International Conference NEW PERSPECTIVES in SCIENCE EDUCATION
3rd Edition

CLIL Science Teaching – Fostering Scientific Inquiry through the Use of Selective Scaffolding

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Abstract

Learning progressions have gained significant attention, recently with the implementation of German National Education Standards in 2004. One aim of the German National Education Standards for Biology is to foster scientific inquiry as one of the four core organizational elements in science class [e.g. [1], [2]). In CLIL ('Content and Language integrated Learning') contexts this aim needs to be treated in a special way: The discrepancy between cognitive competences and verbal skills may lead students to an unsuccessful learning process (e.g. [3], [4], [5]). In order to ensure qualitatively appropriate CLIL biology education, it is crucial to support the negotiation of meaning in scientific inquiry [6]. Verbal and content scaffolds support the negotiation of meaning in general language acquisition and further CLIL contexts.

Our objective is to identify and define those scaffolds, which are appropriate to develop scientific inquiry in CLIL contexts and to foster language competences in the target language at the same time. The research focuses on processes of interaction between tutors and learners as well as on collaborating interactions between learners. The study consists of two phases. In a first step we try to identify scaffolds applied in processes of scientific inquiry in CLIL contexts. For this purpose scaffolds are surveyed and analyzed in an exploratory qualitative study with group experiments and group discussions of students from grade 9, 10 and 11 from secondary schools. Data will be analysed by qualitative content analysis [7]. The identification and definition of applied scaffolds may lead towards more efficient science instruction and towards a successful learning process in CLIL science classes.

Scaffolds that could be identified as appropriate to foster scientific inquiry in CLIL contexts as well as further results will be presented at the conference.

1. Scientific Inquiry in CLIL contexts

With the implementation of the German National Education Standards in 2004 and along with recent educational reforms the focus on learning processes changed from input-oriented teaching instructions to output-oriented learning environments [2]. Thereby demands for scientific inquiry in science class have changed; an orientation to the development of inquiry competences and skills just as much as the imparting of an understanding of scientific inquiry come to the fore. According to Möller, Grube & Mayer, scientific inquiry includes four central elements: "Formulating questions", generating hypotheses", "investigation planning", and "interpreting data" [8]. Within these elements scientific subject-matters should be worked out actively and self-dependent to enable a successful development of inquiry competences and skills.

Transferring the demands of science class to CLIL ('Content and Language integrated Learning') contexts, the relevance of scientific inquiry and the development of inquiry competences must not be neglected in bilingual education. In addition to the elaborate science subject-matter and complexity of scientific inquiry, CLIL teachers have to handle an additional challenge while providing a beneficial learning environment needed to learn scientific inquiry in class: "The CLIL teacher has to ensure that [students] can understand the content at all times" [6]. In order to bridge student's language skills and also to enable qualitatively appropriate science education, it is crucial to support student's science learning. In the following we will expose that scientific inquiry in CLIL contexts allows to develop inquiry competences and to foster language competences in the target language at the same time by means of adequate assistance.

2. Supporting student's learning processes

Methods of assistance and further support to firm up student's learning processes were originally introduced as the term "scaffolding" in contexts of novice-tutor interactions by Wood, Bruner and Ross. In consideration of the social context, where skill acquisition in childhood usually takes place, they identified a promoting factor for learning processes: "More often than not, it involves a kind of "scaffolding" process that enables a child or novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts. This scaffolding consists essentially of the adult "controlling" those elements of the task that are initially beyond the learner's capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence" [9]. In a narrow sense, the term "scaffolding" describes a plurality of supportive methods in the classroom; in a wider sense, it includes the fostering of self-directed learning through developmental psychological principles. Taking Vygotsky's socio-cultural theory of the zone of proximal development (ZPD) into account, scaffolds should range within the current learners' ZPD to promote learning successfully; the ZPD is determined as an area between the zone of autonomous problem solving competence and the zone of the dependent but potential problem solving competence: "The most effective learning, Vygotsky argued, is that which occurs within the ZPD, that is when the challenge presented by a task is ahead of learners' actual or current development" [10]. Walqui and van Lier expose an advancement of the original ZPD theory, which is more adjusted to pedagogical situations in class and therefore builds the theoretical frame of our study. To the contexts of novice-tutor interactions they added contexts of collaboration of novices, assisting a lower-level novice and the context of working alone with internalized learning strategies. This model combines social, cognitive and functional-linguistic elements and thus bears a meaning for CLIL contexts (e.g. [11], [12]).

2.1 Language and content scaffolding in scientific inquiry class

Interactions in the classroom support the negotiation of meaning but therefore require adequate assistance. The process of scientific inquiry and its different phases trigger classroom interactions in a variety of contexts. Figure 1 illustrates the several phases of the inquiry process in science class, in which interactions between teachers and students as well as collaborating interactions of students are enabled. In CLIL contexts, each of these phases demand scaffolds, which support the student's interaction in the inquiry process. According to the language proficiency, students need assistance through a variety of scaffolds in class to ensure the content comprehension and communication at all-time.

