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The Subject Language Use In Year 8 TIMSS-Test Questions - A Comparison Of Language Uses In Science And Mathematics.

Ida Bergvall, Ph D, Department of Education, Uppsala University  
ida.bergvall@edu.uu.se

Tomas Persson, Ph D, Department of Education, Uppsala University  
tomas.persson@edu.uu.se

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General description on research questions, objectives and theoretical framework

In this study we want to make a contribution by making a comparison between the subject languages in mathematics and science based on linguistic theories about language and language function. Through this theoretical foundation in this present study we also have the opportunity to analyze the language function and thus we can also discuss the language's role in teaching. The aim of this study is to compare and thus gain more knowledge of grammatical features in subject language in science and mathematics and how these grammatical features are used to express meaning. To fulfil this purpose, science and mathematics items from *Trends in International Mathematics and Science Study* (TIMSS) 2011, grade eight, have been analysed from a functional perspective on language.

Empirical studies that compare language use in different subjects are sparsely present (Österholm & Bergqvist, 2013) but there are studies pointing out that how language are used to express meaning varies between different school subjects (e.g. Fang & Schleppegrell, 2008; Schleppegrell, 2004). These linguistic differences have been highlighted as arguments for a more differentiated language-based teaching of subjects, leaning on disciplinary literacy (Shanahan & Shanahan, 2008). In order to conduct such a language-based teaching of subjects, an awareness of the different functions in the language used in various school subject is of great importance. One example of a comparative language study is the corpus study conducted by Ribeck (2015) where the language in Swedish teaching materials in science is analyzed, and compared with teaching materials in social science and with textbooks in mathematics. However, Ribeck does not make a direct analysis of mathematical subject language, her focus is rather on the language used in natural science compared to social science. There are also studies that focuses on the language use within subjects. Here it appears that the subject language is used differently and has different functions in different content areas within school mathematics (e.g. Bergvall, 2016) as well as within the different school science subjects, e.g. biology, physics, chemistry and earth science (e.g. Persson, 2016).

This study draws on a social semiotic perspective and systemic functional linguistics (SFL) (Halliday & Matthiessen, 2004). A point of departure is the perspective that different registers of language are used in different social contexts, which in this study is defined as the two school subjects science and mathematics. Grounded in SFL and the three meta-functions ideational, interpersonal and textual function the meaning dimension model of analysis was developed in a previous research project (Bergvall et al., 2016; Persson et al., 2016). Four central meaning dimensions, packing, precision, personification and presentation, were condensed from previous research regarding academic language and language use in the school subjects science
and mathematics. The meaning dimensions can be used as measures of how grammatical features are used in various types of texts in order to express meaning. Packing and precision are regarded as aspects of the ideational meta-function. Packing is a measure of the information density in a text and precision is a measure of how and to what extent the given information in the text is specified. Personification, as an aspect of the interpersonal meta-function, is a measure of how personal relations between the reader and the text are expressed. The last meaning dimension, presentation, concerns how the information is structured in the text and is regarded as an aspect of the textual meta-function. In the present study, the four meaning dimensions are used to describe and compare the language and its function in science and mathematics items in TIMSS 2011.

Methodology, Methods, Research Instruments or Sources Used
By the use of a quantitative method all items in mathematics and science from the Swedish version of TIMSS 2011, grade eight were analyzed. This material consists of 197 items in science and 217 items in mathematics. The language in these items have been analyzed for word class, word length and number of words per items by a computer based automatic parsing. For this parsing Extensible Markup Language (XML) was used. Some other linguistic features, i.e. passive forms and subordinate clauses, were identified manually. Since the meaning dimensions are used as a base for the linguistic analysis, the results will possibly be generally applicable also for other European languages, although the analysis was conducted on the Swedish version of TIMSS items.

Packing was measured by calculating the number of nouns and the number of long words (>6 characters). Precision in the items were provided by words such as adjectives, adverbs, participles and counting words specifying different attributes in the items. Personification was here measured by the number of personal pronouns and proper names and presentation was measured by the presence of subordinate clauses and passive forms. In order to compensate for the varying length of different items, the number of the different linguistic features were divided by the number of words in the particular item. To enable the adding of different features, each feature is normalized by calculating its z-score. An index was then calculated for each meaning dimension based on the linguistic information on each item. From these indices a comparison between the language uses in the two subjects was possible. In the next step of the analysis each subject were separated into content domains: Algebra, Data & chance, Geometry and Numbers for mathematics items and Biology, Chemistry, Earth science and Physics for science items. This enabled variations of language use within the subjects also to be analyzed. The results were compiled in box-plots diagrams which visualized the distribution of the expressions of the four meaning dimensions in the various content domains.

Conclusions, Expected Outcomes or Findings
Preliminary results show that central traits of the academic language as measured by the four meaning dimensions are used in similar ways in both science and mathematics. The levels of packing, precision and presentation are fairly similar when looking at differences between the subjects. Personification shows the largest differences between the subjects, where mathematics as a whole makes more use of personal pronouns and proper names in the items.

When separating the subjects into content domains, Statistics shows the highest level of personification. In this domain it can therefore be concluded that human participants are essential, thus emphasizing that this is a domain that this is an area of relevance for people in general or for the student him/herself. This can be interpreted as signaling the possibility to actively participate and interact in similar situations as described by the items context. On the
other hand, in domains such as Algebra, Geometry and Earth science where the content is expressed with a low level of personification, the interpretation is that the content of these domains—at least as expressed in TIMSS items—are more separated from peoples’ everyday lives and thus the students’ own reality.

Another result that emerges from the analysis relates to the meaning dimension presentation where we see that the written texts, especially in Algebra, but also in Geometry, Numbers and Earth science, mainly contains short sentences without subordinate clauses. In written academic language, subordinate clauses are a common tool for creating information flow and link different parts of the text (Fang, 2006; Schleppegrell, 2004; Veel, 1997). The lack of subordinate clauses in tasks in certain content areas of TIMSS indicates a subject-specific linguistic form that may require a familiarity with this specific form of language use.

References


