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A Model for CLIL in School Chemistry Classes: Combining the Aims of CLIL and Chemistry Teaching

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Content and Language Integrated Learning (CLIL) is a concept that could help reach the linguistic goal of the EU, namely that every citizen should be able to communicate in at least two languages apart from his or her mother tongue. So far in Germany, the subject chemistry is rarely taught as a CLIL subject; possibly because the goals of foreign language learning and the goals of science teaching seem to diverge. This article presents a model that integrates the aims of CLIL with the aims of science teaching, in order to show how both language competence and scientific learning goals can be promoted within one integrated concept.

Keywords: CLIL, model, integration of learning goals, chemistry

INTRODUCTION

Teaching Chemistry through the medium of a foreign language – that seems like a stretch. However, this idea presents a logical consequence of the schools' mandate to prepare students for participation in our modern and globalized world. Nowadays, scientific discourse almost always takes place in English. Yet even outside of universities and scientific research, foreign language competence is a requirement in virtually every field of work. The European Union is aiming for "MT + 2", meaning that every citizen of the EU should be able to communicate in at least two languages in addition to their mother tongue (MT)(European Commission, 1995, p. 47). The CLIL concept (Content and Language Integrated Learning) is the European manifestation of the idea of learning content matter through a foreign language and therefore is regarded as a way to achieve the linguistic goal of the EU (Muñoz, 2002, p. 35).

Improving foreign language competence without compromising the lesson's content: this is the definition and the dual aim of CLIL. Perusing modern chemistry education literature, one can find examples that CLIL in chemistry is not only

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possible, but beneficial, even from a subject point of view. To name but a few, Bonnet and Hegerfeldt find evidence that the use of the foreign language can lead to a deeper, more nuanced, and more precise understanding of chemical terms and concepts (Bonnet, 2005, p. 27; Hegerfeldt, 2006, p. 40), which constitute the basis of the subject. Interestingly, Rittersbacher observed that lessons in a foreign language had a positive effect on the social behaviour of her students. It led to a higher degree of cooperation within the class (Rittersbacher, 2006, p. 35). This does not only improve the learning atmosphere, but is also vital for the learning of the subject, for Bonnet ascertained that a lack of social competence is a limiting factor for developing competences in chemistry (Bonnet, 2004, p. 290).

Despite there being good arguments for CLIL in chemistry, there are still only few schools that practice it. Possible reasons for this would be the facts that suitable teaching material is sparse and that there are few teachers who have a subject combination of chemistry and a foreign language (Klingauf & Lüpke, 2007, p. 30; Köhne & Bohrmann-Linde, 2010, p. 45). Another explanation for this could be that the aims of foreign language and science teaching may seem very far apart, especially for teachers who do not teach a foreign language. For these teachers, it might be difficult to see how these aims can be integrated. This article seeks to show that an overlap does exist between these seemingly diverging goals and will present a model which integrates the competences stipulated by the chemistry curriculum and the CLIL concept respectively.

The Aims of CLIL

In the following, the main aims of CLIL will be summarised. They pertain to the content, to the foreign language itself, and to intercultural competences. The ultimate aim of CLIL can be found in its name: to integrate content learning with language learning. Contrary to the concerns of some subject teachers, CLIL is not supposed to be “backdoor language teaching” (Coyle, 2006, p. 5). The learning of subject content is not put at risk in favour of the foreign language. On the contrary, it can even be promoted: “The experience available shows that both linguistic and content subject competence can be promoted within this integrated concept more effectively than when content and language are taught in isolation” (Wolff & Marsh, 2007, p. 47). Bonnet (Bonnet, 2005), Coyle, Hood, and Marsh (Coyle, Hood, & Marsh, 2010, p. 27) attribute this to synergy effects: students who take delight in learning foreign languages, but are not as interested in sciences are motivated by the fact that the lesson is conducted in a foreign language. On the other hand, the content can motivate scientifically oriented students, who do not enjoy the traditional foreign language lessons as much, to use and thereby learn the foreign language. CLIL lessons should therefore work towards these synergy effects to promote both the learning of the subject and the language.

