Amsterdam University of Applied Sciences

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Link to publication

Citation for published version (APA):
Palha, S., & Koopman, S. (2017). *Learning with Interactive Virtual Math in the classroom*. Poster session presented at ICMT13 (13th International Conference on Technology in Mathematics Teaching), Lyon, France.

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Download date: 02 03 2021

Learning with Interactive Virtual Math: an exploratory study in the classroom

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INTERACTIVE VIRTUAL MATH

Study

Aim and Research Questions

Interactive Virtual Math is a digital tool for learning graphs from dynamical events at high school (14-17 years old students) and to explore the use of new technologies in classroom. The project started in 2016 as a proof of concept in which a prototype tool was developed and tried out (Palha and Koopman, 2016). The aim of this study is to explore the use of the prototype version in the classroom.

- How did the students experience and learned about graphical representations with the prototype-tool?
- How did the teachers integrate the tool, and in particular, the logbook in their lessons and used it in the classroom?

Theoretical background

Conventional curricula have not been effective in learning to construct graphs by dynamical events (Carlson, Larsen, & Lesh, 2003). Learners should be helped to focus on quantities and generalizations about relationships, connections between situations, and dynamic phenomena (Thompson, 2011; Ellis, 2007). Digital tools can be valuable to achieve these aims. Tools that include Educational Data Mining (or learning analytics) also have the possibility to generate new understandings of how students learn and how to adapt our environments to those new understandings (Berland, Baker, & Blikstein, 2014).

Method

Participants

Teachers	Students	Device
DS male, 15 TE	11th grade N=28	Computer
FS female, 5 TE	10th grade univ. N=21	Smartphone
RJ male, 7 TE	10th grade voca N=21	Computer
JV female, 15 TE	HBO bachelor N=9	Laptop, tablet, smartphone

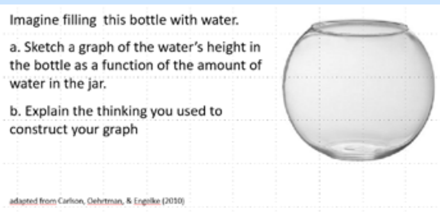
Experiment

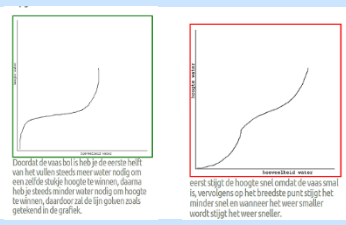
- Four invited teachers with varied teaching experience (TE) used the tool with one class.
- They set up themselves the lesson, and then discussed with the researchers.
- Teachers knew about the tool but they were not used to work with it.

Measurements

- Data collected in May 2017, Amsterdam
- Students and Teachers' questionnaires were about 17-18 questions MC and open
- Lesson observations

Prototype task





Example student work logbook (in Dutch)

Tool Features

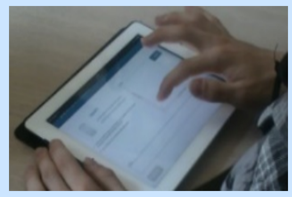
Students' visualization of dynamic events

www.virtualmath.hva.nl

Fig. from up to down: self-construction, help interactive animation, reward, logbook

Self-construction

Students must draw a graph that describes the relationship between two variables in the dynamic event and explain it in words

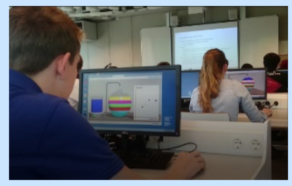


Comparison

The student gets a second assignment with a cylinder-bottle and can compare the graphs and explanations of the two situations

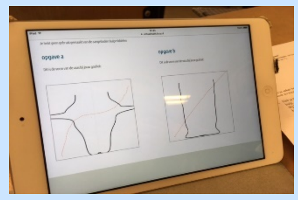
Help 3D animation

The student visualizes the increasing height of the water in the bowl



Help interactive animation

The student connects the graphical representation to the context representation. A Cartesian coordinate system in the plane and the bowl appear next to each other.



Flow

The student can go through the tool at his own pace and several times. He select help

Reward

The student gets the corresponding form of the bowl

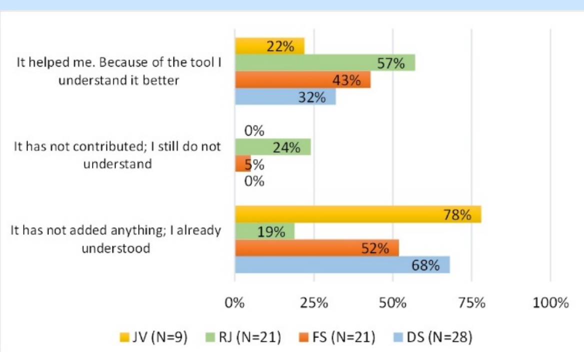
Logbook for teachers

The logbook allows teachers to get real-time assessment on the classroom and individual progress of the students.

