

A conceptual framework for panning as a screen recording technique in software education: Implications for instructional design in educational videos

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Highlights

- Panning is a strategy used during educational video recording to capture a smaller section of a digital screen that is relevant to the instructional activity.
- Panning is a design consideration, especially when creating educational materials for mobile devices with small screens.
- Panning has yet to be fully conceptualized as an instructional technique for software education.
- This research provides a comprehensive overview of how planning is implemented and achieved.
- As discussed in this paper, different panning techniques can provide various benefits for creating more effective instructional videos.

Abstract

Videos as instructional materials have become an important part of higher education. The ability of videos to be shared and used in social and educational settings demonstrates their increasingly significant contemporary impact. Identifying the video features that affect student engagement as a success indicator can therefore contribute to the effective use and design of educational videos. Panning is such a potential video recording and presentation feature/technique. The aim of this study is to reveal the ways panning is accomplished in videos and discuss implications for instructional design. Panning is to record a smaller section of a screen, relevant to the instructional activity, instead of recording the entire screen during video recording. It differs from regular video shots as it refers to the recording of the computer screen or any other display in that manner, whereas regular videos record everyday objects. It is a strategy used during the recording of educational videos developed for software education. It is a design consideration especially for creating educational materials to be displayed in mobile devices due to their small screens. To date, panning has not been comprehensively conceptualized as an educational technique for software education. In this study, the possible types of screen-recording in terms of panning are identified based on video review. Secondly, examples from one of the popular video-sharing sites — YouTube — are identified and presented using these panning types. Finally, a comparison is made between full-screen and panning videos. The implications of panning for instructional purposes are examined. A concise and useful guide is provided for instructional designers interested in creating more effective instructional videos.

Article Info: Research Article

Keywords: *Online learning, panning, screen capturing, software education, video recording*

1. Introduction

In the digital age, with the explosion of available information and the rise of multimedia, the need to simplify complex information has grown significantly (Çaka & Dursun, 2022). The dramatic advances in information and communication technologies in recent years, particularly the rapid expansion of broadband Internet access at home and at school, have led to a reshaping of the educational landscape and the increased use of video in the university environment. Since videos deliver content through auditory and visual means,

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they are potentially more effective at facilitating learning than still content (Berney & Bétrancourt, 2016). Animation- and video-like dynamic visualizations that are able to show time-based transitions in motion have been demonstrated to be especially fruitful for action-dependent instruction (Berney & Bétrancourt, 2016; Höffler & Leutner, 2007).

It is an observation that an increasing number of teachers and academicians are using videos that they produce themselves to address pedagogical concerns that center on improving learning. Their inclination towards incorporating videos is expanding, encompassing both structured learning environments like learning management systems within schools, as well as more casual learning experiences found outside traditional classrooms, as exemplified by platforms like YouTube (Mehrvarz et al., 2021). There has also been a significant surge in video-based instructional activities at universities, course centers, and schools especially during and due to the COVID-19 epidemic (Merkt et al., 2022). So, their use in higher education is growing every day, thanks to research support (Hsin & Cigas, 2013; Kay, 2012; Lloyd & Robertson, 2012; Moore & Smith, 2012; Rackaway, 2012; Schmid et al., 2014; van der Meij & Dunkel, 2020; Vieira et al., 2014) and advances in technology (Seo et al., 2021), indicating that they will continue to contribute to learning as an effective and popular learning tool.

This steady inclination in educators' use and interest — and their improved technological ability to practically create and share videos with the advancement of technology — has created potential opportunities for incorporating videos into instruction in many different contexts. In that manner, as instructional tools, educational videos have become an important asset of higher education. Such videos were first utilized in traditional courses, but as learning management systems evolved, they have become the main support material for many blended courses, the foundation for courses that are based on flipped learning, and the core method for delivering content in massive open online courses (MOOCs) in distance education. And research has demonstrated that videos are an efficient method for facilitating learning (Müller Werder et al., 2018; Noetel et al., 2021).

The production of high-quality educational videos is crucial to providing students with a learning experience tailored to their unique needs and preferences. Incorporating videos into lessons is an excellent approach to enhance students' learning experiences, and there are numerous sound pedagogical reasons why educators should include self-produced video lessons or scenarios in their teaching. By recreating live lectures through video materials, educators can improve the flexibility of studying for students, allowing them to catch up on missed lectures at their convenience. Based on expert opinion and the Broadcast Allocations Committee of the UK Open University, Koumi (2006) describes three different instructional approaches that add value to instruction by leveraging the benefits of video: (1) supporting learning and skill development, (2) providing vicarious experiences, and (3) fostering motivations and emotions. In this regard, videos can be used, for example, to initiate conversations (Boyd et al., 2011), encourage debate (Palaigeorgiou & Papadopoulou, 2019), show real-world connections (Boyd et al., 2011), illustrate solutions to problems (Meyers Martin & Lampert, 2013), and solicit expert feedback (Yagmur et al., 2014). They provide an excellent way to make a course more flexible (Müller Werder et al., 2018), increase the amount of interaction (Vural, 2013), and allow for self-paced instruction (Robinson, 2021). The information provided in videos has the potential to go beyond traditional lectures and provide a variety of educational materials, such as lab prep, hands-on exercises, and advanced course presentations, to meet students' specific interests and open up limitless possibilities.

