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Teaching the concept of angles to multilingual learners

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Introduction

The project EsCo¹ involves researchers from seven countries and focuses on classroom teaching of specific mathematical topics in language responsive ways. It is known that linguistically disadvantaged learners continue to be educationally disadvantaged, and therefore it is important to gain more knowledge about the challenges these learners face. Four topics are chosen: angles, linear equations, proportional reasoning, and probability, to be taught to pupils aged 11-13 years. In the first phase of the project, three to four experienced teachers from each country have been interviewed to gain insight into the approaches they use to teach the specific topics and what challenges particularly multilingual pupils encounter with each of these topics.

The nature of geometric concepts

Geometric concepts may have an advantage in pupils' learning process because they often can be represented with concrete objects known from everyday life, and because the words used are also often well-known from everyday language. However, the connection to everyday language may also be a hindrance because words may have different meanings in the everyday register compared to the mathematical register. Discrepancies between the everyday and mathematical register may be language specific, as has been shown by Rønning and Strømskag (2017, 2019) in connection with naming elements of a polygon (edges and vertices). In the Norwegian language, there is no proper scientific term for the concept *vertex*. The word that is used, *hjørne*, is common to both the scientific and the everyday register, and corresponds to the English word *corner*. Polygons are named based on the number of edges (e.g., *firkant* = 'four edge'), but it was observed that when classifying and naming polygons, the Grade 2 pupils studied by Rønning and Strømskag (2017) counted the vertices but claimed that they counted the edges. Frege (1892) distinguished between the *sense* (Sinn) and the *reference* (Bedeutung) of a word. In semiotics, a word is seen as a sign. The reference is the object that the sign refers to and the sense comprises all thoughts and ideas connected to the sign. Two different signs may have the same reference but different sense depending on the situation, and also one sign corresponding to one reference may have different sense depending on the situation.

For the pupils mentioned above, the *sense* of the word *edge* (Norwegian: *kant*) was that of something sharp, something that would cause pain if you hit it (Rønning & Strømskag, 2019), and therefore they associated the word *kant* with the vertex (*hjørne*), in particular when approaching the vertex from the outside. It could also be observed that the same pupils could refer to a vertex as a *hjørne* when approaching it from the inside. This indicates, using the words of Frege (1892), a different *sense* for

¹ Establishing a collaborative relationship for research on school mathematics teaching with linguistically disadvantaged learners. Project funded by John Fell Fund.

the same *reference* depending on the situation. The previous research was done with monolingual learners, and it is of interest to investigate whether there are particular challenges involved when teaching similar concepts, like *angle*, to multilingual learners.

The angle concept

I conducted a 40-minute semi-structured interview with the teacher Mary. The interview was audio recorded and later transcribed. Mary was asked what strategies she used when teaching the topic of angles and what linguistic challenges the pupils would encounter. Mary said that irrespective of the pupils, she would approach the concept of angles in a very practical manner. She tries to uncover the pupils' learning styles, and this gives an opportunity to observe carefully pupils with linguistic challenges. Mary: "These are often multilingual pupils, but also monolingual children". Challenges are strongly connected to the environment the children grow up in, and whether the adults use, what Mary called "a precise language". Mary finds working with concrete material and practical activities in various settings to be important, and that this gives the opportunity to uncover linguistic challenges.

I detected some issues connected to *sense* and *reference* (Frege, 1892) in Mary's account of working with angles. An angle v is classified as being *acute* ($v < 90^\circ$), *right* ($v = 90^\circ$) or *obtuse* ($90^\circ < v < 180^\circ$). The English words *acute* and *obtuse* are scientific words, with no obvious connection to the everyday register. The corresponding Norwegian words are *spiss* and *stump*. *Spiss* is common in everyday language having the sense of something sharp, e.g., the tip of a pencil. This can be confusing for the pupils, according to Mary, because an angle of e.g., 87° is by definition *spiss*, but it does not look *spiss* (sharp). The word *stump* has a different character. It is an old-fashioned everyday word, possibly with no sense for young people. It sounds like *stum*, which means *dumb*, and Mary says that the pupils find this word strange, because "no angles can speak". A corresponding English word could be *blunt*.

In the interview, Mary pointed to several linguistic challenges when teaching the concept of angle, not necessarily connected to multilingualism. The topic of angles may therefore be challenging because the words used in the Norwegian language come from the everyday register, sometimes with a different sense, and sometimes with no sense at all for young learners.

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