CROSS-NATIONAL ANALYSIS OF EDUCATIONAL VIDEO CHARACTERISTICS

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Abstract The paper presents the first results of the EXPERT project, in which Slovenian e-textbooks and associated video lectures are translated into English using machine translation models. Emergency remote teaching and the characteristics of video lectures in five countries (Slovenia, Finland, Germany, Spain, and Turkey) were thoroughly analysed. The questionnaire consisted of ten broad open questions with several sub-questions. Responses were collected from ten e-learning experts, two in each country. A mixed quantitative and qualitative method was chosen to analyse the data. The various characteristics of video lectures were grouped into four pedagogical and six technical principles. The results show that the countries followed diverse paths in providing open educational resources and teacher training during COVID-19 school closures. In all countries, the video lectures' compliance with the pedagogical principles for video explanations was satisfactory, but the interactivity level should have been higher. However, recording formats and the features related to the machine translation model should be reconsidered. These issues will be addressed in the subsequent phases of the project.

Keywords:
open educational resources,
cross-country analysis,
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machine translation,
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1 Introduction

During the pandemic, the impact of e-learning became significant. The essential difference between distance learning, which we choose to engage in voluntarily, and emergency/crisis remote teaching, into which we are forced by a situation over which we have no control, is essential. While distance learning is carefully prepared, organised, and represents a long-term solution, emergency remote teaching takes place only in times of crisis. All content is taught online, even that which would otherwise be taught in the classroom (Hodges et al., 2020). However, not all students can participate in real-time emergency remote teaching (Lowenthal et al., 2020). Their reasons can be economical (e.g., lack of workspace or technology, especially in families with multiple siblings) or cognitive (e.g., approaches for students with special needs that parents or guardians cannot provide). The effectiveness of emergency remote teaching is still being studied. There are warnings that distance learning increases socioeconomic disparities. Viner et al. (2020) report that the impact of crisis education is particularly unfavourable for younger students and at-risk students (e.g., students with special needs, students from other linguistic and cultural backgrounds, students with low socioeconomic status).

The flipped learning approach has existed for some time but has gained new momentum with the help of technology. In flipped learning, the individual learning phase occurs before the group phase (not necessarily group work). Students first receive an educational resource (usually a video), which they watch independently, and then build higher taxonomic levels of knowledge in a collaborative activity in the physical classroom (Santos & Serpa, 2020). Several meta-analyses suggest that a well-designed inverted classroom could serve as a promising pedagogical approach. Studies report a small positive effect on STEM (Science, Technology, Engineering and Mathematics) achievements (van Alten et al., 2019; Wagner et al., 2021; Zhu, 2021). Teachers are most likely to opt for flipped learning for students between the ages of 13 and 18 (Lo & Hew, 2017). The main problems in using flipped learning are the high workload faced by teachers in creating learning materials and the reduced activity of students in learning outside the classroom (Lo & Hew, 2017). Flipped learning's overall impact on K-12 students' academic achievement is still unknown, especially in different subject areas and grades (Lo & Hew, 2017). Zhu (2021) performed a meta-analysis for the K-12 population and reported more positive correlations for STEM than other subjects. Although teaching mathematics in flipped learning created some teaching difficulties, well-designed flipped learning offered an excellent opportunity to promote 10th to 11th-grade students' mathematical thinking and understanding (Cevikbas & Kaiser, 2020). Yang and Chen (2020) report that flipped learning is effective even in the primary teaching of pronunciation. Students can listen repeatedly to the correct pronunciation by rewinding and repeating the videos until they master it.

Teaching and learning with flipped pedagogy can also be successfully implemented entirely online (Lin et al., 2019). This variation is known as cyber flipped learning. Teachers often implemented cyber flipped learning as an emergency remote teaching method.

So far, research confirms the effectiveness of e-learning with pre-prepared videos (Lipomi, 2020). Videos can serve to (only) motivate, (only) consolidate knowledge, or to develop new concepts. The last ones are, therefore, primarily explanatory. A video explanation is defined as an educational video that follows the principles of the Socrates method. This method is traditionally one of the most widely used and is effective in various fields and within different approaches to teaching and learning, including e-learning. During the COVID-19 pandemic, pre-prepared videos were often used (Lipomi, 2020). The group part also took place in an online environment, based on the cyber flipped learning model.

