MULTILINGUAL STUDENTS' MEANING-MAKING IN SCIENCE

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Abstract
We present results from a study aiming at investigating multimodal classroom interaction and its contribution to multilingual students' meaning-making in science. The focus is on how science content is elaborated and negotiated through various semiotic resources. Data consist of video and audio recordings and digital photographs from three multilingual classes: a middle school physics classroom during the unit "measuring time", a lower secondary physics classroom during the units "sound and light" and a lower secondary biology classroom during the unit "human body". 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 reveal that teachers and students were engaged in meaning-making activities involving a variety of semiotic resources with a potential to develop multilingual students' scientific literacy. However, the teachers' scientific starting points and perspectives on scientific literacy as well as their use of semiotic resources to some extent vary, affording different entries to science meaning-making. The study has implications for ways of promoting scientific literacy, including learning science, competent action, and communicating through different modes.
Keywords: multilingual students, scientific literacy, multimodality

1. MULTINLINGUAL STUDENTS' MEANING-MAKING IN SCIENCE

The discourse of science comprises a specialized language often described in terms of linguistic density, a high degree of abstractness and a need for students to handle multiple resources for meaning-making in parallel (Halliday & Martin, 1993; Lemke, 1998), all of which can be challenging for the learner. For multilingual students, science and its specialized language might be even more distant from their lives if they learn science in their second language.

We present results from a project funded by the Swedish Research Council, aiming to study classroom interaction and its contribution to multilingual students' meaning-making in science. Our point of departure is that meaning-making is always multimodal (Kress, 2010), not the least in science education (Kress et al., 2001), both since each resource can contribute to the content in specific ways, and since a certain level of redundancy is needed in the learning situation (Lemke, 1998). To enhance multilingual students' opportunities to develop scientific literacy a conscious use of various semiotic resources is particularly important. Previous research has mainly dealt with either multimodality or linguistic aspects of science learning, while fewer studies combine these two perspectives (Zhang, 2016).

We take our stance in social semiotics (Halliday & Matthiessen, 2004, Kress, 2010) and pragmatist theory (Dewey, 1938/1997). From a social semiotic perspective, each choice of resource for meaning-making is seen as a result of social, cultural and situational aspects. This concerns choice of semiotic mode (e.g. speech, writing, gesture), or combinations of modes, as well as choice of particular resource within each mode, such as specific verbal formulation or gesture.

Dewey's (1938/1997) principle of continuity means that in all meaning-making, earlier experiences are reconstructed and transformed from a purpose, something which has consequences for the present and future situations. Continuity can be seen in how students proceed in action, using language and other resources, and relate this to the purpose of the learning activity.

Our specified research question concerns how science content is elaborated and negotiated multimodally in multilingual classrooms.

2. METHOD

We present results from three multilingual science classrooms located in three suburbs, where the language of instruction is Swedish, following themes in physics or biology. In the middle school physics classroom (16 students aged 11-12), data was collected during the unit "measuring time". In the lower secondary physics classroom (19 students aged 14-15), we collected data during the unit "sound and light" and in the lower secondary biology classroom (24 students aged 14-15), data was collected during the unit "human body". In the middle school and lower secondary physics classrooms all students were multilingual with various linguistic backgrounds and varied proficiencies in Swedish while in the lower secondary biology classroom this was the case for about half of the students.

Data is analysed through systemic functional linguistics (SFL), multimodal analysis, and Dewey's principle of continuity. On the basis of these analyses we discuss the ways in which different resources are used in whole class communication and small group discussions, respectively, and to what extent teacher lead classroom discussions around the use of different semiotic resources take place.

3. RESULTS

The results are discussed with regard to students' opportunities for developing scientific literacy, here including learning science, competent action in the science classroom, and communicating through different modes. In the middle school physics classroom numerous occasions of multimodal ensembles were noted, in particular when the teacher combined gestures and speech, for example when talking about different points of the compass, combing words and gestures. A student task on the different lengths of sun shadows during a day involved a number of 'transductions', or processes where content was transferred from one semiotic mode into another: from a diagram to a table, and generalizing the results in writing, and finally to discuss the results in pairs. These transductions turned out to be challenging, with students showing difficulties in choosing the level of details, or what aspects to focus on in pair discussions. In our presentation results from the other two classrooms will be presented as well.

4. DISCUSSION AND CONCLUSIONS

Teachers and students were engaged in meaning-making activities involving a variety of semiotic resources in ways that can enhance the development of multilingual students' scientific literacy. The shifts between registers, or everyday and specialized language, noted in the classrooms can support a development of specialized language (Gibbons, 2006; Macken-Horarik, 1996). The students were given several learning opportunities during the lessons, through talking, writing, and performing hands-on activities. However, in some of the classrooms the focus was on norms of how to act in science class and what to include or exclude. In the middle school physics classroom, 'minds-on' in relation to the actual content, was shown in some students' written general statements about "the sun's movement across the sky". Continuity between activities and purposes (Johansson & Wickman, 2011) was shown in various ways. Examples are the students' creations of multimodal texts and the hands-on activities. Here, the students' undertakings were continuous with the proximate purpose about how to act in science class. When writing texts, this was shown in the expected meticulousness according to norms concerning form rather than content. During hands-on activities, the norms appeared to concern "doing" rather than learning the science content.

To sum up, during instruction, the teachers used several resources, increasing the channels for meaning-making and message abundance. Furthermore, these resources were used in multimodal ensembles, with a potential of enhancing multilingual students' meaning-making. Also, the students were given opportunities to use different resources in a variety of semiotic modes. Such teaching can promote students' development of scientific literacy. However, students would also benefit from discussions about modal affordances and how different resources are related in a given situation, for example when involved in transductions from one semiotic mode to another. Such discussions can promote their disciplinary literacy, including learning science, competent action in the science classroom, and communicating through different modes.

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