The language goals of CLIL should be understood within the concept of plurilingualism. Plurilingualism is the aim of foreign language learning (Europäische Kommission). This does not mean that every one of the languages which is included in the individual's repertoire has to be mastered perfectly, but that everyone should be able to successfully communicate in all everyday communicative situations in our multilingual European society. "Functional plurilingualism" means that certain social functions, certain facets of everyday life, are routinely dealt with in only one language, so that the vocabulary is “incomplete” in one language or the other (Grosjean, 2008). This is not seen as a handicap: it is simultaneously the ideal and the reality of many Europeans. The statement: “The term ‘bilingual education’ presupposes that the learners are, or will become, bilingual” (Marsh, 2002, p. 55) is to be understood within the framework of functional plurilingualism. The aim of CLIL is *not* flawless language proficiency, but to guide students towards functional

plurilingualism. The students should learn to use different languages and communicate successfully as required by different situation. As a result, in CLIL lessons the focus is on the message, not the language.

There is one further facet of foreign language learning which is very relevant for CLIL: intercultural competence. Intercultural competence enables a person to think outside the box (Grosjean, 2008) of his or her own culture and to mediate between cultures. It surpasses pure factual knowledge of one's own and other cultures; it includes sensitivity, empathy and acceptance of and respect for other points of view.

The aims of CLIL are manifold. They include linguistic and intercultural goals. However, it is important to bear in mind that in CLIL, the content of the subject is in the foreground, and that pertaining to the language, it is the message and not the accuracy that is important.

Models for CLIL

There are a number of models which can be used to help plan lessons which work towards the aims of CLIL. One of them is the 4C Framework, which goes back to Coyle (1999) (Coyle, 1999, p. 53). This model is widely used all over Europe (Wolff, 2007, p. 22). However, another model, which was devised by Bonnet, Breidbach and Hallet, has had an even greater impact in Germany (Bonnet, Breidbach, & Hallet, 2005). Both models will be described and explained in the following section.

Coyle's 4C Framework lays down four competences CLIL lessons should work towards: Content, Cognition, Communication and Culture. Those keywords are to be understood as follows: (Biederstädt, 2013, p. 7):

Content: The content is determined by the subject and the focus is on the conveyance of subject-specific knowledge and methods.

Cognition: The disposition of cognitive performance is at the center of learning. Tasks and problems have to be solved autonomously and adequately by applying subject knowledge, skills and abilities as well as strategies and routines. The results have to be evaluated.

Communication: Learning processes at school are characterized by different patterns of interaction and communication. Special attention has to be paid to communication about a subject matter in a foreign language within the learning group.

Culture: The aim of intercultural learning is the perception and appreciation of other cultures and the relativisation of one's own point of view in both a cognitive - content and emotional-affective manner.

There are several models and methods which are connected to the 4C Framework which can help with the planning of CLIL-units. For example, Meyer's *CLIL Pyramid* (2012)(Meyer, p. 278) provides systematic steps for the planning of a CLIL unit and Coyle's *Language Triptych* supports teachers in the planning of language scaffolding.

Bonnet, Breidbach et. al. name the following target competences (Bonnet, Breidbach, & Hallet, 2005, pp. 176–185):

- The *conceptual dimension*, which comprises terms and concepts in the foreign language.
- The *language dimension*, which refers to terminology and discourse as well as communicative competence in general.
- The *method dimension*, which relates to subject-specific learning and working techniques.

- The *reflexive dimension*, which is concerned with the personal and cultural identity of the students and how they reflect upon foreign cultures and points-of-view and come to form their own opinion.

The aforementioned approaches to CLIL will be used for the development of a model for CLIL in chemistry in chapter 5.

The Aims of Science Teaching

The following chapter is dedicated to the aims of science teaching, as stipulated by the authorities in Germany. For the German school system, the aims of science teaching are outlined in the *Bildungsstandards* published by the *Kultusministerkonferenz*, the council of the Education Secretaries of all the different federal states. These aims are then specified by the different federal states in their respective curricula.

