INCLUDING EDUCATIONAL RESEARCH PRACTICES IN TEACHER EDUCATION: DIGITAL APPLICATION FOR LESSON OBSERVATIONS

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ABSTRACT

Finnish teacher education is praised for its research-based approach. However, educational research practices are not very common in teacher education. We introduce simple, affordable HTML5-based application (app) software to implement an authentic video research activity in teaching practice. With the observation tool, it is easy to code the activities in the classroom. The observation tool app generates a timeline of the lesson outline from the predefined observation protocol. We introduce the observation tool through two cases: first, how the tool is used in educational research and, second, how these authentic education research practices were implemented in science teacher education. We conclude that the generated timeline of a lesson can be used to facilitate reflective discussions in teaching practice. The app is licenced under Creative Commons 4 and is available through GitHub (https://github.com/MTurkkila/LOBS).

INTRODUCTION

Finnish teacher education and its development is research based. Teacher education prepares students to conduct research as well and enables them to pursue postgraduate studies. As such, teacher education should include authentic educational research practices. However, research practices may not be present in teacher education, especially in student-teachers' practical training.

In this paper, we demonstrate how we are introducing into science teacher education the method used in authentic educational research as a part of practical training. The method is centred around an application (app) software we developed for research purposes. The simple HTML-based app is used for real-time observation and coding of events in classrooms or similar settings. The app generates a timeline of the events that are used for selecting video segments for further analysis in video-based research. In student-teachers' practical training, the timelines function as a basis for reflection when student-teachers' lessons are observed by their peers.

Reflection in student-teachers' practical training

Reflection is considered important for teachers' continuing professional development (Marcos & Tillema, 2006). To be effective, there needs to be a clear understanding of what reflection is and what it is not. There have been many different definitions and uses for the term reflection (Bengtsson, 1995), and sometimes it is used vaguely. However, reflection should differ from regular thinking. For example, Rodgers (2002) emphasizes:

> that the process of reflection is rigorous and systematic and distinct from other, less structured kinds of thinking. It has its origins in the scientific method and, as such, includes precise steps: observation and detailed description of an experience, an analysis of the experience that includes the generation of explanations and development of theories, and experimentation – a test of theory. (p. 863)

This implies that for the reflective discussions to produce authentic reflection, there needs to be some type of artefact to use as a foundation for reflection. For example, the outline of the lesson could function this way and allow student-teachers to see the outline of their actions. This would allow them to think about their experience and to analyse it in a structured manner. One other important aspect of self-reflection is distancing oneself from the practice (Bengtsson, 1995). Using the lesson outlines as focal artefacts could help student-teachers to distance themselves from their actions and therefore aid with the reflection.

One key aspect student-teachers should focus on during the practical training is their talk and interaction with pupils. Teachers often aim in their talk to lead the students to the scientific ideas that are presented as if they are obvious. However, building on ideas proposed by students and exploring ideas together can contribute to learning, as learning science is considered a dialogic process of meaning making (Mortimer & Scott, 2003). Thus, in teacher training, it is important to encourage student-teachers to employ different kinds of teacher-pupil interactions to enhance students' thinking. This can be done with good reflection practices.

As teacher training in Finland is research-based, it is desirable to strengthen the scientific practices of educational research in student-teachers' practical training. Video-based research is one widely used practice in education, and video-based practices could be used in teacher learning (van der Linden et al., 2019). For example, to facilitate reflection, Toom, et al. (2015) have used video records of student-teachers' lessons. The process also included simulated recall interviews and reflection portfolios. While the process seemed beneficial, it was also time consuming. Therefore, it might be difficult to incorporate the process widely into the existing practical training. Research practices included in practical training should be more straightforward and more easily accessible in order to be applicable.

