USING SILENT VIDEO TASKS FOR FORMATIVE ASSESSMENT

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Silent video tasks are currently being developed in collaboration with four mathematics teachers in different upper-secondary schools in Iceland. In silent video tasks, teachers invite students to watch a short silent mathematics film and ask them to work in pairs to prepare and record their voice-over to the video. Next, teachers listen to students' solutions and plan a follow-up lesson in which they initiate a whole-group discussion. The data collection focused on the teachers' expectations and experiences with the silent video task. Thus, the teachers were interviewed before and after assigning the task, and after the follow-up lesson to better understand their experiences. This paper focuses on one of the four participating teachers and discusses the potentials of silent video tasks as means of formative assessment.

Keywords: Silent video tasks, use of new technologies, formative assessment, thinking classroom.

INTRODUCTION

The idea of students recording a commentary to silent mathematics videos was initiated and first tested in a Nordic and Baltic collaboration project for mathematics teachers and teacher educators (Hreinsdóttir & Kristinsdóttir, 2016). The silent videos were short animated films without text or sound, created with the digital geometry software GeoGebra and screen recording technology. The current research project is aimed at i) further developing the silent video tasks' instructional sequence, ii) defining what characteristics a silent video must have for it to be feasible to use in a silent video task, and iii) gaining insight into teachers' expectations and experiences with using the silent video task in their classrooms.

Four mathematics teachers in different upper-secondary schools in Iceland took part in the research project, all of which used the silent video task as a summary of a previously taught topic. A silent video task requires teachers to either make or select a short silent mathematics film to present to their students. In turn, the teacher hands out the link to the video for further viewing and splits the students into pairs to discuss, prepare and record their voice-over to the video. After preparing a follow-up lesson by listening to the students' solutions, the teacher leads a whole group discussion on basis of some example student solutions and addresses topics such as precision in word use.

During the data collection the task was developed further in collaboration with teachers with the goal to support teaching and learning, i.e. following the direction of design-based research where the focus is set on concrete tools and the tool should be sharable and usable for different teachers (Lesh & Sriraman, 2010). The data analysis informed the further development of the silent video task instructional sequence and contributed to a clearer definition of the characteristics that silent videos require in order to be suitable as silent video tasks.

ENCOURAGING DISCUSSION

Silent video tasks are designed to encourage students to communicate verbally about mathematics, to inform teachers about their students' conceptual understanding, and to make a ground for group discussion, e.g. about precision in language use. Not only do silent video tasks encourage classroom discussions about mathematics, they also seem to open teachers' eyes to students' ability to use new technologies (Kristinsdóttir et al., 2018). Different discourses get exposed in the silent video task solutions. Some of the student-produced discourse may not be mathematically correct or fulfil what is expected according to the mathematics curriculum. By listening to different solutions and discussing them with the whole group, the silent video task has a potential to become a mediator between the different types of discourses, i.e. it might shorten the knowledge or meaning gap described by Leung (2017). Keeping the follow-up group discussion in the task instructional sequence enables teachers in collaboration with students the opportunity to narrow or bridge the gap between students' intuition based mathematical world and the formal mathematical world. This gap exists because students rather use their own presumed mathematical ideas and discourses in learning activities that promote discussion and not the more formal mathematical concepts (Leung, 2017).

In order not to restrict this open task in any way, no list of concepts for students to address gets handed out. If students find it hard to start recording, a suggestion for them to draft a script can be made. The aim is to assess students' different levels of understanding of the previously studied concepts and to uncover possible imprecise language use, misconceptions, and/or misunderstandings; laying the groundwork for a whole group conversation on selected topics. This requires the teacher to listen to the student recordings and prepare a group discussion for the follow-up lesson. In the follow-up lesson some (randomly or strategically) selected solutions are presented and discussed, and topics such as problems arising from imprecise language use and possible misconceptions or misunderstandings can be addressed and clarified. After the whole group discussion, students can be asked to write about their experiences.

