

Use of videos, virtual reality elements, and online texts in science lessons – An exploratory study across selected European teacher cohorts

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Abstract

Digital transformation in education poses challenges for science education but also offers numerous opportunities. This exploratory study examines how often videos, virtual reality (VR) elements, and online texts are used in science lessons. Pre-service and in-service science teachers from Austria, Cyprus, Estonia, and Germany were surveyed using a mixed-methods design. The results show that videos are utilized most frequently, while VR elements are rarely used. Online texts are used occasionally. Neither age nor professional experience was significantly related to the frequency of use of any of the three media. Despite its educational potential, the low usage of VR points to existing barriers such as a lack of technical skills. The respondents highlight various elements that are conducive to learning in all three areas, such as structuring features and visualizations. The study underlines the importance of teacher education in universities and professional development programs that are specifically designed to integrate digital media into science lessons. Implications for this and for further research, such as research on teacher education programs, are discussed. It should be noted that the sample was dominated by respondents from Germany and Austria.

Keywords: digital media, videos, virtual reality, online texts, science teacher education

INTRODUCTION

Digital technologies have led to far-reaching changes in almost all areas of education in recent years and have resulted in strategies and measures being taken worldwide to integrate information and communication

technology into education systems (Timotheou et al., 2023). Not least, the COVID-19 pandemic has shown that digital learning is an important factor in increasing the resilience of the education sector to crises (Connolly et al., 2023; Iivari et al., 2020). Even after the pandemic, teachers continue to favor some digital distance learning practices, for example to improve learning and

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Contribution to the literature

- Existing research has extensively examined the educational potential of videos, virtual reality (VR), and digital learning materials, whereas considerably less attention has been paid to their actual use in science lessons.
- The findings reveal a discrepancy between the documented potential of VR in science education and its very limited use in educational practice.
- By comparing videos, VR elements, and online texts within this exploratory study, the article provides insights into how teachers prioritize different forms of digital media in everyday science teaching.
- The study identifies teacher-perceived features that support learning with digital media and thereby informs teacher education and professional development.

communication in the classroom (Kosmas et al., 2022). The digital transformation of education opens up a wide range of opportunities, but it also requires critical reflection, among other things, on the effectiveness of teaching and learning processes with digital media (Bilyalova et al., 2020). As a result, teachers in Europe are constantly faced with the challenge of using digital technologies effectively both as a tool for digital transformation and as educational content in curriculum requirements (Begičević Redep et al., 2020). The rapid pace of technological progress poses a particular challenge in this regard (Schmidt & Tang, 2020).

These developments have a direct impact on science education. For example, there are new opportunities for subject-specific working methods, such as virtual experimentation (Wörner et al., 2022), digital simulations (Kefalis et al., 2025), or working in completely virtual laboratories (Potkonjak et al., 2016). Some of these innovative techniques are themselves part of scientific thinking and working methods, e.g., in the sequencing of genome segments or the evaluation of data from scientific experiments (Nerdel & von Kotzebue, 2020). Digital tools are used to support analog tools (Otterborn et al., 2024). In this context, it is important that digital tools do not simply replace analog tools, but rather redefine them (Puentedura, 2006). A review concludes that artificial intelligence and learning analytics can also be promising tools for assessing students' understanding of scientific concepts (Chiu, 2021). Research in the field of science education shows that teachers themselves greatly appreciate these science-specific digital possibilities, but that there are various barriers to their use in lessons, including lack of time and, in some cases, lack of infrastructure, but also fear of change (Wohlfart et al., 2023). Although these research findings have first implications for the practice of science teaching and teacher training, many questions in this area of research remain unanswered in science education. These include the question of how often digital media are used in everyday lessons and, above all, the question of which elements make these media conducive to learning from the perspective of teachers. It is important to gain insights into this topic in order to draw conclusions about the implications of specific

digital media not only for teaching, but also for teacher education. In addition, identifying the features that are conducive to learning offers a direct look into teachers' everyday teaching practices involving digital media. These observations form the starting point for this study.

This article examines how often science teachers use three different digital technologies (videos, VR elements, and online texts) in their lessons, as well as which elements they consider conducive to learning. As described, the digitization of lessons is a global topic. Furthermore, science education is not merely a local matter but is also undergoing globalization, developing multinational structures (DeBoer, 2011). Therefore, the survey of teachers from Austria, Cyprus, Estonia, and Germany provides a multinational perspective on these topics. The theoretical background section presents these three technologies – videos, VR elements, and online texts – from a theoretical perspective, with reference to their use in school education.