Software education is another context where videos have great potential. Recent years have seen new creative uses of screenshot technology as a tool for both student and teacher feedback and student assessment (Soto & Ambrose, 2016; Vincelette & Bostic, 2013). Studies show that students generally view the use of screen recordings and video lectures very positively and find them helpful (Green et al., 2012; Kinnari-Korpela, 2015; Tunku Ahmad et al., 2013).

However, not all software education videos are equally effective. Generating videos that are useful to students necessitates a deeper dive into instructional video design and production. Therefore, thoughtful research is necessary for the identification of instructional design principles for multimedia. To address this need, a potential approach involves examining principles derived from an awareness of how individuals acquire knowledge from textual and visual elements. The Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2008) posits a few fundamental assumptions about learning: the dual channel assumption, which suggests that individuals possess two distinct tracks for handling visual and verbal information (Paivio, 1990); the assumption of limited capacity, indicating that individuals can only handle a certain amount of content within a channel at any given time (Baddeley, 1997); and the active processing assumption, which asserts that effective knowledge acquisition is achieved when students actively seek appropriate information, arrange it into a cohesive framework, and incorporate it into appropriate previous learning (Wittrock, 1989). Instructional video design has points of departure from all three of these assumptions. However, some aspects of screen-captured videos may be simpler but go beyond these assumptions. For example, the issue more specifically concerns the *visual channel*. While online video resources have created new opportunities for education, they have also created new educational issues to be overcome, especially in terms of software education that relies on screen captures and mobile learning. Screen size and resolution are some of such challenges.

Many educators record software screens for the purpose of quickly providing educational materials to their students without much thought as to how their videos will be viewed and understood. High-resolution screenshots have a lot of detail. They look great on large screens, but cannot be viewed effectively on small screens without zooming in. Video does not allow for easy zooming, and may not even be practical for zooming, as it is difficult to temporally keep the focus on moving parts. So, it is a challenge to take full-size, high-resolution screen recordings and show them to viewers. One solution is to resort to panning.

Panning is the practice of capturing a smaller portion of the screen that is relevant to the instructional activity, rather than the entire screen during video recording, and is a strategy used in the production of instructional videos for software training. It is a design consideration for creating instructional materials that may be particularly useful for viewing on mobile devices due to their small screens. To date, panning has not been comprehensively conceptualized as an instructional technique for software education. Given these premises, the goal of this study is to conceptualize panning in this context, demonstrate different types of panning with examples, and discuss its effectiveness.

2. Panning Overview

Panning in instructional software videos can be conceptually linked to several principles proposed in Mayer's (2009) CTML, one of the most influential theories in the field of multimedia learning. This theory provides a framework for instructional design and includes 12 fundamental principles that have been further explored and expanded upon in subsequent research. When considering panning, the following principles are particularly relevant:

Coherence Principle: This principle suggests that extraneous or unnecessary elements should be minimized to promote a clear and coherent learning experience. Panning may affect the coherence of instructional materials by potentially fragmenting the visual presentation. However, it is important to ensure that panning is used purposefully to support the learning objectives and not detract from the main message. Excessive or unnecessary panning can be distracting and lead to cognitive overload.

Signaling Principle: According to this principle, the effectiveness of learning is enhanced when individuals are guided to focus their attention on specific elements presented on the screen. Panning can be used as a signaling cue to direct learners' attention to specific areas

of the screen. If the content creator pans to relevant elements or highlights important content, learners can focus their attention on the key information being presented.

Spatial Contiguity Principle: This principle emphasizes the importance of presenting corresponding words and visuals in close proximity to reduce cognitive load and enhance learning. Panning can impact the spatial contiguity of information, as it involves moving the frame or altering the visual field. Panning can be used to show the spatial relationships between different elements on the screen. When the content creator pans across the screen, learners can see the connections between different parts of the content in varying degrees, possibly affecting their understanding of the relationships between objects or concepts.

Redundancy Principle: This principle advises the exclusion of unnecessary information and advises against unnecessary repetition as it can overload the learner's cognitive resources. Usually thought of in terms of the redundancy of text and narration presented together, it can also be thought of in terms of how unused visual elements can create unnecessary repetition of information over time. Panning can help by presenting less repeated information at any given moment in the video.

Multimedia Principle: This principle suggests the effective use of text and visuals. Panning can enhance multimedia presentations by providing visual movement and variation. It can help the content creator choose the text-visual composition dynamically and carefully. The combination should assist the learner in better understanding the information.

Viewing panning from Mayer's perspective tends to emphasize the benefits of panning. However, it is important to acknowledge that panning may also impose limitations on learners' visual perception. The Cognitive Load Theory (CLT) (Sweller, 1988) offers valuable insights into how panning can hinder learners' ability to grasp the big picture. According to CLT, learners possess limited cognitive capacity for processing and storing information in their working memory. Dealing with complex learning tasks, such as comprehending the overall structure or organization of a concept, can potentially overload cognitive resources.

In the context of panning in software education videos, the limited viewing area caused by panning can restrict learners' access to the entire visual context. This limited field of view can hinder learners' ability to perceive the overall structure, relationships, and connections within the content. The smaller the captured area, the larger the restriction. The fragmented view resulting from panning can lead to a fragmented mental representation of the information, making it challenging for learners to integrate and synthesize the material effectively.

