Web Frameworks for Content and Language Integrated Learning in Primary School

Luca A. Ludovico[1] and Claudia Zambelli[2]

[1] Dipartimento di Informatica, Università degli Studi di Milano
Via Comelico, 39 - 20135 Milano, Italy
luca.ludovico@unimi.it
[2] Università degli Studi di Milano-Bicocca
Piazza dell'Ateneo Nuovo, 1 - 20126 Milano, Italy
c.zambelli5@campus.unimib.it

Abstract. This paper proposes the adoption of Web technologies in order to bring the approach known as *Content and Language Integrated Learning* (CLIL) into primary school. CLIL is a form of language immersion where the learners' foreign language represents the medium for classroom instruction regarding other school subjects. The idea is to design and implement ad hoc Web interfaces oriented to bi- and multilingualism. In this context, we will propose two educational environments: the first one uses standard Web technologies such as HTML5 and JavaScript, whereas the second one adopts in addition IEEE 1599, a format originally designed for the representation and synchronization of music and media contents, whose multi-layer structure – suitably adapted – can foster abilities and reinforcement techniques typical of CLIL.

1 Introduction

An emerging trend in pedagogy is to propose rich educational environments based on integrated approaches, including traditional lessons, manipulative activities and multimedia. The goal is to enhance that educational cross-component able to influence key aspects of children's growth such as expressiveness, autonomy and sociality, in accordance with the fundamental concepts of pedagogical activism by Dewey [11]. In this sense, technology can greatly support pedagogy. Ad-hoc approaches, techniques and devices can be designed to make children learn how to interact, listen, watch, discriminate, transpose concepts, develop their cognitive and social skills in meaningful learning contexts.

Multimedia and technology can be profitably coupled to create multi-layer learning environments aiming at the integration of skills and abilities. As stated in [17], multimedia is more than just a collection of sound, images, video and animations; rather, it is a vital, dynamic field offering new challenges, interesting problems, exciting results, and imaginative applications. The educational impact of multimedia – already discussed in a huge number of projects and scientific works – requires an explicit design effort geared to kids [13].

Integration is a keyword also for a teaching methodology known as *Content and Language Integrated Learning* (CLIL). This locution refers to methodologies adopted in teaching situations where a foreign language is used as a medium for teaching non-language content [24]. CLIL encourages a cross fusion of didactic subjects – currently considered as a relevant educational trend [8] – by approaching content through the target language. In this sense, CLIL acts as a bridge able to connect multiple learning aspects into a coherent whole where interdisciplinary elements prevail [1].

The goal of this work is to discuss a novel approach to CLIL by joining commonly-accepted pedagogical theories, current trends in education, multimedia, computing devices, and information systems. As explained below, Web technologies can be the thread that ties all these elements together.

2 A Brief Overview of CLIL

The CLIL initiative was launched in 1994. 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. Soon CLIL experimentation was endorsed by the European Commission, since multilingualism was considered at the heart of European identity, and in this sense languages are seen as a key cultural aspect of European citizenship [12].

CLIL aims to develop in children both *Lower* (LOTS) and *Higher Order Thinking Skills* (HOTS), according to Bloom's taxonomy of cognitive objectives [3]. CLIL is mainly focused on the latter skills, which in any case are clearly dependent on an earlier acquisition of the former skills. Consequently, CLIL 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 leads to a higher level of engagement and motivation [25].

Another aspect to consider is the difference between *Basic Interpersonal Communicative Skills* (BICS) and *Cognitive Academic Language Proficiency* (CALP). BICS refers to conversational fluency in a language, whereas CALP refers to students' ability to understand and express, in both oral and written modes, concepts and ideas that are relevant to success in school [9]. In CLIL, teachers have to address CALP more than BICS. CLIL students have to know content-specific vocabulary for the subject 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 Krashen, one of the key aspects in CLIL lessons is the *input* [20, 21]. The foreign language in use gives learners a substantial amount of comprehensible input, without which its acquisition could not occur. Content is conveyed by the teacher as a way to facilitate understanding, and the input is represented by the language learners are exposed to [6].

All constructivist comprehension theories underline the importance of input in the construction process. However, it is not the input as such which

is important for successful processing, but rather the significance it has for the comprehender. Cognitive psychologists argue that a comprehender can only process input successfully if he/she can relate it to knowledge which 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 even involved in – can be processed and will finally lead to a construction which he/she can make use of [32].