THEORETICAL BACKGROUND

Videos as a Technology in Lessons

As digital platforms such as YouTube enable simplified explanations and visual demonstrations, educational videos are generally well suited for teaching scientific content (Beautemps & Bresges, 2021). From the perspective of science teachers, their students enjoy watching videos in class (Kettle, 2020). The significance of the COVID-19 pandemic should also be mentioned in this context. The use of YouTube videos among students has increased significantly during the pandemic, and even after the pandemic, students still want teachers to incorporate relevant scientific videos into their regular lessons (Breslyn & Green, 2022). In this respect, the importance of videos as a teaching aid can be confirmed by both teachers and learners.

Teachers themselves rarely produce their own videos, even though they generally express a positive attitude toward doing so, stating that lack of time and technical skills are the main barriers (Santos Espino et al., 2020). A study in the field of flipped learning showed that students found videos created by teachers to be more educational than YouTube videos, but the latter

were rated as more enjoyable (Bakla & Mehdiyev, 2022). This highlights the importance of the specific context and the respective teaching intention. Educational videos on YouTube can generally serve as a tool for disseminating scientific information, but in addition to the platform itself, the situation of users when using the media, their preferences and knowledge, their social status, and their peer groups also have various influences on learning outcomes (Kohler & Dietrich, 2021).

While the potential of using YouTube videos has already been extensively researched for language education, for example (Kaboocha & Elyas, 2018), our thorough literature review has not identified any specific findings in the field of science education to date.

Elements With Virtual Reality as a Technology in Lessons

VR has emerged as a promising tool for promoting the practical skills of learners in science education (Yang et al., 2024). A review shows that the use of VR can have positive effects on learners' motivation and cognitive abilities, but that there are also risks of distraction and reduced imagination (Jiang et al., 2025). Interventions lasting less than two hours have a particularly strong learning effect (Villena-Taranilla et al., 2022).

In science education in particular, there are a large number of studies that investigate the possibility of using VR in lessons with specific interventions. For example, it has been found that VR visualizations of molecules in chemistry lessons can improve the accuracy of responses to spatial-cognitive tasks (Qorbani et al., 2024). In addition, in mathematics, in the field of geometry, a positive influence of the use of VR on learning motivation and learning performance has been proven. VR is also becoming increasingly important in biology education. The development of content from the fields of cytology, ecology, and botany in virtual environments leads to better performance by participants in a knowledge test than without these VR applications (Maimatayeva et al., 2025). Similarly, VR-supported 3D environments, for example with content related to osmosis, can have a positive influence on learning performance (Reinke et al., 2021).

For teachers, perceived usefulness and perceived user-friendliness are key factors in their satisfaction with using VR in their own lessons (Du et al., 2022). Even pre-service teachers see both advantages, such as motivational effects, and disadvantages, such as technical challenges, in using VR in the classroom (Cooper et al., 2019). This group therefore emphasizes the importance of their own technological skills (Ogegbo et al., 2024), which is why it is beneficial to address the acquisition of the necessary skills during their studies (Hur, 2025).

A review shows that, to date, pre-service teachers in particular are trained in this area, while in-service teachers tend not to be (Huang et al., 2023). The need for teacher training is particularly clear given that in-service teachers cite a lack of technical knowledge and a lack of practice as challenges to the use of VR in their lessons (Alalwan et al., 2020). In order to tailor this training precisely, it is important to gain an insight into the usage habits of teachers in their everyday teaching.

Online Texts as a Technology in Lessons

Although VR elements and videos from digital platforms can represent innovative concepts, the integration of classic formats in digital form can also bring advantages for teaching. These include, for example, online texts. Although it has been possible to implement teaching with digital texts for much longer than with VR, for example, there is comparatively little research available in this area. A study on mathematics teaching compared the effectiveness of using digital textbooks with that of using analog textbooks. It became clear that students benefited more from working with the functions of these digital teaching aids than from working with the printed medium (Brnic et al., 2024). A similar comparison was made in another study, which examined the effects of the medium on academic procrastination among secondary school students. Since no differences could be demonstrated in this regard, the authors conclude that the use of e-books instead of printed books is important as a sustainable digital learning resource (Al Mulhim & Zaky, 2023).

