Towards a Music-based Framework for Content and Language Integrated Learning in Preschool

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Abstract: This paper aims to discuss the applicability of the approach known as *Content and Language Integrated Learning* (CLIL) to preschool. CLIL is a form of language immersion where the learners' second language represents the medium of classroom instruction. The novel idea is to use music and related multimedia contents in order to foster bi- and multi-lingualism by addressing children aged from 3 to 6. In this context, we will propose a computer-supported education environment which adopts IEEE 1599, an XML format originally designed for the representation and synchronization of music and media contents. Its multi-layer approach represents a valid tool to support multiple interconnected descriptions, thus fostering abilities and reinforcement techniques typical of CLIL. Finally, we will present an example aiming to test the efficacy of the proposed approach in real-world use cases.

1 INTRODUCTION

Musical language is a sophisticated mean of expression: on one side, it is necessarily rooted in the composer's cultural background; on the other side, it has an amazing capacity to take on forms that come from the surrounding world, assuming new shapes and identities. This relationship between identity and otherness can reach extraordinary levels of artistic perfection, providing a precious opportunity for a lifelong education to the globalized world (Ferrari, 2012).

Music can be a powerful way to teach and learn before reading and writing abilities have been acquired. By scaffolding children's early musical experiences and investigations, their engagement in the world of sound as well as their trans-modal redesign of known literature and song repertoire help children establish strong, confident, vibrant, and creative identities in learning, communication, and performance (Tomlinson, 2013).

A new music pedagogy based on an integrated approach is currently emerging. The goal is to enhance that educational cross-component able to influence key aspects of the growth such as expressiveness, autonomy and sociality, in accordance with the fundamental concepts of pedagogical activism (Dewey, 2005).

Music is able to influence the construction of personality because it promotes the integration of perceptual, motor, affective, social and cognitive dimensions (Willems, 2011) by relating basic aspects of human life (e.g., physiological, emotional and mental spheres) with key elements of music (e.g., rhythm, melody and harmony). The abilities of listening, exploration and analysis are fundamental for the development of general meta-cognitive skills of the child, such as attention, concentration, and control. In this sense, music is both an opportunity and a crucial educational strategy. For example, through music young students can develop the aspects of analysis and synthesis, problematization, argumentation, evaluation and application of rules. As it regards the ability to read and understand, children have the possibility to train their transcoding skills – moving from the musical domain to the verbal language – in order to describe what they heard (Branca, 2012).

Music-based pedagogy can be promoted by (and through) technology. Ad hoc approaches, techniques and devices can be employed to make children interact with the world of sound, develop their cognitive and social skills, learn how to transpose, listen, look and discriminate sounds in meaningful learning contexts (Profumo, 2012). For example, musical games let children improve perceptual and motor skills, grasp concepts, remember musical patterns, in-

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vent ideas, experience music in group and build self-confidence (Young and Glover, 1998).

In our opinion, music and technology can be profitably coupled to create multi-layer learning environments whose main goal is the integration of heterogeneous skills and abilities. *Integration* is a keyword also for a teaching methodology known as Content and Language Integrated Learning (CLIL). Consequently, the idea discussed in this paper is to adopt music as a means to convey contents as well as cognitive abilities to young children in a computer-supported CLIL context.

This work is structured as follows: Section 2 recalls the basic concepts about CLIL; Section 3 describes the state of the art about the adoption of CLIL in conjunction with music and its current diffusion as a preschool didactic tool; Section 4 is focused on the MUSICLILY project, namely the framework that implements the proposed approach; Section 5 introduces the concept of multi-layer pedagogy resulting from the previous discussion; Section 6 provides an overview about IEEE 1599, namely the markup language adopted to encode information in a multi-layer and Web-compliant format; finally, Section 7 presents a case study in order to test the efficacy of our approach.

