Promoting Scientific Literacy: Science Education Research in Transaction

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PREFACE

This proceedings volume is a documentation of a symposium that was part of the Linnaeus Tercentenary 2007 Celebrations held at Uppsala University. Gaalen Erickson and Douglas Roberts received Honorary Doctorates in the area of Science Education and to celebrate this, a special symposium entitled *Promoting Scientific Literacy: Science Education Research in Transaction* was held. A large group of invited speakers presented a diversity of perspectives as they explored a future vision for science education research and practice by articulating a more expansive notion of scientific literacy than has previously been the case. These explorations involved discussions of both theoretical and practical issues in relation to questions regarding the teaching and learning of this 'revised' notion of scientific literacy at both the individual and the societal levels.

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During the past twenty to thirty years, the call for a language perspective on learning has increased. This is discussed in terms of a ‘linguistic turn’ in social sciences. The essence of this linguistic turn is also reflected in professor Roberts’ summoning up of his paper submitted to the present conference on Scientific Literacy: “Clearly, more research is warranted about the development of SL and PUS through an examination of how discourse is understood, enacted by teachers and students, taken up in student learning, measured, and discussed in the science education community and beyond.” (2007:88)

As early as 1978, the linguist Michael Halliday stated that “In the development of the child as a social being, language has the central role. Language is the main channel through which the patterns of living are transmitted to him, through which he learns to act as a member of a ‘society’ […]” (Halliday 1978:9). In such a social semiotic perspective developed within Systemic Functional Linguistics (Halliday 1978 and later), the semiotic systems which we live by, are considered to form a meaning resource. It is from this meaning resource that we choose when we articulate and structure meaning. By these choices, certain aspects are foregrounded while other aspects are put in the background or completely excluded. In that respect, the selected language forms are highly significant and coloured with ideology. However, the freedom to choose language resources and the explicit awareness of the importance of lexical choices may differ immensely between cultures and individuals. These issues will be further addressed later on in the present paper.

This paper thus focuses on what kind of knowledge a linguistic perspective and more specifically a social semiotic perspective can provide to the study of scientific literacy in an educational setting. By using an example from a first grade classroom, we will highlight some dimensions that have proved to be central for the study of the language of science. We will also comment on the relevance of these dimensions to the study of scientific literacy.

**Language dimensions**

In the following example, some students in first grade are discussing their work on different animals together with their teacher.

1. **Teacher** Thank you very much! I think that we found out a little bit about the ladybird. Yes? *(to Karl)*
2. **Karl** May I, I want to tell you about my guinea pig.
3. **Teacher** Yes, but we are not going to talk about that now, now we are going to. What does it say next? Which is the next animal?
4. **Jeanette** A mouse.
5. **Teacher** It is that table. Then it is your turn to tell us *(referring to a group of girls)*. And then everyone else must be quite so that you can hear. *(…) We are
going to talk about what the animal looks like. What it eats, how it lives. If you know anything about its babies. What does it look like?

6. Ulla It has hair on itself.

7. Teacher It has hair. That is something the ladybird didn’t have, so that is a difference. (. . .) What else!

8. Ulla Four legs.

9. X Hair on itself.

10. Teacher What about the tail? Is it long or short or thin or thick, or

11. Girl Short and thin.


14. Teacher How does the mouse live? (the children are restless) Come on, you have to listen now! ..........

(The example is from Einarsson & Hultman 1984 pp. 134-136)

In a social semiotic perspective this event or context of situation is seen as one out of many instances of the practice or context of culture that is constructed by the languageing in these particular situations. All participants are looked upon as active participants and co-creators of these situations as well as of the evolving cultural contexts. This can be discussed in terms of having “agency”. In other words, the students come from specific social backgrounds, they are boys or girls, and they have desires, special interests, goals and plans. By simply being, they instantiate their child and youth culture, its norms and values and are in this respect (together with their female teacher) ideological subjects of flesh and blood.

