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Bilingual Modules in Chemistry Classes

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Abstract

In the context of bilingual modules (BM) in the German educational system, English is used as the medium of communication in certain time-limited thematic units, where the topic offers itself to be taught in a foreign language.[1] These BM can be implemented in most school subjects and are well suited for project work. An advantage of bilingual education and BM is that students are exposed to the many benefits of being able to communicate in English, promoting their motivation to learn the language and allowing them to acquire scientific English.[1] Since not all German schools offer bilingual chemistry streams, carefully selected BM can serve as a way of exposing students to scientific English as well as the benefits of bilingual education.

A potentially promising concept of learning that could be used as a base for the educational design of BM is Lave and Wenger's situated learning. The concept is based on the "situated character of human understanding and communication" and promotes learning as participation in a community.[2][3] Thus, the paper's scope focuses on the advantages of BM and gives a concrete example of how application of the principles of situated learning can provide a learning context, in which the use of English in a chemistry classroom can make sense. Furthermore, the paper shows how bilingual models can develop intercultural, scientific and linguistical competences.

1. Introduction

Bilingual education is gaining importance in Germany as parents, educators, students and employers are valuing English language proficiency more and more. Due to the focus of the European Union to homogenize language education and develop the intercultural competence of Europeans, bilingual education is in high demand. [4] In addition, nowadays in the chemistry classroom, students could highly benefit if English played a more important part in the students' chemical education due to its role as the world's leading scientific language. Therefore, it is important that students come in contact with scientific English, especially if they intend to pursue a career in one of the many scientific fields.

Besides bilingual education streams, which are already embedded in school curricula, bilingual modules offer another way to expose students to the benefits of bilingual education. [1] These modules are time-limited and subject-relevant thematic units in English for subjects that are usually taught in the mother tongue of the students. Just like regular bilingual classes, modules allow for the development of the students' communicative competence in a wide variety of situations and subject areas while drawing attention to cultural differences. [1] This also allows the development of an intercultural competence, one of the goals of the European language policy. [4]

In this paper, an example of a bilingual chemistry module on the topic of alternative fuels will be given. The module was developed based on principles suggested by Lave and Wenger's *situated learning* concept, such as maximization of student-student interactions and working in a context. [2] Using students' imagination, a specific interactive context for the learning of alternative fuels was created. This context provided motivation and a reason for students to speak in English, creating situations where communication in the classroom had to take place and where students saw as to why it should be in English. This then required the use of scientific

vocabulary and allowed for the development of intercultural, scientific and linguistical competences.

2. *Situated Learning* as the Basis of the Educational Design of Bilingual Modules

The basic idea of Lave and Wenger's *situated learning* is that learning is a process of participation in a society which makes it inseparable from social interactions. Understanding, learning and communicating depend on the context in which these processes happen. Therefore, the focus is on which social participations in a context allow for learning to happen rather than what cognitive processes are necessary for it. The idea is that the learner takes part in "legitimate peripheral participation", meaning he or she partially participates in a social situation to learn from experts (teachers or students) while only having limited responsibility for the outcome. [2]
Keeping this in mind, students best learn in a context while socially interacting. This suggests that creating a continuous context for a bilingual module is beneficial for the students when learning about the new topic. The proper context can provide motivation and a reason for students to speak in English. Furthermore, activities where students interact with the teacher and each other can further enhance the learning process. Therefore, to maximize learning potential and motivation in bilingual modules, context and social interaction should be carefully considered during lesson planning. In Germany, these principles of *situated learning* have already been used as one of the main theoretical components in the German school textbook *Chemie im Kontext.* [3]

3. Example of the Use of Context in a Bilingual Chemistry Module

The following bilingual chemistry module was developed for a German grade 10 class at the *Gymnasium* level. The topic of the module is "Alternative Fuels" due to its current relevance in science and society.

3.1 Structure of the Bilingual Chemistry Module

The bilingual chemistry module has four different 90-minute components divided into four days (see Fig. 1).

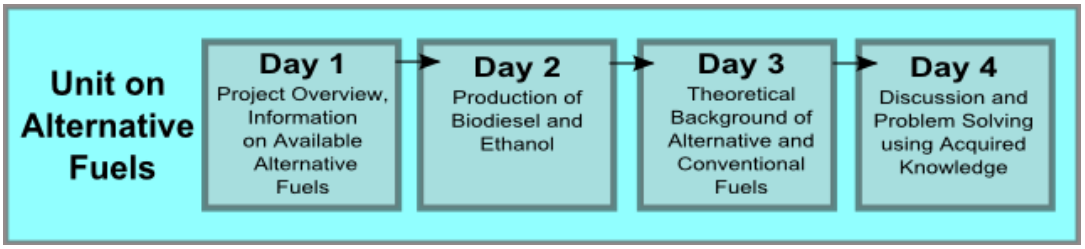

Figure 1: *Structure of the bilingual chemistry module.*

The first day gives the students a general overview of project's context and available alternative fuels in general. The second day re-establishes the context and gives students the chance to produce one of two alternative fuels in the laboratory, biodiesel or ethanol. Learning by stations is the method used on the third day, allowing students to learn about the theoretical background of conventional and alternative fuels. Also, the session reviews experiments done in the previous component and gives information about the fuels' emission life cycle and their harmfulness. The last day allows students to use and evaluate the knowledge

obtained during the entire module by discussing a current alternative fuel problem. All materials used are in English and students are further provided with supplementary material such as vocabulary lists, picture dictionaries of lab equipment and discussion aids to help them access vocabulary they need to work with the chemical topic in English. The before mentioned class materials can be accessed online at http://www.unterrichtsmaterialien-chemie.uni-goettingen.de.