MOTIVATION AND THE ICELANDIC CONTEXT

The mathematics curriculum for upper secondary schools in Iceland describes goals regarding the knowledge, skills, and competences in mathematics that students are expected to reach partly or fully at each of four competence levels. At all levels, schools are expected to provide students with a foundation for understanding in mathematics, i.e. the aim is to not only get proficient in calculation methods (procedural fluency) but also to reach some level of conceptual understanding. The competence goals also include some adaptive reasoning as students are expected to understand and interpret the explanations and arguments of others without prejudice, showing respect and tolerance (Ministry of Education, Science, and Culture, 2011).

Nevertheless, interviews with teachers and observations in classrooms in nine Icelandic upper secondary schools revealed that the mathematics teaching practice was mostly limited to expository methods and recitation, drill, and practice (Jónsdóttir et al., 2014) and this was confirmed in a more recent study by Sigurgeirsson et al. (2018) where mathematics lessons stood out among other subjects taught in upper secondary schools for lack of diversity in the teaching methods used. Given these conditions, junior teachers might like to implement changes in the teaching practice. In Iceland, however, a study by Eiríksdóttir and Jóhannesson (2016) revealed that if school policy did not support changes in the teaching practice, the senior faculty in the group of mathematics teachers determined whether changes would be implemented or not, sometimes limiting possibilities for change and causing frustration for junior teachers. This aligns with findings from other international studies (Thurlings, Evers, & Vermeulen, 2015).

As one of the participating teachers in the teaching experiment conducted with silent videos in the previously mentioned Nordic-Baltic teacher-researcher collaboration project, I (the first author) became interested in developing further the tasks and their implementation in mathematics classrooms at upper secondary school level. After the international conference ICME-13 in Hamburg, I realised that what I had experienced in my classroom whilst working on and discussing the silent video task with the students was a *thinking classroom*, i.e. a classroom organized in a way that students are expected to think and given opportunities to think via activities and continuous discussions (Liljedahl, 2016). I was interested whether the silent video tasks would awaken teachers' interest in practices that support a thinking classroom. Of course, I was aware that many teachers probably had not heard of the characteristics of a thinking classroom. Yet, by listening to what teachers had to say about their experiences, connections might be recognized. Also, my intention was set to consider how different parts of the process of assigning the task could be made clearer, and it especially seemed quite important to find a good way to organize the follow-up discussion.

SILENT VIDEO TASKS AS FORMATIVE ASSESSMENT

We agree with Suurtamm et al.'s (2016) claim that the primary purpose of assessment is to improve student learning of mathematics. Silent video tasks give students an opportunity to explain to others and/or to receive explanations from their classmates do so. They also have the potential that students become aware of the fact that once they are able to explain to others what they have learnt, they also improve their understanding. One of the students who completed the silent video task commented the following in an online survey: "You don't know the material well enough if you cannot explain it to others in a good [understandable] way."

Silent video tasks that serve as a summary of previously worked-on topics can be used as formative assessment, supporting students' learning of mathematics. This is partly because after the follow-up lesson, teacher decisions about the next steps in instruction are likely to be better founded and the process of assigning a silent video task then would fulfil Wiliam's definition (2011, p. 43) of formative assessment:

> An assessment functions formatively to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have made in the absence of that evidence.

Wright, Clark, & Tiplady (2018) list six potentials that technology-based formative assessment strategies have to support learning: providing immediate feedback, encouraging discussion, providing a meaningful way to represent problems and misunderstandings, giving opportunities to use preferred strategies in new ways, help raising issues that were previously not transparent for teachers, and providing different outcomes feedback (Wright et al., 2018, p. 219) and the silent video supports all but the first one since the feedback is not immediate but finds place in the follow-up lesson.