The real text and the produced text

The students in the example above are guided, or one might perhaps call it domesticated, in certain ways by their teacher. They are encouraged to focus the real text, i.e. the text about the animals they have studied. Karl tries to contribute something that is not congruent with the shared meaning previously discussed. He is thereby contributing a new relation that is not accepted by the teacher as belonging to the real text.

In his discourse analysis of classroom settings, Anward (1983:100-140) discusses how the norms for constructing a text on a subject matter in a classroom affects the students’ ability to contribute to the text. He shows that depending on the pedagogical practices, these norms differ and as a result different contributions are accepted or not accepted. The text that is accepted is named the real text. This is only part of the actually produced text about the subject in focus. Contributions to the subject area which are not accepted by these norms belong to the produced text. In some pedagogical contexts the norms for the real texts are very strict and many contributions to the subject from the students are left out or ignored. For example, these norms concern what aspects of a subject that are judged to be relevant and adequate. The norms may also regulate very strictly the order in which these aspects can be given and in what language shape they are allowed to appear. In other pedagogical contexts more liberate and inclusive practices are used. In these cases the real text is extended in such a way that it more or less overlaps with the produced text.

Genre

The teacher in our example is working really hard to keep up with the tradition of how to organize facts about nature within natural science. The mouse should in this tradition be talked about from the perspective of a descriptive report. According to Veel (1997), the descriptive report is one among twelve different communicative genres typical of work within science. These genres are primarily found within four domains: ‘Doing science’,
‘Explaining events scientifically’, ‘Organizing scientific information’ and ‘Challenging science’. Within the domain of doing science we find the procedure and procedural recount. Explaining events scientifically is fulfilled by using exploration or sequential, causal, factorial, theoretical or consequential explanations. The descriptive report together with the taxonomic report is used to organize scientific information. Finally challenging science is carried out in the form of expositions or discussions.

**Everyday language and academic language**

The language resources or wordings used both by the teacher and the students in the example above belong to the meaning resources of everyday language. However, by using the words in their generic sense, the mouse and its attributes, properties and behaviours are talked about in a generalized manner. In this sense, the language use exhibits traits found in the academic language that characterizes the science discourse. This discourse is in general very specific and distant from the discourses of everyday language (Schoultz 1998:30) as for example manifested in a large number of technical terms, often created through nominalisations (Writing Science 1993). By nominalisations we are referring to the process of expressing qualities and processes as nominal phrases instead of as verbs or adjectives. By doing this, processes and qualities can be treated as things in the text and thereby discussed without reference to participating actors or time. In general, nominalisations add abstraction to texts and, as previously mentioned, they are typical of the science discourse. However, sometimes abstraction comes into play also in everyday language. When generalizations instead of descriptions of “here-and-now” are used, the use of abstract language increases. Abstraction and concreteness could therefore be seen as a continuum where the first step towards abstraction goes through the use of generalized expressions (Edling 2006). In other words, there are no clear cut border lines between everyday language and academic language.

Technical terms are furthermore not just an unnecessary way of making science more difficult, but intrinsically linked to doing science and to science itself. They belong to the conceptual space of science. Just like technical terms in other areas, they are dense with information and to retrieve the information it may be necessary to unpack them. Nevertheless, packing up a word also entails that the new wording has another meaning. For example, to unpack ‘solar eclipse’ with ‘eclipse of the sun’ may not change the meaning significantly. But to replace it with ‘the sun is darkened’ or ‘the sun gets dark’ is much more questionable. It is uncertain if these last replacements actually include the reason why the sun gets dark in the same way as in the term ‘solar eclipse’. These translations rather only scratch the surface of the meaning of the original term.

In educational settings in the primary grades (including reading material for the children) as well as in popular science, it is not uncommon to find these types of unpacked wordings. It could be seen as a launching pad for the technical term. A basic or surface conceptual structure is thus built through the use of everyday language.

