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ELABORATION AND NEGOTIATION OF NEW CONTENT. THE USE OF MEANING-MAKING RESOURCES IN MULTILINGUAL SCIENCE CLASSROOMS

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This presentation reports results from a study aiming at examining multilingual students' meaning-making in science when instructed through Swedish. Focus is on how new content is elaborated and negotiated through various semiotic resources such as written and spoken language, still and moving images, gestures and physical artefacts. Data consist of video and audio recordings and digital photographs from two multilingual physics classrooms (students aged 11-12 and 14-15 respectively) and one biology classroom (students aged 14-15 years). Theoretically, the project takes its stance in social semiotics and pragmatist theory. Data are analysed through systemic functional linguistics, multimodal analyses and Dewey's principle of continuity. The results show that the teachers and the students were engaged in meaning-making activities involving a variety of semiotic resources in ways that sometimes matched both students' linguistic and scientific level. However, some observations indicate classroom practices that might constitute a hindrance for meaning-making. The study has implications for ways of promoting multilingual students' meaning-making in science, including learning science, competent action, that is, norms about how to act in the science classroom, and communicating through different modes.

1 Introduction

We present results from a project funded by the Swedish Research Council, studying classroom interaction and its contribution to multilingual students' meaning-making in science. Our point of departure is the fact that various semiotic resources are used in all meaning-making situations, especially in science classrooms (Danielsson, 2016; Kress, 2010; Kress et al., 2001; Lemke, 1998). Lemke (1998) found that multiple resources were used in an upper secondary physics classroom. He concludes that various semiotic resources need to be used in the science classroom, since each resource can contribute to meaning-making in specific ways, and since a certain level of redundancy can be beneficial for learning. Kress and colleagues (2001) showed that multimodal ensembles were used in a lower secondary biology classroom to present different aspects of blood circulation, such as a 3D model of a torso, gestures, speech, drawings, each resource being used in accordance with their modal *affordance* (Kress, 2010). Likewise, Danielsson (2016) revealed that lower secondary chemistry teachers used gestures, writing, speech and drawings in accordance to their respective modal affordances when introducing the atom as a scientific concept. Gestures (and speech) highlighted dynamic aspects, while images highlighted the different particles, giving a static image of the atom. An implication is that classroom discussions might enhance students' learning, which might be important especially for students learning science in a second language.

Our research question addresses how new content is elaborated and negotiated in classroom activities through various semiotic resources. Hur positionerar sig deltagarna? Vilka konsekvenser får det för meningsskapandet i klassrummen (alltså vilket lärande som möjliggörs och blir synligt?)?

2 Theoretical framework

Our theories emanate from social semiotics (Halliday & Matthiessen, 2004; Jewitt, 2016; Kress, 2010) and pragmatist theory (Dewey, 1938/1997). In social semiotics, the choice of resource for meaning-making is viewed as a result of social, cultural and situational factors, including participants and available semiotic modes and resources. A central concept for our analyses is the notion of 'affordance' (Gibson, 1977; Kress, 2010), here defined as the potential for meaning-making or potentials and limitations of the resources used (Kress, 2010).

Dewey's (1938/1997) principle of continuity implies that earlier experiences are reconstructed and transformed from a purpose, having consequences for meaning-making in the present and future situations. Accordingly, science meaning-making is *continuous*, however, not always taking the route intended by a teacher (Jakobson, 2008; Lave, 1996; Wickman, 2006). Continuity can be seen in how students interact and proceed in situated action, using language and other resources.

