

## **Linguistic Features in TIMSS-Science Test Questions. Scaffolding or Hampering different groups of 8th grade Students.**

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### **General description**

To draw conclusions about students' understanding solely based on test results is not an uncomplicated endeavour. An incorrect response does not necessarily indicate a lack of knowledge. A lack of vocabulary, deficit in knowledge of the language of the test, poor reading skills or misinterpretations can also be the cause (Harlow and Jones 2004; Oakland and Lane 2004). Another problem is that some students may have necessary skills and strategies to solve a problem, but may still interpret the question in another way than the intended (Schoultz 2000; Harlow and Jones, 2004). The reading demand the question has on the student can influence what is being measured (Haladyna et al., 2002).

The study presented in this paper is part of a larger study of the academic language of school science, and its significance for students' reading and solving of questions in science. Each sub-study will approach various aspects of the academic language in school science such as linguistic features, vocabulary and coherence. Focus in this first sub-study is linguistic features concerning questions in science in the international study The Trends in International Mathematics and Science Study (TIMSS). Using a large scale study like TIMSS, it is possible to investigate the significance of language in a systematic manner for different science subject areas and also different groups of students.

This study aims to:

- Develop a method for characterizing science questions regarding linguistic features.
- Examine which -and to what extent- linguistic features influence how different groups of Swedish 8th grade students succeed in answering questions posed within different science subject areas in TIMSS.

To develop a method for characterizing science questions regarding linguistic features this study is based on a social semiotic perspective as it is developed in systemic functional linguistics (SFL) (Halliday 2004). A text and its features are seen as a realization of the context of situation, and thus reflecting the social order. In different social contexts, different registers of language are used. In SFL a register is described as a configuration of what the text is about (field of discourse), personal relationships in the text (tenor of discourse), and how the text is structured (mode of discourse) (Halliday & Hasan 1989). Each discourse could be described as a continuous scale. The continuum for field of discourse spans from common-sense and everyday aspects to technical and specialized. The register tenor of discourses goes from personal, informal and subjective aspects to formal and objective. The mode of discourse continuum covers less complicated and unpacked language to more complicated and packed language. By using register as a base for the linguistic analysis the results will also be more generally applicable for different languages.

To discuss results of different groups of students this study is also based on a reception theoretical perspective (for a school context see e.g. Graesser et al. 2011; Langer 2011; Liberg et al 2013; Luke & Freebody 1999). In such a perspective the text as such or the language of the text is not seen as inherently cognitive demanding. The cognitive demands are relative the encounter between reader and text within a specific context, i.e. no task can be called cognitively demanding out of context (Schleppegrell 2004). Of importance are the reader's experiences and knowledge of the language used, the reader's pre-knowledge of and interest in the content of the text, and of reading such texts and participate in practices where such texts are read (e.g. Liberg 2001). Here the results of six different groups of students will be investigated, concerning language background and thereby presumed skills in the language of the test, sex (boys/girls), and high/low performance on the test.

## **Method**

The data used consists of the 223 science test questions used for grade 8 in TIMSS 2011 and the test scores from in total 5573 Swedish students. Although the Swedish version of the questions is used, the analysis in terms of register opens up for results on a more abstract and language independent level. The material allows for division into the four subject areas: Biology, Chemistry, Earth Science and Physics. As each test question has a large number of student responses (on average 783 responses) it also enables further divisions of students into different groups. Examples of such groups are boys/girls, high/low-performing students or native/non-native students. For each studied group the questions average solution frequency –compensated for different maximum points- is calculated and used as the dependent variable in the statistical analysis.

Independent variables are different linguistic features of each test question, tested both separately and in combinations motivated by previous research of the register used in academic language. For these analyses a database with linguistic information on each question in TIMSS has been used (see <http://stp.lingfil.uu.se/timss/#Publications>). In this database each question is classified according to linguistic features such as the word class each word belongs to, number of words per question, word length, and sentence length, using Extensible Markup Language (XML) in a computer based automatic parsing. This kind of information is commonly used in different readability formulas. The use of a computer based parsing offers advantages by being able to quickly analyse large materials. A

disadvantage is that the study is limited to the analytical potential the automated computer parsing provides.