2 A SHORT OVERVIEW OF CLIL

The locution *Content and Language Integrated Learning* (CLIL) refers to methodologies employed in teaching situations where a second language is used as a medium for teaching non-language content (Mehisto et al., 2008). CLIL encourages a cross fusion of didactic subjects – which currently is a relevant educational trend (Coyle et al., 2010) – by approaching subject contents through the target language and acting as a bridge that connects learning aspects into a coherent whole where interdisciplinary elements prevail (Agolli, 2013).

The CLIL initiative was launched in 1994 in conjunction with the European Commission. In fact, multilingualism was – and it is still – considered at the heart of European identity, and in this sense languages are seen as a fundamental cultural aspect of European citizenship (Directorate-General for Education and Culture, 2006). The idea was originated by a discussion among experts, above all in Finland and the Netherlands, on how to bring the language-learning excellence typical of a restricted number of institutes into mainstream government-funded schools and colleges.

CLIL aims to develop in children both *lower* and *higher order thinking skills*, according to Bloom's taxonomy of cognitive objectives (Bloom, 1956). CLIL is mainly focused on the latter skills, even if these are dependent on an earlier acquisition of the former abilities. Consequently, such a methodological approach is more cognitively engaging for both students and teachers. On one side, this fact may increase the demands and difficulty of CLIL, but on the other it also leads to increasing engagement and motivation (Pinner, 2013).

Another aspect to consider is the difference between *Basic Interpersonal Communicative Skills* (BICS) and *Cognitive Academic Language Proficiency* (CALP). The acronym BICS refers to conversational fluency in a language, whereas CALP refers to student's ability to understand and express, in both oral and written modes, concepts and ideas that are relevant to success in school (Cummins, 2008). In CLIL, teachers have to address CALP rather than BICS, and students have to know content-specific vocabulary for the topic they are learning (e.g., technical terms), as well as a suitable language to carry out activities during the lesson (e.g., sentence starters).

According to some researches, one of the key aspects in CLIL lessons is the input (Krashen, 1982; Krashen, 1985). The second language (L2) offers learners a substantial amount of comprehensible input, essential for L2 acquisition. Content is conveyed by the teacher as a way of facilitating understanding, and the input is represented by the language to which learners are exposed (Costa and Coleman, 2010). All constructivist comprehension theories underline the importance of input in the construction process. However, the input as such is not important for successful processing, rather the significance it has for the comprehender is fundamental. Cognitive psychologists argue that a comprehender can only process input successfully if he/she can relate it to what is already part of his/her body of knowledge. Social constructivists carry their argument even further: in their opinion, only input in which the comprehender can get engaged – or involved in – can be processed and will finally lead to a construction which he/she can make use of (Wolff, 2003).

In order to provide an effective input, educators need to know what CLIL exactly is, mastering both the methodology and a specific language for contents. Consequently, specific professional training is required for teachers. Among a number of initiatives, it is worth citing CLIL4U[1] and the British Council's CLIL project.[2]

[1] http://languages.dk/clil4u/index.html

[2] http://www.britishcouncil.org/europe/our-work-in-europe/content-and-language-integrated-learning-clil

3 STATE OF THE ART

In this section we will focus on two aspects that are fundamental for this proposal: i) CLIL in preschool education, and ii) the use of music as a means to convey content in a foreign language.

In most educational systems that encourage an early study of a foreign language, preschool and school curricular approaches are rather similar, usually consisting of general lessons that include foreign culture, art and craft activities. A great importance is given to the development of phonemic awareness and vocabulary, and these goals are traditionally achieved through reading and writing assignments.

In the educational systems open to CLIL experimentation, this methodology is usually applied to secondary education (Costa and Coleman, 2013; Llinares and Whittaker, 2006; Whittaker et al., 2011) or even to academic learning (Strotmann et al., 2014). An interesting review of CLIL across multiple educational stages, ranging from primary to tertiary level, is contained in (Dafouz, 2009).