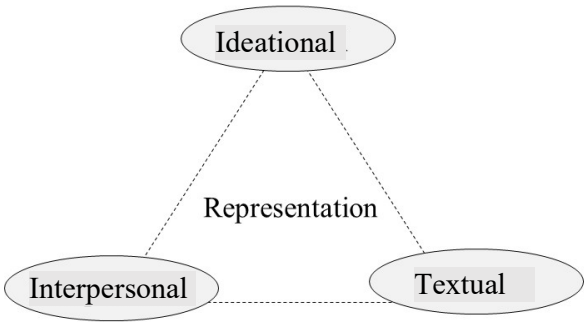
3 Research methods

We present results from three multilingual classrooms in three different schools, two physics classrooms (students aged 11-12 and 14-15) and one biology classroom (students aged 14-15 years). The schools are linguistically and culturally diverse, located in suburbs. Most of the students are multilingual with varied proficiencies in Swedish.

The lessons deal with the units *Sound*, *Measuring time* and the *Human body.* Data consist of video/audio recordings, digital photographs and students' written texts. The project adheres to the ethical principles outlined by the Swedish Research Council (2011).

Data is analysed through multimodal analysis by the use of systemic functional linguistics (SFL) and Dewey's principle of continuity.

We describe the overall design of the lessons according to a number of activities that were noted. For each activity, we specify the semiotic resources used, including *multimodal ensembles*, that is, combinations of resources in different semiotic modes forming an entity (Jewitt, 2016).



Figur 1. Metafunctions in communication (Halliday 1978; Bergh Nestlog 2012).

A basis for SFL (Halliday 1978) is the idea that all communication and all resources used in communication can be described through three metafunctions realised simultaneously in all communicative events (Figure 1): ideational, textual and interpersonal. Regarding disciplinary discourse, all subjects have developed resources in relation to these dimensions: displaying knowledge (field; ideational metafunction), being authoritative (tenor; interpersonal metafunction) and organizing information (mode; textual metafunction). The framework has mainly been used for written texts and needs some adaptation for analyses of classroom interaction (Bergh Nestlog, 2012). Our data is analysed in regard to content (ideational metafunction), how the content is expressed and organised (textual metafunction) and the

interpersonal metafunction as to how relations are created through interaction between participants or between participants and the resources used. Regarding the interpersonal metafunction, special focus is on how teachers and students position themselves in relation to the discourse of science, i.e. to what extent they use the authoritative voice of science or more everyday ways of expressing content. Moreover, central to our analyses is to what extent the use of different resources is continuous, or coherent, with the purpose of the activity.

4 Results

Teachers and students used several resources when elaborating and negotiating about content, often in multimodal ensembles. Analyses from all units revealed similar results, although with some difference. The following example is from the *Sound* unit in one classroom:

- Ideational metafunction: content was specialised - sound waves and the wave model to explain how sound travels through different media. This content was explained by connections to students' everyday experiences (throwing a stone in water, which creates waves) or through the scientific wave model.

- Textual metafunction: content was expressed through various resources and could be more or less specialised, such as spoken exposition combining gestures and specialised concepts like compression vs. expansion in multimodal ensembles or an analogy to standing in a line being pushed.

- Interpersonal metafunction: on the one hand students were drawn into the content through questions, inclusive voice and connections to earlier experiences. On the other hand, the teacher used resources in line with science proper.

Moreover, this lesson was continuous with learning about sound, seen in student's actions and discussions. Their earlier experiences were reconstructed and transformed in the new situation in line with the teacher's purpose. Consequently, the students made meaning of the science content.

4 Discussion and conclusion

The students were afforded various channels for meaning-making which can be especially beneficial for students learning in their second language. However, an implication of our study is that teachers might need to enhance their awareness of their use of different resources as well as the ways in which they create opportunities for students to make meaning of the science content through a variety of semiotic modes. Possibly, students can benefit from getting opportunities to reason about their observations in small groups or whole class, and from receiving instructions about both *how* and *what* to discuss. Furthermore, students would also benefit from discussions about modal affordances and how different resources are related in a given situation. Such discussions can promote continuity between the purpose of the activity and the actual meaning-making. Also, through such discussions, students can develop their disciplinary literacy, in this case learning science, expressed through competent action in the science classroom and communicating through different modes.

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