Video-based research in education

Video-based research is widely used in educational research. Video records of lessons allow researchers to re-observe and analyse points of interest multiple

times. Video records also allow flexibility and collaboration in research. However, because video-based research can yield an immense amount of data, selecting, processing and analysing the data can take a long time. In fact, Derry et al. (2010) identified selection and analysis as two key challenges in video research of education (with the other two being technology and ethics). Selection refers to the demanding task of choosing what to record and what to select for further analysis. Furthermore, researchers need to consider what analytical framework to use and whether they are scientifically valid and appropriate even before recording a video.

To address the above-mentioned challenges, researchers have developed different kinds of methods for selecting and analysing video segments (Derry et al., 2010). Some methods blend the selection and analysis together. For example, Ash (2007) suggested an approach with three levels of analysis in discontinuous science meaning making. The first level comprises a rough overview of identifiable segments within the video, which can then be chosen for more detailed analysis at the second level. In this second level, the segment is broken down into smaller segments, which Ash calls significant events. The final level of analysis entails detailed dialogic analysis of the significant events.

Even though Ash used this method in informal settings, it has been adapted for formal education research (Mehto et al., 2020). The three-level approach is appropriate, as the lesson's structure is usually discontinuous, comprising different activities. The different activities divide the lesson into independent segments in which teaching and learning take place (Burns & Anderson, 1987). In this regard, the first level would be the general outline of a lesson, wherein each different activity would be one segment.

Analysing the video, even the first level, usually begins after capturing the video with numerous software applications available (Goldman et al., 2014). However, if the first level comprises observed activities in a lesson, it could be analysed live while video recording. This live observation would produce an overview or outline of the lesson segments. Timed together with video records, this would facilitate identification of video segments for future analysis. This could result in great time savings.

Observation of lessons can be completed with a pre-designed form with instructions as to what to observe or with simple field notes on pen and paper (or computer with text processing). However, writing down the observations can distract the observer from activities happening in the classroom, especially if the observer needs to look up what time the activities are occurring to merge them with the video records.

It is possible to improve classroom observation with digital tools, such as desktop or mobile apps. Currently, such apps exist both commercially and from research groups. For example, Observer XT by Noldus is a commercial software for behavioural research. Observer XT can synchronize multiple data streams and calculate statistics in addition to timeline visualizations (Noldus, n.d.). Another example is the SMART SPEECH research project at the University of Jyväskylä (Kronholm et al., 2017). SMART SPEECH uses a mobile phone app for classroom

observations and speech recording. The project also aims to automatically ana-lyse speech and text. Both apps include much more functionality than is needed for straightforward observations, and neither is affordable and available.

Aim of the paper

This conceptual paper intends to show that by using the app, authentic educa-tional science practice — video research — is possible in teaching practice and can facilitate student-teachers' reflections. The app guides peer observation of stu-dent-teachers' lessons, allows student-teachers to see the outline or the segments of their own lessons, and functions as a basis for reflective discussions.

This paper begins by describing the app. The app was first developed to address the challenges of data selection, time management, and field notes in video-based research. After describing the app, we will show how it has been used in educa-tional video-based research (Case 1) to emphasize the use of the app as an au-thentic research practice. In the latter part of this paper, we will demonstrate how the app was used for reflection in student-teachers' practical training (Case 2) and discuss further research plans utilizing the app.

THE APP

The design principles for the app comprised ease of use, adaptability, and fast development. The key idea was to create a tool to assist classroom observations with minimal cognitive load so that focus could be concentrated on the observa-tions. Another goal was to be able to synchronize observational data and video data.

The lesson observation (LOBS) app was built with HTML5, and as such, it is ac-cessed using an internet browser. It can be used online or offline. The tool is based on a stopwatch that is programmed with JavaScript (JS) and uses the Date.now() method to retrieve the Unix time. The method is called when a user starts the stopwatch and is called continually every second to keep the elapsed time accu-rate. At each step, the elapsed time is shown in minutes and seconds. The loop continues to update the elapsed time until the stopwatch is stopped.