CLIL is usually experimented in secondary education [5, 22, 31] or even in academic contexts [30]. Conversely, its administration to very young students – in primary school or even preschool – is a relatively novel idea. An interesting review of CLIL across multiple educational stages, ranging from primary to tertiary level, is contained in [10] and [27]. Besides, it is worth citing well-focused pilot case studies, such as an experimentation for curricular infant education occurred in Spain [14], and the adoption of nursery rhymes as resources to teach a foreign language in preschool [18]. In all the mentioned activities, CLIL has been considered effective not only to learn another language as well as curricular contents, but also to foster cognitive development, communication abilities and cultural awareness in very young children [26, 28].

Didactic experiences designed for primary school can include motivating games and short activities in which young students can improve their listening and speaking skills. Since content learning in this period is facilitated, the acquisition of a foreign language can be profitably integrated into basic topics of primary school curricula, such as numbers for Math lessons, animals for Science, or musical instruments for Music. More details about the pedagogical and theoretical bases of CLIL are provided in [23].

3 A Web-based CLIL Environment

As stated in [16], 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 (Strong) CLIL*, where teaching and learning are primarily content-driven, and *Soft (Weak) CLIL*, which is mainly language-driven. The version of CLIL we are going to adopt stands in the middle, consequently it is sometimes called *Mid (Comfortable) CLIL*: learning occurs as a combination of both language and content, thus its aims can be considered dual-focused. Mid-CLIL requirements imply a mixed use of graphical and audio-visual elements (i.e. multimedia in its multiple forms), necessarily predominant if compared to texts due to the young age of students. A key role is played by audio, that mainly allows listening activities in the native as well in the foreign language. Moreover, audio can be used to introduce additional sounds that can reinforce learning, as in the examples below.

Computer-based solutions and technological devices can respond to the mentioned needs, since they provide those audio-visual aids required to involve young learners and to overcome the typical problems caused by an unknown language in young students. In addition to traditional resources already in use at schools

(blackboards, textbooks, etc.), technological resources such as interactive whiteboards and the Internet can foster the acquisition of linguistic competence in an entertaining and motivating way.

Narrowing the field to the Web, the new possibilities offered by HTML5 – and specifically by its built-in support of audio and video – allow the creation of playful environments specifically oriented to CLIL in primary school. JavaScript, another W3C-compliant standard, can add the interactivity required to enrich the interface from both a graphical and a functional point of view.

Needless to say, a Web application in opposition to "traditional" software presents a number of advantages, such as: multi-platform portability, availability on a wide range of devices,[3] natural continuation of classroom activities at students' homes, and so on. Besides, the adoption of purely client-side technologies allows teachers to distribute materials through physical media (CD-ROMs, USB pens, etc.), and users to work off-line, namely without network availability.

In order to test the efficacy of our approach, we have designed, implemented and tested a basic Web environment dealing with typical primary-school subjects, like farm animals and musical instruments. The idea was to equip teachers with a flexible tool, easily adaptable to students' age, skill levels and didactic goals. Needless to say, a single class is composed by many different children, each one presenting his/her own way to learn. In accordance with the theory of multiple intelligences [15], we aimed to provide multiple inputs, multiple interaction modes and multiple ways to employ the same Web environment, so that the resulting learning experience can be really "student-tailored".

Consequently, we embedded *different kinds of content* into each single *learning resource*: multiple graphical representations, pronunciation of terms in the native and foreign language(s),[4] other contextualized audio content (animal sounds, music excerpts, etc.) and a text transcription of foreign words.

The resulting interface, shown in Figure 1, lets teachers choose among scenarios that present a gradually increasing number of learning resources as well as a gradually increasing graphical complexity. At the moment of writing, two sample lessons – dealing with farm animals and musical instruments respectively – are available at http://clil.lim.di.unimi.it.

4 A Multi-layer Pedagogical Approach

With respect to the approach described in Section 3, a more advanced goal is to realize a multi-layer pedagogical environment based on the role of multimedia not only as a privileged means to convey content, but also as a way to create a complex network of correlated and synchronized information. Foreign language, multimedia and technologies are the entities to integrate in order to foster a

[3] A W3C-compliant application can be virtually run on desktop computers, tablets, interactive whiteboards, smartphones, and – in general – any network-connected device equipped with an HTML5 browser.

[4] Please note that a strict interpretation of CLIL completely excludes the use of students' mother tongue during lessons.

Fig. 1. A Web interface for CLIL implemented through HTML5 and JavaScript.

stratification of skills, in accordance with Coyle's "four Cs" [7]: 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).

We can define this new proposal as "multi-layered" because it embraces different media types and media instances – each one with its own features, granularity and level of abstraction – and keeps them together in an interconnected information network. This approach was already present in the Web environment described in Section 3, but in a more embryonic state. The most distinctive feature is the network of links that must be established among the various facets of learning resources. For example, in the time domain this implies synchronization, as explained below.