By restricting the visual field, panning can increase the cognitive load on learners as they must mentally piece together the fragmented information to construct a coherent understanding of the big picture. The reduced spatial contiguity resulting from panning can disrupt the natural flow of information, requiring additional cognitive effort to mentally connect the dispersed elements.

Therefore, from a theoretical perspective, panning in software education videos can have implications for cognitive load. It is crucial for instructional designers to take into account the potential cognitive load effects of panning and carefully balance its usage with other instructional strategies to ensure learners can effectively perceive and comprehend the big picture of the presented content.

The shift towards digital and blended learning and teaching, particularly accelerated by the COVID-19 epidemic since 2020, has significantly impacted the production frequency and methods employed for digital videos. Panning is one such method that content creators can utilize through various screen recording software options like Adobe Captivate and Blender. This technique holds particular implications for mobile learning, which has opened up new horizons in education by offering enhanced convenience, accessibility, and efficiency for both educators and students. Notably, mobile learning technology places high

dependence on screen size when it comes to the electronic devices used. In our smartphone-driven era, where most tasks are performed on mobile devices, effectively utilizing images and videos on limited mobile screens has become paramount. Educational videos recorded from computer screens can pose challenges in terms of comprehension when viewed on mobile phones. Nonetheless, it is crucial to give due consideration to display size, not only for mobile screens but also for computer screens, as an attentive approach to this aspect is essential.

Panning has different meanings in different situations. In regular video recording, clips are shot using cameras. There are a number of ways to capture a shot. For example, Storyblocks (2019) lists 7 basic camera movements, such as zoom, tilt, and dolly, for shooting video clips. Pan is one of them. In this setting, pan (or panning) refers to the horizontal movement of the camera (see Fig. 1). However, the camera itself is usually fixed in one place while being rotated to the left or right along its axis to record. In this mode, the camera continuously photographs objects from a particular perspective, while the appearance of the objects changes depending on the camera angle.



Fig. 1. Illustration of panning in regular video recording. The leftmost and rightmost images represent the initial and final frames of the recording, respectively. These images demonstrate the changing perspective of the visible portion of the object—a small box in this case—throughout the recording, aligning with the concept of pan as described by Storyblocks (2019).

Panning in screen capture is different, at least in the context of this article. It involves capturing a small portion of a desktop or similar screen, rather than the entire screen, and it does not involve a camera. It has a limited set of capabilities in this regard. The area being captured is moved around the screen according to mouse movement or preference. Many content creators use this to fit their content into a small, published video display size, or for personal preference, perhaps believing that it makes the video look better. Because the size of the video recording—the area the video covers on the screen, or the resolution of a video—can only be constant for the entire video, the idea is to have a continuous video recording. It is common practice to keep the size constant.

There are not many research studies that investigate panning or discuss its effectiveness or impact on learning. This study is an attempt to present a conceptual understanding of the term in the context of software education.

3. Methodology

After reviewing educational videos available on the Internet and drawing from personal viewing experiences, this descriptive and comparative research study begins by conceptualizing the different types of screen recording with respect to panning. Subsequently, a selection of examples showcasing these panning techniques is gathered from YouTube, a popular video-sharing platform, and presented alongside their corresponding panning types based on content analysis. Finally, to facilitate readers' comprehension of the impact of panning on the viewing experience, screenshots of an educational video are included, showcasing both the full-screen and panned versions for direct comparison.

For the comparison, a concise tutorial video on Microsoft Excel was created using Adobe Captivate version 11.5.1.499 for Windows. From the initial tutorial video, two distinct versions were generated using Blender

version 3.2.2 for macOS. The first version retained the original size, displayed at full-screen with a resolution of 1592×856 pixels. The second version demonstrated the panning effect, showcasing a smaller size at 796×428 pixels, representing half the width and height of the original video. These videos were then uploaded to a test server and played using Firefox Browser version 112.0.2 (64 bit) for macOS, utilizing the responsive mode feature to simulate a mobile device screen. The setting in Firefox to simulate the mobile device was iPhone 12/13 + Pro iOS 14.6 Safari 14. Screenshots capturing the same moment in time were taken and presented for analysis.

Throughout this paper, as shown in Fig. 2, the figures illustrating the panning concepts use the conventions *A* and *B* to refer to the source screen and the target video, respectively, and the figures presenting the actual examples use the conventions *S1* and *S2* (and consecutive numbering) to refer to the screenshots of the same video taken at progressive times. Additionally, *V1* and *V2* represent two different videos if they are presented in a single figure.