The effectiveness of video lectures depends on many characteristics. Firstly, most empirical results concern video lectures at the university level. Guo et al. (2014) examined 862 lecture videos from 4 courses on edX, a massive online learning platform (MOOC). Within the scope of the review, the behaviours of 127,839 students watching course videos a total of 6.9 million times were analysed. Guo et al. (2014) found that videos shorter than 6 minutes are more interesting; videos that blend an instructor's talking head with slides are more interesting; lessons taught using informal language are more interesting; classes taught by drawing on a tablet are more interesting; it is not interesting to videotape and broadcast formal classroom environments; videos of enthusiastic and fast-talking instructors are more attractive.

Lin et al. (2019) suggest (a) inclusion of direct communication between the lecturer and the audience, (b) inclusion of the lecturer's face during the presentation, (c) minimalist style of lectures is better than "eye candy", i.e., extensive design components, transitions and other unnecessary additions, (d) suggested usage of tripods, separate voice recorders, removal of cell phones from audio equipment to avoid radio frequency interference, appropriate lighting, (e) using video editing programs, which enable adjusting the audio levels, cropping, inserting cutaways, and removing pauses in lecturer's speech. Similarly, Mayer et al. (2020) reviewed several studies and suggested that people learn better from an instructional video when:

a) the lesson contains prompts to engage in summarising or explaining the material (generative activity principle);
b) the instructor draws graphics on the board while lecturing (dynamic drawing principle);
c) the instructor shifts eye contact between the audience and the panel while lecturing (gaze guidance principle); and
d) a demonstration is filmed from a first-person perspective (perspective principle).

In the following study by Mayer (2021), the evidence-based guidelines for designing video lectures were:

- include multimedia (present words and graphics);
- coherence (avoid extraneous material in slides and script);
- signalling (highlight key material);
- avoid redundancy (do not add captions that repeat the spoken words);
- include spatial contiguity (place printed text next to corresponding part of graphic);
- temporal contiguity (present corresponding visual and verbal material at the same time);
- segmenting (break a complex slide into progressively presented pieces);
- pre-training (provide pre-training in the names and characteristics of key concepts);
- modality (present words as spoken text), personalisation (use conversational language);

- voice (use appealing human voice);
- image (do not display a static image of the instructor's face);
- embodiment (display gesturing instructor); and
- generative activity (add prompts for a generative learning activity).

The essential goal of video lectures should be *interactivity*. It is well-known that interactivity (e.g., adding interactive questions) significantly improves video explanation completion (Geri et al., 2017). It seems clear that people learn better from a video lecture when they are asked to engage in generative learning activities during learning. *Generative learning activities* are behaviours that the learner performs to improve understanding (Fiorella & Mayer, 2015). Examples include taking summary notes (i.e., learning by summarising) or writing an explanation (i.e., learning by self-explaining) or physically imitating the instructor's demonstration (i.e., learning by enacting). Prompts can enhance the educational impact of video lectures and demonstrations. These activities can be particularly effective for students with lower knowledge.

Especially for STEM subjects, it is essential that the content be "created", e.g., mathematical problems be solved gradually, experiments explained in steps, products created in phases, etc. Neither a completed solution (even with a procedure), a completed experiment, nor a finished product reinforce active learning. Therefore, recording of video lectures must be live. Hence, pre-produced drawings are inferior to *dynamically created drawings* by the instructor. In their study, Fiorella et al. (2019) reported that the dynamic drawings group significantly outperformed the static drawings group on the posttest. *Seductive details* are interesting, but irrelevant words or graphics may thus be added to a lecture. While adding exciting video clips or a talking-head window may be tempting, these features can turn into seductive details. Clark and Mayer (2011) point out that people don't necessarily learn better when an interesting, but off-topic, video is added to a multimedia lesson. Mayer et al. (2001) reported that college students who watched a multimedia lecture on how lightning storms develop performed significantly better on a transfer test if short video clips of lightning storms were not interspersed in the lecture. In a computer-based game of how plants grow, college students did not perform better on a transfer test when narrated animations included a talking-head window (Moreno et al., 2001). Adding interesting but irrelevant videos to a multimedia lesson did not help student learning. This suggests that elements unrelated to the lesson distract students from the lesson and are unnecessary.