Teachers assess the possibility of working with online texts in science lessons as positive. Although initial work has shown that this can increase student motivation and learning performance and improve the atmosphere in the classroom, some teachers find it rather difficult to integrate online texts (Zedan, 2022). Our literature review did not identify specific findings on the frequency of use of online texts.

RESEARCH QUESTIONS

In accordance with the objectives outlined in the introduction, this exploratory study investigates the research question (RQ1) of how often science teachers use videos (RQ1a), VR elements (RQ1b), and online texts (RQ1c) in their lessons.

In addition, it is examined whether there are correlations between the frequency of use and age (RQ2) as well as professional experience (RQ3). Furthermore, it is also investigated which elements are considered by the respondents to be conducive to learning when used in lessons (RQ4). Once again, videos (RQ4a), VR elements (RQ4b) and online texts (RQ4c) are considered in this context.

Table 1. Frequency of use of the various media

Medium	<i>M</i>	<i>SD</i>
Videos	2.50	.57
VR elements	1.16	.37
Online texts	2.16	.60

METHODS

In the study, 68 in-service teachers and 21 pre-service teachers from Austria, Cyprus, Estonia, and Germany took part. Selection of countries was determined by the institutions participating in the project. The sample is a convenience sample. The 89 respondents were 38.19 years old on average (standard deviation [*SD*] = 9.52) and had an average of 10.19 years of professional experience (*SD* = 9.98). A total of 62 respondents identified as female and 27 as male. Of these, 63 respondents worked in Germany or Austria, and 13 each in Cyprus and Estonia.

The survey was conducted online in all countries in the respective official language. Therefore, there was one version of the questionnaire in German, Greek, and Estonian. Since scientists from all of the countries mentioned were involved in the project team, it was possible to proceed accordingly. For example, the answers to open-response questions were each translated into English by native speakers. This served as the basis for the data analysis. The data were collected at a single point in time and without any specific intervention.

This exploratory study follows a mixed-methods approach. Participants were asked to indicate the frequency of use of videos, VR elements, and online texts in their lessons on a three-point rating scale with the options 1 = *never*, 2 = *sometimes*, and 3 = *often*. For RQ1, the arithmetic mean was calculated. For RQ2 and RQ3, Spearman's rank correlations were calculated between the frequency of use of these digital media and the age and professional experience of the respondents. In addition, Mann-Whitney U tests compared in-service and pre-service teachers on all three media.

The survey of elements conducive to learning was carried out using open-response questions. Respondents were asked to answer the following question about the videos, VR elements, and online texts: "Which elements (e.g., subtitles, summaries, and highlighted words) do you think make the following media conducive to learning?" The data for RQ4 were analyzed at a content level. The responses were categorized using qualitative content analysis (Kuckartz & Rädiker, 2024). The categories were formed inductively, i.e., from the data itself. In accordance with the recommendations from research methodology literature, 10% of the data were coded independently by two researchers. This approach is common practice in qualitative content analysis and is considered sufficient to establish coder reliability (Bortz & Döring, 2006). The remaining data were then coded by

Table 2. Correlations between the use of digital media and age as well as professional experience

		Videos	VR elements	Online texts
Age	ρ	-.01	.22	-.09
	<i>p</i>	.948	.117	.500
Professional experience	ρ	.06	.21	-.19
	<i>p</i>	.666	.131	.155

Note. ρ : Spearman's rank correlation coefficient

Table 3. Elements conducive to learning for use of videos

Category	Examples	Mentions
Structure	Clarity through task descriptions, subtitles, or summaries	108
Visualizations	Animations, drawings, models, or diagrams	39
Control	Options for pausing, rewinding, or controlling speed	29
Form of integration	Cognitive conflict, discursive or interactive	9

a single researcher. Based on a Cohen's kappa value of $\kappa = .81$, the interrater agreement can be rated as almost perfect (Landis & Koch, 1977). This high agreement further confirms that the category system was applied consistently.

An overview of the questions asked is included in **Appendix A**.

RESULTS

Frequency of Use

Table 1 shows the results for RQ1. The results indicate that in-service and pre-service science teachers from Austria, Cyprus, Estonia, and Germany use videos most frequently in their lessons. With mean (*M*) = 2.50, the value lies exactly between the options *sometimes* and *often*. VR elements, in contrast, are almost never used, with *M* = 1.16.

Mann-Whitney U tests compared in-service and pre-service teachers for each medium. Videos ($U = 341.50$, $p = .479$), online texts ($U = 309.50$, $p = .844$) and VR elements ($U = 330.00$, $p = .051$) showed no significant differences.

