

# Adaptive Learning in Computing for Non-English Speakers

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## Abstract

A significant proportion of e-Learning resources for engineering and computing education appear to be exclusively in English, requiring many learners to adapt themselves to learning within an English language context. Adaptive learning has a role to play in minimizing this adjustment and strengthening the learning. This research plans to understand learning needs, and take a Content and Language Integrated Learning (CLIL) approach to create algorithms to supply online learning experiences and content to meet these needs, adding novel mechanisms to help learners cope, develop their language capabilities, and enhance their ability to learn in another language. This work in progress describes the early stages of the research and we welcome insights into taxonomies of adaptive learning techniques, and mixed methods approaches to evaluating learning effectiveness, for those learning in an additional language.

**Keywords:** Adaptive learning; MOOC; CLIL; e-Learning

## Introduction

The mastery of foreign languages has become a core competency for Computing students both in the pursuit of their studies and to facilitate their future job search. The European Commission has identified CLIL (Content and Language Integrated Learning) as a strong alternative to Language Immersion and Content-Based Instruction. CLIL refers to “educational settings where a language other than the students’ mother tongue is used as a medium of instruction” [1]. For example, non-language subjects such as mathematics or programming can be taught in English to French-speaking students. CLIL is alternative approach to communicative language teaching (CLT). One of the main goals of CLIL programs is to enhance the language competences of learners by increasing the time of exposure to a language without requiring extra time in the curriculum [2].

Intelligent and adaptive learning systems aim to improve learning by individualizing the learning process for each student [3]. These systems diagnose what learners individually know and don’t know (Intelligent), then generate learner specific content and interfaces, including learning paths and features that match the learner’s preferred approach (Adaptive). Learners then can explore articles, e books, audio files, videos, quizzes, and courses covering fresh topics, instead of unnecessary repetition (while repetition is effective in some situations it can be demotivating in others). The system does this in a way that the learners will find engaging, and which saves them time. It can be an alternative, or a supplement, to individual tutoring.

Adaptive learning itself needs improvement: current research and tools do not seem to consider students who use different languages in their everyday lives. An adaptive learning tool, based on a CLIL approach, can bring many advantages to students and teachers. Rather than see the use of a foreign language as a barrier in the learning process, we propose to use it as a springboard, both for learning specific content, but also to learn or improve language proficiency. Although learning foreign languages is compulsory throughout high school in most countries, language learning is too often lacking in most university programs. Almost all courses are taught in the local language. When a program does include language courses, these are usually optional and divergent from the rest of the curriculum. Yet learning a language does not only take place in a dedicated language class, it happens whenever a student has to interact with the foreign language.

## Motivation and Objectives

As yet, we have found no in-depth studies in the field of adaptive learning for multilingual students. Our objective is to research best practice in bilingual learning and define methods to apply in an online learning tool: for example, constructs to define students’ levels of English and French, and to model the preferred styles and strategies of each learner. Specifically, we aim to create a tool that allows French and English students to kill two birds with one stone: learning a non-language course while improving their second language proficiency. Learners will be able to self-assess to identify their weaknesses. This would allow them to access only unfamiliar material presented in their preferred style when learning online, and focus on what they don’t know when self-learning. In the context of a flipped classroom, where students discover and learn content online using an adaptive learning tool then apply what they have learnt in individual or group projects, teachers will be able to use the tool to quickly visualize learners’ levels and progress, and personalize activities and explanations to match individual and collective knowledge. Teachers would be able to use learners’ data to establish working groups composed of students facing similar difficulties to work together on the same problem.

We aim to create and validate a model of relevant factors and so develop a specific algorithm to determine the optimal content to present to the learner, based on factors such as the student’s proficiency in the native and second language, knowledge of the subject matter, preferred learning styles and strategies, and learning trajectory. This research and these tools aims to benefit international students who have to think, learn, research and write in several languages throughout their educational careers. It will also benefit industry by giving them access to multilingual Computing students who can be better placed to investigate and understand end users’ needs across cultures. It may even aid programmers to acquire additional programming languages.