A multi-layer structuring of information can be conferred to a Web environment through a suitable representation format. To this end, our choice fell on the international standard known as IEEE 1599, promulgated 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 CS TC on CGM).

Originally conceived for music information, IEEE 1599 adopts XML (eXtensible Markup Language) in order to describe a music piece in all its aspects, ranging from notation to audio, aiming to provide potentially the most comprehensive description for it. In the following, we will provide a short overview of those characteristics that are relevant to our goals, whereas a detailed descrip-

tion of IEEE 1599 is beyond the scope of this work. For further details, please refer to the official IEEE documentation or to scientific literature, such as [2].

5 A Paradigm Shift for IEEE 1599

The IEEE 1599 format has been chosen since it introduces some features particularly relevant for CLIL-based education, such as multi-layer information structuring and multimedia synchronization. In particular:

1. It is flexible enough to host not only music, but also a great number of related multimedia materials, including still graphics, video, and text. These potentialities can be profitably reused in a CLIL-oriented context;
2. It supports full synchronization among embedded contents. This feature opens new scenarios, giving for instance the possibility to use timed contents, and it can be exploited to reinforce learning;
3. It is XML-based and – consequently – fully compliant with W3C recommendations for Web applications. IEEE 1599 players realized through W3C technologies such as HTML5 and JavaScript are already available;
4. It is a free and standard format, well documented in dedicated Web sites and portals, official IEEE channels and scientific papers;
5. Its characteristics let programmers design and implement rich and engaging environments, as required by our expected audience;
6. Software tools to prepare and play IEEE 1599 materials are available.

In IEEE 1599, the goal of addressing a comprehensive music description is realized through a multi-layer environment. Music and music-related contents are arranged within six layers, in accordance with scientific literature (see e.g. [19] and [29]): General, Logic, Structural, Notational, Performance, and Audio. In order to provide a rich network of interconnected and synchronized descriptions of the same entities, music events are univocally identified inside a data structure called the *spine*. In this way, events can be described multiple times inside different layers (e.g., the graphical aspect of a chord in the *Notational* layer and its performance in the *Audio* layer), as well as multiple times within the same layer (e.g., different performances of the same cadence taken from the audio tracks stored in the *Audio* layer). Such a multi-layer environment simultaneously supports two synchronization modes: i) an *inter-layer synchronization* taking place among contents described inside different layers, where heterogeneous categories of information (i.e. additional descriptions of the same entities) are stored; and ii) an *intra-layer synchronization* occurring among the contents of a single layer, where homogeneous information (i.e. concurrent descriptions of the same entities) is stored.

The implementation of a CLIL framework based on IEEE 1599 clearly requires a paradigm shift, thus rethinking the concepts of music event, score, and audio track. In this case, events are no more associated to music symbols (chords, rests, etc.), but to learning resources (animals, music instruments, etc.); the role of the score (i.e. a container for music symbols) is played by the background

Table 1. Comparison of the key features of the two approaches.

Feature	*Pure HTML/JS*	*IEEE1599*
Web players available	yes	yes
User-friendly authoring tools available	yes	no
Multi-language support	yes	yes
Multimedia (text, images, audio) support	yes	yes
Storytelling through timed contents	no	yes

picture (a container for graphical representations of learning resources); finally, audio tracks are no more performances of music events but rather narrations that involve learning resources. These narrations, that are basically timed sequences of references to learning resources, may present different forms (tales, rhymes, songs, etc.) and give the possibility to change both the language and the order in which resources are mentioned.

The most relevant advancement with respect to the proposal in Section 3 is the possibility to include multiple timed contents and to experience them in a synchronized environment. While the previous interface required specific user actions to trigger events, such as mouse rollover to open panels and clicks to launch audio, now it is possible to use a tale, a rhyme or a song to connect events. Similarly to the music case, the user is allowed to switch current materials in real time: graphic backgrounds can be changed to increase or decrease the difficulty level without stopping the narration, the sequence of events can be altered by choosing a different kind of timed content, multiple audio tracks can be employed to illustrate different pronunciations, the language itself can be switched in the context of a multilingual lesson, and so on. The downside for this rich network of interconnected information is a heavier workload in preparing lesson contents, due both to the intrinsic complexity and to the lack of user-fiendly authoring tools. Table 1 provides an at-a-glance comparison of the two mentioned approaches.

An example of such a paradigm shift has been uploaded to the "Music Box" section of the *EMIPIU* framework,[5] a repository of music examples encoded in IEEE 1599 format. The comparison between a music piece and CLIL learning material is shown in Figure 2.