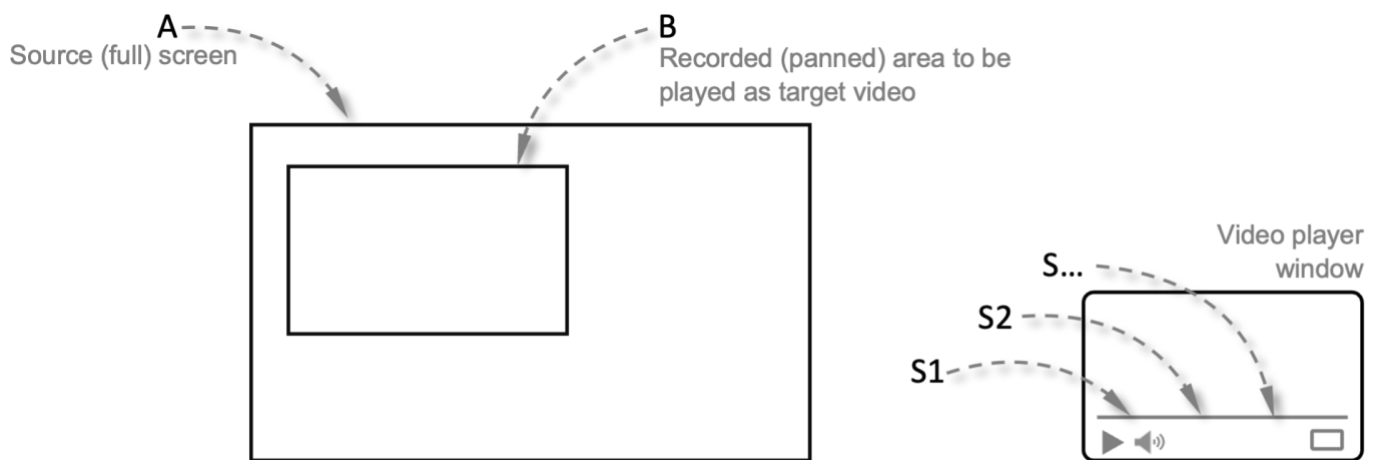


Fig. 2. Figure labeling conventions used throughout the paper.

4. Results

Different approaches are required in terms of presenting content when it comes to recordings of software screens, unlike regular videos. However, before continuing with the presentation of information on panning, it should be noted that the conversation revolves around the phrase *display resolution*, which is referred to as the number of horizontal and vertical pixels that compose a screen or projection area (for example, 1920×1080 pixels). It should be noted that it implies nothing about the density of the image displayed to the viewers. The same display resolution can exhibit high density on a tiny display device, while a larger display device may present the same display resolution with lower density. The density, measured in pixels per inch (PPI), is determined by the technology used to display the image to the audience. A higher quality appearance is usually indicated by a higher density. In this paper, the issue is discussed using the display resolution because the content is seen by the viewers without our discretion.

4.1. Definition & Classification of Panning

Several different types of panning can be used for screen recording (see Fig. 3–Fig. 11). You can also find videos with a combination of these types. Some of these effects are achieved during recording, while others are achieved during publishing. It was possible to identify five distinct panning types that are presented in the following sections. The illustrative drawings in Fig. 3 through Fig. 11 deliberately include shapes of different types and colors, including proportional representations of windows found in the Windows

operating system. The shapes have been drawn proportionally so that they can be visually compared in size between the source and target.

4.1.1. Simple Panning

One of the simplest ways to achieve panning, which I call *simple panning*, is shown in Fig. 3. Only a small portion of the screen is captured to be displayed as the target video (B) by the software used to capture a source screen (A). The objects on the source screen appear the same size in the published (target) video when this way of recording is enabled. In other words, when the resulting video is played on the source display, the objects will appear the same size as the original. Software programs that allow such capture usually let content creators see what part of the screen is being captured by marking it with a frame. In such programs, in addition to manual frame movement, there are usually options to have the frame move automatically to follow the mouse action during recording.

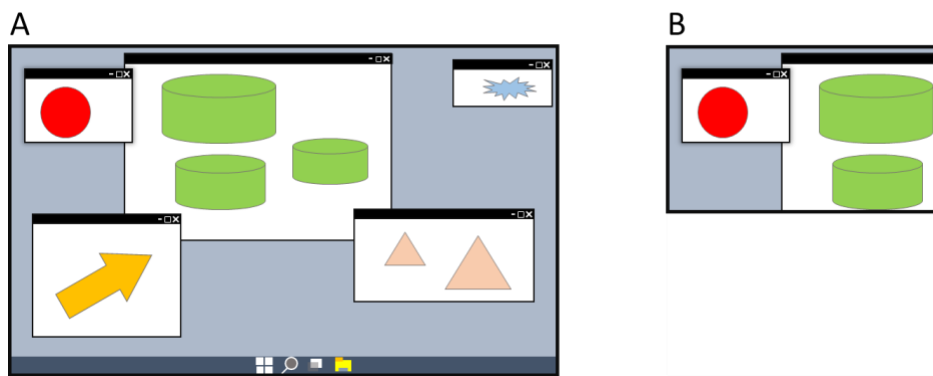


Fig. 3. A: The source screen being captured (e.g., 1920×1080 pixels); B: The published target video size shown to the audience (e.g., 960×540 pixels). Object sizes remain the same between the source screen and the target video.

Fig. 4 showcases two illustrative shots that exemplify the simple panning technique described in Fig. 3. In this particular example, it is effortless to distinguish the icon and text items. While the objects maintain their clarity when the video is viewed at its original size, some blurring becomes noticeable when it is viewed in full-screen mode. Fig. 4 provides a coherent and continuous image flow, particularly evident when tracing the Windows taskbar from S1 (Screenshot 1) to S2 (Screenshot 2), offering viewers a glimpse into the size of the source desktop. Another noteworthy instance of simple panning can be observed in the tutorial video titled “Tutorial How To Add a Captivate Scorm Package To Moodle 2.2” available on the web (https://www.youtube.com/watch?v=p7yFO_9GE8M).



