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Learning subject content through a foreign language should not ignore human cognitive architecture: A cognitive load theory approach

Stéphanie Roussel [a, *], Danielle Joulia [b], André Tricot [c], John Sweller [d]

[a] Languages Department, University of Bordeaux, LACES (Culture, Education & Society Research Center), 16 avenue Léon Duguit, 33608 Pessac, France
[b] Department of Computing, IUT Paul Sabatier, University of Toulouse, CNRS, CLLE / LAIRDIL, 133 av Rangueil, 31077 Toulouse Cedex 4, France
[c] CNRS, CLLE - Work and Cognition Lab., University of Toulouse, 5 allées Machado, 31058 Toulouse Cedex, France
[d] School of Education, University of New South Wales, Sydney, NSW 2052, Australia

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ABSTRACT

Several widely implemented educational approaches aim to provide academic content in a foreign language. While Content and Language Integrated Learning (CLIL) works because it focuses both on content and on foreign language learning, approaches aiming at transmitting academic content through a foreign language should not be implemented without explicit foreign language instructional support. Based on cognitive load theory, there are theoretical reasons to hypothesize that exposure to new content in a foreign language without any foreign language instructional support may interfere with rather than facilitate learning compared to learning language and content separately. In three experiments conducted in higher education, a text was presented to 294 students in three different conditions: native language, foreign language, and foreign language with a translation into the native language. We varied the foreign language (English, German) and the domain (Law, Computer Science). Our results indicated that reading in the foreign language was never the best condition to learn either language or academic content. We concluded that considerable care should be taken when transmitting academic content in a foreign language, without explicit foreign language instructional support.

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1. Introduction

Around the world, and in Europe in particular, there are several approaches which aim to teach academic content through a foreign language in primary or secondary schools (immersion). Whereas some approaches aim to teach only content, others aim to teach both content and language simultaneously (variously known as Content and Language Integrated Learning - CLIL, Content Based Instruction - CBI). In France, according to the Ministry of Education in 2014, 10%[1] of children participated in such programs. In the context of growing internationalization, higher education has followed the trend initiated by primary and secondary education and also has provided tuition in languages other than the official language of the country, despite that language being neither the learners' nor the teachers' native language (mainly English as a Medium of Instruction, or EMI). For students who did not follow a CLIL program in school, the shift to learning content in a foreign language in higher education is sudden (Arkin & Osam, 2015) and widespread (Bruton, 2013).

CLIL is defined as: "a dual-focused educational approach in which an additional language is used for the learning and teaching of both content and language (…)" (Coyle, Hood, & Marsh, 2010, p. 1). CLIL thus contains a strong pedagogical component aiming to support foreign language learning. Pedagogical approaches which aim at transmitting content through a foreign language in higher educational contexts tend to omit this important element, although their implementation is mostly based on research results from secondary programs using CLIL (Tatzl, 2011; Jimenez-MunozA, 2016). While considerable research has been carried out in this field (Bruton, 2011, 2013; Cenoz, Genesee, & Gorter, 2013; Coyle et al., 2010; Dallinger, Jonkmann, Hollm, & Fiege, 2016; Dalton-Puffer, 2007, 2011; Dalton-Puffer, Llinares, Lorenzo, & Nikula, 2014; Fortanet-Gomez, 2013; Verspoor et al., 2015; Piesche, Jonkmann, Fiege, & Keßler, 2016; Rumlich, 2014, 2016), some researchers have also suggested that many variables that are not

* Corresponding author.
E-mail addresses: stephanie.roussel@u-bordeaux.fr (S. Roussel), danielle.joulia@iut-tlse3.fr (D. Joulia), andre.tricot@univ-tlse2.fr (A. Tricot), j.sweller@unsw.edu.au (J. Sweller).

[1] http://www.education.gouv.fr/cid87947/classes-bi-langues-et-sections-europeennes-ou-de-langues-orientales-selo-en-college.html.

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easily controlled in ecologically valid contexts such as selection of participating students, time exposure to the foreign language in and outside foreign language classes, the learning material and its presentation (Dale & Tanner, 2012), students' and teachers' motivation, students' initial language proficiency, and the official languages of the country may lead to an overestimation of academic content and foreign language learning benefits (Dallinger et al., 2016). For these reasons (pedagogical component and contextual variables), it is obvious that CLIL may be difficult to transpose to every context. In particular, it should not be transposed to higher education without any foreign language instructional support, as it often occurs.

In this context, some researchers have warned against a lack of foreign language instruction in bilingual academic programs (Jimenez-MunozA, 2016) and in adjustments to the approach of already existing mother-tongue-taught courses. We may need to be concerned by what happens in situation where students, who are not selected, not particularly motivated, not particularly prepared and not particularly trained in the foreign language, are exposed to academic content in this foreign language without any foreign language instructional support. "The negative potential impact on grades and outcomes (Clegg, 2001) of this lack of adaptation is an evident concern" (Jimenez-MunozA, 2016, p.112) to researchers of the field. In this paper, we argue that empirical research using randomized, properly controlled trials (Shohamy, 2012; Perez-Canado, 2013) and theoretical argumentation, here based on cognitive load theory, are needed and can contribute to the discussion.