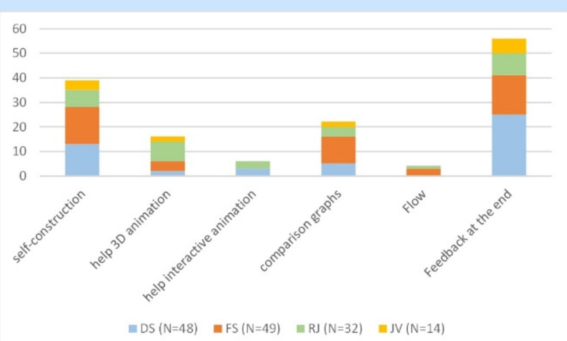
FINDINGS

Students self-reported learning

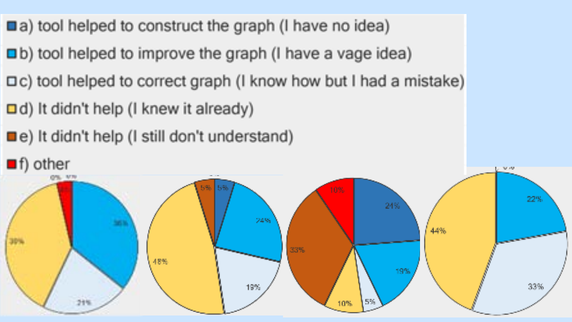
Has the tool contributed to your understanding of graphs?



Tool features that students found to help them most



How the tool helped to construct or improve the graph by the bottle assignment



Teachers'use of the logbook

Teachers' goals and instruction for a lesson with IVM

Learning goal of the lesson	Developing new knowledge (FS, RJ) Deepen knowledge (DS) Discuss technology for learning (JV)
Students' work form	work in duos (FS) work (initially) individual (DS, RJ, JV)
Introduction of the tool to students	purpose of the tool is explained, students learn on their own with hand-out (FS, RJ, JV) and without (DS)
Integration of the tool with other lessons/topics	The tool was a stand-alone assignment (DS, FS, RJ) The tool was integrated in a sequence of lessons about ICT (JV)
Discussion of the learning results with the students	selected different examples of student work with the logbook for whole-class discussion (DS, FS, JV) Selected from logbook beforehand student work from other class (RJ)

Timing and reasons to use the logbook

When did the teacher use the logbook	Only after the students have accomplished the assignment (1) At the time the students were working in the assignment and later on as well (3)
Reasons for using it <u>during</u> students'work	To select student work for the classroom discussion (3) I only consulted afterwards (1)
Reasons for using it <u>afterwards</u>	To gain insight into the learning outcomes (1) To provide students with individual feedback later on (1) To select students work for the classroom discussion (3) To the interview later on with the students (1)

Teachers'self-reported experience with the tool in the classroom

DS: For 11th grade math B might be too simple but the students worked well and there was still room and need for discussion. Students have gone through the tool several times. The tool invites for discussion with classmates. It is difficult to get a global impression of the students' work as a teacher.

RJ: The students liked to work with the tool. It was challenging and broader. Some students are not used to think independently and they didn't respond seriously to the tool

FS: Students were all busy and interested in the tool. The drawing went quite well on the screen. Many graphs, which were good, were not considered correct by the tool

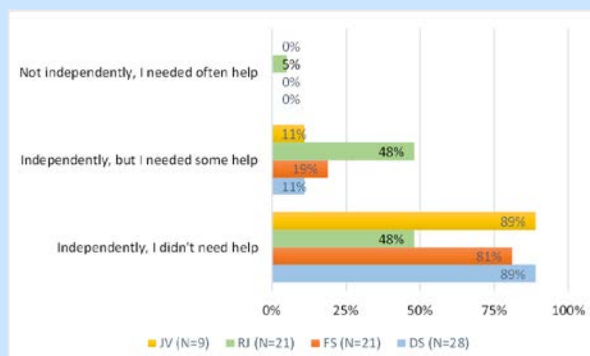
JV: It was nice to see the students with the tool and interesting to discuss it with them. They were all at work and discussing about mathematics. For the teacher 'logistics', it is difficult to find beautiful material [to use in the discussion]

More results …

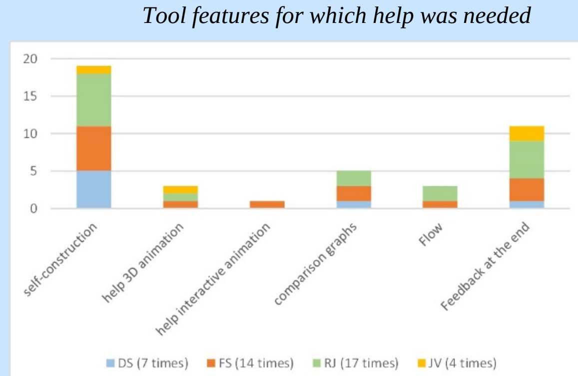
Examples

Usability in the classroom

How independent did you go through the application?



Tool features for which help was needed



Features of the tool that need to be improved

Tool environment and features

- The tool must scan graphs more accurately, so that well-drawn graphs are considered correct
- By the help-buttons it is not clear how they can be helpfull
- The water falling in 3D takes too lang; it should be possible to stop it or accelerate it
- It should be possible to go through the tool again without having to start login

Logboek

- The selection of studentwork must be easy and fast (e.g. overview of all graphs in one screen)
- Possibility for teachers to select their own students
- Possibility to see the shape of the bottle

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Development team (AUAS & UvA)

Developers (UvA): Ernst-Jan Verhoeven - Tom Kuipers - Maarten Veerman - Jaap Tuyp – Audio/Visual specialist (UvA): Renee Cornelissen – Interaction designer(UvA): Fleur van Keimpema. Srum maste (UvA)r: Pierre Bocande. Researchers and product owners (AUAS) Sonia Palha and Stephan Koopman