Fig. 4. Screenshots from “Sample of Captivate 5.5 Panning Sample” (<https://www.youtube.com/watch?v=HpCIKxMq2Xg>). It demonstrates an example of simple panning. S1: Full screen shot at 00:02; S2: Full screen shot at 00:15.

4.1.2. Close-up Panning

An additional way in which panning can be implemented in videos is depicted in Fig. 5, and this method is referred to as *close-up panning* throughout the paper. It should be emphasized that this is a hypothetical method. The idea is presented merely to demonstrate its feasibility and indicate the possibility, and it is believed that this technique would not be preferred by anyone due to the requirement of additional storage space compared to the method illustrated in Fig. 3. However, this sort of video may inadvertently be created by inexperienced content creators when adjusting settings in video recording or editing software. It differs from Fig. 3 in that a portion of the source screen is enlarged to fit the full screen while being recorded or during publishing. The point is that the resolution of the target video is greater than the resolution of the captured portion of the source screen. The full screen source and target display resolutions remain the same. In such recordings, the objects in the video would appear larger than the original objects when displayed in the source screen. Moreover, since it is not possible to reproduce the objects on the screen to be larger while maintaining the same quality, the visuals will unavoidably appear blurry in the video if played on the source screen.

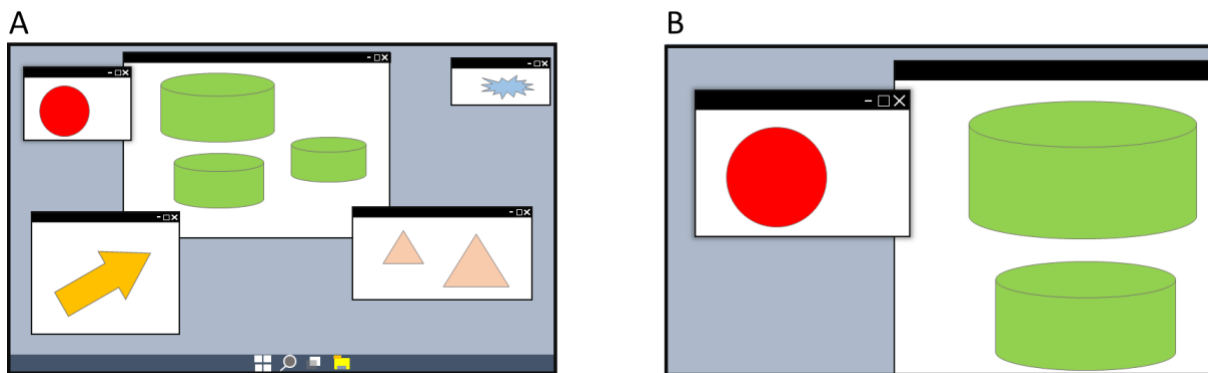


Fig. 5. A: The source screen being recorded (e.g., 1920×1080 pixels); B: The published target video shown to the audience (e.g., 1920×1080 pixels). Object sizes in the target video appear larger than the ones in the source screen.

4.1.3. Zoom-out Panning

Another panning method that combines the simple panning technique shown in Fig. 3 with the utilization of the entire screen as shown in Fig. 6 is referred to as *zoom-out panning* in this paper. Typically, this merging process is performed in capable software during publishing rather than during recording. The full screen (B, top image) and the part of the screen (B, bottom image) are switched back and forth in the video as deemed necessary by the content creator. The resulting display video resolution is smaller than the source screen resolution. Alongside the explanation given for Fig. 3, when the entire screen is displayed in the video (B, top image), the objects in the video are portrayed smaller than the original screen. The switching between the views in this method can also be attributed to a zoom-out effect. However, for this action to be considered panning, it is expected that there will be some sort of movement of the recorded frame for the bottom image. Due to the video display resolution being lower than that of the source screen, the objects will appear blurry in any view when the video is played full screen on the source screen but have the same quality or better when played at the native size.

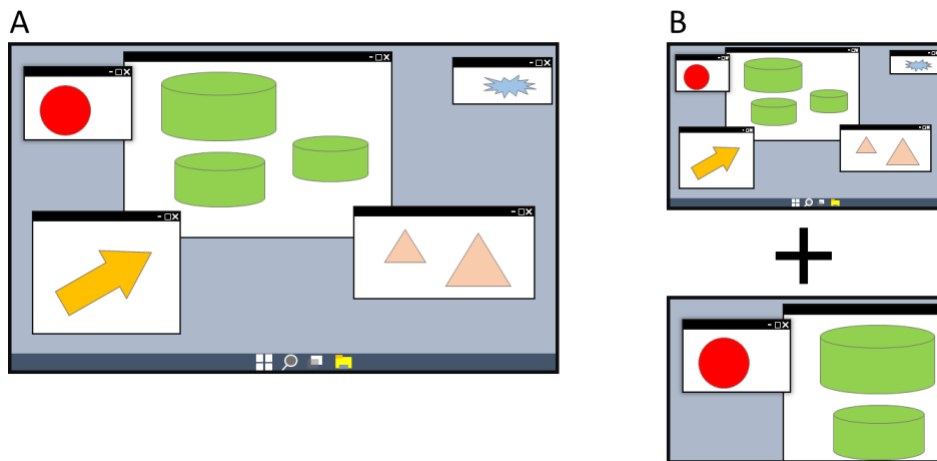


Fig. 6. A: The source screen being recorded (e.g., 1920×1080 pixels); B: The published target video shown to the audience (e.g., 960×540 pixels). Object sizes remain constant between the source screen and the bottom target video, but objects appear smaller in the top target video.