The knowledge involved in assessing students' solutions to a silent video task and preparing the follow-up lesson is manifold. To name a few things, teachers need to be aware of listening with an open mind, to notice and address any lack of precision in word use, to identify misunderstandings, to point out where the students might be able to dig deeper, and where to change the timing of information given or even offer more information.

Instead of unpacking mathematics for students, like would be done if the teacher would prepare a mathematics video with sound, in a silent video task the students are asked to add their commentary to the video. This connects to what Mason (2002) describes as disturbance that can trigger development in the case that it is seen as an opportunity for learning. It becomes the students' role to take apart mathematical concepts and present them in such a way that it might enable other students to gain access to the mathematics shown in the video. An inner monologue is started, and an attempt is made to make this inner monologue visible by bringing it out and into the conversation. The teachers get the role to recognize solutions or parts of solutions that should be addressed in the follow-up lesson. The unpacking of mathematics thus becomes a shared responsibility.

Mason (2002) notes on support that if one starts to do things for other people, it is easy to fall into the trap of doing always more and at the same time it is more likely that people will expect you to do things for them. This is especially true of new things that people expect will take great effort and time and foresee themselves doing it rather slowly and inefficiently; then it is of course much more convenient to get someone else to think and do the exercise! To the student all this relates to the concept of learner autonomy, i.e. the ability to take charge of one's own learning, and to the teacher this relates to the delicate task of keeping students in flow, challenging them such that they do not get bored and yet not so much that they give up (Csikszentmihalyi, 2014).

RESEARCH DESIGN

In my research project the focus is set on teacher expectations to and experiences with using silent video tasks in class. Another goal set was to develop further the process of assigning silent video tasks and to define what characteristics a silent video should have. I worked with four mathematics teachers in different upper secondary schools in Iceland who assigned a silent video task to their 17-year-old students in fall 2017.

I prepared a two-minutes-long silent video with focus on the unit circle (see https://ggbm.at/BfRqGSKq) for the teachers to show to their students. Next, I prepared semi-structured teacher interviews (Brinkmann & Kvale, 2009) to conduct before and after the assignment of the silent video task, and after the follow-up lesson. The video was pilot tested with some students and the interview questions were also pilot tested with an upper secondary school mathematics teacher. The teacher interviews were to be my main data source, however I also prepared two short questionnaires for students regarding their experiences of a) recording a voice-over to the silent video, and b) taking part in the whole-class discussion. Each questionnaire included an open comment field and five short questions to be answered on a Likert-scale.

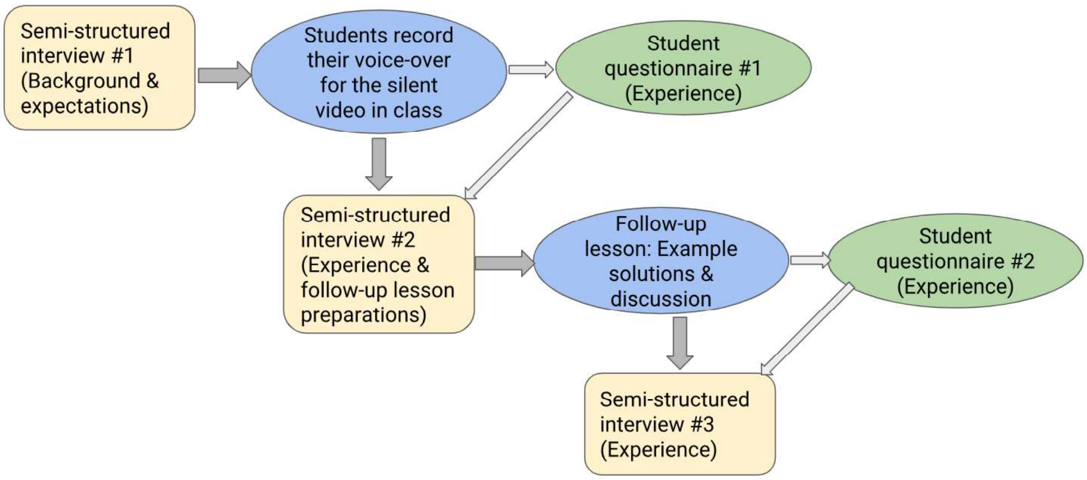

Figure 1. This flow chart shows the research design workflow. Each teacher was interviewed before and after implementing the silent video task in class, and after the follow-up lesson. Despite not being the focus of the study, the short online questionnaires for students are also shown.