Conversely, the application of CLIL to preprimary school is a relatively novel idea. In this sense it is worth citing a pilot project in Spanish curricular infant education described in (Esteban, 2015). Another relevant initiative aiming to examine the effects of general L2 exposure vs. specific language exposure was carried out in a semi-private school located in Lleida. Since this institute offers preschool, primary and secondary schooling – thus covering three educational stages – the experimentation involved very young students who were monitored in their progress and performances (Saladrigues and Llanes, 2014). Finally, reference (Haces Tamés, 2015) proposes the use of nursery rhymes as resources to teach English in preschool education through CLIL methodology. In all the mentioned activities, CLIL has been considered effective not only to learn another language and curricular contents, but also to foster cognitive development, communication abilities and cultural awareness in very young children (Sakurai, 2015; Sokół, 2015).

Didactic experiences designed for preschool education can encompass motivating games and short activities to make children improve their listening and speaking skills. Content learning in this early stage of life is facilitated, and the acquisition of a foreign language can be integrated into basic curricular topics such as numbers, colors, animals, etc. (Fernández López, 2014).

On the other hand, music is publicly recognized as a universal feature of human cognition: every human is born with the ability to appreciate it (Brandt et al., 2012). Music gives students motivation, creates a group and a good atmosphere for learning, allows the development of language and communication abilities, prepares both the ear and the brain to listen to, assimilate and produce sounds. Songs and rhymes can be used to teach new words, increase vocabulary, introduce a specific lexicon, and improve pronunciation (Atta-Alla, 2012). Moreover, songs are memorable for a long time. In this sense, a recent research has confirmed the long-held belief that singing in a foreign tongue can facilitate language learning (Ludke et al., 2014).

Music quite naturally provides opportunities to practice patterns, math concepts, and symbolic thinking skills, all in the context of a joyful noise, which makes it attractive and engaging even for very young children. There are multiple and heterogeneous ways to participate in music activities, and such experiences can be easily adapted for a range of developmental levels and skills depending on the learner's age (Parlakian and Lerner, 2010).

Recalling the concept of *input* introduced in Section 2, music lessons offer three distinct sources of language input (Willis and Paterson, 2008):

1. the language used to manage classroom activities and to set up music experiences;
2. the process itself that leads to a performance (audience participation in rhythm games, use of home-made instruments, etc.);
3. the actual words and phonological features of songs, rhymes, musical stories, etc. performed by the audience or already available as media content.

Finally, it is worth underlining the availability of research results about the integration of music in CLIL experiences (Kuncířová and Vojtková, 2013), but mainly as a diversification of music lessons in secondary school. Besides, these works do not take into account the possibilities offered by information and communication technologies, an aspect that conversely will characterize our proposal.

4 THE MUSICLILY PROJECT

MUSICLILY is a project currently under development at the *Laboratorio di Informatica Musicale – Università degli Studi di Milano* in cooperation with external experts of the educational and pedagogic domain. MUSICLILY aims to unveil original and innovative ways to learn content and language in preschool by using music as a privileged medium.

The final goal is to design and implement a multi-platform, publicly-available environment addressing young learners. Because of their age, the approach has to be playful and mainly based on visual elements and multimedia. Consequently, music, video, and graphical contents will be integrated into a unique framework explicitly designed to encourage CLIL. As we will explain in Section 7, text contents can be embedded too, in order to foster reading abilities even at an early age.

Such a framework will be accessible on a wide range of devices, including tablets and desktop computers, interactive whiteboards, smartphones, etc. Virtually any network-connected device equipped with an HTML5 browser should be able to support MUSICLILY.

In our vision, this framework will be suitable for different purposes:

- As a way to introduce a specific topic from scratch – While playing and experimenting the device in a CLIL context, children will experience a stimulating learning environment that integrates still graphics, audio, video, etc.;
- As a learning reinforcement environment – During the exposition to a new lexicon, children will find a number of hints and multimedia stimuli to deepen the meaning of new words and link them to other domains (e.g., multiple translations of a term, contextualizations of words through stories and songs, etc.);
- As a playful evaluation tool – For example, at the end of a CLIL session about a specific topic (say farm animals), the teacher could ask students to locate a given subject on the interface (e.g., spelling out an animal's name in another language). In this way, the teacher can evaluate if children have learned the meaning of lexicon and realized the connection between the oral word and the corresponding image. If results are not satisfactory, reinforcement techniques can be employed as additional scaffolds.