Fig. 7 showcases illustrative examples of the zoom-out panning technique outlined in Fig. 6. In the initial shot (Fig. 7 S1), discerning the icons and their names proves challenging. However, as the panning commences, the information displayed on the screen gradually becomes legible within the video (Fig. 7 S2). This dynamic shift in visibility highlights the effectiveness of the zoom-out panning approach in enhancing the readability and clarity of the captured content.

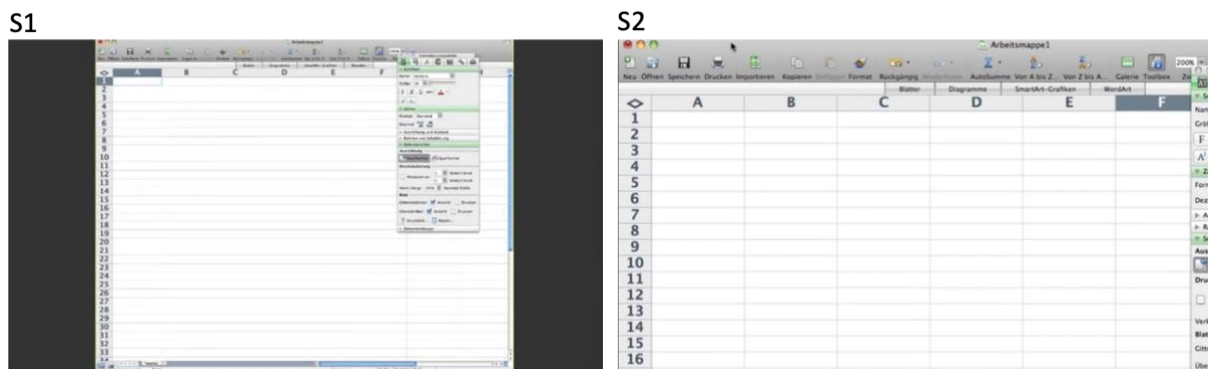


Fig. 7. Screenshots from “Zoom & Pan with Adobe Captivate” (<https://www.youtube.com/watch?v=qamkh2hr23E>). A combination of zoom-out panning and zooming is visible. S1: Full screen shot at 00:08 (the black background is visible at the original video); S2: Partial screen shot at 00:11.

4.1.4. Zoom-in Panning

Fig. 8 depicts yet another panning method that combines the close-up panning technique presented in Fig. 5 with the utilization of the entire screen. This method, referred to as *zoom-in panning* in this paper, is typically implemented during publishing in capable software, rather than during recording, by merging the two techniques. The switching between the full screen (B, top image) and the part of the screen (B, bottom image) is performed by the content creator as deemed necessary throughout the video. The resulting display video resolution remains the same as the source screen resolution. Building upon the explanation provided for Fig. 5, when a section of the screen is displayed in the video (B, bottom image), the objects in the video appear larger than the original screen. The switching between the views in this method can also be attributed to a zoom-in effect. However, for this action to be considered panning, some movement of the recorded frame for the Fig. 8 B bottom image would be anticipated. Since the video display resolution is the same as that of the source screen, when the video is played full screen on the source screen, the objects in the partial view will appear blurry because the part of the screen must be enlarged to fit the full screen.