The reason for including a students' questionnaire was that it seemed important to me to be able to refer to students' voices in the teacher interviews, e.g. in the event of a teacher receiving solutions that were very different from expected. In this case, referring to the students' answers on whether they had understood the task might be helpful. Another reason was to partly triangulate the data so that both student and teacher perspectives could be considered.

There are thirty upper secondary schools in Iceland that prepare students for studies at university. In fall 2017, I contacted and found teachers in six such schools who were willing to try out the silent video task with their 17-years-old students. The order in which I contacted the schools was randomly generated but since teachers could reject participation, the sample was self-selective. One of the six teachers dropped out because less than five students signed up for her trigonometry course. Another teacher participated only in the first interview and quit participation after that; giving lack of both time and students' interest as the reason.

Four teachers took part in all three interviews and were given the following pseudonyms (*gender, teaching experience in years*) Gauti (*m, 9*), Lilja (*f, 13*), Magni (*m, 4*), and Snorri (*m, 37*). Their students answered the questionnaires with answer rate 86% (before the follow-up) and 70% (after the follow-up), and their solutions to the task were collected. The questionnaire answers were partly used as input in the second and third teacher interviews. Both the student solutions and the teacher interviews were transcribed verbatim and words with special emphasis were underlined. The teachers did not assign the silent video task simultaneously. Practical information that was gathered from the teacher experiences (e.g. the previously mentioned "it is easier to let the students record their voice-over with their mobile phones") was communicated by the researcher to the other teachers on the go in order for each teacher to have the best information available at each point in time on how to assign the task and how to prepare the follow-up lesson. The order in which the teachers assigned the silent video task is reflected in the alphabetical order of their pseudonyms.

DATA ANALYSIS

As the focus was set on the task development, the teacher and the teachers' expectations to and experiences with using the task, I decided to analyse the data by using open coding. Some results of this work regarding the use of technology in the mathematics classroom were discussed in a conference paper (Kristinsdóttir, 2018) and in this paper we will focus on Lilja, who was the only teacher who got the discussion properly started in her classroom. This is not surprising, considering that orchestrating a discussion in a follow-up lesson using some student solutions to view and discuss is a difficult task (Stein & Smith, 2011), and the fact that the procedural tasks normally used in the Icelandic mathematics classrooms did not evoke any need for discussion.

FINDINGS AND DISCUSSION

To prepare the follow-up lessons, together with the researcher, teachers (each at different point in time) listened to the students' solutions. They were invited to think aloud, and the goal was not to assign grades to the student solutions, but rather to find possible topics to address in a whole-group discussion and to prepare feedback for the students.

Lilja described in the interview how students at her school all had little, but still some experience of taking part in mathematical group discussions. The other three teachers described little or no experience with group discussions and as Cobb (2000) points out, students are influenced by the classroom microculture that they participate in. It influences what it means to them to know and do mathematics and it is of course hard to suddenly change students working culture and thus violate the didactical contract (Brousseau, 1997) between teacher and students that is present in the classroom. Since Lilja's students were not used to working independently on tasks of a kind that they had never seen before, it created tension. Her students were especially upset about the random assignment into groups, the very short oral instructions for the task and the transfer of the responsibility to solve possible technological issues to the students themselves, i.e. the enhancement of student autonomy

Lilja: Then they just “But wait a minute, aren’t you going to help us?” “No, you will figure this out”

After a short discussion, her students understood that the random assignment into pairs was fair. Lilja would, in retrospect, not have liked to rob students of the joy of getting past some technical obstacles themselves. It caused tension but it was a productive struggle. In Lilja’s opinion it also would be an important step in the teachers’ preparation to try to record a solution to the task before assigning it.