Moreover, children can work alone, in pairs or in little groups. When working with classmates, they can experiment the so-called *cooperative learning*. Social constructivism theories argue that knowledge is acquired in a context, and – in this sense – cooperative learning encourages the development of communication skills and positive interdependence (Coonan, 2007).

MUSICLILY aims to make children the protagonists of their learning. Since it is available on any network-attached device, the proposed learning approach does not necessarily occur only in a classroom. Preschool learners can find a "red thread" from school to their every-day life, thus applying what they experienced at school also to other contexts. For example, activities occurring at home may involve also parents in the learning process.

Needless to say, this initiative implies both theoretical and practical problems. As it regards the former aspects, mainly concerning pedagogical approaches and technological challenges, we are addressing them in the present paper. Conversely, the latter aspects require further investigation and will be discussed after the release of an early version. Nevertheless, in Section 7 we will provide a concrete example of content encoding and a discussion about its possible uses.

5 A MULTI-LAYER PEDAGOGICAL APPROACH

Considering the psychological and cognitive characteristics of young people, preschool contents must be organized from a global, comprehensive and interdisciplinary perspective rather than developing CLIL in unrelated areas. Such an approach – focused on specific topics but covering cross-curricular contents – seems the most effective model to be implemented in a bi- or multi-lingual preschool class.

As stated in (Glušac, 2012), CLIL exists in different guises on a continuum where content-based education is at the softer end and bilingual education is at the harder one. As a consequence, we can recognize *hard* or *strong CLIL*, where teaching and learning are primarily content-driven, and *soft* or *weak CLIL*, which is mainly language-driven. The version we are adopting stands in the middle, thus it is sometimes referred to as *mid* or *comfortable CLIL*: its aims are dual-focused and learning occurs as a combination of both language and content.

Moreover, our goal is to realize a multi-layer pedagogical environment based on the role of music not only as a privileged medium to convey content, but also as a way to create a complex network of correlated information. In fact, a class is composed by many children, each one presenting his/her own way to learn. In accordance with the theory of multiple intelligences presented in (Gardner, 2011), we want to provide multiple inputs, multiple interaction modes and multiple ways to employ this environment, so that the resulting learning experience can be a student-tailored one.

The current proposal can be defined "multi-layered" because, given a specific topic, it embraces different methods and media - each one with its

own features, granularity and level of abstraction - to achieve the final educational goal. Foreign language, music and technologies are the main actors that are used in an integrated manner to foster a stratification of skills, in accordance with Coyle's *four Cs* (Coyle, 2002): Communication (i.e. improving overall target language competence), Content (i.e. learning the knowledge and skills of the subject), Culture (i.e. building inter-cultural knowledge and understanding), and Cognition (i.e. developing thinking skills).

In order to achieve this goal, we give a particular importance to the Vygotsky's theory of *Zone of Proximal Development* (ZPD). Such a concept, presented in (Vygotsky, 1978), establishes two developmental levels in the learner: the *actual developmental level*, which is determined by what the learner can do alone, and the *potential level of development*, which can be established by observing what the learner can do when assisted by an adult or a more capable peer (De Guerrero and Villamil, 2000). ZPD is strictly connected to *scaffolding*, namely a set of strategies and instruments encouraging an interaction between teacher and learner that helps young students to build or improve their knowledge (Berk and Winsler, 1995).