Our empirical work was intended to investigate some of the relevant variables that may determine the efficacy of foreign language instruction in higher educational contexts. As previously mentioned, there are reasons based on cognitive load theory (Sweller, 2015, 2016a; Sweller, Ayres, & Kalyuga, 2011) to hypothesize that without any foreign language instructional support, learning academic content through a foreign language is likely to lead to sub-optimal results. We will outline some of the available data followed by predictions flowing from cognitive load theory.

2. Learning language and content simultaneously

2.1. Definition and theoretical justification

CLIL is defined as a dual-focused educational approach, whereby a foreign language is dedicated to learning and teaching both the content *and* the foreign language (Mehisto, Marsh, & Frigols, 2008) in a balanced way. In Europe, CLIL, and in North America, Content Based Instruction (CBI) are widely used acronyms with no fundamental difference between the two terms (Cenoz, 2015). Such approaches thus include a pedagogical component to support both content and foreign language learning. English as a Medium of Instruction (EMI) designates certain courses or programs offered in English where English is a foreign language (Doiz, Lasagabaster, & Sierra, 2012), in particular in higher educational contexts and describes approaches in which a foreign language is used to learn content, without any or with restricted instructional support to learn the foreign language, even if the use of the foreign language in this context is likely to incidentally enhance students' competence in the second language.

Presenting content in a foreign language with no instruction concerning the foreign language whatsoever results in immersion. Immersion occurs mainly in higher education and is called EMI when the language of instruction is English. We are primarily concerned with this common version of immersion, where content is transmitted in a foreign language without or with very limited foreign language instruction.

Many foreign language acquisition theories support positive consequences of immersion on students' foreign language skills (Dallinger & et al. 2016). The (socio)constructivist approach (Bruner, 1978), the input hypothesis (Krashen, 1985), interaction approach (Gass & Mackey, 2007), the natural approach (Krashen & Terrell, 2000) advocate that foreign language learners need sufficient amounts of input and opportunities to interact in a foreign language to learn efficiently. Moreover, according to these theories, the best learning conditions should be similar to those of native language acquisition. CLIL, EMI and immersion-classrooms conform to these criteria (Eurydice, 2006, Zydatiβ, 2007; Surmont, Craen, Struys, & Somers, 2014).

Another theoretical argument in favour of CLIL or immersion is supported by research on bilingual children. As emphasised by Piesche et al. (2016), CLIL-students are able to "process information more deeply because they invest more mental effort in the task" (p.109). This claim is supported by the work of Heine (2010) who promoted a cognitive linguistic perspective on CLIL and showed that a focus on language has positive effects on the processing of semantic content. In sum, this stream of research suggested that cognitive control and selective attention can be intensified through processing information in a second language, and that this procedure fosters better long-term retention. Piesche et al. (2016) also emphasised that other theories indicate the opposite. For example, from a cognitive load theory perspective, (Sweller et al., 2011), students' working memory can be overloaded by simultaneously processing new content and the foreign language.

2.2. What do the data say?

Grounded on the previous theoretical considerations, several studies have been concerned with the effect of CLIL instruction on students' language skills (Jexenflicker & Dalton-Puffer, 2010; Ruiz de Zarobe, 2010) and have shown positive effects of this approach on linguistic outcomes (Admiraal, Westhoff, & de Bot, 2006; Lasagabaster, 2008; Ruiz; de Zarobe, 2008; Loranc-Paszylk, 2009; Várkuti, 2010). Dalton-Puffer (2007, 2011) suggested that students have better language performance, and show more ability, accuracy and fluency in using a foreign language than mainstream students. Ikeda (2013) indicated that a 'weak' form of CLIL works in the Japanese context if teachers are trained properly. Jiménez-Catalán and Ruiz de Zarobe (2009) also reported advantages in favour of CLIL students in the development of reading comprehension skills. In contrast, Roquet and Pérez-Vidal (2015) investigated the differential effects of two learning contexts (formal language instruction as opposed to content and language integration) on the written production skills of adolescents but the superiority of CLIL could not be confirmed. Pladevall-Ballestera and Vallbonab (2016) did not find any significant differences between CLIL and non-CLIL students regarding reading skills. Rumlich's longitudinal study results in Germany testing almost 1400 German students were quite disappointing and "counterintuitive" (Rumlich, 2016, p. 448) concerning CLIL benefits on learners' performance (see also Rumlich & Stebner, 2016), although motivation increased for language learning among prospective CLIL students (Rumlich, 2014), no significant effect of CLIL was found. Dallinger et al. (2016) found that a CLIL approach increased listening comprehension but no other language skills.

Concerning the learning of content, the results are even less conclusive and some studies demonstrated little benefit for content learning (Van de Craen et al., 2007) while others (Badertscher & Bieri, 2009; Dallinger et al., 2016; Jäppinen, 2005; Piesche et al.,

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