The *Bildungsstandards* for chemistry, physics and biology name four core competences as the building blocks towards scientific literacy (Kultusministerkonferenz, 2004a, p. 7; Kultusministerkonferenz, 2004b, p. 7; Kultusministerkonferenz, 2004c, p. 7): subject knowledge, gaining of knowledge, communication and evaluation. Even if the curricula of the individual federal states differ, science lessons in all states still need to include and cater towards those four core competences. In the following, the curriculum of Lower Saxony will be used as an example curriculum.

The curriculum from 2007 of the federal state of Lower Saxony gives a definition of the four core competences which are translated in the following table. The competences are used in all sciences up to grade 10.

Table 1. Core competences in the sciences.

Dealing with scientific questions and problems	
Subject knowledge	- obtaining and structuring basic knowledge - linking concepts
Gaining of Knowledge	- recognizing and understanding scientific procedures and ways of thinking - drawing up strategies for solving scientific problems - understanding the importance of experiments
Communication	- arguing convincingly - distinguishing everyday language from scientific terminology - using sources of information - preparing and giving presentations
Evaluation	- forming an opinion based on facts - comprehending the importance of science in our society - using scientific knowledge and skills

According to the *Kultusministerkonferenz* and the curriculum of Lower Saxony, the overall aim of science education is the acquisition of scientific literacy [*naturwissenschaftliche Grundbildung*] (Kultusministerkonferenz, 2004b, p. 6; Niedersächsisches Kultusministerium, 2007). In a nutshell, this concept means the ability to take part in scientific discourse not only within the classroom but also beyond. Hallet states that this is crucial since anyone who cannot take part in the discourses of our society risks social and cultural marginalisation (Hallet, c2008, p. 88).

The goals of science teaching, as can be seen here, are quite complex. They refer to both the content and the process of learning. Their overall aim is to capacitate students to comprehend or even contribute to the decision-making processes in our society.

Integrating the Aims of CLIL with the Aims of Science Teaching

In After the foregone elaboration of the aims of CLIL and the aims of science education, this chapter will now work towards integrating these goals in order to construct a model for CLIL in chemistry. Comparing the CLIL 4C model and the target competences by Bonnet, Breidbach and Hallet with the core competences for sciences, one can see that there is a lot of common ground. This can be shown in the following graphic:

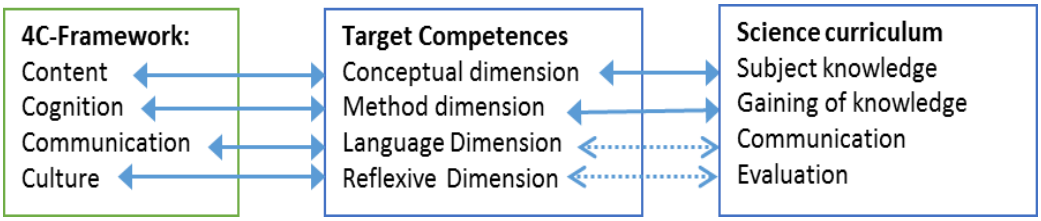

Figure 1. Juxtaposition of competence aims.

There is striking similarity between the 4C model and the target competences as well as a lot of correspondence between these two models and the aims of the science curriculum. The aims "Subject Knowledge" and "Gaining of Knowledge" parallel the aims „Content" and „Cognition", and the conceptual and method dimension, respectively. This is indicated by the continuous horizontal arrows that connect the concepts. The arrows pointing towards "Communication" and "Evaluation" in the science curriculum are dotted arrows. This indicates that they do not completely mirror the corresponding concepts of the *4C-Framework* and the *Target Competences*. The main difference regarding "Communication" is that the science curriculum assumes a monolingual communication in the official state language while CLIL aims for successful communication in a foreign language. Also, "Evaluation" only partly overlaps with the "Reflexive Dimension" and "Culture". Although all three concepts revolve around opinion-making processes, the "Reflexive Dimension" and "Culture" explicitly include the cultural dimension of this process while "Evaluation", as defined in the Lower Saxony curriculum, seems to assume that only factual, objective arguments are relevant for the forming of an opinion ("sachgerecht urteilen"/"Forming an opinion based on facts" Niedersächsisches Kultusministerium, 2007, p. 9)[1]. The Target Competences and the 4C-Framework, however, allow for the possibility of different perspectives and value systems. Those different perspectives can sometimes, but not always or exclusively, be traced back to cultural differences. This large overlap between the aims of CLIL and the aims of science teaching strongly suggests that they can be integrated. The following model does this by using the Lower Saxony core curriculum as a basis and adding aspects only mentioned in the CLIL concepts. This was done for two reasons: Firstly, because the *Kultusministerkonferenz* explicitly states that the subject curricula are to be the basis for CLIL (Kultusministerkonferenz, 2013) in the respective subjects, and secondly because teachers are used to working with the curriculum. Furthermore, this representation shows how well the different concepts can be combined into one method.

