DIGITALLY INCREASING THE QUALITATIVE UNDERSTANDING OF THE DERIVATIVE

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ABSTRACT

Students difficulties with interpreting and using graphs in a meaningful way are well documented in the literature. In the Netherlands students are required to be able to sketch the graph of the derivative of a function given only the graph of that function. In this explorative study we investigate on the performance of a digital environment designed to enhance the qualitative understanding of the derivative.

Keywords: derivative, feedback, digital environment, learning with technology.

AIM AND RATIONAL OF THE STUDY

It is a known fact that students often struggle with making a sketch of a derivative in the absence of a formula that can be computed. This is also collaborated by Stahley (2011). Previous research (e.g. Sari, Hadiyan and Antari, 2018) shows that digital environments provide opportunities for students to explore graphs in a qualitative way.

In our research we investigate how students learn to sketch the graph of a derivative within a digital environment developed by Van der Hoek (2019). Furthermore we investigate on a GeoGebra applet as a possible addition to the environment. We use an adapted version of the framework of Vos, Braber, Roorda, and Goedhart (2010) to investigate students' understanding of the derivative. Within this framework we distinguish five levels of qualitative understanding where a student exhibiting a certain level also possesses the previous levels: *no operable knowledge (L0), knowledge of some connection* between the slope of the function and the derivative *(L1), knowledge of the location* of points on the graph of the derivative relative to the horizontal axes *(L2), understanding the derivative as slope* that is, the derivative represents the course of the slope of a graph *(L3), understanding the derivative as gradient*, that is a point on the graph of the derivative represents the gradient of a tangent *(L4)*. In this paper we present the results of an explorative study which involved 4 students.

THE DIGITAL ENVIRONMENT AND GEOGEBRA APPLET

The environment presents an animation video explaining the relation between a graph and its derivative followed by four tasks to sketch the derivative of a given graph digitally. Feedback on the sketch can be obtained using a button. This feedback is designed to increase the level of understanding. Since it proves difficult to design

feedback to increase to L4 we also developed a GeoGebra applet in which the gradient of a tangent is plotted as the student moves it along a graph.

METHODOLOGY

We used individual semi structured interviews to investigate students learning. Four students (age 16, 17) participated in this study. First they were given a pre-examination. Two of the students (students 1 and 2) then had the opportunity to practice using the digital environment while the other two students (3 and 4) practiced using a textbook. Directly after that, a post-examination was conducted. A third interview took place three weeks later. During the last interview all the students also interacted with the GeoGebra applet.

RESULTS

Analyses of students interviews shows that students 1 and 2 have risen two levels after three weeks. However students 3 and 4 had the same rise in understanding. Furthermore we found that student 3 achieved a rise from L3 to L4, the highest recorded level, after interacting with the GeoGebra applet.

PRELIMINARY CONCLUSIONS AND IMPLICATIONS

Based on these results we may carefully conclude that the contribution of the environment to the qualitative understanding is roughly the same as the contribution of a textbook. Which begs the question: What may we add to the environment to make a difference? Interacting with the GeoGebra worksheet did give student 3 a more profound understanding of the relationship between a function and its derivative. Why does this interaction lead to better understanding? And how may we implement this interaction in a digital learning environment? These are questions that we want to discuss at MEDA and incorporate in our future work

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