The user interface was created with HTML button elements, as shown in Figure 1, with default settings. At the top is the stopwatch with the start/stop and clear buttons. Next are the numbered buttons along with the +, -, and rename buttons to change the number and labels of the buttons. The number of buttons and their labels are stored locally in the user's web browser and do not revert to the default even if the web page is refreshed. The local storage can be cleared in the drop-down instructions panel, activated by the i-button in the top right corner.

Figure 1. The user interface of the LOBS app. Here, the stopwatch is running, and buttons 0 and 3 are toggled on.

The numbered or labelled buttons can be toggled on and off independently of each other. Every time one button is toggled on or off, the elapsed time in seconds is saved in dedicated JS arrays. There are two arrays corresponding to each button: one with the on times and the other with off times, or the start and stop times, respectively.

At the bottom are buttons for generating a timeline from the saved timestamps and downloading a .csv file of the timestamps. The timeline is depicted using a HMTL5-canvas element. The generated timeline can then be saved as an image for future use with a right mouse click. The .csv file is generated if the download button is pressed. The first line contains the button number with the leading start or stop text.

The app is used for observations by starting the timer and toggling the buttons on and off according to the events occurring in the classroom. All observations, with or without a video recording, should be theory driven; thus, before using the app, some sort of observation protocol should be formulated. This can then be used to label the buttons. For example, if one is to study instructional practices, there could be a few different buttons for different kinds of practices. The timer is started at the beginning of the lesson, and when one of these practices begins, the corresponding button is clicked. When the practice ends, the button is clicked again to toggle it off. The timeline can then show what practices were used and when and for how long they were used.

Case 1: Streamlining data collection in video research

Case 1 is a study that investigated information flow between human actors and material affordances with network analysis during student experiments in an upper secondary school physics classroom. Video recordings were used in the data collection, and the app was employed to streamline the process of selecting the video segments for investigation. The study is part of an ongoing research project in which project-based learning (PBL) units are co-designed with in-service teachers. PBL is a form of situated learning that emphasizes active knowledge construction, social interactions, and the use of cognitive tools (Krajcik & Shin, 2015), thereby giving rise to the student actions that are under investigation.

Videos for the research were recorded in five separate physics courses (the first course in upper secondary school physics) with three different teachers in two different urban schools in the Capital Region. From each course, one or two volunteer student groups were selected for observations. There were six focus groups overall, and the actions of these groups were video recorded with two cameras placed close to the students. One researcher was present in the classroom to manage the cameras, and they also observed students using the LOBS app during the lesson.

Before observing and video recording the lessons, a straightforward observation protocol was created. It included aspects specific to PBL and other general classroom activities. A large observation protocol was chosen so that the timelines could also be used for other purposes within the research project. The observation protocol and the button labels are shown in Table 1.

Table 1. Button labels and English translations from the observation protocol used in Case 1.

Button	Finnish label	English translation
1	*Kysymysten teko*	Asking questions
2	*Mallin/artefaktin teko*	Building models/artefact
3	*Tutkimuksen suunnittelu*	Planning experiments
4	*Tutkimuksen tekeminen*	Conducting experiments
5	*Opettajan tuki*	Teacher support
6	*Kognitiiviset työkalut*	Cognitive tools
7	*Ankkurointi*	Anchoring events
8	*Tiedon jakaminen*	Sharing information
9	*Tehtävät*	Learning material exercises
10	*Muu ryhmätyöskentely*	Other group work
11	*Dialogi*	Teacher-classroom dialog
12	*esm-kysely*	esm-questionaire

The timer and the video recording were started simultaneously. Thus, the timeline and timestamps were synchronized with the video, which allowed the videos to be cut into segments with only the parts that were of interest in the study. After the lessons, the timelines were generated, and the timestamp data were saved. Figure 2 shows a timeline from the second lessons of the PBL unit.

