Using Variation Theory to explain a complex mathematical phenomenon
(Article submitted for presentation only)

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1. INTRODUCTION

This study describes what is required in a learning situation in order to make it possible for students to discern the distinction between a function and an equation, irrespective of if the students are taught via internet or in class. The questions the study responds to are:

- what is offered the students to learn and what do they actually learn concerning functions and equations during the research lesson?
- which are the critical aspects in order to understand the distinctions between functions and equations?

We consider that both within and between the concepts function and equation there are various meanings contributing to the difficulty to discern the difference between them. A definition is made, which this study is based upon.

2. THEORETICAL ASSUMPTIONS

The study is based on the Variation Theory [1, 2, 3, and 4]. Variation theory has three integral components. The first is *discernment.* Learning implies that one allows different aspects or features to change position: what was once background may take a more prominent position, and what was initially focused upon retreats into the background. The second feature

of the Variation Theory is *simultaneity*. Part of something can at the same time constitute a complete unit in itself, and a complete unit can be part of something larger. The third feature of variation theory is *variation*, i.e. opposites and deviations. Understanding a phenomenon is the result of observing how it deviates from the 'normal'. If you discern a person as tanned, you probably usually meet other persons not so tanned. Using Variation Theory to examine learning and education gives teachers more precise knowledge about what matters in a learning situation, irrespectively of if it is an internet or face-to-face learning situation. In this study, by using a theory in an iterative fashion, the teachers and researchers were able to try out different designs. This was made to find a powerful way to teach students the difference between a function and equation.

3. METHOD

The method used was learning study [3, 4] including three research lessons in a cycle. Three teachers and three classes (n=23/16/20) have participated in the study. Three research lessons have been carried out, in three different student groups. Each student has taken three tests (pre test, post test and delayed post test) to describe the development of their knowledge. The research lessons have been video recorded, transcribed and analyzed. The results from the first lesson have been founded in the design of the second and so on.

4. RESULTS

The result points out that the students developed understanding and kept it, concerning functions and equations, mostly in the last group (mean +5,85 in the post test and +0,2 in the delayed post test). The result points out some minor aspects, critical for learning the difference between functions and equations; negative numbers, algebraic understanding and handling of co-ordinate systems. But the major critical aspect is to understand that a function's graph consists of an *infinite varying number of points*; co-ordinates. The students who have discerned this aspect have simultaneously also discerned the solution of an equation system as a *specific* co-ordinate that also exists in all belonging functions. Thereby, the students have been offered to understand the distinction between functions and equations.

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[3] M. Holqmvist, L. Gustavsson & A. Wernberg, Generative learning. Learning beyond the learning situation. **Educational Action Research**, vol 15, no 2, June 2007, pp 181-208 .
[4] M. Holmqvist, L. Gustavsson, & Wernberg, A. Variation Theory - A tool to improve education. In Kelly, A.E., & Lesh, R. (in press) **Handbook of design research methods in education**. Mahwah, NJ: Erlbaum.