Filming from a third-person perspective involves placing the camera across from the instructor to demonstrate a sequence of actions (as is common in YouTube videos or films). In contrast, *first-person perspective* involves placing the camera on or above the instructor's shoulder or forehead (as in GoPro videos). People learn better from narrated videos of a manual demonstration when filmed from a first-person perspective rather than a third-person perspective. In two experiments conducted in the United States and the Netherlands, students who watched the first-person video performed significantly better in the posttests than students who watched the third-person video (Fiorella et al., 2017). The first-person perspective is a social cue that serves to involve learners more in the actions shown in the video. The first-person perspective seeks to craft a sense of self-reference, where students are more likely to feel as if their hands are building circuits, thereby creating a more robust memory for the actions in the video. This approach complements other multimedia design principles to promote productive processing, such as the personalisation principle, which includes using spoken language, and the editing principle, which includes using appropriate gestures (Mayer, 2021).

Horovitz and Mayer (2021) additionally point out the importance of the teacher's *emotional state* in video lectures for university students. They report that the instructor's emotion has similar effects for human and virtual instructors. When the onscreen instructor is visible, people learn better from a video lecture (Rosenthal & Walker, 2020). Additionally, instructors should *shift their gaze* between the audience and the board while lecturing rather than looking only at the board or only at the audience. Looking from the audience to the board is called *gaze guidance* because it suggests that the learner should look at the relevant portion of the board. In one set of studies, Fiorella et al. (2019) reported results with college students who learned about human kidneys from a video lecture with a transparent whiteboard (and had gaze guidance from the instructor). Students performed better on a transfer test than students who viewed the video lecture with a conventional whiteboard (and had no access to the instructor's eye gaze). In another set of studies, Stull et al. (2018a; 2018b) also found that students who learned about chemistry from a video lecture with a transparent whiteboard significantly outperformed students who learned from a video lecture with a conventional whiteboard on an immediate posttest, but only at a nonsignificant level on a delayed posttest. In an eye-tracking study involving a video lecture in chemistry (Stull et al., 2018a), college students in the transparent whiteboard group tended to look more at the instructor's face and less at the material on the board than students in the conventional whiteboard group. However, the transparent group performed slightly better than the traditional group on a delayed posttest. Overall, there is some evidence that students learn better from lecture videos when gaze guidance cues are visible, yet there were no significant differences in the learning outcomes between conditions (van Wermeskerken et al., 2018).

The language of instruction plays a crucial role. Lee and Mayer (2018) asked Korean college students to view a 16-minute video on wildlife in Antarctica taken from a TV documentary with *subtitles* in English. Students performed better on a comprehension posttest if they viewed a video with printed words rather than a video with spoken words or a video with printed and spoken text rather than a video with spoken text alone. However, adding subtitles to a fast-paced 9-minute episode of a science TV show containing dialogue in English did not help non-native English speakers perform better on a subsequent comprehension test.

Standard video lecture *formats* include lecture capture, picture-in-picture, and voiceover (Chen & Wu, 2015). Lecture capture involves video recording a physical lecture. Picture-in-picture combines a full-screen presentation of the slide content with a small video recording of the instructor (e.g., talking head in a lower corner). In contrast, voiceover combines a full-screen presentation with audio narration by the instructor. Rosenthal and Walker (2020) present an additional format that combines instructor images and content, which the instructor can monitor in real-time; they named the format "live composite". The composite uses two layers: the instructor's video and the lecture slides. Live composite recording can use the green screen technique or other equipment like a glass blackboard. Rosenthal and Walker's (2020) results show that live composite lectures have a distinct advantage over other video lecture formats.

The various characteristics were summarised into ten principles. Four of the principles are somewhat more didactically oriented; probably the most important being the principle of interactivity, followed by the principle of generative activity, the principle of dynamic drawing, and the principle of seductive details. The other six principles are slightly more technical and are also related to pedagogy. They are the principle of the perspective of the recording, the principle of the teacher's visibility, the principle of the teacher's emotional state, the principle of gaze guidance, the principle of subtitles, and the principle of the live composite of the recording.

