, attention focusing) and *self-observation* (self-recording and self-experimentation). Self-control processes help musicians to concentrate on their musical performance and to optimize efforts. For instance, they can adopt *self-tasks* to learn a difficult section during instrumental practice. This kind of self-instruction let students monitor their concentration during learning activities (Vygotsky, 1962). Other examples are: *inner self-speech*, also known as *positive self-talk* (e.g. “I can do this!”), that increases the focus on performance and alleviates performance anxiety; the creation of *mental blueprints* about specific goals; breaking up the whole piece into smaller sections, easier to be studied (Miksza, 2007).

Self-observation highlights progresses - or their lack – in performance skills and instrumental techniques. In (Lehmann and Ericsson, 1997) the process has been decomposed into 3 kinds of representation: an *aural representation* of the target performance (i.e. how the piece should be played), a *motor representation* of the physical actions required, and finally the *representation of current performance*, constantly monitored and compared to the performance of reference the musician has in mind. Feedbacks act as cues prompts by suggesting to young students how to improve their performance. A clarifying example is switching from the interpretation of graphical symbols for crescendo and diminuendo to an *inward feel* about music expression.

2.3 Self-reflection

The third phase of the self-regulated learning cycle is based on *self-evaluation*, *causal attribution*, *self-satisfaction/affect* and *adaptivity* (Zimmerman and Campillo, 2003). Self-evaluation is one of the initial processes of self-reflection, and it implies a comparison between personal performance on one side and

performance of peers on the other. The latter is considered either a standard to satisfy or a goal to achieve. Self-regulated musicians typically attribute their success to causes that can be improved only through a greater effort. Adaptive inferences will lead to reflect on the best learning strategy, while defensive inferences will tend to limit the personal commitment and will lead to the abandonment of the activity. A high self-satisfaction level will push students towards new goals and challenges.

3. TOWARDS ACTIVE E-BOOK FOR SELF-REGULATED

The idea of making a school subject more engaging through computer-based technologies is not new at all. An example is the adoption of interactive blackboards in primary and secondary education in order to add multimedia and interactive contents to "traditional" ones. For instance, (Sunners et al., 1994) describes a framework that integrates the blackboard model with a graphical user interface, and (Van Zeir et al., 1998) provides an extensive overview of the data models and the knowledge sources that form the back-bone of an interactive Computer Aided Process Planning (CAPP) kernel. In the field of music education, this approach is particularly relevant, since the subject is strictly related to multimedia and multi-modal interfaces. In fact, e-books for music education have been already designed and released. Unfortunately, their typical approach provides a linear pathway through contents and allows a low degree of interaction: in other words, they are usually digital copies of traditional paper texts. Needless to say, digital technologies can introduce some aspects of novelty peculiar to music:

- Hyper-links can easily provide further information about an instrument, an author, a music genre, etc.;
- Scores can have a performance associated with, so that the learner can listen to a pre-recorded performance by either a professional player or an automated system;
- Music notation can be presented in alternate formats, designed for visually impaired students or people affected by learning disabilities.

However, music e-books available on the marketplace are far from the definition of "active book" mentioned in Section I. The *study mode* proposed by an active book is different from the *reading mode*, where the learner is able to freely read any part of a text, and solve any task or interactive part without any restriction. Rather, the model is characterized by the fact that the progress of reading (in this case studying) is handled by the textbook itself (Binas et al., 2012). In this approach, there are many concurrent study paths related to the goals and levels of detail of a given subject. Any chapter, activity, exercise proposed to the learner is related to a previous path made of actions that can be seen as prerequisites.

In *study mode*, different paths are offered to access contents by skill degree, personal interest, and goals to achieve. Contents are structured to provide guidance to learners, keeping the didactic framework supervised and designed to achieve the best results.

Digital active books should let students adjust their cognitive as well as meta-cognitive behaviours (Aleven et al., 2010; Azevedo et al., 2011; Winne, 2011) thanks to appropriate scaffolds (e.g. *feedbacks* and *prompts*). As stated in (Aleven and Koedinger, 2002) and (Graesser et al., 2000), scaffolds are functional to the development of specific self-regulation skills in the music field. For this reason, in Section V the subject will be discussed in depth.