In the model, the green fields represent the science curriculum while the keywords in the yellow fields stem from the aims of CLIL. The aspect "forming an opinion based on facts" within the competence "Evaluation" has been replaced by the concept of Intercultural Competence (ICC). This concept is connected to the aspect "putting scientific knowledge and skills into use by a dotted line, because in science teaching, the two are interwoven. Many of the additions made are implicit in

[1] The *Bildungsstandards* published by the Kultusministerkonferenz actually give consideration to different value systems. However, this was not transported to the Lower Saxony curriculum.

the science curriculum, even if they are not mentioned, as for example "solving problems in a team", "writing texts" and even "deducing the meaning of words from

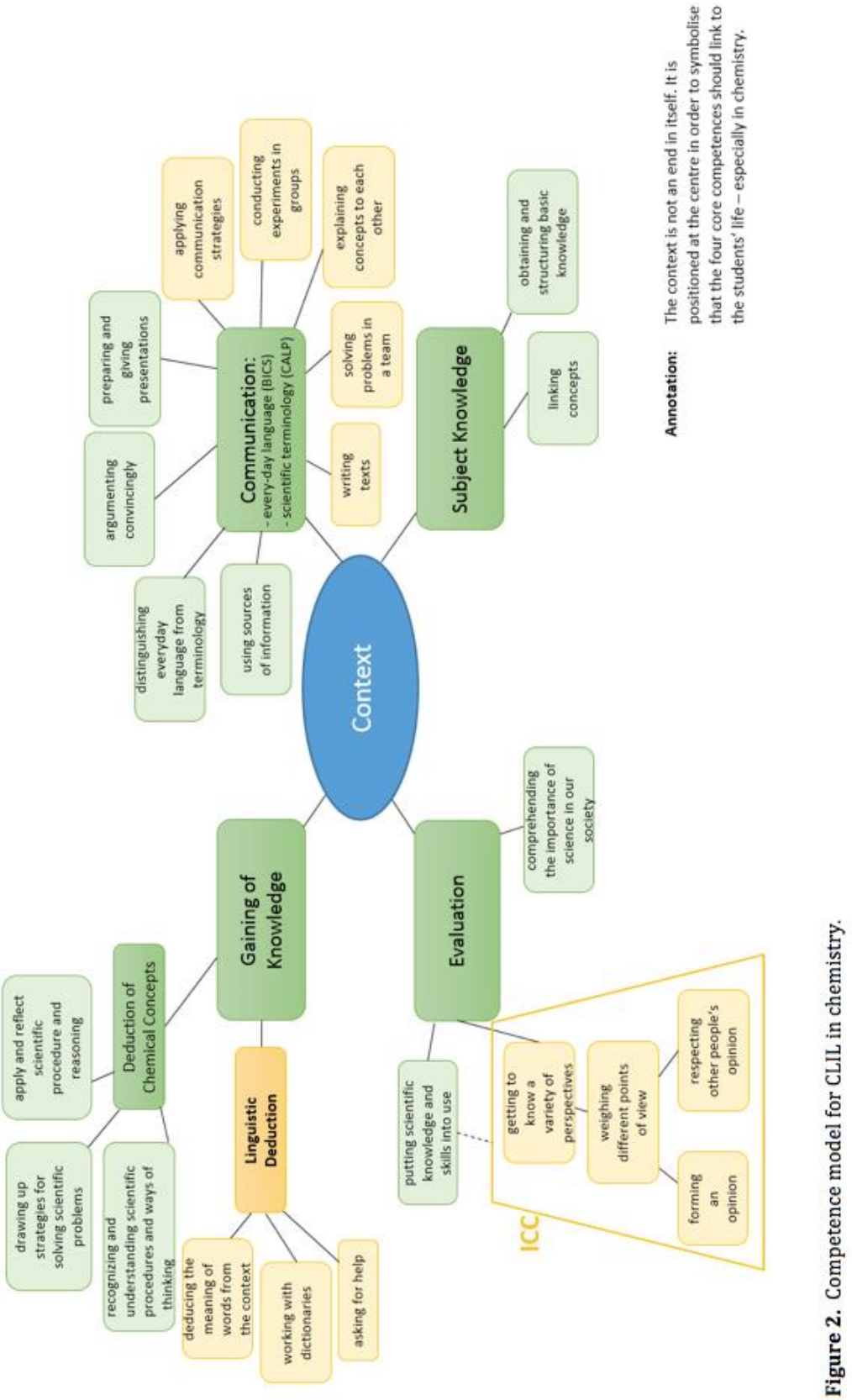

Figure 2. Competence model for CLIL in chemistry.

a context". Many of the "new" aspects are also part of lessons taught in the mother tongue, but they are usually not paid attention to, since they appear to not be relevant or challenging in monolingual science class. In CLIL, language is an explicit part of the learning process which, as has already been mentioned, also has the potential to enhance subject learning.

The analysis has shown that there is a broad consensus between the aims of CLIL and the aims of science teaching. The model of CLIL in chemistry, which was presented in this chapter, integrates the goals of both fields and it can be used as a basis for the preparation of CLIL chemistry units.

CONCLUSION