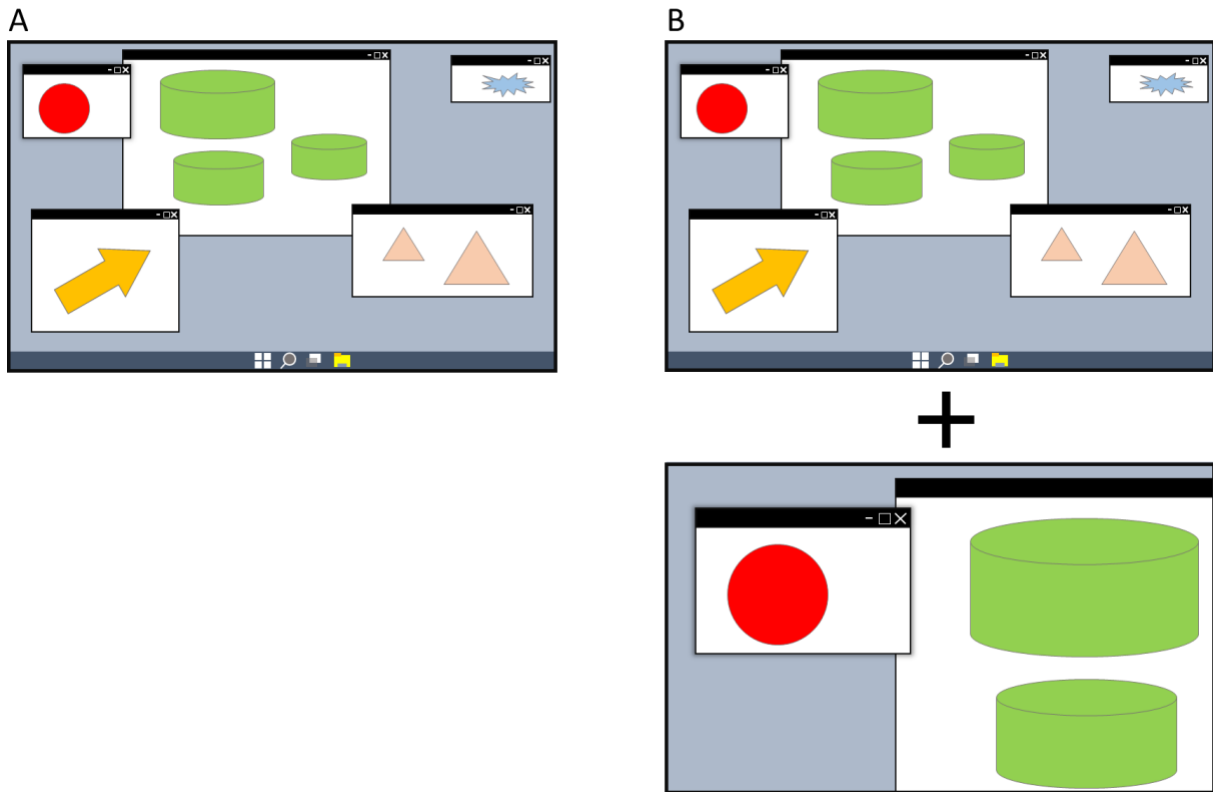


Fig. 8. A: The source screen being recorded (e.g., 1920×1080 pixels); B: The published target video shown to the audience (e.g., 1920×1080 pixels). Object sizes remain constant between the source screen and the top target video, but objects appear larger in the bottom target video.

Fig. 9 and Fig. 10 provide concrete examples that illustrate the concept of zoom-in panning as presented in Fig. 8. These screenshots serve as visual references to demonstrate the application of zoom-in panning in action. Within the figures, S1 represents the full screen view, while S2 represents the partial screen view of the published video at a different point in time. Notably, the display resolution of S1 corresponds to that of the source screen, matching in visual quality and clarity.

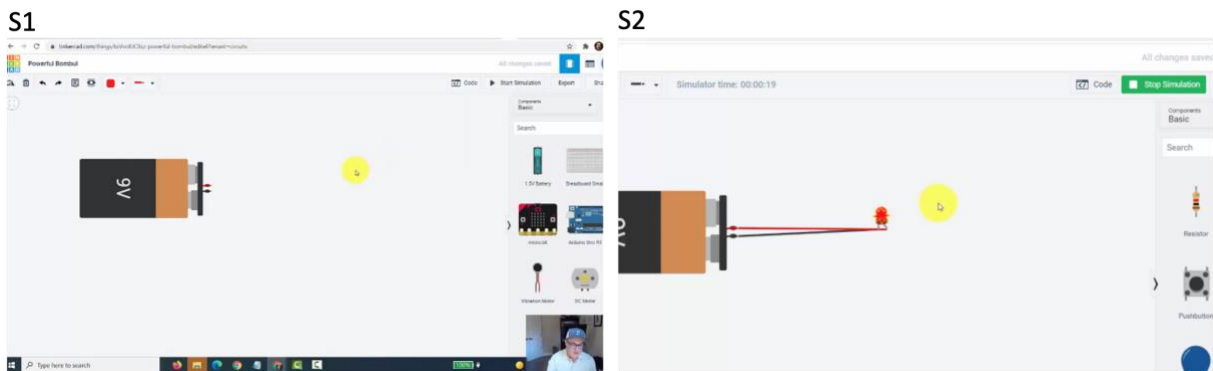


Fig. 9. Screenshots from “Learn Arduino and Circuits with Tinkercad!” (<https://www.youtube.com/watch?v=Xgj5L7UOJDw>). A combination of zoom-in panning and zooming is visible at least between 8:00 and 9:10 minutes. S1: Full screen shot at 7:54; S2: Partial screen shot at 8:56.

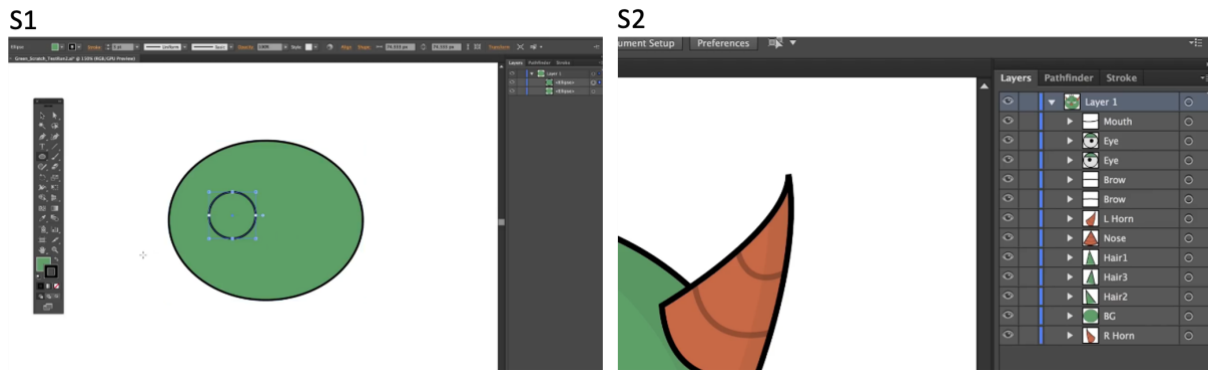


Fig. 10. Screenshots from “Making Your First Character - 2016 Version (Adobe Character Animator Tutorial)” (https://www.youtube.com/watch?v=_smLXODTd6U). A combination of zoom-in panning and zooming is visible at least between 3:38 and 4:50. S1: Full screen shot at 1:30; S2: Partial screen shot at 2:52.

