FROM A CAUSAL QUESTION TO STATING AND TESTING HYPOTHESES: EXPLORING THE DISCURSIVE ACTIVITY OF BIOLOGY STUDENTS

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ABSTRACT

This paper aims at exploring the discursive activity of one group of second year biology students during their collaboration on a task of stating and testing hypotheses to answer a causal question. The specific task is a part of a didactic sequence that was developed in the context of genetic engineering considering aspects of situated-learning theory, with the aim of providing students the opportunity to 'talk science' with their peers as participants of a hypothetical gene cloning project. Our focus is set on certain cognitive aspects of peers' discourse. Hence, this paper is concerned with the construction of arguments, particularly on the level of argumentative operations (e.g. claims, justifications, challenges) and the context-bound epistemic operations (e.g. abducting, appealing to instances) activated by peers in order to produce a joint answer to the task's causal question. Furthermore, it is concerned with the development of the *'if...and...then'* hypothetical-deductive reasoning pattern potentially involved in peers' hypothesis-testing process.

1. INTRODUCTION

Recent research in science education focuses on the study of students' argumentation in various contexts (Mason, 1996; Desautels & Larochelle, 1999; Jimenez, 2000; Driver et al., 2000; Simonneaux, 2000). Our study attempts to build on this body of research work by focusing on the construction of biology students' arguments while interacting in the context of genetic engineering for the formulation of a hypothesis and the development of *'if... and...then'* reasoning patterns to test their hypothesis.

Stating hypotheses (tentative explanations to causal questions) constitutes, in general, a complex process of combining empirical evidence, previous knowledge, and intuition (Lawson, 1995). The role of argument in this process seems to be crucial. Partial scientific claims towards an explanatory framework do need to be well grounded in warranting structures that are built on reliable epistemic criteria (Driver et al., 2000). Furthermore, the possible formulation of more than one alternative hypothesis for the same causal question, activates a process of comparative evaluation of their explanatory efficacy to decide which one is the

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fittest (Giere, 1991) and therefore should be experimentally tested. Argument is also a necessary tool when designing the experimental tests to be used in hypothetical-deductive reasoning. Stating, justifying, and evaluating scientific claims remains a prerequisite for making predictions about the expected outcomes of the test, assuming the hypothesis' validity, and for defining the conditions of the hypothesis's rejection by comparing the expected and the potentially observed outcomes of the proposed test (Lawson, 1995).

Our focus is set on the process of formulating and testing hypotheses and the employment of argumentative and epistemic tools in this process. Thus, the question framing our study is *'how do collaborating students formulate and test hypotheses in the context of genetic engineering?'*. More specifically, *'what kind of argumentative and epistemic operations do students activate in the process of stating and testing hypotheses?'* and *'to what extent do they follow the hypothetical-deductive reasoning pattern to explore the validity of their hypotheses?'*. In summary, the objective of this paper is to highlight students' reasoning patterns on hypothesis stating and testing by analyzing both the argumentative process towards its construction and the resulting construct itself.

2. METHODS

The task and the setting

A didactic sequence of genetic engineering was developed on aspects of *situated-learning theory* to provide biology students with an *authentic* context for practicing scientific reasoning and discourse. In a student-centered setting, peers collaborated in small groups to create joint answers to tasks embedded in a hypothetical gene cloning mission as its meaningful and purposeful steps. Peers who were supposed to be responsible for cloning a medically useful plant gene were faced with choices, predictions, experimental proposals, and stating/testing hypotheses. The teacher's role was limited to introducing themes, giving hints, and conducting whole class discussions after the group work.

The participants of the group discussion presented here are three female students who volunteered to be tape-recorded while interacting as they stated and tested tentative explanations of the cloned gene's inability to synthesize its protein in bacteria (see Appendix*)*. Lawson's hypothesis-testing quizzes (Lawson, 1995) were taken into account for the task's development, resulting in the insertion of a scaffolding device which explicitly requires that peers predict the expected outcomes of their experimental test regardless of the adequacy of their hypothesis. The task aims at encouraging students to practice scientific reasoning through argumentative discourse. It does this by engaging peers in a process of developing hypothetical-deductive reasoning to answer a causal question which derives its meaning and purpose from a hypothetical cloning mission, and which also challenges the application of peers' background declarative and procedural knowledge.