Computer-based solutions and technological devices can be the answer to the mentioned needs, since they can implement those audio-visual aids required to involve young learners and overcome the typical problems caused by a new language in preschool-age children. In addition to traditional resources already in use at schools (blackboards, textbooks, puppets, etc.), technological resources such as interactive whiteboards and the Internet can foster the acquisition of linguistic competence in an entertaining and motivating way. As stated in (Coyle et al., 2010), CLIL requires to organize cognitively challenging materials by providing effective scaffolding supported by some *model-view-controller* frameworks. Learning activities such as songs, dances, storytelling, etc. can be presented orally and visually, but also through suitable media support (García Esteban, 2013).

In order to realize CLIL activities in a multi-layer and computer-supported environment, we need: i) a suitable digital format to represent music and music-related information, and ii) a framework able to offer an engaging learning experience to preschool children. These aspects will be discussed in the next sections.

6 THE IEEE 1599 FORMAT

IEEE 1599 is a standard internationally recognized by the Institute of Electrical and Electronics Engineers (IEEE), sponsored by the Computer Society Standards Activity Board and designed by the Technical Committee on Computer Generated Music.

IEEE 1599 employs XML (eXtensible Markup Language) to describe a music piece in all its aspects (Baggi and Haus, 2009). The goal of the format is to provide a comprehensive description of music and music-related materials referring to the same music piece within a single document.

Comprehensiveness in music description is realized through a multi-layer environment. The XML format provides a set of rules to create strongly structured documents, thus IEEE 1599 can implement the multi-layer feature by arranging music and music-related contents within six layers:

1. *General* – Music-related metadata (i.e. catalogue information about the piece);
2. *Logic* – Logical descriptions of the original score in terms of music symbols (e.g., notes, rests, articulation signs, etc.);
3. *Structural* – Identification of music objects and their mutual relationships resulting from musicological analyses or other kinds of investigation;
4. *Notational* – Score graphical representations (e.g., different editions, part extractions, piano reductions, etc.);
5. *Performance* – Computer-based descriptions and automatic performances of music (e.g., MIDI or MPEG4 formats);
6. *Audio* – Digital or digitized audio/video tracks (e.g., complete recordings with different performers, audio covers, excerpts, etc.).

In order to provide a rich network of interconnected and synchronized descriptions of the same entities, music events are uniquely identified in the encoding. In this way, they can be described multiple times in different layers (e.g., the graphical aspect of a chord and its audio performance) as well as multiple times within the same layer (e.g., different performances of the same chord). In formal terms, the multi-layer environment provided by IEEE 1599 simultaneously supports two synchronization modes:

1. An *Inter-layer Synchronization*, that takes place among contents described in different layers, where heterogeneous categories of information (i.e. additional descriptions of the same entities) are stored;
2. An *Intra-layer Synchronization*, that occurs among the contents of a single layer, where homogeneous information (i.e. concurrent and/or alternative descriptions of the same entities) is stored.

Synchronization is not strictly required: an IEEE 1599 document would be valid even if it does not contain synchronizable media objects. Nevertheless, this format shows all its potential when the document is rich both in homogeneous and in heterogeneous descriptions of the same music entities.

A detailed description of IEEE 1599 is beyond the scope of this work. For further details, please refer to the official IEEE documentation or to scientific works that cover specific aspects of the standard (Baggi and Haus, 2013).

One of the typical application fields of IEEE 1599 is music education, as discussed during the 4th International Conference on Computer Supported Education (Baratè and Ludovico, 2012). In the past, the format and its related technologies have been adopted to foster the acquisition of music skills. Conversely, using music as a tool to scaffold extra-music abilities and knowledge is an innovative aspect of the current proposal. In this sense, IEEE 1599 is suitable for the MUSICLILY initiative for a number of reasons:

- It is an international standard explicitly designed to represent music content, and MUSICLILY is exactly focused on the use of music in CLIL context;
- It is flexible enough to host not only music, but also a great number of related materials, including still graphics, video, and text. The characteristics of IEEE 1599 let programmers design and implement rich and engaging environments, as required by the preschool audience expected for MUSICLILY;
- It supports full synchronization among embedded contents, a feature that can be exploited to reinforce learning;
- It is XML-based and consequently fully compliant with W3C recommendations for Web applications. In fact, already-available IEEE 1599 players have been realized through W3C languages and formats such as HTML5, JavaScript, and PHP;
- It is a free format, well documented by dedicated Web sites and portals, official specifications and scientific papers.

