The development of the mathematical discourse of biology students working with mathematical modelling

Olov Viirman

University of Agder, Norway, olov.viirman@uia.no

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INTRODUCTION

This paper builds on the ongoing pilot phase of a developmental research project (Goodchild, Fuglestad & Jaworski 2013) aimed at increasing biology students' motivation for, interest in, and perceived relevance of studying mathematics through the use of mathematical modelling. The project is a collaboration between two of the four Norwegian centres of excellence in higher education – the Centre for Research, Innovation and Coordination of Mathematics Teaching (MatRIC) and the Centre for Excellence in Biology Education (bioCEED) – and is motivated by changing demands in undergraduate biology education. The increased relevance of mathematics in biology (e.g. Cohen 2004) has created a need for developing the education of future biologists through a greater integration of mathematics and biology in the curriculum through, for instance, the use of mathematical modelling (Brewer & Smith 2011; Steen 2005). The focus of this paper, however, is on how the mathematical discourse of the students develops as they participate in the project.

MATHEMATICS AS DISCOURSE

In the commognitive framework of Sfard (2008), mathematics is conceived of as a form of *discourse*, that is, a specific type of communication drawing some individuals together while excluding others (ibid, p. 91). Mathematical discourse is distinguished by four characteristics: *word use*, *visual mediators*, endorsed *narratives*, and *routines* (ibid, p. 133-134). Learning is defined as individualizing discourse, becoming more capable of communicating within the discourse. Learning can take place both on the object-level, expanding the existing discourse, and on the meta-level, involving changes in the meta-rules of the discourse, that is, the rules governing the actions of the discursants. Central to meta-level learning is the notion of *commognitive conflict*, which occurs when different discursants act according to different meta-rules (ibid, p. 256). Such conflict is often a necessary aspect of meta-level learning, and identifying and analysing commognitive conflict is important when trying to understand students' difficulties.

THE TEACHING DEVELOPMENT PROJECT

The pilot phase consists of meetings with 12 first-year biology students from the University of Bergen on four occasions during the autumn of 2015. The meetings take place in parallel with the one compulsory mathematics course included in the

undergraduate biology program. During these three-hour meetings a mathematician skilled in mathematical modelling and with extensive teaching experience works with the students, presenting them with modelling tasks intended to bridge the gap between mathematics and biology, on which the students then work in groups. In the first session the teacher also gave an introduction to the notion of mathematical modelling, presenting the modelling cycle as a way of understanding modelling processes. Tasks given to the students included, for instance, estimating the population density of rabbits in an area based on the number of road-kill rabbits along a stretch of highway; and estimating the size of an extinct species of bird through comparing data on dimensions of fossilized bones with similar data from contemporary species of birds. All sessions are audio- and video-recorded, both the group work and the whole-group activities.

PRELIMINARY RESULTS

At the time of writing only three of the four sessions have been conducted, and none of the recordings have been transcribed. Hence, only very tentative observations can be presented here. One observation made concerns the notion of 'assumption'. The making of reasonable simplifying assumptions was emphasised by the teacher as central to the modelling process. Apparently, the students took this to heart, and when they presented their work on the rabbit task all groups emphasised the simplifying assumptions they had made. However, two of the three groups had made unfounded and more or less random assumptions on the percentage of rabbits hit by cars. This caused some consternation on the part of the teacher, since from his standpoint it basically amounted to assuming what you want to find out. This can be interpreted as a case of commognitive conflict, where the students' use the language of mathematical modelling discourse in a way that contrasts with the teacher's use.

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