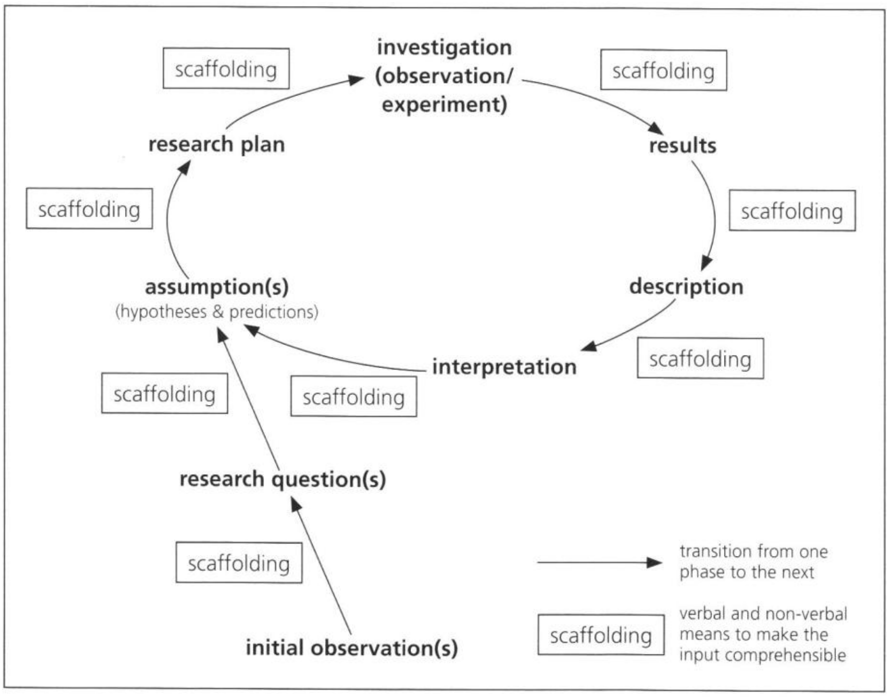

Fig. 1: "Iterative, spiral process of epistemological methodology in science and loci of language and content scaffolding in CLIL lessons" [6].

Brush and Saye distinguish two types of scaffolding techniques: Hard scaffolds give "static supports that can be anticipated and planned in advance" [13] and soft scaffolds, which are "dynamic, situation-specific aid provided by a teacher or peer to help with the learning process […]" [13]. In both groups, the variety of scaffolds ranges from verbal scaffolding techniques, like providing key vocabulary and phrases to make the input more comprehensible and assist students' verbal expressions and communication in class, to content scaffolding techniques, including actions like defining, displaying and reviewing content as well as provision of task or process models [14]. The scientific inquiry process requires scaffolds to create a learning environment, which encourages students to explore content actively using inquiry methods and in a continuative sense to develop inquiry competence and the ability to do scientific inquiry. In addition to the mentioned scaffolding techniques above, science teachers should provide a variety of scaffolds to facilitate the scientific access, like ascertaining, interpreting and elucidating students' views on subject-matters or providing motivating experiences and suggesting demonstrative procedures as well as presenting evidence from the scientist's view [15].

2.2. The importance of scaffolding students' learning processes

Scaffolding scientific inquiry in CLIL classrooms obtains a considerable role: The discrepancy of cognitive competences and language proficiency may lead students to an unsuccessful learning process (e.g. [3],[4]), which could be simply covered with teacher- and input-centered instruction [4]. In consideration of recent educational reforms, innovative forms of learning environments with practice oriented and out-put centered methods should be implemented in the classroom. These innovative studying techniques have a positive impact on students' learning progress (e.g. [16], [17]), if fundamental prerequisites are fulfilled: The innate psychological needs for competence, autonomy and relatedness [5]. By creating learning environments, which encourage students to work out subject-matters self-directed and actively and support students' communication with appropriate scaffolds within the inquiry process, the innate psychological needs should be given. The objective of this study is to identify and define those scaffolds, which are specifically appropriate for the development of inquiry competences in CLIL contexts and the fostering of language proficiency at the same time.

3. Study Design

In order to identify and define beneficial scaffolds for CLIL scientific inquiry purposes, we focus on classroom interactions in secondary school levels. In a first step we survey biology lessons and lessons with scientific subject-matters in bilingual courses and conventional classes from grade 9, 10 and 11 for applied scaffolding methods in inquiry processes. In this phase two types of data are collected: (1) Classroom interactions in contexts of novice-tutor interactions, collaboration of novices and assistance of a lower-level novice within the scope of guided group experiments and group discussions and (2) classroom interactions in mentioned scopes of conventionally taught lessons. The collected data are analysed by qualitative content analysis [6]. Results of this exploratory study will be integrated in the second step, the analysis of the effect of applied scaffolds on student's competences in scientific inquiry.

