Assessment of students' learning mathematics with technology using video-based activities in an online course

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Using technology for mathematical learning, but also for assessing students' mathematical learning has proven to enhance, support and impact mathematics education in innovative, yet challenging ways. One of the goals of the online asynchronous master's module we designed is to prepare postgraduate students (who are either prospective or practicing mathematics teachers) for assessing school students' mathematical learning when using digital technologies. Fostering postgraduate students' noticing and interpreting skills when analysing and assessing mathematical learning while a digital tool is used, has become a key priority for the design of our module's activities. This paper presents: (a) our current research study for investigating how best to support postgraduate students develop skills for assessing mathematical learning when using digital technologies; and (b) an innovative video-based activity that addresses this developmental need.

Keywords: Digital technologies, assessment, mathematical learning, video-based activity, professional development.

Introduction

Assessment plays a crucial role in the learning process, and in the digital era, we cannot underestimate the potential impact that digital technologies can have on mathematics education. Incorporating digital technologies into the assessment of mathematical learning opens up new possibilities, but also presents new challenges (e.g., Jankvist, et al., 2021; Drijvers & Sinclair, 2023). For instance, while automated assessments can offer immediate scoring, feedback, and adaptivity (e.g., Hoogland & Tout, 2018), there is a risk of overemphasising procedural fluency at the expense of capturing the depth and reasoning behind a student's response.

Over the past 15 years, there have been discussions about how 'slow' the transformation of assessment practices and policies in education with the support of digital technologies has been, despite the advancements in digital technologies (e.g., Timmis et al., 2016). For example, the rapid integration of Artificial Intelligence (AI) and tools like ChatGPT into educational assessments without proper research evidence and consideration of the implications is concerning. Therefore, it is important to gain an understanding based on rigorous research evidence, of how mathematical learning can be assessed when doing and learning mathematics with digital technologies. One of our goals as mathematics educators is to contribute to this research field whilst supporting the professional development of mathematics teachers in the digital era. In other words, we are carrying out a research study that investigates how best to support prospective and practicing mathematics teachers in assessing mathematical learning when a learner interacts with a digital tool. The context of our study is a ten-week online asynchronous master's module that introduces postgraduate students

to several dynamic and interactive digital technologies for mathematical learning via numerous innovative activities. One such activity is the use of video-based activities, which are short videos that show school students working on mathematical tasks in GeoGebra and Desmos. Our module's postgraduate students are asked to analyse the videos and assess the learning of mathematics.

In this paper, we present some details about our research study, before moving on to describe the design and rationale of the innovative video-based activity. We conclude this short paper by discussing future outcomes and contributions of our study.

Research study and context

We are interested in identifying the best pedagogic strategies for supporting our postgraduate students, most of whom are prospective or practicing mathematics teachers, in developing skills for assessing school students' learning of mathematics while they interact with digital technologies. Before we go into more detail about the research work, we need to give a brief presentation of our master's module, which we refer to as the 'Digi' module.

The Digi module is taught online, with participants being given a series of tasks over a ten-week period. The weekly tasks are signposted on a virtual learning environment (Moodle) at the beginning of each week and include offline tasks such as: familiarisation with a piece of software and example problems using specific software, designing a maths activity using the specific digital environment, and trialling out the activity with learners. In our context, learners could be either school students from the schools that some of our postgraduate students (practising teachers) work at or school students from our postgraduate students' own personal networks. Online tasks include engaging with the ideas in the key readings of this module, reading one of the essential reading articles and writing a response about the points agreed or disagreed with from the article, and also contributing to online discussion forums with written observations on views and perspectives of their module peers. For example, in the third, sixth and ninth weeks, our postgraduate students are required to choose a software tool introduced in the prior two weeks, design a learning activity using features of good practice identified from the literature, use the activity they designed with students and analyse its implementation through engagement with research and the ideas assimilated from the literature reviewed to evaluate and justify the implications of using digital technology for students' learning. Being an asynchronous online course, our postgraduate students' contributions are solely in written format and consist of their weekly written task submissions, forum contributions such as written comments to peers' tasks, reflections on their own learning and peer assessed work, peer reviews and peer assessment.

The research study involves three student cohorts enrolled on our Digi module in 2024-2026 and it focuses on how students develop critically reflective and interpretative skills for assessing mathematical learning that takes place when a learner interacts with a digital tool. We will focus on different activities from the Digi module to answer the following main research question: *How are postgraduate students' skills for assessing mathematical learning that takes place when a learner interacts with a digital tool developed and supported by different activities?*, and our secondary research question: *In what ways do video-based activities develop postgraduate students' skills for assessing mathematical learning during interactions with a digital tool?*

Online video-based activity

To assist our postgraduate students in critically engaging with research and applying it to reflect on classroom practices involving digital technology, we are experimenting with the use of online video-based activities in one of the weekly activities. We have created videos that showcase pairs of school students actively engaging in mathematical tasks within a digital setting. We wanted to provide our postgraduate students with a simulation of a classroom-based scenario where two pupils worked together on a maths task involving digital technology. For this reason, the videos were not edited, and our students were invited to select their own segments of the recordings to analyse. Inspired by Van Es and Sherin's (2002) research, we explored the utilisation of video-based activities to offer our postgraduate students a shared learning episode for analysis. Video cases have been employed by numerous mathematics educators and researchers to guide teachers in focusing on students' learning and the decisions made by teachers during lessons. Van Es and Sherin (2002) suggested that videos could be effective tools in enhancing teachers' ability to observe, notice and interpret classroom interactions.