In the field of remote teaching, there is a notable lack of high-quality, research-based learning material (e.g., Mayer, 2021). Slovenia has created advanced interactive e-textbooks and a collection of video lectures in the style of the Khan Academy (Pestano Pérez et al., 2020). Unfortunately, both are limited to the national level owing to the language barrier. The materials allow asynchronous use. Therefore, they are helpful for diverse learners, as economic and cognitive impairments can be reduced by teaching outside real-time. STEM subjects were chosen for EXPERT due to their international applicability and because the authors wanted to follow the principle of gender equality. In EXPERT, the authors set themselves the following goals: upgrade and improve learning materials, translate these materials into English, use advanced machine learning models (pivot language), include materials in the Learning management systems (LMS), and explore new models for use in classrooms in an international environment. EXPERT comprises expert organisations from five countries (Slovenia, Finland, Germany, Spain, and Turkey). About 500 primary and secondary school students will be involved in the digital pilot of open education resources (OER). The participation of about 150 teachers and researchers is expected. With developed OER and MOOC, the study will reach a much broader population. The authors are also aware of the low acceptance of this technology by teachers, so they will prepare explicit Instructional Principles for distance teaching and learning in cyber-flipped learning pedagogy and additional instructions for adapting the learning paths in the learning management systems to the needs of the students. The authors will use various project methodologies, as four intellectual outputs are technical, and four are pedagogical. The pedagogical outputs design the pedagogy for technical improvements, integrate the open educational resources into the classroom settings, and evaluate their implementation. Specific methodologies will also be used, such as qualitative and quantitative social science methodologies for pedagogical research.

Only the first results obtained in EXPERT regarding the country report will be presented in this paper.

2 Method

The authors chose mixed quantitative and qualitative methods for analysing data.

2.1 Sample

The data consist of country reports from 5 countries (Slovenia, Finland, Germany, Spain, and Turkey). The data were gathered from May 2021 to September 2021. E-learning experts in five participant countries answered the open questions. At least two experts in each country compromised on their answer. In four countries (Finland being an exception), one of the experts was an active teacher and an educational researcher.

2.2 Instrument

For the purpose of this study a questionnaire was designed, which consisted of several open questions, referred to STEM subjects. The questionnaire was answered by experts in the field of e-teaching.

1. Response to COVID-19 by country
   a. When (approximately) were schools closed in your country (in 2020 and 2021)? (Were ALL schools closed? Which schools were open? What restrictions were applied because of COVID-19?)
   b. Was a consensus reached at the national level on a curriculum (possible teaching recommendations) that is primarily implemented in emergency remote teaching (e.g., recommended objectives/content that is "easier" to implement in distance learning)?
   c. Did teaching staff get **specific** instructions (similar to https://www.distanzunterricht.bayern.de/ in Bayern, Germany) on efficient teaching approaches (e.g., flipped learning?)
   d. Are there any open educational resource (OER) websites with interactive materials for STEM (like http://iucbeniki.si/ in Slovenia)? If yes, were they formed during COVID-19 or before? Who funds them? How is quality management realised? Are there any open educational websites with video lectures for STEM

(similar to https://razlagamo.si/gradiva/ in Slovenia or https://wirlernenonline.de/ in Germany)? Who funds them?

e. How were teacher training courses on creating or using video lectures organised and realised? Was this training mandatory?

2. Video lecture characteristics
   a. Can you estimate the predominant goals of video lectures (e.g., explaining phenomena, consolidating knowledge, motivation, etc.)?
   b. Are video lectures structured in modules (e. g., several consecutive video lectures for a given content area, e.g., a linear function)? If yes, do modules include explanation video lectures and supporting video lectures (e.g., practical assignments, experimental work, motivational video lectures, consolidation video lectures – solving mathematical tasks)?
   c. Can you estimate the predominant structure of video lectures? Do they include learning objectives? Do they have a summary? Do video lectures include instructions for students to summarise content (e.g., take notes)? Do video lectures include instructions for students that help/direct them to explain the material to others?
   d. Is the instruction specific to the medium? Do video lectures follow different instructional steps compared to onsite teaching?
   e. Can you estimate the predominant characteristics of video lectures, according to the listed features:
      i. the interactivity of the video lecture,
      ii. the lesson contains elements to engage students in summarising or explaining the material,
      iii. the instructor draws graphics on the board while lecturing,
      iv. extraneous videos include many seductive details,
      v. visibility of the teacher in the video lecture,
      vi. instructor's emotional state in video lectures,
      vii. the instructor shifts eye gaze between the audience and the panel while lecturing,
      viii. a demonstration is filmed from a first-person perspective,
      ix. the predominant ways of lecture formats,
      x. Are subtitles included or not?