In the timeline, we can clearly distinguish one segment of the experiment with a cognitive tool (green and red overlapping bars). This is the only segment to warrant closer examination as the point of interest of the study. The remainder of the video data from that lesson can be ignored.
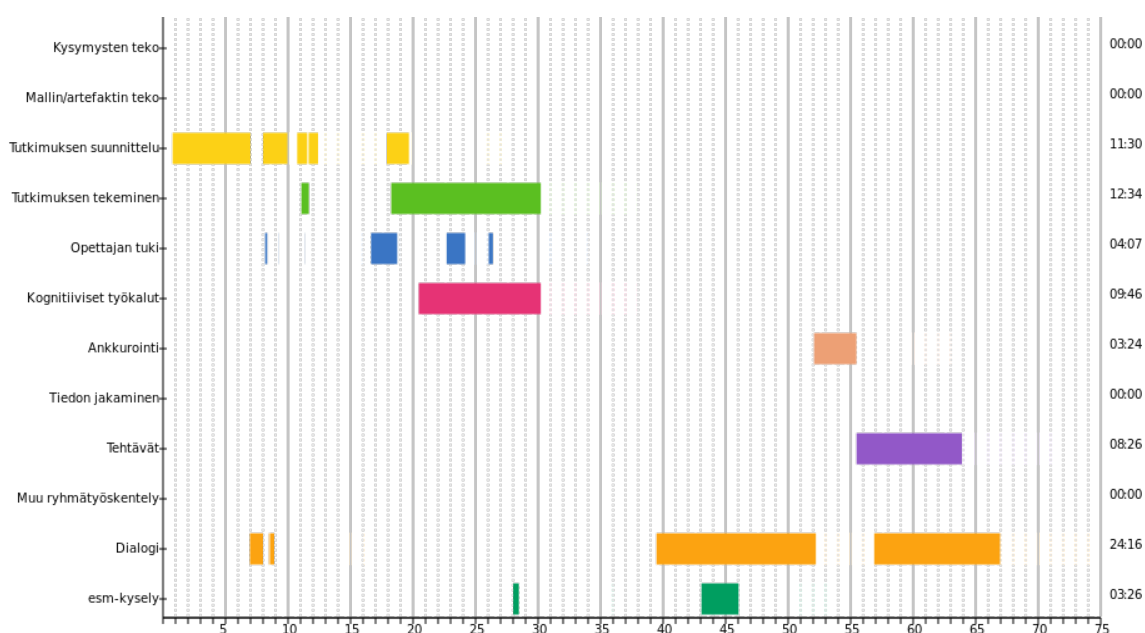

Figure 2. Example of a timeline generated from observing a PBL lesson.

Overall, 32 hours of video were raw coded for the student actions during the observation. Timeline images and .csv files with timestamps were downloaded. From the timelines, 15 segments were chosen for further viewing and selection. The timestamps from the .csv files were used to cut the raw video into these segments for easier handling and processing. Cutting the recorded videos into segments took approximately two hours of active work. The segments totalled six hours of video, meaning that 26 hours of video could be ignored from additional viewing.

Using the app during the video recording and while downloading the timestamp data does not increase the time or workload. Furthermore, as more than 80% of the videos can be ignored, the overall time saved was significant even when considering the time used for cutting the video segments. If we contemplate the time used for programming and testing the app, the time savings are not substantial for this one data collection. However, with additional data collection and other usages for the app, the time spent producing the app will become insignificant.

In addition to time saved, using the app in the described manner can alleviate problems arising from the large file sizes of high-quality video. Large files can

require a decent amount of hard disc space and can be resource heavy for computers to handle in analysis software. After cutting the raw data, it is possible to store only these relevant segments during the analysis phase and to store all the raw video on external hard drives or servers.

Case 2: Digital science practice for reflection in student-teachers' practical training

For the practical training of science student-teachers, the app serves a twofold purpose. First, it activates student-teachers in observing each other's lessons and guiding what to observe. Second, it makes the structure of different activities visible and what practices were used through the timeline produced by the app. These are produced to facilitate reflective discussions after each student-teacher lesson between peers and a mentor teacher. The aim of these discussions is to help student-teachers to reflect on their actions and to grow into professional teachers.