These aspects will be discussed and exemplified through the following case study.

7 CASE STUDY

In order to test the efficacy of our proposal, we will apply a music-based and computer-supported CLIL methodology to a specific topic, namely the teaching of farm animals in one (or many) foreign language(s). Farm animals provide a typical lesson subject in preschool learning, often reinforced by multimedia learning materials or visits to animal exhibits, zoos and museums (Tunnicliffe, 1995).

The final goal will be to design and implement through a computer-based approach a multimedia lesson about farm animals, where multilingual audio is used to link and synchronize a number of related multimedia contents.

Music and sound can be key elements in this kind of educational initiatives. For example, the pronounce of animal names implies a listening activity, animals themselves produce sound (whose transliteration sometimes differs significantly from language to language), there are songs and rhymes about animals, etc.

As discussed in Section 6, IEEE 1599 can be used to aggregate and synchronize information. It has been conceived for music-centered descriptions, nevertheless extensions to fields such as live theatrical performances (Baratè et al., 2012), city soundscapes (Ludovico and Mauro, 2009), and concert promotion (Baratè et al., 2015) have been investigated in the past. The common thread that links these extended uses of the format is the centrality of music and audio. In this case, instead of describing a music score, an IEEE 1599 document is used as a sound-driven aggregator of information related to farm animals. This process requires a reinterpretation of some aspects of the format, as detailed below.

7.1 From Music Symbols to Farm Animals

In a traditional IEEE 1599 representation, we would find a logic description of music events (typically notes and rests), and the possibility to link lyrics, music scores and audio tracks. If we were able to adapt the meaning of such concepts in response to our needs, then we could benefit from the multi-layered approach of IEEE 1599, as well as reuse the software tools already available to create, view and interact with content.

Let us review in this new light the six-layer structure presented in Section 6:

1. *General* - Now this layer can list author information, lesson title and details, and link the additional lesson materials that cannot be synchronized to audio contents;
2. *Logic* - Since IEEE 1599 specifications do not provide a strict interpretation for the concept of

event, we can adapt it to our specific needs. For example, if a storytelling or a song will provide the canvas, each scene, or line, or word, or phoneme, or even note (when music is available) can be considered as an event to be identified and encoded. Please remember that the events in the *Logic* layer are the anchors available for all other descriptions within the remaining layers: the choice of the granularity is strategical. This layer allows also the encoding of lyrics, so the text can be transcribed into written form, too;

3. *Structural* - For our purposes it is unlikely that this layer is filled;
4. *Notational* - All the graphical representations that can be synchronized to lesson contents should be put here. Purely by way of example, such representations can include a transcription of animal names and/or sounds (also in different languages), a picture version of the storytelling and its translations, interactive animal drawings and mapped scenes accompanying the reading, a simple score for the music tune (if available), etc.;
5. *Performance* - For our purposes it is unlikely that this layer is filled;
6. *Audio* - All the audio and video objects that can be synchronized to lesson content should be put here. Purely by way of example, such representations can include multilingual audio tracks for the storytelling, live recordings of animal sounds, vocal sketching of animal sounds by people from different Countries, short video clips showing real animals in their habitat, etc.

The examples above give only a broad idea of the rich learning environment that can be realized through IEEE 1599. Heterogeneous contents can be used together in a fully synchronized environment as scaffolding and reinforcement elements.

7.2 Towards a Multimedia-integrated CLIL Experience

The final goal of MUSICLILY is to release a Web-based prototype publicly available on a wide range of network-attached and browser-equipped devices. Actually, a Web application that supports IEEE 1599 and provides users with advanced tools to enjoy music in a multi-layer environment is already on line,[3] but its *Music Box* area mainly addresses traditional scores. From one side this implementation shows that the approach discussed so far can be concretely implemented, but on the other side we firmly believe that preschool CLIL requires an ad hoc interface. Consequently, our future efforts will consist in a children-oriented customization of the existing technological framework.