In scientific literature many different theories and visions are present about scaffolding. This heterogeneity resulted in a number of adaptive approaches and assistive technology solutions, often united by the concept of fixed and adaptive scaffolds (Azevedo et al., 2004). Researchers have stressed how adaptive scaffolding in hypermedia environments can assist students in developing more sophisticated mental models, increasing declarative knowledge as well as the frequency of some self-regulated learning strategies (Azevedo and Hadwin, 2005). The mentioned studies have inspired the design and development of innovative learning systems employing the adaptive component in didactic self-regulation.

Further studies (Kramarski and Hirsch, 2003) have provided empirical evidence that an adaptive scaffolding - based on *feedbacks* and *prompts* -when applied to scientific subjects supports the execution of regulation strategies. The importance of *cueing* and *prompting* has been confirmed by the work of (Azevedo

et al., 2011), thus paving the way for new studies on adaptive scaffolding as a key element in the education of self-regulated learners.

Nowadays, the scientific community is paying a great attention to the effectiveness of different kinds of scaffold on students' self-regulation processes (Lajoie, 2005; Hadwin and Winne, 2001; Baylor, 2002; Puntambekar et al., 2003). Research results are used to revise the design of adaptive hypermedia learning environments.

4. TECHNOLOGIES FOR AN ACTIVE MUSIC E-BOOK

HTML5 is currently the latest release of HyperText Markup Language (HTML), specially designed to deliver rich content without the need for additional plugins. It can deliver a wide range of media contents, ranging from animation to graphics, from music to videos, etc. It can also be used to build complicated and rich web applications. HTML5 is cross-platform, in fact it has been designed to work on personal computers, tablets, smartphones, e-book readers and even smart TVs. Thanks to its features, HTML5 is revolutionizing not only the Web but also many other fields. With the release of the EPUB 3 specification (Garrish, 2011), HTML5 is officially a part of the EPUB standard. Consequently publishers are able to take full advantage of its feature set to add rich media and interactivity to their e-book content.

Some relevant examples are described in (Kleinfeld, 2011) and (Choi et al., 2014). The integration of HTML5 into e-book readers allows a number of advanced and innovative applications, such as the support of audio/video, the use of geolocation to customize a work of fiction, the creation of colouring books, etc. Nevertheless, some features oriented to music education and instrumental practice require an appropriate format, able to represent music contents by maintaining compatibility with HTML technologies. This format could be IEEE 1599 (Baggi and Haus, 2009), an international standard aiming at a comprehensive description of music contents that has been approved by the IEEE Computer Society in 2008. IEEE 1599 adopts Extensible Markup Language (XML) in order to describe a music piece in all its aspects. XML is a simple, but very flexible text format which is playing an increasingly important role in the exchange and publishing of a wide variety of data on the Web and elsewhere. Since XML is one of the standards recognized by the World Wide Web Consortium (W3C), the choice of integrating IEEE 1599 into an e-book is coherent, as demonstrated in Section V.

With respect to other music formats, the innovative contribution of this standard is providing a comprehensive description of music and music-related materials within a unique framework, ranging from symbolic score to catalogue metadata, from score images to performance audio tracks. Comprehensiveness is realized through a multi-layer environment where data are arranged within six layers, each corresponding to a different information type: general, logic, structural, notational, computer-driven performance, and audio.

Music events are univocally identified through a common data structure known as the spine, and then instanced in the mentioned layers.

Thanks to this concept, IEEE 1599 supports two synchronization modes: i) *Inter-layer synchronization*, which takes place among many descriptions of the same event in different layers, and ii) *Intra-layer synchronization*, which occurs among multiple instances of the same event within a single layer. An in-depth description of the key aspects of the standard is provided in (Ludovico, 2013). For further details, please refer to the official IEEE repository. Finally, it is worth citing the EMIPIU portal,[1] where an HTML5 viewer for IEEE 1599 documents is publicly available.

