Interactive videos can foster comprehension: Results of a pilot study

Sina Wetzel, Matthias Ludwig

Interactive videos can foster comprehension: Results of a pilot study

Sina Wetzel[1] and Matthias Ludwig[1]

[1]Goethe-University Frankfurt, Germany; wetzel@math.uni-frankfurt.de

Keywords: Instructional mathematics videos, interactivity, conceptual knowledge.

Introduction

On YouTube and other platforms, instructional videos are available as free online learning resources which students can use for independent study. Fiorella (2021) defines instructional videos as "dynamic audiovisual presentations in which an instructor delivers oral explanations while presenting corresponding visual information" (p. 487). However, this definition does not specify who that instructor is or how the content is presented, hence, the quality of available videos varies. Especially instructional videos targeting mathematical content are often criticised for only conveying procedural knowledge and for leaving students as passive recipients of knowledge (e.g. Bersch et al., 2020).

Aim and research question

Instructional mathematics videos also have many advantages, e.g., they can be watched anywhere on demand and allow for individual learning (cf. Wetzel & Ludwig, 2021). It is thus desirable to examine how instructional videos must be designed so that students actively engage with them and receive not only procedural but also conceptual knowledge. One idea that could lead to more cognitive engagement is to enrich videos with interactive tasks. Furthermore, a comprehension-oriented approach when designing a video might lead to students learning more than procedures. These ideas lead to our research question:

RQ: How do a comprehension-oriented design of and interactive tasks in an instructional video influence the acquisition of both procedural and conceptual knowledge?

Methods

We aim to answer our research question with a study in an experimental pretest-posttest design. Systems of linear equations were chosen as a topic since determining the set of solutions can be taught focusing only on procedures but also in a comprehension-oriented way. The videos will serve as a repetition at a point of time when the students already know the topic. There will be four experimental groups which will each receive a different video to watch: group 1 (focus on procedures, no interactive tasks), group 2 (focus on procedures, with interactive tasks), group 3 (focus on comprehension, no interactive tasks) and group 4 (focus on comprehension, with interactive tasks). The videos were created as screencasts following design guidelines in e.g. Bersch et al. (2020). Based on the results of an expert rating, twelve items were chosen for both pretest and posttest with six items requiring procedural and six items requiring conceptual knowledge, respectively. We will report on first results of the pilot study which was conducted in four classes (grade 9 and 10) in January 2023.

Results

Items in the test were rated dichotomously (1 = correct / 0 = incorrect). Scores and gains from pretest to posttest were compared using t-tests. The mean score on the pretest across all groups is 4.1 (SD =

2.4), for only procedural items 2.24 (SD = 1.5) and for conceptual items 1.86 (SD = 1.5). However, the pretest scores of the single groups are statistically different from each other which can be attributed to their small sample sizes (between n = 18 and n = 24). The mean gains from pretest to posttest are summarised in Table 1. Each of the four groups gained significantly from pretest to posttest ($p < 0.01$). The highest mean gain from pretest to posttest for procedural and conceptual items combined can be reported for treatment 4 with M = 2.9, though it is not significantly higher than for the other groups. Looking at the conceptual items only, both, group 4 and group 2 have a significantly higher gain than group 1 ($p < 0.05$) which is an indicator that interactive tasks can support conceptual learning.

Table 1: Overview of number of participants and mean score increase from pretest to posttest. NI = No interactions (group 1 and 3), WI = With interactions (group 2 and 4), FP = Focus on procedures (group 1 and 2), CO = comprehension-oriented (group 3 and 4). First number indicates procedural and second number indicates conceptual item gain score.

Groups	1	2	3	4	NI	WI	FP	CO	Total
Participants	24	21	18	22	42	43	45	40	85
Mean gain	0.9 / 0.9	0.8 / 2.0	0.9 / 1.6	0.9 / 2.0	0.9 / 1.2	0.8 / 2.0	0.8 / 1.4	0.9 / 1.8	0.9 / 1.6

Conclusion and outlook

The results of the pilot study are not sufficient to answer the research question due to the small sample size. However, a first trend that interactive tasks can support conceptual learning can be reported from the significant gains in conceptual knowledge of the two interactive groups 2 and 4, at least when compared with group 1 (focus on procedures, no interactions). The study will be repeated in summer 2023 with a larger sample after a thorough analysis of the test items and, consequently, a rework of the test instrument.

Acknowledgment

The tablets used in the study were funded by *Freunde und Förderer* of Goethe University Frankfurt.

References

Bersch, S., Merkel, A., Oldenburg, R., & Weckerle, M. (2020). Erklärvideos: Chancen und Risiken - Zwischen fachlicher Korrektheit und didaktischen Zielen. [Explanation videos: Opportunities and risks – Between technical correctness and didactical goals]. *Mitteilungen der Gesellschaft für Didaktik der Mathematik, 46*(109), 58–63.

Fiorella, L. (2021). Multimedia Learning with Instructional Video. In R. Mayer & L. Fiorella (Eds.), *The Cambridge Handbook of Multimedia Learning* (pp. 487–497). Cambridge University Press.

Wetzel, S., & Ludwig, M. (2021). Categorising perceived advantages of instructional mathematics videos. In M. Inprasitha, N. Changsri & N. Boonsena (Eds.), *Proceedings of the 44th Conference of the International Group for the Psychology of Mathematics Education*, Vol. 4 (pp. 273–281).