In the discussion above, the sources of two possible marginalization processes within science teaching can be found. One type is when science is taught through the use of everyday language and on a superficial level only. Another type is when the teaching starts out on an abstract level using academic language, thus potentially leaving out all the students who are not acculturated into this type of discourse.

**Foregrounding aspects of content**

In our example from first grade, the generic mouse is foregrounded. This generic mouse is made the theme of the conversation. To put an aspect in the theme-position is one
important meaning making resource for foregrounding content. In some languages, like English and Swedish, this is done by putting this aspect at the beginning of each sentence. In some other languages the theme is marked by a special prefix or suffix.

Another way to foreground a specific aspect is to emphasize it in some way. This can be accomplished by expanding on the aspect of interest. However, this is not used to a large extent by the teacher in grade one. It is just when the hair of the mouse is in focus that she adds that this is in contrast to the ladybird. By this expansion she is actually using difference in order to scaffold the children’s learning. Within Systemic Functional Linguistics Halliday and Matthiessen (2004, in af Geijerstam 2006) discuss three different types of expansive relations. ‘Elaboration’ is used when defining or clarifying an idea (expressed by e.g. ‘for example’, ‘in other words’, ‘at least’, ‘actually’). ‘Extension’ on the other hand is used when joining two ideas by addition or variation (expressed by e.g. ‘and’, ‘but’, ‘on the contrary’, ‘instead’). Finally ‘enhancement’ is used when qualifying something with more information such as time, place or cause (expressed by e.g. ‘then’, ‘next’, ‘likewise’, ‘so’, ‘consequently’, ‘in that respect’). The use of expansions does not just support the foregrounding of an aspect. It also makes this aspect more comprehensible.

An aspect of the content can furthermore be emphasized by evaluation. Within Systemic Functional Linguistics Martin and White (2005, in Folkeryd 2006) have developed a framework for analyzing evaluation in discourse named the Appraisal framework. Within this system utterances are classified as ‘Attitude’ if they express positive or negative evaluation of a person, thing, situation or state of being (for example ‘the situation is dangerous’ or people are suffering’). ‘Engagement’ entails utterances that either accept or ignore various positions to what is discussed in the texts. These utterances thus react to what is presented, what has been presented or will be presented (for example ‘Naturally this is the way to go’, ‘Of course this is the truth’). ‘Graduation’ is finally about turning up or down the volume of the evaluation (for example ‘She was very upset’, He was a little bit hurt’).

Meaning resources and scientific literacy

The teacher is a very important person in a student’s educational life. He/she can be looked upon “as a creator of social man – or at least as a midwife in the creation process” (Halliday 1978: 9). In this position a teacher has the power to control the meaning resources being used in the class room. The teacher also governs both what aspects of a subject matter that is foregrounded and how this is done. But there are very few indications that the teachers of science are aware of her/his languageing power or have any knowledge about the meaning resources that are used in science languageing (af Geijerstam 2006; af Geijerstam & Liberg forthc). This is one very important reason why the students’ freedom of choosing meaning resources is severely restricted.

In order to facilitate learning and the linguistic challenges posed on the students, there is thus a need for an orientation to language that allows all students to develop their linguistic resources as they enter classroom contexts. This includes a focus on the language dimensions presented above, i.e. the way language construes content, how a particular text type or genre can be structured and how certain lexical choices make one text more powerful than another.

The widening of the scope of scientific literacy also calls for new meaning resources that the science teacher has to be equipped with. Today this is not only a question of the verbal language discussed above. For example, there are recent studies of multimodality where
modality switches are discussed as transformations scaffolding the learning process (Knain 200X). An example of this would be doing lab work in science, talking about it and then writing it down in a lab-report, which is a process of at least two modality switches that can enhance understanding and learning.

In summary, this paper emphasizes that scientific literacy must include a component consisting of reflective competence and an awareness concerning the language and languageing of science as it is shaped in both Vision I and II.

References