5. DESIGN PRINCIPLES FOR AN ACTIVE MUSIC E-BOOK

This section aims at reviewing the key features of the active e-book exposed in Section III in order to apply them to the self-regulated learning of music described in Section II through the technologies mentioned in Section IV. Let us go back to the definition of the three macro-phases typical of self-regulation cycle, namely forethought, performance or volitional control, and self-reflection (see Figure 1). For each of them, we can identify a number of scaffolds and consequently design a possible implementation in an active e-book.

[1] http://emipiu.di.unimi.it

As regards forethought, first we propose *computer-assisted sight reading*. This feature implies an automatic score follow ing algorithm with customizable tempo.[2] Tempo can be set either to improve performance or to add new obstacles. The IEEE 1599 format supports this feature, since both symbolic and graphical information are encoded in a single environment, specifically in the logic and notational layer. In this way, it is possible both to propose a specific printed version of the piece, page by page, and to reconstruct notation starting from its logical description, e.g. on a unique linearized staff system. In score editing software, these approaches are often called *score view* and *scroll view* respectively. Both graphical representations can be automatically scrolled at a given rate that the student can customize.

Another scaffold regarding forethought implies asking *meta-cognitive questions* to the students in order to improve their comprehension of the difficulties to be faced during performance. Answering such questions allows relating students' problems with their previous knowledge, as well as to redirect them to *ad-hoc* learning paths, potentially crossing different semantic axes. If the e-book page presented not only a score to be played, but also a number of final questions about its musical and extra-musical meaning, its key features (melody, rhythm, genre, etc.) and main performance obstacles, the e-book would become adaptive and active in suggesting a proper path to improve learning. For instance, if a student is experiencing difficulties with a jazz piece because of its swung notes, the interface can automatically propose a link to a page containing a historical performance: from the comparison between the printed score and the audio/video track, the concept of swing in jazz music can be intuitively acquired. From a technical point of view, this feature is implemented just taking full advantage of the hypertext possibilities. Please note that IEEE 1599 supports synchronization between score and audio/video contents, even with differently temporized performances.

The second phase introduces a new set of scaffolds. As mentioned in Section II, *jumping* is one of the most adopted and successful techniques to practice. A piece can be subdivided into smaller parts on the base of music sections, performance difficulties, etc. The intra-layer and inter-layer synchronizations provided by IEEE 1599 support two kinds of jump. As regards the first one, after selecting a given score version and one of the corresponding audio/video tracks, the student can enjoy them not only in a linear way, but also jumping from a point to another, and without losing neither the score following nor the synchronization effect. This requires implementing a number of sensitive areas and controls in the interface. However, please note that the mapping of music events (time position, space coordinates, mutual synchronization, etc.) resides inside the IEEE 1599 document, and the interface simply has to implement devices to make them explicit. In this way, the learner can easily create jumps or loops on specific score sections. Besides, another kind of jumps is supported: IEEE 1599 describes within a single document many concurrent digital objects (all related to the same piece), as regards both graphical scores and audio/video performances. Consequently, during a session a student can compare different performers or different notations in real time, simply switching from one to another. Once again, score following and synchronization are preserved.

Other scaffolds to be implemented are: *noting* and *think-aloud processes*, explicitly invoked by the system as a learning tool; *peer seeking*, intended here as help requests to other students*; search for new sources*, in order to get further information about a given music domain or to improve previous knowledge. Needless to say, also these scaffolds can be easily implemented in an active e-book, even if they could require network connectivity.

Finally, as regards self-reflection we have identified another set of scaffolds fit for an active music e-book. Once again, *peer seeking* can be employed to improve the learning process, but in this case it implies a comparison between personal performance on one side and performance of peers on the other. Another possibility offered by this scaffold is cooperative learning, namely the translation of traditional classroom activities into academic and social learning experiences. In this case, peer seeking does not mean searching for a yardstick to measure personal performances against other students, but searching for other musicians of equal or similar skill to study and play with them. Web technologies, such as HTML, XML, and IEEE 1599 can support both mentioned approaches. Possible consequences are *gamification* and reward mechanisms, two ways described in scientific literature to encourage self- regulated learning. Please note that, with an Internet connection available, this kind of music e-book could even push students towards distributed music performance.