6 Conclusions and Future Work

In this work we have described an educational proposal based on the integration of three domains: computer technologies, multimedia, and foreign language. Since our approach makes them tightly interconnected each other, it can be difficult to establish the exact role played by each of them: any aspect can be seen as the input, the means or the educational goal of the initiative.

[5] URL: http://emipiu.di.unimi.it

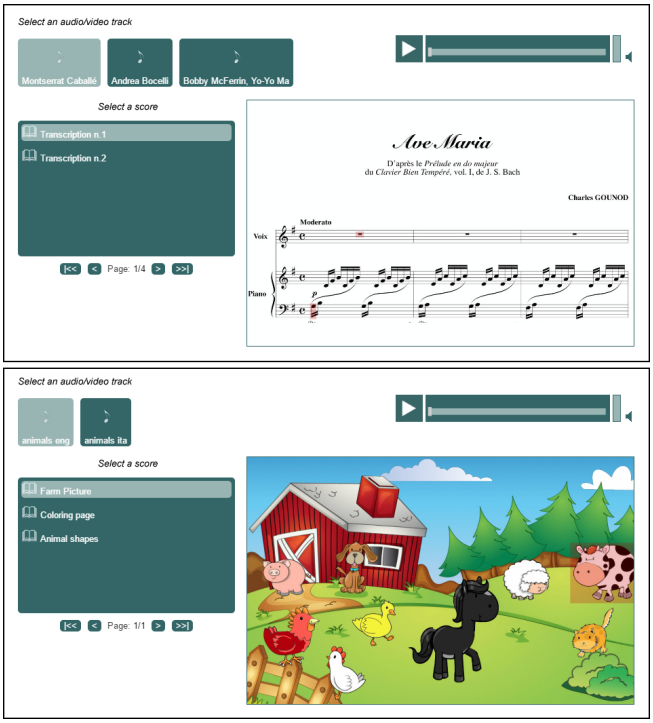

Fig. 2. A Web interface for advanced music fruition and its CLIL reinterpretation.

The frameworks we have described present a number of advantages. First, they are useful tools to introduce a specific school subject from scratch in the context of CLIL. Besides, they provide learning reinforcement environments: after the exposition to a new lexicon, children can find a number of hints and multimedia stimuli to deepen the meaning of new words, to experience multiple representations of concepts and to link them to other domains. Finally, they can be playful evaluation tools, easy to be integrated with "traditional" classroom activities. 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., asking Italian children to find the "dog", which corresponds to the Italian word "cane"). In this way, the teacher can evaluate if children have learned the meaning of lexicon and have realized the connection between the oral word and the corresponding image.

The proposed frameworks let children work alone, in pairs or in little groups, possibly with the assistance of an adult. When working with classmates, they can experiment the so-called *cooperative learning*. New theories of social constructivism and constructivism network argue that knowledge is acquired in a context, and – in this sense – cooperative learning encourages the development of communication skills and positive interdependence [4].

With respect to the experiences cited above, other school subjects can be suitably chosen in order to get further benefits from such an articulated approach. Lessons could be enriched through additional digital content (e.g., photos and videos), including materials produced by students. Besides, computer activities could be combined with classroom manipulative tasks, role games, and external initiatives (school trips, exhibits, etc.). To this goal, we have not only released the Web environments described in Section 3 and 5, but also equipped educators with related teaching materials such as printable coloring pages.

We conducted a pilot validation of the didactic experience in cooperation with an Italian primary school.[6] A detailed discussion of the pedagogical outcomes would fall outside the present work, that aimed to focus mainly on technological aspects, but the learning results obtained by young students – aged between 6 and 7 – seem to be very encouraging. As it regards future work, we want to extend the experimentation to other classes and add new school subjects in order to test the efficacy of our Web-based approaches.