Lilja: Mmm.. I think that the teacher would profit from recording herself beforehand and check [...] then she puts herself in the kids’ place [...] I tried it myself and I found it too short [...] it is good to understand this stress factor before assigning it.

This was also reflected in interviews with other teachers. All four teachers noticed and identified things that they had expected but were missing in some of the students’ solutions.

Lilja: ...only thing that surprised me yes there were some who did not <u>mention</u> cosine and sine at all.

The fact that some students only focused on the coordinate system, the moving point, and/or the line segments, but never used the word sine or cosine in their voice-over was something that surprised all four teachers. Furthermore, when students mentioned the trigonometric functions, some further explanations or type of phrasing were noted missing. Lilja, Gauti and Snorri all noted that their students would have no problems solving simple procedural trigonometry tasks. However, being able to solve the equation $\sin(x) = 0.6$ not necessarily implies understanding of the topic. In this way the task helped raise an issue that was previously not transparent to teachers: Students often had not given much thought to the definition of the sine and cosine functions.

A similar pattern was recognized regarding not all student pairs making a clear distinction between a circle and a unit circle in their solutions. When students referred to these two concepts precisely, teachers found and mentioned some other deficit. However, Lilja managed in her follow-up lesson to get the discussion going around this exact topic. She started by showing examples from two volunteering groups. Both solutions had some errors in them, and she discussed with her students that every solution had something that could be done better, tiny errors or imprecise word use. Her students got into a heated debate regarding at which point in time it is acceptable to say that the circle is a unit circle

Lilja: ...and they found it unbelievable that I interfered… that I did not approve of when they said “This is a unit circle” at the start before it was visible that it was a unit circle because they have already watched it all and then of course they see that it becomes a unit circle… and they found it strange that I should mention this and got quite heated about it […] “Why do you say that we cannot say it at the start?”

This was a starting point for a discussion about mathematical definitions. Also, her students discussed hard whether to focus on the length of the line segment or to rather refer to the projected point on the corresponding axis. That discussion gave an opportunity to point out the value of different approaches, and address some difficulties, bearing in mind that a length is always positive.

Lilja was tempted to give her own version of a solution in the follow-up lesson. Especially in order to illustrate that every second could be used to explain something. Teachers noted that in many cases, students’ solutions contained surprisingly many seconds of silence and that there was some lack of dialogue practice. This lack of exercise with talking about mathematics was most often blamed when deficits came up and at some point, during the interview, all teachers expressed that they were convinced that their students knew better than they showed in their solutions.

Lilja: There was something that got messed up… When they were talking, I think they were thinking it correctly just they are not used to talking

Apart from that, the fact that it was an open task with no direct questions was mentioned as a possible factor causing students to forget to mention what the teachers considered important aspects and the teachers all had their suggestions for changing the task, making it less open.

CONCLUSION

Out of the eleven practices supporting a thinking classroom described by Liljedahl (2016) Lilja used the following six: begin with an open problem, assign students visibly randomly into groups, give short oral instructions, answer only keep-thinking questions, build student autonomy, and formative assessment. The other teachers used two to three of those. Her experience with using the silent video task was positive and she, like the other three teachers, noted that it helped to break up the normal teaching routine. Lilja said it was possible but not sure that she would use such a task again. The reason being that it was "not the most important input into [her] teaching". This could relate to what the other three teachers noted on the task not preparing their students for the exam. In this regard, it is important to note, that in Iceland there is no standardized examination for upper-secondary school and each school decided how and what to test.

Silent video tasks seem to have a potential to be used as part of formative assessment practices, shedding light on differences in conceptual understanding and making classroom discussion around that issue possible. This will be developed and tested further in the next cycle of the research project.

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