Overall, CLIL in chemistry, as represented by the model above, seems to be well suited for the achievement of scientific literacy. Furthermore, it could be argued that it may even be better suited to reach this goal than the science curriculum in its current form: For one, global scientific discourses almost exclusively take place in English, which makes the English language competence a vital skill for taking part in these discourses. In addition to that, intercultural competence is an essential prerequisite for taking part in the aforementioned discourses and for participating in national and global communities in general. These facts are given consideration in the CLIL chemistry model presented in this article.

REFERENCES

Biederstädt, W. (2013). Ein innovatives Unterrichtskonzept. In W. Biederstädt (Ed.), *Scriptor Praxis. Bilingual unterrichten. Englisch für alle Fächer ; [Sekundarstufe I]* (1st ed., pp. 5–14). Berlin: Cornelsen Scriptor.

Bonnet, A. (2004). *Chemie im bilingualen Unterricht: Kompetenzerwerb durch Interaktion. Studien zur Bildungsgangforschung: Vol. 4.* Opladen: Leske + Budrich.

Bonnet, A. (2005). Was kann Bilingualer Unterricht zum Verstehen von Chemie beitragen? *Chimica didactica, 31*(96), 6–28.

Bonnet, A., Breidbach, S., & Hallet, W. (2005). Fremdsprachlich Handeln im Sachfach: Bilinguale Lernkontexte. In G. Bach & J.-P. Timm (Eds.), *UTB Anglistik: Vol. 1540. Englischunterricht. Grundlagen und Methoden einer handlungsorientierten Unterrichtspraxis* (3rd ed., pp. 172–196). Tübingen: Francke.

Coyle, D. (2006). Content and Language Integrated Learning: Motivating Learners and Teachers. *Scottish Languages Review, 2006*(13), 1–18. Retrieved March 11, 2014, from http://www.scilt.org.uk/Portals/24/Library/slr/issues/13/SLR13_Coyle.pdf.

Coyle, D. (1999). Supporting students in content and language integrated contexts: planning for effective classrooms. In J. Masih (Ed.), *Learning through a foreign language. Models, methods and outcomes* (pp. 46–62). London: CILT.

Coyle, D., Hood, P., & Marsh, D. (2010). *CLIL: Content and language integrated learning.* Cambridge, Reprinted 2010: Cambridge Univ. Press.