Relevance of Age and Professional Experience

Table 2 presents the results of the correlation analyses for RQ2 and RQ3. None of the rank correlations between age or professional experience and the frequency of use of videos, VR elements, or online texts was statistically significant (all $p \geq .117$).

Elements Conducive to Learning

The following section presents the elements that are conducive to learning, which the participants mentioned for the use of videos (**Table 3**), VR elements (**Table 4**),

Table 4. Elements conducive to learning for the use of VR elements

Category	Examples	Mentions
Structure	Structure of the multisensory experience through highlights, subtitles, or illustrations	42
Visualizations	3D, immersive visuals, interactivity	22
Individual benefits	Independent experimentation, receiving feedback, or dialogues	19
Technology	Technical support or clear implementation	9

Table 5. Elements conducive to learning for the use of online texts

Category	Examples	Mentions
Structure	Structure through sections, subheadings, or highlighting	85
Multimodal elements	Integration with other media, such as audio or video	22
Tasks for students	Differentiations or explanatory material	21

and online texts (**Table 5**) in lessons. The respective category system is presented for each area. For each category, the main category, specific content examples from the respondents, and the number of mentions per category are given.

The respondents consider structural elements in particular to be conducive to learning when using videos in science lessons.

With regard to the use of VR elements in lessons, it becomes clear that, among other things, these must also have a clear structure from the participants' point of view. Technological aspects are also discussed.

In order for online texts to be used in the classroom, multimodal elements and tasks for students are particularly relevant, in addition to a clear structure.

DISCUSSION

The results of this exploratory study provide various insights into the use of digital media by in-service and pre-service teachers in science lessons from a multinational perspective. The results are discussed below in the order of the research questions, with implications for teacher education and further research projects being provided. In addition, the limitations of this study are outlined.

In a direct comparison between videos, VR elements, and online texts, respondents show a clear preference for the use of videos. This result is consistent with the literature. On the one hand, it confirms that teachers find these videos generally suitable for conveying content (Beautemps & Bresges, 2021) and therefore incorporate them into their lessons. On the other hand, it stands to reason that respondents want to accommodate their

students' wishes to watch such videos (Breslyn & Green, 2022) in the spirit of student-oriented teaching. The finding that science teachers assume that students enjoy watching videos in class (Kettle, 2020) can thus also be confirmed.

The digital medium of videos appears to be a very popular tool for science education. Subsequent studies should focus on the specific effectiveness of individual videos and their characteristics in order to identify specific conditions for successful use. For example, an experimental research design could be used to examine the effects of using different videos in comparison to teaching with other media. In addition, there should be a focus on videos produced by teachers themselves in order to enable implications for teacher education. Although teachers are positive about this process, a lack of technical qualifications, among other things, is cited as an obstacle to its implementation (Santos Espino et al., 2020). Therefore, this issue should be addressed in an interdisciplinary manner as early as teacher training at university, and a corresponding range of courses should be created to counteract this situation.

Participants of the study use online texts less frequently than videos in their lessons. They report that they do so sometimes on average. Since studies show that the use of digital texts is beneficial for learners (Brnic et al., 2024) and that these media can be a sustainable resource (Al Mulhim & Zaky, 2023), this frequency of use can be considered surprising. Nevertheless, this result of the present study reinforces the argument that some teachers find it difficult to integrate online texts into their lessons (Zedan, 2022). Teacher education should therefore show both pre-service and in-service teachers how this can be achieved in practice.

Although respondents from Austria, Cyprus, Estonia, and Germany use online texts less frequently than videos in their lessons, they almost never use VR elements. From the perspective of modern science education, this result can be assessed critically, as VR elements have great potential for promoting the practical skills of learners in science education (Yang et al., 2024). They can promote motivational and cognitive aspects of learners (Jiang et al., 2025). These relate in part explicitly to subject-specific working methods, such as virtual experimentation (Wörner et al., 2022) or working in virtual laboratories (Potkonjak et al., 2016). As shown, there is a wealth of evidence in science education for the various positive effects of using VR elements in lessons (Maimatayeva et al., 2025; Qorbani et al., 2024; Reinke et al., 2021). The very low frequency of VR elements being used in lessons, as reported by respondents, is a further indication of the need to counteract the factors that are already known to be responsible for this. This involves overcoming technical challenges (Cooper et al., 2019), promoting technical skills (Ogegbo et al., 2024), and at the same time emphasizing the perceived usefulness for lessons (Du et al., 2022). The results confirm that

addressing this issue during university studies is a useful approach (Hur, 2025).