4. Preliminary results and Discussion

The analyses are aligned to the main research questions: (1) which scaffolds are integrated in inquiry processes of (bilingual and conventional) science class to make the input more comprehensible and assist students' verbal expressions and communication in class, (2) which scaffolds are beneficial for supporting the negotiation of meaning within the inquiry process, (3) do the applied scaffolds have an impact on students' inquiry competence and language proficiency?

Trends in the analyses of interactions in CLIL science class show an occasional use of several hard and soft scaffolds in novice-tutor interactions, in the collaboration of novices and in the assisting of a lower-level novice. These scaffolds could be identified as verbal and content scaffolding techniques, which mainly support the comprehension of input and students' verbal expressions; only a marginal use of scaffolding techniques to support the negotiation of meaning and the comprehension of the inquiry process were displayed in the analysed data. Further analyses should give information about the use of scaffolds in conventional taught science class and a comparison of the use and types of scaffolds applied in inquiry processes in science class, both in CLIL contexts and in conventional science lessons.

References

[1] Hammann, M. (2004): Kompetenzentwicklungsmodelle: Merkmale und ihre Bedeutung dargestellt anhand von Kompetenzen beim Experimentieren. IN: Der mathematische und naturwissenschaftliche Unterricht 57/ 4, 196-203.

[2] Klieme et al./ Bundesministerium für Bildung und Forschung(Hrsg.) (2007): Bildungsforschung Band1. Zur Entwicklung nationaler Bildungsstandards. Bonn, Berlin; http://www.bmbf.de/pub/zur_entwicklung_nationaler_bildungsstandards.pdf

[3] Richter, R./ Zimmermann, M. (2003): Und es geht doch: Naturwissenschaftlicher Unterricht auf Englisch. IN: Wildhage, M./ Otten, E. (2003): Praxis des bilingualen Unterrichts. Berlin: Cornelsen, 116-146.

[4] Thürmann, E. (2003): Eine eigenständige Methode für den bilingualen Fachunterricht? IN: Heine, M./ Riccò, A./ Schoof-Wetzig, D. (2003): Bilinguales Lernen im interkulturellen Kontext. Westermann: Braunschweig,110-126.

[5] Deci, E./Ryan, R. (1993): Die Selbstbestimmungstheorie der Motivation und ihre Bedeutung für die Pädagogik. IN: Zeitschrift für Pädagogik 2/93, 223 – 239

[6] Burmeister, P./ Ewig, M. (2010): Integrating science and foreign language learning. IN: Massler, U./ Burmeister, P. (2010): CLIL und Immersion. Fremdsprachlicher Sachfachunterricht in der Grundschule. Westermann: Braunschweig, 100-107.

[7] Mayring, P. (Hrsg.): Die Praxis der qualitativen Inhaltsanalyse (172–189). Weinheim, Basel: Beltz.
[8] Möller, A., Grube, C. & Mayer J. (2007). Kompetenzniveaus der Erkenntnisgewinnung bei Schülerinnen & Schülern der Sekundarstufe I. In Bayrhuber et. al. (Hrsg.), Ausbildung und Professionalisierung von Lehrkräften, Internationale Tagung der Fachgruppe Biologiedidaktik im Verband Biologie, Biowissenschaften & Biomedizin; Essen.
[9] Wood, D./ Bruner, J.S., Ross, G. (1976): The role of tutoring in problem solving. Journal of Child Psychology and Psychiatry. 17, 89 – 100.
[10] Gibbons, P./ Hammond, J. (2005): Putting scaffolding to work: The contribution of scaffolding in articulating ESL education; http://www.neilwhitfield.files.wordpress.com/2008/11/20_1_1_hammond.pdf
[11] Walqui, A. (2006): Scaffolding Instruction for English Language Learners: A Conceptual Framework. The International Journal of Bilingual Education and Bilingualism Vol. 9, No. 2, 159 – 180.
[12] Thürmann, E. (2013): Scaffolding. In: Hallet, W./ Königs, F.G. (2013): Handbuch Bilingualer Unterricht. Content and Language Integrated Learning. Seelze: Klett, Kallmeyer, 236 – 243.
[13] Brush, T.A./ Saye, J.W. (2002): A Summary of Research Exploring Hard and Soft Scaffolding for Teachers and Students Using a Multimedia Supported Learning Environment. The Journal of Interactive Online Learning Vol. 1, No. 2
[14] Massler, U./ Ioannou-Georgiou, S. (2010): Best practice: How CLIL works. In: Massler, U./ Burmeister, P. (2010): CLIL und Immersion. Fremdsprachlicher Sachfachunterricht in der Grundschule. Westermann: Braunschweig, 61 – 75.
[15] Osborne, R./ Freyberg, P. (1985): Learning in science – the implications of children's science. Auckland: Heinneman.
[16] Huber, Anne (2007): Wechselseitiges Lehren und Lernen als spezielle Form kooperativen Lernens. Berlin: Logos
[17] Konrad, K./ Traub, S. (2001): Kooperatives Lernen. Theorie und Praxis in Schule, Hochschule und Erwachsenenbildung. Baltmannsweiler: Schneider.