Europäische Kommission. *Mehrsprachigkeit: Trumpfkarte Europas, aber auch gemeinsame Verpflichtung.* Retrieved May 05, 2014, from http://www.eu-bildungspolitik.de/uploads/dokumente_mehrsprachigkeit/2008_09_kom_mehrsprachigkeit_trumpfkarte.pdf.

European Commission (1995). *WHITE PAPER ON EDUCATION AND TRAINING: TEACHING AND LEARNING*. TOWARDS THE LEARNING SOCIETY. Retrieved March 12, 2014, from European Commission: http://europa.eu/documents/comm/white_papers/pdf/com95_590_en.pdf.

Grosjean, F. (2008). *Studying Bilinguals.* Oxford: Oxford University Press.

Hallet, W. (c 2008). Diskursfähigkeit heute. Der Diskursbegriff in Piphos Theorie der kommunikativen Kompetenz und seine zeitgemäße Weiterentwicklung für die Fremdsprachendidaktik. In M. K. Legutke (Ed.), *Giessener Beiträge zur Fremdsprachendidaktik. Kommunikative Kompetenz als fremdsprachendidaktische Vision* (pp. 76–96). Tübingen: Narr.

Hegerfeldt, A. (2006). Die Fremdsprache im Anfangsunterricht Chemie. *Praxis Fremdsprachenunterricht, 3*(6), 36–41.

Klingauf, M., & Lüpke, D. (2007). Alkali Metals go Bilingual. *Naturwissenschaften im Unterricht. Chemie, 18*(98), 30–38.

Köhne, T., & Bohrmann-Linde, C. (2010). "You can't - was heißt trennen? - these particles" und es geht doch: bilingualer Chemieunterricht. *Praxis der Naturwissenschaften - Chemie in der Schule, 59*(7), 45–48.

Kultusministerkonferenz (2004a). Bildungsstandards im Fach Biologie für den Mittleren Schulabschluss.

Kultusministerkonferenz (2004b). Bildungsstandards im Fach Chemie für den Mittleren Schulabschluss (Jahrgangsstufe 10): [Beschluss vom 16.12.2004].

Kultusministerkonferenz (2004c). Bildungsstandards im Fach Physik für den Mittleren Schulabschluss.

Kultusministerkonferenz (2013). *Konzepte für den bilingualen Unterricht - Erfahrungsbericht und Vorschläge zur Weiterentwicklung: Beschluss der Kultusministerkonferenz vom 17.10.2013.*

Marsh, D. (Ed.) (2002). *CLIL/EMILE: The European dimension ; actions, trends and foresight potential.* Jyväskylä: Univ. of Jyväskyla.

Meyer, O. Introducing the CLIL Pyramid: Key Strategies and Principles for Quality CLIL Planning and Teaching. In M. Eisenmann & T. Summer (Eds.), *Anglistische Forschungen: Band 420. Basic issues in EFL teaching and learning* (2nd ed., pp. 265–284).

Muñoz, C. (2002). Relevance & Potential of CLIL. In D. Marsh (Ed.), *CLIL/EMILE. The European dimension ; actions, trends and foresight potential* (pp. 35–36). Jyväskylä: Univ. of Jyväskyla.

Niedersächsisches Kultusministerium (2007). Kerncurriculum für das Gymnasium Schuljahrgänge 5 -10 - Naturwissenschaften.

Rittersbacher, C. (2006). We're doing science: Bilingualer Sachfachunterricht an der Realschule. *Praxis Fremdsprachenunterricht, 3*(6), 31–35.

Wolff, D. (2007). Bilingualer Sachfachunterricht in Europa: Versuch eines systematischen Überblicks. *Fremdsprachen Lehren und Lernen (FLuL); Themenschwerpunkt: Fremdsprache als Arbeitssprache in Schule und Studium, 36*, 13–29.

Wolff, D., & Marsh, D. (Eds.) (2007). *Mehrsprachigkeit in Schule und Unterricht: Bd. 6. Diverse contexts, converging goals: CLIL in Europe.* Frankfurt: Peter Lang

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