Subsequent work should include the development of appropriate programs and accompanying empirical research. This is the only way to effectively address this area. Such measures can be implemented directly in the design-based research approach (Tinoca et al., 2022), among others, in order to guarantee ongoing quality assurance and evidence-based further development.

The results for RQ2 and RQ3 show that neither age nor professional experience is a particularly significant factor in the use of the digital media considered in the classroom. This finding could well be considered unexpected. The assumption might have been that more experienced teachers—who are correspondingly older and not always comfortable with digital media—would generally use digital media less frequently and prefer traditional formats compared to younger teachers with less professional experience. However, the present study does not allow conclusions about why no such relationships emerged. Further research is needed to investigate the factors that influence the use of digital media in science education. The findings of this study therefore provide initial insights into this area. A supplementary comparison between in-service and pre-service teachers showed no significant differences for all three media. Therefore, there is no distortion of the results.

The fact that there are no statistically significant correlations between age and the use of videos, VR elements, or online texts may be considered surprising. For example, educational research has found that older teachers are less likely to approve of the use of smartphones in the classroom (O'Bannon & Thomas, 2014). Such an assessment does not seem to exist among the respondents in the context under consideration, measured in terms of practical use. In follow-up research, this aspect should be taken up and examined to determine whether teachers have media-specific attitudes.

The inductively formed categories show that there are elements conducive to learning that are particularly relevant for videos, VR elements, and online texts. As **Table 3**, **Table 4**, and **Table 5** show, the respondents consider structure to be the element that enables conducive use in the classroom. It is therefore clear that an appropriate structure is necessary for the use of digital media. Visualizations, which were mentioned for videos and VR elements, are also of great importance. For online texts, on the other hand, the integration of additional media is cited. In this respect, from the perspective of in-service and pre-service teachers, it seems to be important to use a combination of media, in contrast to videos and VR elements.

Control is also an important factor when it comes to using videos. Thus, for the integration of videos, which,

as already mentioned, are considered suitable by teachers for teaching scientific content (Beautemps & Bresges, 2021), control over the use of this digital medium seems to be a prerequisite. In subsequent projects, the learners' perspective should be explored and examined to determine which conditions must be met for successful use from their point of view. Concrete conditions for success can be derived from a potential overlap, which can already be considered in the university training of teachers.

An important aspect of VR elements that promotes learning is the individual benefits they offer students. It has been shown that subject-specific working methods that can be implemented in VR (Kefalis et al., 2025; Potkonjak et al., 2016; Wörner et al., 2022) provide individualized opportunities. In this respect, the respondents seem to be aware of the potential of VR elements for differentiation in science lessons.

Limitations

Although this exploratory study takes a multinational perspective to determine how often science teachers use videos, VR elements, and online texts in their lessons, and which elements are conducive to learning, it is important to highlight not only the potential of this perspective but also its limitations. A holistic perspective was adopted and, due to the relatively small sample size, no comparison was made between respondents from Austria, Cyprus, Estonia, and Germany. Subsequent studies should aim to implement this.

The sample was also unevenly distributed across countries. Over 70% of the participants came from Germany and Austria. The findings should therefore be read as an exploratory account of these four countries, not as representative of science teachers across Europe.

Furthermore, only three different digital media were considered. Although this diversity could provide a broad overview, it is important to include additional media in future projects. The conclusions in the discussion offer some suggestions for corresponding research projects.

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collected anonymously, and no personal or identifying information was recorded at any point.

AI statement: The authors declare that no generative AI or AI-based tools were used.

Declaration of interest: No conflict of interest is declared by the authors.

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APPENDIX A: QUESTIONNAIRE

1. How often do you use the following online learning resources in your lessons?

Table A1. How often do you use the following online learning resources in your lessons?

	<i>Never</i>	<i>Sometimes</i>	<i>Often</i>
Videos			
VR elements			
Online texts			

2. Which elements (e.g., subtitles, summaries, highlighted words) do you think make the following media conducive to learning?

Table A2. Which elements (e.g., subtitles, summaries, highlighted words) do you think make the following media conducive to learning?

	<i>Elements</i>
Videos	
VR elements	
Online texts	

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