Exploring the Use of VR Technologies in Mathematics Class

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A school in Hedmark County is conducting a small trial (pilot project) to explore how VR technologies can be used to teach and learn mathematics. This project is being carried out in the 5th-grade math classes at the school. The purpose of the project is to see if the pupils' basic skills in mathematics improved while using VR as a part of the learning process. The pupils took a mapping test in mathematics before and after the project. A math class at a different school that did not use VR technology took the same mapping tests as control data for comparison. This short article is a presentation of the preliminary results from this project.

Background information

Time is a significant learning factor at schools. That is to say that many pupils spend a relatively limited amount of time during lessons to actually learn. This substantive learning time is often referred to as Academic Learning Time (ALT), which on average constitutes about 50% of the time allocated for teaching and learning (Hattie & Yates, 2015). For some pupils, ALT is less than 10 %. Of course, this means learning outcomes are far less than one could have expected because learning requires commitment and effort. There are many reasons why pupils use classroom time for other things than learning at school. Some of these reasons include disturbing other pupils, being noisy or individual pupils who struggle with concentration. Moreover, many pupils fail to see the relevance or meaning of instruction and learning activities. These pupils show little effort, they often find it difficult to get started and have limited staying power (Nordahl et al., 2017).

VR technologies can potentially increase academic learning time. There is less interference from fellow pupils when one is inside a virtual reality. Furthermore, VR technologies may stimulate more interest and even more staying power and perseverance during a VR learning activity. Overall, these factors indicate that VR technology may have the potential to increase academic learning time, and thereby improve learning outcomes among pupils.

The pilot projects carried out in mathematics classes in 3rd and 4th grade only used VR headsets as a supplement to other teaching methods. VR has functioned as one of several approaches to teaching mathematics. The project lasted six weeks, and it was only used as part of two teaching lessons a week.

Investigative methods

We decided to test the pupils' knowledge and skills in mathematics before the project began and after it was completed. We developed our own skills test in the four basic arithmetical operations (addition, subtraction, division and multiplication) to set the baseline for our investigations. The same test was given to 5th-grade pupils at a different school in the same municipality at the same time. These pupils served as the control group. That made it possible to assess whether the pupils who used VR to learn math developed differently than pupils who followed a standard teaching plan in mathematics.

35 pupils participated in the VR in mathematics project, while the control group had 31 pupils. All of these pupils participated in mapping tests associated with the "Culture for Learning Project" hosted by Hedmark County. This gave us the opportunity to study various background variables to see if there are any differences between the intervention group and the control group. A preliminary analysis indicates that the groups are relatively the same.

Preliminary results

We used the number of correct answers on the mapping test as the basis for analysis of the results. This involved checking the pupils' answers and entering this data in a data file (SPSS). This was done by the researchers. Variance analyses were then carried out to evaluate any changes in pupil responses on the test, comparing the first test to the second test. The developments at the intervention group/school were then compared with any developments in the control group/school. The changes to pupil development in mathematics skills are expressed as standard deviations (Cohen's d) in our analyses. That means we took averages and spread into account in our analyses, which is considered a better way of expressing differences than simply looking at changes to average results.

The diagram shown here compares developments after test 1 and test 2 for all the pupils at both schools. The red columns show the intervention group; the blue columns show the control group. We looked at multiplication separately, because the VR tool was specifically designed for learning multiplication. The mapping test however included all four arithmetical operations, so we also evaluated the overall scores for all learning in these operations.

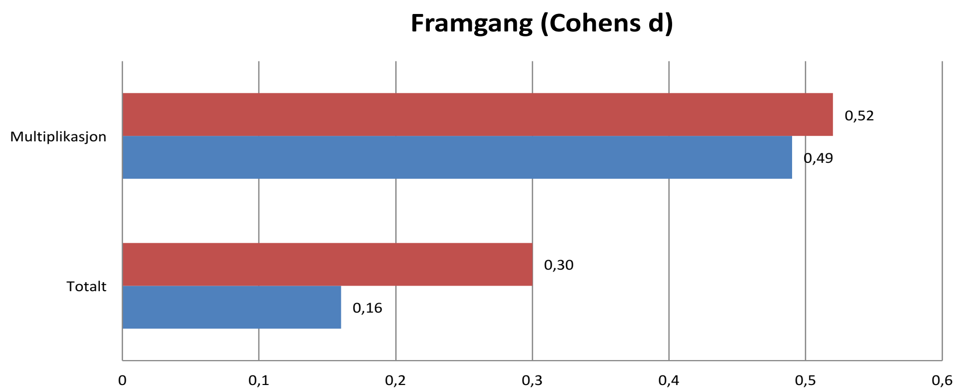

Diagram 1: Improvements from mapping tests 1 and 2 in mathematics for all pupils

The diagram shown above indicates improvements in the results from the mapping test at both schools. On the whole, the mapping test (total) indicates an improvement as a standard deviation of 0.14 (030 – 0.16) higher for the VR school than the school that had regular instruction in mathematics. When one considers the fact that the trial only lasted six weeks, the results indicate a considerable improvement and interesting progress or effect. The pupil groups were relatively equal, and the teaching is thought to be relatively equal, so there is good reason to argue that the difference in improvements in mathematics is the result of VR technology

We also analysed whether there are differences in progress in mathematics between boys and girls during the 6-week period. The results of this analysis are shown in the table below:

School	Gender	N	Total Cohen's d	Effect Cohen's d
Control group/school	Boys	13	.04	
	Girls	18	,27	
Intervention group/school (VR)	Boys	12	,53	0,49
	Girls	23	.23	-0,04

Table 1: Comparing development of boys and girls

This table indicates that boys at the intervention school progressed after the second mapping test was taken. An effect size of 0.49 in six weeks is considered a major effect/improvement. This is a noticeable and interesting change; it is important here to emphasise that the boys in the VR school improved in all four arithmetical operations after automation training in multiplication that focused on the multiplication tables. One assumption of the researchers who led the VR project was that boys would profit using this approach. This is an important fact, because boys score worse than girls in all subjects at school, including mathematics.

The girls however showed no noticeable/positive development. This may be related to the fact that many girls expressed feeling nausea when using the VR glasses. That means they used VR in mathematics class much less than the boys did.

<u>Preliminary conclusion</u>

The results of our pilot project in the use of VR technology in math class are both interesting and uplifting. Keeping in mind that the project only involved a small selection of pupils and limited scope and time, we were surprised to see documented improvements in pupil skills and knowledge in mathematics. The boys who used VR technology to learn mathematics showed more progress than the boys in the control group who were subject to standard teaching methods. This is a significant finding, because boys currently score lower than girls in terms of learning outcomes. It is important to emphasise that the boys' results from the mapping tests suggest boys improved in Surface Learning (automation) and Deep Learning in mathematics.

Although these are only preliminary results and this is just a trial/pilot project, the results still indicate that VR technology should be tested and used systematically for teaching and to a much greater extent. VR technology may be an important contribution to improving learning outcome and interest for learning among at school.[1]

References:

Hattie, J. & Yates, G. (2014). *Visible Learning and the Science of How We Learn*. Frederikshavn: Dafolo.

Nordahl, T., Egelund, N., Nordahl, S. & Sunnevåg, A.-K. (2017). *Culture for Learning T1. Hedmarken.* Hamar: Senter for praksisrettet utdanningsforksning (practice-based education research center).

[1] We are preparing a referee-based article that documents the results from our pilot project in more detail.