To serve as an effective basis for reflection, the timeline and buttons in the app should be relevant for the needs of practical training. The activities and practices students were guided to observe—and, thus, the buttons' labels (shown with English translations in Table 1) with explanations—were designed together with researchers and university lecturers organizing the reflection. The university lecturer had, through experience as a mentor teacher, a clear notion of what can be difficult for the student-teachers to perceive in their own teaching, including the use of time, interactions with pupils, the amount of experimental work and the general activity of the pupils. The experimental work and general activity relate to the independent lesson segments (Burns & Anderson, 1987). For science lessons, these segments include conducting investigations and tasks for skills and content (Vilhunen et al., in press). According to Mortimer and Scott (2003), communication and interaction with pupils can be divided into four classes of communicative approaches: interactive and dialogic, non-interactive and dialogic, interactive and authoritative and non-interactive and authoritative. The authoritative ones are more prevalent (Scott & Mortimer, 2006).

The communicative approaches and lesson segments formed the basis for the button labels. The first four buttons relate to teachers' talk and interaction with pupils. The two middle buttons represent teachers demonstrating phenomena and students performing experiments. The following two buttons separate teamwork and individual work. The last two buttons are for general instructions given by the teacher and pupils taking notes. The button labels with their translations are shown in Table 2.

The preliminary experimentation on how to use the app in practical training took place in fall 2019 within the University of Helsinki's teacher training schools. During practical training, student-teachers teach 16 lessons (75 min) and observe 40 lessons held by supervising teachers or peer students.

Table 2. Button labels and English translations from the observation protocol used in Case 2.

Button	Finnish label	English translation
1	*Kysely*	Posing questions
2	*Luento*	Lecture
3	*Opetuskeskustelu*	Study Conversation
4	*Opettajan pohdinta*	Teacher reflection
5	*Demonstraatio*	Demonstration
6	*Kokeellinen työskentely*	Student experiments
7	*Ryhmätyö*	Teamwork
8	*Yksilötyö*	Individual work
9	*Ohjeistus*	Instructions
10	*Muistiinpanot*	Taking notes

The use of the tool was demonstrated, and the designed observation protocol was explained to the student-teachers before the practical training started. The student-teachers were introduced to the four communicative approaches of Mortimer and Scott (2003) in the physics didactics course.

The student-teachers used the app to produce the timeline (see Figure 3) as an outline of their peers' lessons. The lesson outlines were then used in the reflective discussion after the student-teacher's lesson.
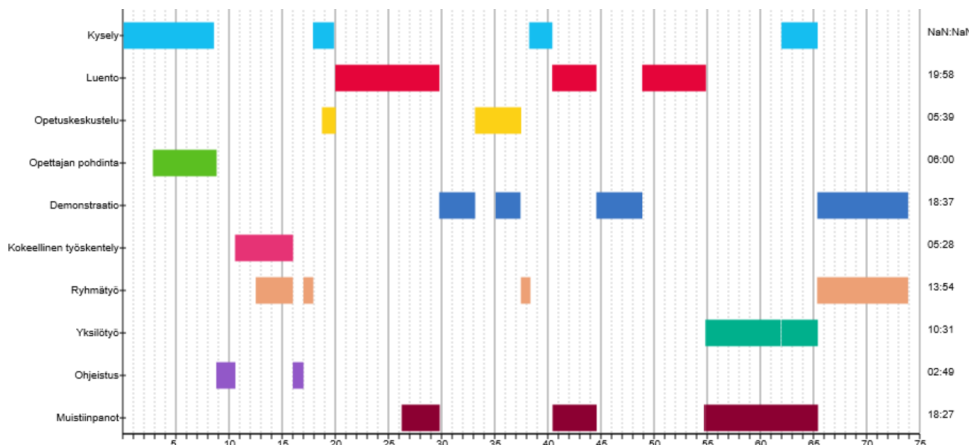

Figure 3. An example of a student-teacher's timeline image of a physics training lesson. The top four bars relate to communicative approaches and the others to classroom activities.