3 Results

The results will be shown in two subsections: the results for country background in the COVID-19 crisis and the results regarding open educational platforms and video lecture characteristics.

3.1 Results by Country

The results by country in the COVID-19 crisis are reported in *Table 1*. The results correspond to questions 1a, 1b, 1c and 1d.

Table 1: Response to COVID-19 (by country)

	School closure (months)	Emergency remote teaching curriculum	Instruction for teaching staff	Video lecture production training
Slovenia	7.5	yes	yes	no
Finland	3	yes	yes	yes
Spain	3	yes	yes	no
Germany	4.5	yes	yes	yes
Turkey	7.25	no	yes	no

There are several additional pieces of information that aid in interpreting the results. For instance, the "third wave" was based on national regulation in Germany. However, such regulations beyond states are atypical for the Federal Republic of Germany, where the states decide on health and educational issues. Similarly, Finnish teachers had various online platforms for sharing teaching guidelines. Some were public, and some were private.

In some countries (like Finland or Turkey), the private providers (aivoapina.fi and Toni Tran, for example) leaned toward the schools and their content of instruction (books, curriculum, tests) and the public ones (MOOD.fi) had exercises and exams online.

Teacher training on the creation of video lectures was exemplary in Germany. It was not mandatory but available to all teachers for free on a recurring schedule. In the state of Bavaria, there were three different organisational levels on which such courses were offered: the state level, via the central academy for teacher training and human resource management, "ALP" in Dillingen, the regional district level (regional teacher training), and school type-specific consultants on a district level. Some private companies offered teacher training, but they were costly and often advertised non-free software, materials, or expensive tools. The free training courses provided by the state included video and audio recording, video cutting, video embedding in learning management systems, and the enrichment of videos with interactions with particular topics. The consultants on the district level offered free teacher training for schools on demand (e.g., the catalogue of teacher training for higher secondary schools in Upper Palatinate).

3.2 The Characteristics of Open Educational Platforms and Video Lectures

The results corresponding to questions 2a, 2b, 2d and 2e are reported in *Table 2*.

Table 2: Predominant OER platform characteristics

	Goals	Video lecture modules	Video lecture structure	Media specific teaching methods
Slovenia	acquisition	yes	yes	yes
Finland	acquisition	yes	no	no
Spain	acquisition	no	no	no
Germany	acquisition	yes	yes	yes
Turkey	acquisition	yes	yes	yes

In Germany, in many cases, the video lectures were embedded in learning management systems courses together with considerable additional materials. At the beginning of the module presentation, the pre-test was applied in Turkey, and the answers were recorded. After the presentation of the subject, a 5-question evaluation test was done. In Finland, self-study platforms (e.g., aivoapina.fi) had playlists for the video lectures. There were assignments (exercises) connected to the videos.

In Finland, a mathematical problem was solved multiple times during the mathematical video, so the learning objective was to master the problem. The videos didn't include summaries, or they didn't recommend taking notes. This could be due to having the option of rewatching the video.

Even though video lessons in Turkey used the same curriculum as onsite teaching, while the classes were only 40 minutes long in onsite lessons, the lessons decreased to 30 minutes in video lessons. For this reason, practice and course exams were sometimes given to the students in the form of homework. Sometimes they were sent to the student in the form of online exams. In Germany, the instructional steps – in an instructional phase of the lesson – were mostly the same compared to onsite teaching. Where there is individual video instruction, in one phase of any exercise, then the method is specific for the medium.

Table 3 provides results corresponding to question 2e.