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Received July 18, 2017; Accepted July 27, 2017; Published July 31, 2017

Citation: Hemavathy R, Harshini S (2017) Adaptive Learning in Computing for Non-English Speakers. J Comput Sci Syst Biol 10: 061-063. doi:10.4172/jcsb.1000250

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## Related Research

In exploring our approach, consideration should be given to the use of adaptive learning and CLIL in Massive Open Online Courses (MOOCs). MOOCs have been criticized as a one-size fits-all solution and the incorporation of adaptive learning would allow them to provide individualised learning experiences on a massive scale. As current MOOCs are mostly in English, CLIL could be also implemented in order to help learners to improve their understanding and language skills.

## Adaptive learning in MOOCs

MOOCs are much in vogue and attract a significant number of learners from all over the world. Other than “chunking” content into smaller sections, we argue that MOOCs essentially automate the traditional mass instruction learning experience, with primitive understanding of individual students’ needs. Equivalent courses on MOOCs usually extend over several months, a chapter each week (admittedly, at present, much usage is limited to “taster courses” for graduates, rather than an alternative mode of mass learning). Perhaps due to lack of time, interest or motivation, users abandon their online course. Others see this as a virtue – learners stop because their needs are satisfied – but are learners best able to judge their future learning needs? Additionally, we observe that the social context in face-to-face learning helps maintain engagement during over-familiar content until the next novel item arrives. Conversely, who has not abandoned an online video after the first few moments thinking “I know all this”?

Several strategies have been tested to reduce the dropout rate: edX matched students to advisors, and connected students with complementary interests and abilities, to investigate if offline support was an additional factor in student’s success, beyond educational background and experience in the topic [4]. Although MOOC content is no longer exclusively in English, MOOCs do not yet seem to support users to improve their foreign language capability, while also learning new subject matter. However, Coursera recently announced [5] a community project to translate courses into other languages.

Some adaptive e-learning tools have proven effectiveness [6-12]. Learners using such tools achieved significantly higher results, than those obtained with a teacher [5]. Adding adaptive learning techniques to MOOCs might allow learners to create their own paths through the learning material, and, via recommender systems, to relevant learning suggestions for others. Teachers could then support learners’ journey to higher levels of competency, and also motivate learners to persevere. Data analysis of student achievements and learning profiles could further enhance the quality of the adaptation and recommendation, or simply improve the relevant learning object. Adaptive e-learning tools might increase completion rates by maintaining engagement and motivation.

Adaptive MOOC research [13] seems to focus more on technical feasibility and content structuring, than learning efficacy. However, a current project [14], funded by the Bill and Melinda Gates foundation, aims to identify how students’ goals are expressed through their activities on the edX learning platform and how they evolve over time, and findings from this might help personalize students’ learning experiences.

The use of Adaptive Learning in MOOC is still experimental, and we have found three companies exploring it: edX [15], Cogbook [16] and Spanishmooc [17]. As yet, none of these companies seem to report any results from the use of adaptive learning in their platforms.

Other obstacles hinder research in MOOCs. The access and the use of data from learners require researchers to create their own MOOC or to work in partnership with a specialist company such as Coursera. Creating a MOOC requires substantial investments and much work. Such a project requires professionals in different disciplines to design of course, translate, record, and edit audio files and videos, design quizzes and assessments, develop and host the personalised platform. As an example, the University of Pennsylvania spends around \$50,000 per MOOC [18].

## Benefits of adaptive learning in CLIL

CLIL programmes have grown rapidly in number since 1994 and they are widely implemented throughout Europe, although as yet there seems to be no bilingual MOOCs based on the CLIL approach. We have only found a few e-learning platforms using a CLIL approach and none of them were intended for students in higher education. The use of CLIL raises several questions on its application in classrooms and its effects on students. Adaptive learning tools could enhance learning and reduce disadvantages of the use of CLIL approach in different situations.