Incorporating the app into the existing practices was straightforward and did not need to include video recording. Instead, the timeline could be used as is, and it was ready to use immediately after the lessons. This allowed the use of video-based research methods in the practical training without additional resources or time.

CONCLUSION

We have developed a simple app for lesson observations. Herein, we presented two cases where we used the app as a part of streamlined data collection in video-based research and in student-teachers' practical training to facilitate reflection. This was done to show how authentic educational research practice can be included in science teacher education.

Two key challenges in video-based research are the selection and analysis of the video data (Derry et al., 2010). Using the app as part of video research answers these challenges by necessitating considerations of what to observe before recording video and not allowing the collection of unneeded videos. The timeline produced by the app streamlines video recording processing and saves significant time in the analysis.

As Finnish teacher education is research-based, it should include actual educational research practices. The LOBS app allows straightforward incorporation of video-based research practices into student-teachers' practical training as a part of reflective discussions. Reflective discussions are currently an essential part of successful practical training; using the app does not aim to change these practices but rather to enhance them through digitalization. The timeline of the lesson segments produced by the app is an artefact in practice that functions as a foundation for reflective discussions. The artefact refocuses attention from a person to the practices used, thereby facilitating the distancing proposed by Bengtsson (1995). Additionally, the artefacts are needed to structure the reflection (Rodgers, 2002). The structure includes the observation, the description of the experience and the analysis of the experience. As the use of the app facilitates observation and allows description of the experience, it is possible to readily move on to the analysis of the experience during the reflective discussion. By distancing the students from the practice and bringing structure to the reflective discussions, using the app elevates the discussions to become proper reflections instead of merely regular discussions. While the use of the app was presented within science lessons, it could be used within all other subjects as well.

Though the app was deemed useful in both cases and its use will continue, there is some room for future development. In video-based research, it could be useful to add a time offset option to the stopwatch or the reaction time to the buttons to account for the small time it takes to notice a change in the activities and toggle the corresponding button. Another advancement would be the ability to group buttons together so that only one button could be toggled on at any given time (i.e. when toggling a button on, it would automatically toggle off another button in its group if necessary). Mortimer and Scott's (2003) classes of communicative approaches could be included in this kind of button group, as there can be only one communicative approach present at any given time. We can observe overlaps of the communicative approaches in Figure 3. This could slightly reduce the cognitive load of the observation. Both additions described can be implemented quite easily. These or other small changes could be made for the main programme or as specialized versions if needed.

In addition to the small improvements, the tool could be advanced as a proper web application, and its use on mobile devices could be improved. Another possibility would be to make a dedicated mobile app version of the tool. Moreover, allowing users to save different observation frames and the data on local machines or dedicated servers would improve and diversify the usability of the tool. However, these changes would require more resources for the development than possible at this time.

We recognize that there are commercial applications or systems that might have the above-mentioned or even more refined features, for example, Observer XT by Noldus. However, these can be quite costly and include unnecessary hardware. Our app, though not professionally developed, is free to use for any and all users, and it can be used with existing hardware (i.e. laptops, cameras). The source code for our app is available in GitHub (https://github.com/MTurkkila/LOBS), and it is licenced under a Creative Commons 4 licence, meaning that anyone can use and modify the app for their own purposes with little technical knowledge. We will update the GitHub repository with any appropriate improvements we might make during the usage of the app.

Rather than focusing on technical improvements, in the future, we will concentrate more on how the tool could and should be used in research, especially in student-teachers' practical training. For example, attention must be paid to the number of buttons used. In both use cases, the number of buttons was considered to be too many. It might be that using ten or twelve different buttons exceeds the user's available working memory (Diamond, 2013). As with any tool or technology, how the app is used determines how and to what extent it can support learning. For practical training, research is needed to determine whether using the app can generate the kind of reflective discussion that helps students to better achieve the goals of teachers' practical training.

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