Another problem to solve is the possibility for teachers to prepare student-tailored materials, possibly with little effort in terms of time and money resources. Unfortunately, available IEEE 1599 authoring tools – being focused on music – are not completely adequate yet. For instance, the list of events of the *Logic* layer has to be produced manually, while in the music case it would be automatically exported from a notation software through a plug-in. Conversely, as it regards audio and graphical mapping tools, also for music the current approach is not fully automated, but only computer-aided: music symbols have to be manually identified in the score, and similarly tempo has to be tapped while listening to the audio track. As a consequence, even if materials are clearly different, the use of mapping tools does not substantially differ and they can be easily reused in this new light.

7.3 An Example

For the sake of clarity, we prepared an example for a hypothetical lesson on farm animals in a multilingual class. The canvas is a simple story about a day in a farm, when animals are awakened by the crowing of the cock.

In this context, the logic events – namely those events whose occurrence triggers synchronization among heterogeneous contents – could be the verses of the tale. This is not a fine granularity indeed, but it is precise enough to enable a number of features, as detailed below. Please note that the choice of a master language is not required, provided that each localized version of the tale contains the same number of verses with comparable semantics. Consequently, the name of logic events should be generic (e.g., `verse_01`, `verse_02`, etc.), since the details about their semantics (e.g., the verse itself translated in multiple languages, its pronunciation, etc.) are demanded to other layers.

As it regards visual contents, we embedded and mapped a number of pictures containing not only the graphical representation of animals, but also localized strings with their names and sounds, one drawing per language. During fruition, mappings become evident to the user through highlight effects on animal shapes and/or labels. For the sake of clarity, in our example we adopted only English and Italian as reference languages, but inter-layer synchronization would support countless alternatives, thus going far beyond bilin-

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

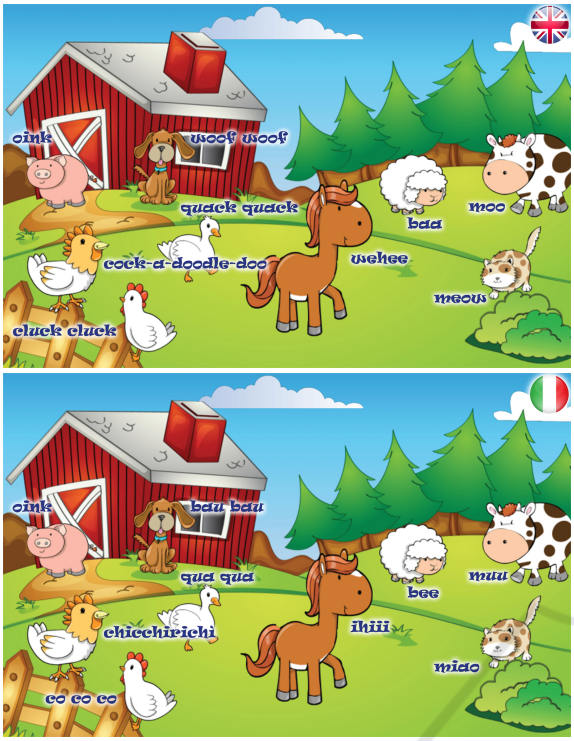

Figure 1: Two alternative graphic files contained in the *Notational* layer and showing animal sounds in English and Italian language respectively.

gualism. If on one side we could expect differences among animal names in different languages, some relevant discrepancies in the onomatopoeic transliteration of their sound are quite surprising. For instance, let us compare the cock's crow shown in the upper and in the lower part of Figure 1: "cock-a-doddle-doo" vs. "chicchirichì".

As it regards audio contents, they currently include the Italian and the English version of the tale, properly linked verse per verse to the corresponding logic events. Besides, for each animal sound we produced both a real recording and a number of vocal sketches by native speakers.