[2] Tempo is the speed or pace of a given piece in terms of beats per minute (BPM).

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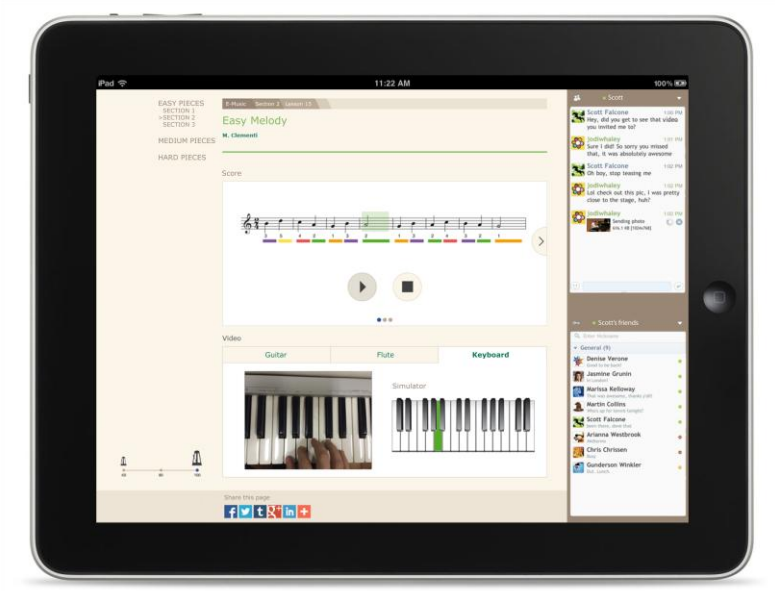

Figure 2. Implementation proposal for an active music e-book.

Probing and *checking* are two other scaffolds referable to self-reflection. The former implies that students conduct systematic analysis on their conceptual map, using both causal reasoning and computer aid to locate potential errors. An example is watching videos performed and commented by professional musicians, who can stimulate self-reflection. Thanks to IEEE 1599, these videos could be synchronized with all other music contents, and comments and hints could be enabled/disabled just like subtitles in movies. As regards *checking*, quizzes and automatically generated feedbacks on performance could help evaluating conceptual maps.

An instance of the proposed model can be implemented by using Web technologies such as HTML5, Javascript and PHP. Figure 2 shows a possible interface for an active music e-book presenting some of the mentioned self-regulated processes.

The music piece to perform is shown in multiple ways: through a standard score, through a color coding of pitches, through the keys to be pressed on different instruments (in this case, a keyboard, a guitar and a flute). Additional material is available, in the form of video performances and explanation texts (not shown in Figure 2). Standard controls allow to play, pause and stop the pre-recorded performance, and the audio track changes according to the currently selected instrument. Besides, the musician can choose a tempo to feel confident about.

6. CONCLUSION

Empirical evidences show that new media can help to innovate the paths of musical learning. Starting with the most recent studies on music education, an analysis was conducted on music students' self-regulation capabilities, highlighting their importance in a learning experience.

The design of traditional e-books in general - and music e-books in particular - has been rethought according to the macro-phases the self-enhancing cycle is made of: forethought, performance/volition control, and self-reflection.

The transition from a reading mode to a study mode made some scaffolds emerge. These scaffolds aim at training self-regulated learners who will be able to improve their performance and maintain high motivation in their music studies.

From a technological point of view, the implementation of scaffolds in a multi-modal, adaptive and dynamic interface is possible, thanks to the integration of HTML5 with IEEE 1599. The latter is an XML-

based format aiming at a comprehensive description of music materials in an integrated and fully synchronized environment.

The educational approach presented in this work is driving the design of a working prototype. As shown in Figure 2, an early interface for an active music e-book has been already implemented. An early experimentation phase will take place next year, in the context of music courses for Italian middle school. Such a product follows the guidelines of the project "Scuola digitale - Editoria Digitale Scolastica" released by the Italian Ministry of Education, Universities and Research. If successful, this experience will be repeated at European level thanks to the cooperation with an international publisher.

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