Before participating in a CLIL experience, language proficiency of candidates must be tested to assess if their level is suitable for a CLIL program. Indeed, a minimum level is required for learners to understand and express themselves adequately in the foreign language. Unfortunately, this excludes students who do not yet have the required level to be part of a class. An adaptive tool might be adequate for a group of heterogeneous learners as long as they have basic skills in a foreign language, thus being inclusive to students with less knowledge of that language, while not hindering the learning of students with more knowledge.

If students experience overly complicated or unfamiliar subject content, this might hinder rather than benefit language development [19]. In practice, teachers tend to simplify the content, thereby reducing the learning outcomes of the course [20]. An adaptive learning tool could identify an appropriate combination of the taught language and content by varying the complexity of one of the two according to the level of learner in the foreign language. This variation would evolve during the learning experience according to the progress of the learner. In addition, the combination of the language and the content could be personalised for each student if they prefer to put emphasis on the language rather than the content and vice versa.

In practice, faced with a class of diverse learners, it is difficult for teachers not to give preferential treatment to either the content or the language [21,22]. This issue can easily be remedied by the use of an algorithm providing an optimal treatment, in term of time and amount of information. While studying at home, students might struggle to find help in the foreign language [23]. Adaptive learning platforms can provide quick and automated feedback. If students still struggle, they can find help provided by other students following the same online course or from teachers who can answer questions asked by students.

Without a doubt, CLIL is hard work for teachers [23]. Teachers working on CLIL often do it in teams [20]. A recurring criticism of CLIL relates to the skills of teachers. They are asked to teach in a foreign language, one in which they are not experts. It seems also to be very difficult to find qualified teachers capable of teaching senior-level courses [24]. During the design of an online adaptive course using CLIL approach, one or more linguistic experts can create teaching materials in collaboration with content experts. However, while this collaboration may enable the production of high quality courses, a modification or

improvement of the course would require the intervention of several teachers from the team and generate additional costs.

Is CLIL suitable for all students? Other pedagogies may be preferable to students. For instance, some may choose to learn a foreign language first and then take a course taught in that language. Another option would be to take a course in their native language and take the same course in the foreign language. Without an adaptive learning system, these learning strategies would be difficult to implement since a high flexibility of the schedules of teachers and students would be required. In order to maximise its linguistic effectiveness and subject matter learnability, we suggest combining an adaptive learning tool with the use of a CLIL approach.

## Research Phases

Two fully bilingual courses will be designed, in English and French, one for a technical Computing subject and the other in a more discursive subject such as Business Information Management. These courses will be made available for students in two universities, one in France and the other in the UK, who want to improve their language skills in English, in French or in both languages.

The course content will be available online in various forms (text, animation, audio, video) on a dedicated platform. Special attention will be given to granularity (that is, the size of each unit of learning), style and type of content, exploiting research in fields such as pedagogy, content management (CM) and digital media asset management (DMAM).

Initially, the platform and courses will be tested for robustness, and then evaluated, by a small group of students. The results from this will be used to identify scalability issues and enhance the platform and the algorithm, making it possible to evaluate with a larger number of students, including international students. Quantitative measures will include demographic profiles and student achievement. The Effect Size (ES) will be used to analyse the effectiveness of the system and compare outcomes from one pedagogical experiment to another. ES promotes a more scientific approach to the accumulation of knowledge [25]. A comparison will be made between two groups: one group will use the algorithm that will select the most suitable content, type of content and language (experimental group); the other group will use the same course without the algorithm (control group).

The algorithm will be improved based on statistics and feedback from students. Further studies will be proposed to establish the generalizability in other academic disciplines, and with other languages.

## Conclusion

In this work-in-progress paper, different solutions have been suggested to improve learning experiences and to maximize language effectiveness in MOOCs. MOOCs seem immature. Current investments from the main actors on the market focus on the volume of learners and courses, rather than adaptive and language features. Although the trend is changing, most courses in MOOCs are still only available in English. The CLIL approach was implemented in several schools within Europe but its application in e-learning remains rare. This research intends to verify if positive effects of CLIL observed in traditional classrooms, combined with adaptive features, can provide significant improvements in the learning process of students.

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