3.2 Creating Motivation through a Learning Context

Students are introduced to the context of the unit *A Scientific Exchange to Canada* through an information brochure the week before the first class. Here, students are informed about having won a science exchange to Canada and are given information about their flight, itinerary, host family and cultural information about the exchange town and school in Inuvik, Canada. This allows students to familiarize themselves with the context, to prepare themselves to speak English and to build excitement for the first class.

During the first session of the module, the student's flight and arrival in Canada are simulated through pictures. The authenticity of the context depends on the ability of the teacher to narrate. During the students' imaginary bus journey from Edmonton to Inuvik the bus runs out of gas. This creates a situation where students have to brainstorm about how to continue travelling. Then they are supplied with information on alternative fuels which they read, discuss in groups and use to create an informative poster. At the end of the class, the students should be able to evaluate which alternative fuel is most suited for their needs and brainstorm how they can produce it.

In the second session, the students recap their journey and produce biodiesel (3 groups) and ethanol (3 groups). Finally, the produced alternative fuels are "tested" and the students have to decide which of the fuels is most suitable to continue to their destination.

On the third day of the module, students are "asked" by curious Canadian students why they arrived in Inuvik so late. After responding to several questions which are meant to revise the previous classes, questions are asked about the theoretical background of alternative fuels which the students cannot answer. Having been shown the need to inform themselves about the topic's chemistry, they learn the chemical knowledge in distinct social groups at four different stations. At the end of the class, they can answer the questions which they were not able to before.

On the last day, students are presented with an environmental and political problem in the Inuvik area. Here they have to find arguments for alternative fuels based on the knowledge acquired during the unit which they then have to defend during a fishbowl discussion with the whole class. After having helped the local community with their scientific knowledge, the students "return" to Germany.

Situating the entire unit in a context which accompanies each lesson motivates students to participate and also creates continuity between the different classes. Through the context, students can see the need to speak English and should not question why English is used in class. Furthermore, most learning takes place using a variety of group work methods such as gallery walks which enhances the process of learning according to Lave and Wenger.

3.3 Development of Scientific, Linguistical and Intercultural Competences

The German curriculum in Lower Saxony (*Kerncurriculum Niedersachsen*) requires the development of four main competences in the chemistry classroom. These are

Evaluation, Knowledge, Communication and the *Gaining of Insight*. All can be developed with bilingual chemistry modules where students work with authentic sources, argue from specific points of view, create presentations, communicate and help each other with all aspects of learning. [5] Furthermore, the intercultural competence, especially important in bilingual education, is developed since students learn about different perspectives, evaluate distinct points of view and form opinions about specific topics. Additionally, competences from the language classroom are also strengthened since students have to act linguistically in a new setting. On top of that, they deduce semantics of vocabulary from context and practice their pronunciation, speaking and mediation skills as well as their ability to communicate adequately in the chemistry classroom. [6]

3.4 Student's Evaluation of the Module

At the end of the teaching unit, an informal survey (n=19) was conducted in order to receive feedback from students with regards to the effectiveness and reception of the module as well as its context. Overall, 13 students stated improved knowledge in all three inquired subject areas (harmfulness of alternative fuels, production of alcohol, life in northern Canada), while six responded with having improved in two (see Fig.2). This suggests that students learned during the unit. Furthermore, 16 students said that they liked the context of the module and 14 admitted to having or maybe having had personal gain due to their participation in the bilingual unit. Additionally, five students claimed that the module increased their interest in chemistry class, six in English class and 11 in Canada. Here, tendencies of a general positive attitude towards the context and the advantages of bilingual modules are visible.

1. How would you evaluate your knowledge about the following topics?

	Before the unit "Alternative Fuels"				Now			
	very low	low	good	very good	very low	low	good	very good
Harmfulness of alternative fuels	☐	☐	☐	☐	☐	☐	☐	☐
Production of alcohol	☐	☐	☐	☐	☐	☐	☐	☐
Life in northern Canada	☐	☐	☐	☐	☐	☐	☐	☐

Figure 2*: Example of a question from the informal survey***.**

4. Conclusion

Using principals of situated learning in bilingual models can help build motivation in the classroom for the scientific topic and to work and communicate in English while possibly enhancing learning processes. This allows for the development of students' linguistical, scientific and intercultural competences which is currently the main focus of the German educational system. [5,6] Moreover, students can gain some of the benefits of bilingual education through participation in bilingual modules which can help them develop both scientific and linguistical skills important for future academic careers in the sciences.

References

[1] E. Otten, M. Wildhagen (**2003**). *Praxis des bilingualen Unterrichts.* Cornelsen: Scriptor, 18-31, 194-216

[2] J. Lave, E. Wenger (**2009**). *Situated learning. Legitimate peripheral participation.* New York: Cambridge.

[3] I. Parchman (**2007**). "Chemie im Kontext: Situating Learning in Relevant Contexts while Systematically Developing Basic Chemical Concepts" In; *J.Chem.Educ.84(9),* 1439-1444.

[4] Council of Europe, "Education and Languages, Language Policy" In: http://www.coe.int/t/dg4/linguistic/Cadre1_en.asp [20.11.**2014**].

[5] Niedersächsisches Kultusministerium (**2007**). *Kerncurriculum für das Gymnasium Schuljahrgänge 5-10 Chemie.* Hannover.

[6] Niedersächsisches Kultusministerium (**2009**). *Kerncurriculum für das Gymnasium Schuljahrgänge 6-10 Spanisch.* Hannover.