The statistical analysis is done in steps. Firstly a bivariate correlation analysis is made to sift out linguistic features that might be of importance both for the indication of register in the four subject areas, and for the different groups' ability to respond correctly to the test question in focus. Secondly the linguistic features are fitted into models using multiple regression analysis.

## **Results**

Computer based techniques for analysing readability or information load of texts is generally not intended for short texts such as science questions in TIMSS. Interesting methodological outcomes of this study are therefore which techniques that can provide useful results for register classification for such short texts.

Empirical outcomes are if some student groups are disadvantaged or privileged by certain types of linguistic features, and thereby different registers. As many language features are specific to particular discourses, preparing students for understanding such features could be more beneficial for students in the long run, rather than giving them questions written in a kind of general language (Hyland and Tse, 2007). Results can therefore be relevant for people choosing and creating school science texts. With an understanding of scientific language features, teachers can meet different students' needs thus enabling students to learn science aided by learning the nature of scientific language.

Results show that students with both parents born abroad are more influenced by linguistic features than students with Swedish born parents. It is also found that boys are more influenced by linguistic features than girls. As nominalization – the turning of verbs or adjectives into nouns - is a common feature of scientific language one would suspect nouns to be of importance for test results. Instead verbs are found to have negative influence on test results. The results also show that there are more linguistic features of significance in chemistry than in biology, earth science and physics. A surprising result is that almost all linguistic features that are of significant importance for the top 25 % performers are not of any significant importance for the low performing 25 %, and vice versa.

## **Intent of publication**

The results from an extended form of this study are intended to be published as a scientific article in an international journal concerning language and education.

## References (/400)

Graesser, Arthur C. & McNamara, Danielle S. & Kulikowich, Jonna M. (2011). "Coh-Metrix: Providing Multilevel Analyses of Text Characteristics." *Educational Researcher* 40(5): 223-234.

Haladyna, T. M. & Downing, Steven M. & Rodriguez, Michael C. (2002). "A Review of Multiple-Choice Item-Writing Guidelines for Classroom Assessment." *Applied Measurement in Education* 15(3): 309-334.

Halliday, M. A. K. & Hasan, Ruqaiya (1989). *Language, context, and text: aspects of language in a social-semiotic perspective*. 2. ed. Oxford: Oxford Univ. Press

Halliday, Michael. A. K. (2004). *An introduction to functional grammar*. 3. ed. London: Arnold.

Langer, Judith A. (2011). *Envisioning knowledge: building literacy in the academic disciplines*. New York: Teachers College Press

Harlow, A. and A. Jones (2004). "Why Students Answer TIMSS Science Test Items the Way They Do." *Research in Science Education* 34(2): 221-238.

Hyland, Ken & Tse, Polly (2007). "Is There an "Academic Vocabulary"?" *TESOL Quarterly* 41(2): 235-235.

<http://stp.lingfil.uu.se/timss/#Publications>

Liberg, Caroline (2001). Svenska läromedelstexter i ett andraspråksperspektiv - möjligheter och begränsningar. I: Naucier, Kerstin (red.) *Symposium 2000 – Ett andraspråksperspektiv på lärande*. Nationellt centrum för sfi och svenska som andraspråk. Stockholm: Sigma Förlag. S. 108-128.

Liberg, Caroline, af Geijerstam, Åsa, Wiksten Folkeryd, Jenny, Bremholm, Jesper, Halleson, Yvonne & Holtz, Britt-Maria. (2012). Textrörlighet - ett begrepp i rörelse.. I: Synnøve Matre och Atle Skaftun (red.), *Skriv! Les! 1. Paper presented at Skriv! Les! Nordisk forskerkonferanse om skrivning og lesing*. Trondheim: Akademika forlag. S. 65-81.

Luke, Allan & Freebody, Peter (1999) Further notes on the Four Resources Model. *Reading online*. <http://www.readingonline.org/research/lukefreebody.html> [downloaded 2012-02-13].

Oakland, Thomas & Lane, Holly B. (2004). "Language, Reading, and Readability Formulas: Implications for Developing and Adapting Tests." *International Journal of Testing* 4(3): 239-252.

Schleppegrell, Mary J. (2004). *The language of schooling; a functional linguistics perspective*. London: Lawrence Erlbaum Associates.

Schoultz, Jan (2000). *Att samtala om/i naturvetenskap : kommunikation, kontext och artefakt*. [diss.]. Linköping: Univ; 2000.