Table 3: Predominant video lecture characteristics

		Slovenia	Finland	Spain	Germany	Turkey
Pedagogical principles	PP1 interactivity	medium	medium	medium	high	medium
	PP2 generative activity	medium	medium	medium	high	n. d.
	PP3 dynamic drawing	medium	high	medium	medium	n.d.
	PP4 no seductive details	low	medium	low	high	n.d.
Technical principles	TP1 first perspective	medium	n.d.	n.d	low	n.d
	TP2 emotional state	neutral	neutral	neutral	neutral	neutral
	TP3 teachers' visibility	medium	n.d.	n.d.	medium	n.d.
	TP4 gaze guidance	low	n.d.	n.d.	low	n.d
	TP5 subtitles	no	no	no	no	no
	TP6 format	Voice over	n.d.	Lecture capture	Voice over	n.d.

In Germany, video lectures were mainly enriched by interactions or embedded exercises with automated feedback used in remote teaching (e.g., via H5P). Teachers could share those videos via download or Moodle. In Slovenia and Spain, JSXGraph animations were used to build videos, making them more interactive. In Finland and Turkey, teachers were usually interactors, especially in recorded lecture videos, asking the present students questions.

The generative activity principle is the gold standard and is widely used in Germany. In Finland, Toni Tran used a blackboard, chalk, and sponge to draw (in his lecture videos), but numbers appeared on the screen (the drawing was not shown).

In several countries, predefined slides were often shown only for a short period of time. In some video lectures on razlagamo.si, a teacher could be seen writing and drawing on the blackboard. On the Astra.si, the teacher used a pointer to show a trace on the board where they want the students to look.

Video lectures for younger students often included an avatar (e.g., in a PowerPoint saved as a video), which can disrupt the students' attention. The Finish elementary (lower levels) mathematics (e. g., Alakoulun matematiikkaa) videos contained various objects, distracting the students.

Mathematics video lectures that show hands-on activities or solving a task on a piece of paper are often in the first perspective. Video lectures, in which the teacher is visually present (e.g., in front of a blackboard or as a "talking head") or the teacher is not visible, give the impression of a third perspective. In Germany, first perspective filming was rarely used.

Visibility is essential for all age groups. On the Slovenian website razlagamo.si, the teacher was visually present in only a small percentage of the videos. On Astra.si, the teacher was not visually present. However, visibility depends strongly on the intended use. Suppose the author in Germany aims to publish the video as an open educational resource. In that case, the instructor is not visible in the video. If the video is intended only for the students being taught by the teacher, the teacher is visible in the video.

The teachers primarily had a neutral emotional state, only exceptionally were they positive. Positive states often lead to disruptive elements. During direct instruction, the instructor should be clearly motivated. There can be role-playing elements in video lectures, where certain emotional states simulated by the instructor can be helpful. One of the preferred practices to ensure that presenting the information is more compelling is using body language. Energetic talking, using a varied tone of voice, and making gestures appropriate to the subject content are only a few examples of using body language.

On the Slovenian website razlagamo.si, there were some videos in which the teacher explained the mathematical content on the blackboard directing their gaze directly at the students and the material being written on the blackboard. In Germany, onsite lessons were rarely recorded (recording in the classroom is not allowed by law, and exceptions are rare) Thus, there was no onsite audience in video lectures for usage in schools. Some teachers recorded themselves standing in front of a blackboard while explaining – and yes, most of them respected the gaze guidance principle.

4 Discussion

The results show that responses to COVID-19 in education in participating countries were diverse and not connected to the time of closure. Germany had a relatively short time of full school closure, but they provided teachers with exact instructions for teaching. On the other hand, Turkey and Slovenia had extended closures, but instructions for teachers were not concrete, and training courses on creating video lectures were not provided by national institutions.

Open educational resource platforms' features did not differ significantly by country, with Spain being an exception.

The video lectures were still too long. Regardless of the video lecture's length, students' engagement time is at most six minutes (Guo et al., 2014). Using videos in short chunks or segments is essential for younger children who lack general knowledge and have elevated cognitive loads when processing new information (Slemmons et al., 2018). But these longer videos can often be split into shorter ones. Additionally, interactivity (e.g., H5P) significantly improves video lecture completion (Geri et al., 2017).