References

1. Agolli, R.: A penetrating content and language integrated learning (CLIL) praxis in Italian mainstream education: Stemming novelties and visions. Research Papers in Language Teaching and Learning 4(1), 138 (2013)
2. Baggi, D.L., Haus, G.M.: Music Navigation with Symbols and Layers: Toward Content Browsing with IEEE 1599 XML Encoding. John Wiley & Sons (2013)
3. Bloom, B.S.: Taxonomy ofeducational objectives. New York: David McKay 356, 1998–1999 (1956)
4. Coonan, C.M.: Insider views of the CLIL class through teacher self-observation–introspection. International Journal of Bilingual Education and Bilingualism 10(5), 625–646 (2007)
5. Costa, F., Coleman, J.A.: A survey of English-medium instruction in Italian higher education. International Journal of Bilingual Education and Bilingualism 16(1), 3–19 (2013)
6. Costa, F., Coleman, J.: Integrating content and language in higher education in Italy. Ongoing research. International CLIL Research Journal 2010(3), 19–29 (2010)
7. Coyle, D.: Relevance of CLIL to the European Commission's language learning objectives. 2002). CLIL/EMILE the European Dimension. Finland: UniCOM (2002)
8. Coyle, D., Hood, P., Marsh, D.: Content and language integrated learning. Ernst Klett Sprachen (2010)
9. Cummins, J.: BICS and CALP: Empirical and theoretical status of the distinction. In: Encyclopedia of language and education, pp. 487–499. Springer (2008)
10. Dafouz, E.: CLIL across educational levels: Experiences from primary, secondary and tertiary contexts. Richmond Publ. (2009)
11. Dewey, J.: Art as experience. Penguin (2005)
12. Directorate-General for Education and Culture: Content and Language Integrated Learning (CLIL) at School in Europe. Eurydice, European Commission (2006)

[6] An early experimentation phase took place at I.C.S. Mahatma Gandhi, Trezzano Rosa, Italy.

13. Druin, A., Solomon, C.: Designing Multimedia Environments for Children: Computers, Creativity, and Kids. ERIC (1996)
14. Esteban, S.G.: Soft CLIL in infant education bilingual contexts in Spain. International Journal of Language and Applied Linguistics 1, 30–36 (2015)
15. Gardner, H.: Frames of mind: The theory of multiple intelligences. Basic books (2011)
16. Glušac, T.: CLIL and one-to-one classes. Content and Language Integrated Learning (CLIL) in Teaching English to Young Learners p. 63 (2012)
17. Gonzalez, R., Cranitch, G., Jo, J.: Academic directions of multimedia education. Communications of the ACM 43(1), 89–95 (2000)
18. Haces Tamés, B.: Nursery rhymes for content and language integrated learning in preschool education. Master's thesis, Facultad de Formación del Profesorado y Educación, Universidad de Oviedo (2015)
19. Haus, G., Longari, M.: A multi-layered, time-based music description approach based on xml. Computer Music Journal 29(1), 70–85 (2005)
20. Krashen, S.: Principles and practice in second language acquisition. Oxford Pergamon (1982)
21. Krashen, S.D.: The input hypothesis: Issues and implications. Addison-Wesley Longman Ltd (1985)
22. Llinares, A., Whittaker, R.: Linguistic analysis of secondary school students' oral and written production in CLIL contexts: Studying social science in english. Current Research on CLIL p. 28 (2006)
23. Ludovico, L.A., Zambelli, C.: Towards a music-based framework for content and language integrated learning in preschool. In: Proceedings of the 8th International Conference on Computer Supported Education (CSEDU 2016), pp. 75–84. SciTePress - Science and Technology Publications (2016)
24. Mehisto, P., Marsh, D., Frigols, M.J.: Uncovering CLIL. China: Macmillan Publishers Limited (2008)
25. Pinner, R.: Authenticity of purpose: CLIL as a way to bring meaning and motivation into EFL contexts. Asian EFL Journal 15(4), 137–158 (2013)
26. Sakurai, S.: Bilingual education in primary school: aspects of immersion, CLIL, and bilingual modules. Language and Education 29(1), 83–85 (2015)
27. Saladrigues, G., Llanes, À.: Examining the impact of amount of exposure on l2 development with CLIL and non-CLIL teenage students. Sintagma: revista de lingüística 26, 133–147 (2014)
28. Sokół, M.: Helping preschool and primary school children to develop phonemic awareness and bilingual literacy skills in the light of SLA theories. Master's thesis, Institute of Iberian and Ibero-American Studies and College of English Language Teacher Education, Warsaw University (2015)
29. Steyn, J.: Framework for a music markup language. In: Proceeding of the First International IEEE Conference on Musical Application using XML (MAX2002). pp. 22–29 (2002)
30. Strotmann, B., Bamond, V., Lopez-Lago, J.M., Bailen, M., Bonilla, S., Montesinos, F.: Improving bilingual higher education: Training university professors in content and language integrated learning. Higher Learning Research Communications 4(1), 91–97 (2014)
31. Whittaker, R., Llinares, A., McCabe, A.: Written discourse development in CLIL at secondary school. Language Teaching Research 15(3), 343–362 (2011)
32. Wolff, D.: Integrating language and content in the language classroom: Are transfer of knowledge and of language ensured? ASp la revue du GERAS 41–42, 35–46 (2003)