Unfortunately XML documents are too verbose to include a complete code listing, even for a simplified example like this. However, the IEEE 1599 document and all related multimedia objects have been integrated into a compressed archive that is available at the following URL:
http://www.lim.di.unimi.it/download/clil_example.zip.

Such a complex network of linked information fosters multiple fruition models. First, it is possible to launch a listening activity in any language and passively watch one of the visual representations, where graphical elements are properly highlighted and/or replaced by new ones in accordance with synchronization. For instance, when an animal is mentioned in the tale, its shape is colored on screen.

Another fruition model is to change either audio or graphical contents in real time, for instance switching from a language to another, or from a kind of representation to an alternative one. In this way, when an animal is cited the user can choose to watch one of the still drawings or one of the video fragments without losing synchronization.

Finally, it is possible to interact with contents, for instance by clicking on sensitive areas of the interface and causing a prompt response by the system. An example of fruition is to let children click animal shapes and labels, thus triggering one of the audio documents associated, so as to create a mind association among shapes, graphemes and phonemes in a foreign language.

This kind of experience can be further improved thanks to additional stimuli accompanying the computer-based solution. For example, teachers can encourage learning by distributing extra materials (e.g., printable coloring pages, like the one shown in Figure 2), or organizing activities such as classroom games, cultural visits, and school trips.

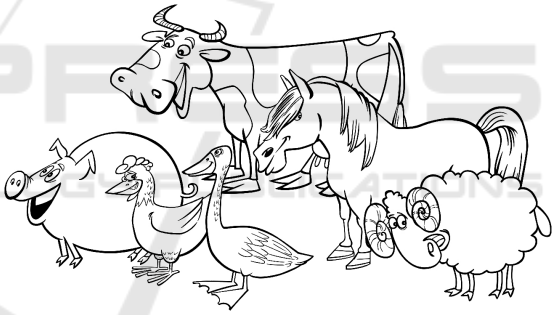

Figure 2: Additional material to reinforce learning: a printable coloring page.

8 CONCLUSIONS AND FUTURE WORK

In this work we have described an educational proposal based on the integration of three domains: information technology, music, and foreign languages. Since our approach makes them tightly interconnected each other, it can be difficult to establish the exact role played by each of them. In fact, each domain can be seen as the input, the medium or the educational goal of the initiative.

For instance, if we wanted to implement a standard form of CLIL, namely a learning experience where a specific topic is treated in a foreign language, then audio could provide the input (e.g., a

song, a nursery rhyme, a narration, etc.) and computer tools could be used to implement multimedia fruition. Alternatively, interaction with technological devices could be seen as the input, while music or other multimedia contents as a way to encourage an early use of technologies within a playful environment. Similarly, a learning experience could address educational aspects that go beyond the specific topic – in this case a given school subject would be the input – including for instance computational thinking or multi-layer fruition of contents.

As a final remark, let us focus on the concept of language cited in the definition of CLIL: it is worth underlining that not only a foreign language in a strict sense, but even music, computer languages and formats, and human-computer interaction models can be seen as alternative forms of expression. This complex network of interconnections among heterogeneous domains, as well as the versatility of the roles played by each component, can be easily justified through the multi-layer approach mentioned above.

The use of music as a playful and engaging way to convey information on one side, and the support obtained from computer technologies on the other are fundamental to involve young learners in CLIL activities, such as in a preschool context. Moreover, lesson topics can be suitably chosen in order to get further benefits from this articulated approach. For example, if the lesson is about musical instruments or city soundscapes, a multimedia environment where a music-oriented format plays a key role will prove to be a flexible, powerful and effective learning tool.

As it regards future work, please note that – at the moment of writing – MUSICLILY is only an educational proposal. Both the pedagogical bases and the technical aspects have been already explored, and research has shown promising prospects, but ad hoc implementations and validation activities are required to test the efficacy of our approach.

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