Pedagogical principles were followed in the video lectures. The authors believe that dedicated teachers produced video lectures in ERT. Those teachers had good PCK-pedagogical content knowledge (Ball et al., 2008) and excellent TPACK-technological pedagogical content knowledge (Mishra & Koehler, 2006). However, all experts in all countries agreed that video lectures should include more interactivity (e.g., JSX Graph features or H5P). Nevertheless, the video lectures mostly followed the generative activity principle, fostering intersubjectivity. Intersubjectivity is described as an "unspoken reaction in the room" or "*implicit* conversation between speaker and (silent) audience" (Crook & Schofield, 2017).

In following technical principles (still connected to pedagogy) there is still a lot of room for improvement. Younger children are more prone to respond to teachers' emotional states (Sutton & Wheatley, 2003; Horovitz & Mayer, 2021). Instructors' positive emotions could be applied in all video formats. The authors also noticed that there were too many third-person scenes in video explanations for the first three grades, i.e., placing the camera across from the teacher as they perform the lecture. Videos should be prepared in a more appropriate first-person perspective format, including gaze guidance, according to Mayer et al. (2020). However, this principle could only be observed in some types of VL (e.g., voiceover does not provide perspective data). There were also too many seductive details in the video explanations for the first three grades, which could, according to Clark and Mayer (2011), harm students, as it disrupts the lesson's coherence.

Overall, there is emerging evidence that learners are sensitive to the instructor's presence in an educational video (Mayer et al., 2020; Mayer, 2021). Based on these findings, it may be helpful for video lectures that include an onscreen instructor to make sure that the instructor looks at the audience while talking and sometimes shifts their gaze to the board to signal where to look. Instructional videos where the instructor looks directly at the audience throughout a lecture may be less effective than those in which the instructor occasionally looks over at the material on the board that they are talking about.

Changing the predominant type from voiceover to live capture would be beneficial. The most used video type of video lecture was voiceover without the teacher's presence, which is the type with the lowest learning performance, according to Rosenthal and Walker (2020).

5 Conclusion

Even though COVID-19 measures were approached differently in different countries, there were no significant differences except in Germany, where nationwide teacher training courses and open educational resources of high quality were provided during school closure. The characteristics observed in video lectures show that the video lectures were in line with video pedagogy guidelines except for the level of interactivity. Including interactive elements (e.g., using H5P) was low. The nature of open educational resources can explain that. Our data did not allow information on post inclusion in learning management systems. Technical characteristics showed a lot of room for improvement, especially in the recording format providing visibility of the teacher and language aspects that allow machine translation to remove the language barrier. Additionally, using equipment for live capture would be beneficial. Additional steps should be taken to create video lecture formats without language-specific texts, which could be done via graphical elements (e.g., arrows).

In EXPERT, several innovations will be designed, such as:

- a machine learning model to be trained to translate e-textbooks efficiently and correctly first into English (as a pivot language) and later into other partner languages;
- community-driven use and improvements of e-textbooks (similar to Wikipedia);
- the possibility of including certain topics from interactive textbooks in learning management system (LMS) and constructing personalised learning paths;
- the first taxonomy of video explanations;
- the first research-based emergency distance learning guides with video explanations; and
- Cyber-flipped LMS didactics for use in situations similar to the COVID-19 lockdown.

The taxonomy of video explanations will be designed to help teachers choose the appropriate video explanation for their students. Explicit guidance will be given on how to help better learners develop in-depth knowledge of distance learning STEM with OER. New innovative ways of individualising the work with prepared materials within the LMS will also be prepared. The results are highly transferable to other subjects in the school system (especially hierarchical subjects, such as languages) and outside the school system (e.g., the neural model of machine transcription and translation). The authors expect an impact on more profound understanding and knowledge through STEM, the effective use of ICT in teaching by teachers, and the encouragement of decision-makers to achieve a higher level of digital literacy in all stakeholders in the school system. As STEM competences are positively related to the gross domestic product (GDP), the authors expect a potential long-term benefit in society's technological and economic development. The authors see another advantage in raising the digital competences of teachers, researchers, and students.

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