Among the various features of videos extensively documented in literature (Calandra et al., 2009; Van Es & Sherin, 2002), we highlight the capability of a video to be paused, rewound, and replayed multiple times, allowing viewers to focus on specific segments strategically chosen for their relevance to the viewers' goals, which in the case of the activity we present in this paper, is assessing school students' learning of mathematics during their interactions with Desmos and/or GeoGebra. The design of the video-based activity was guided by recommendations from researchers (Van Es & Sherin, 2002) emphasising that video clips could help shift attention away from teachers and classroom events, redirecting it toward students' work. In our research study, the videos produced are recordings of the collaborative efforts of a pair of school age students, narrowing the focus to the pedagogical activity of noticing significant episodes and analysing students' learning. The videos for this online module feature two Year 8 students, Tim and Tom (pseudonyms), both 12 years old, attending different secondary schools in a large city in the UK. Given the importance of understanding how students interacted with the provided digital environment, we utilized screencast video-recording software to capture on-screen work and audio recordings of student-student interactions during the mathematics activity. The maths activities presented to Tim and Tom were related to plotting points in a graphical environment that satisfy the equations of given straight lines; finding the equations of straight lines graphs already plotted; investigating and proving properties of quadrilaterals constructed in specific ways. Our postgraduate students were encouraged to watch these short videos and analyse how Tim and Tom used the digital tools to investigate the mathematics task. They were then invited to submit a piece of writing (800 words) where they assess and justify Tim and Tom's mathematics learning in a digital environment as portrayed by the videos.

It is worth adding that the ethical aspect of producing and utilising the videos underwent careful consideration (Flewitt, 2005). To ensure ethical standards, explicit consent from participants and parents was obtained, wherein the researcher transparently communicated the intended use of the video material and its purposes.

Concluding remarks

The first set of data collection from the first student cohort ends in March 2024 and we intend to present the findings of one of our enquiries: *In what ways do video-based activities develop postgraduate students' skills for assessing mathematical learning during interactions with a digital tool?* at the FAME1 conference. The data analysis will focus on postgraduate students' interpretations of the learners' interactions with GeoGebra and Desmos and assessment of potential learning outcomes, as observed in the video episodes, and reported in their written contributions. Evidence of development of critical reflection skills will also be sought in the postgraduate students' assignments where they are required to design, trial, evaluate and critically analyse a series of mathematical activities in their own practice, utilising the potential of digital technologies.

Future steps

In collaboration with our university partnership schools, the module tutors intend to produce a series of videos, with real classroom settings, featuring school students engaging in mathematics activities within a digital learning environment. These video recordings will then be edited to highlight key segments, transforming them into video-based activities for professional development. We are hoping to be able to offer guidance for the creation of such innovative video-based professional development activities with a focus on promoting and supporting effective assessment strategies when using digital technologies in mathematics learning.

References

Drijvers, P., & Sinclair, N. (2023). The role of digital technologies in mathematics education: purposes and perspectives. *ZDM - Mathematics Education.* https://doi.org/10.1007/s11858-023-01535-x

Flewitt, R. (2005). Conducting research with young children: some ethical considerations. *Early Child Development and Care, 175*(6), 553-565. https://doi.org/10.1080/03004430500131338

Hoogland, K., & Tout, D. (2018). Computer-based assessment of mathematics into the twenty-first century: Pressures and tensions. *ZDM - Mathematics Education, 50*, 675–686. https://doi.org/10.1007/s11858-018-0944-2

Jankvist, U. T., Dreyøe, J., Geraniou, E., Weigand, H.-G., & Misfeldt, M. (2021). CAS from an assessment point of view: Challenges and potentials. In A. Clark-Wilson, A. Donevska-Todorova, E. Faggiano, J. Trgalova, & H-G. Weigand (Eds.), *Mathematics Education in the digital age: Learning, Practice and Theory*, (pp.99–120). Routledge.

Timmis, S., Broadfoot, P., Sutherland, R., & Oldfield, A. (2016). Rethinking assessment in a digital age: opportunities, challenges and risks. *British Educational Research Journal, 42*(3), 454–476. https://doi.org/10.1002/berj.3215

Van Es, E., & Sherin, M. (2002). Learning to notice: Scaffolding new teachers' interpretations of classroom interactions. *Journal of Technology and Teacher Education, 10*(4), 571–596.