4.1.5. Drag Panning

A final type of panning, called *drag panning* in this paper, is showcased in Fig. 11. This technique bears similarities to Fig. 3 in terms of capturing different sections of the screen, with one key distinction: instead of moving the frame on the source screen, content creators have the flexibility to both drag objects into and out of the recorded area or frame. By employing a mouse or any other suitable method, creators can seamlessly drag objects into the frame to include them in the recording or drag them out as needed. This dynamic approach grants creators the freedom to adapt the composition and content captured within the recorded area, ensuring a comprehensive representation of their desired visual elements.

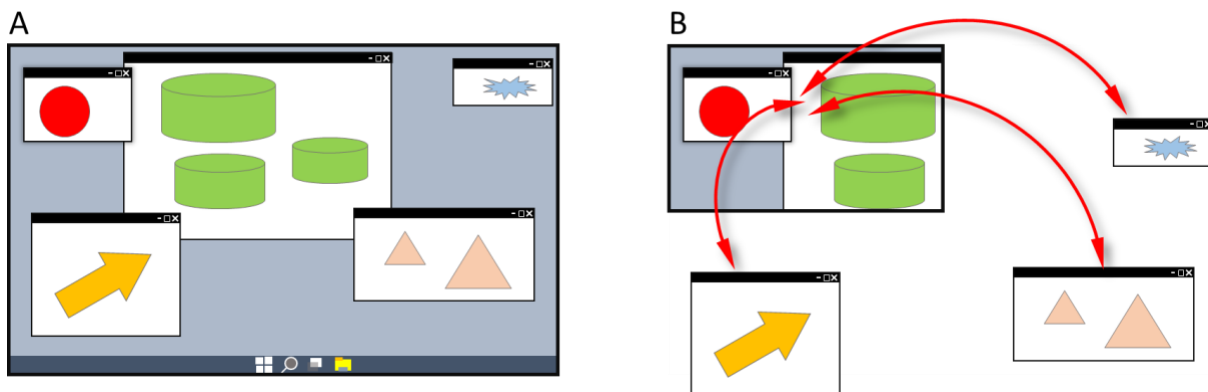


Fig. 11. A: The source screen being recorded (e.g., 1920×1080 pixels); B: The published target video shown to the audience (e.g., 960×540 pixels). Red arrows depict the mouse drag actions through which objects are brought to the recorded area (frame) to be captured.

Fig. 12 presents a set of example screenshots extracted from a video that showcases the implementation of drag panning, as demonstrated in Fig. 11. In this figure, the dynamic nature of drag panning is evident on several occasions. In screenshot S1, a toolbar located on the left side of the screen is displayed, illustrating how objects can be dragged from outside the captured area into the frame. On the other hand, in S2, the recorded area encompasses the same region, yet the previously shown toolbar is no longer visible. Instead, a different toolbar (specifically, a timeline) has been dragged into the frame, while a red rectangle is also presented, representing an additional element captured within the recording.

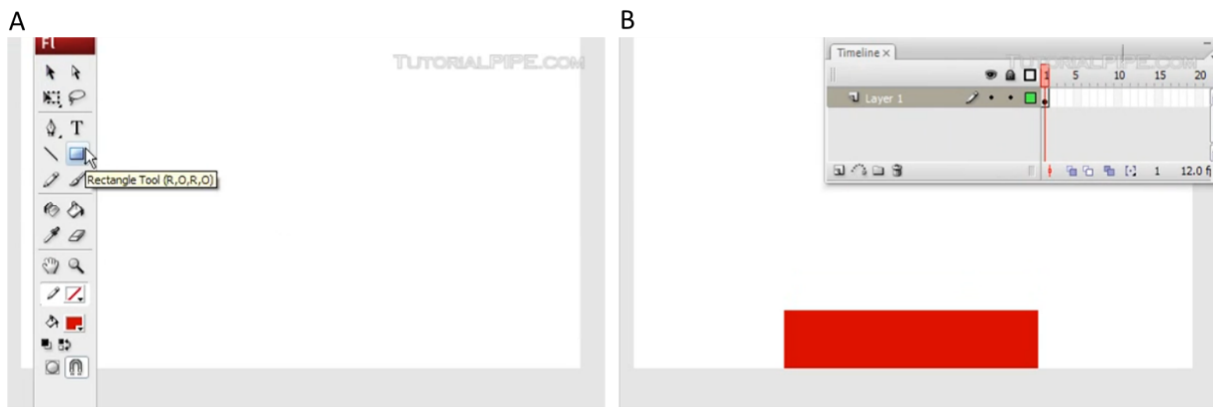
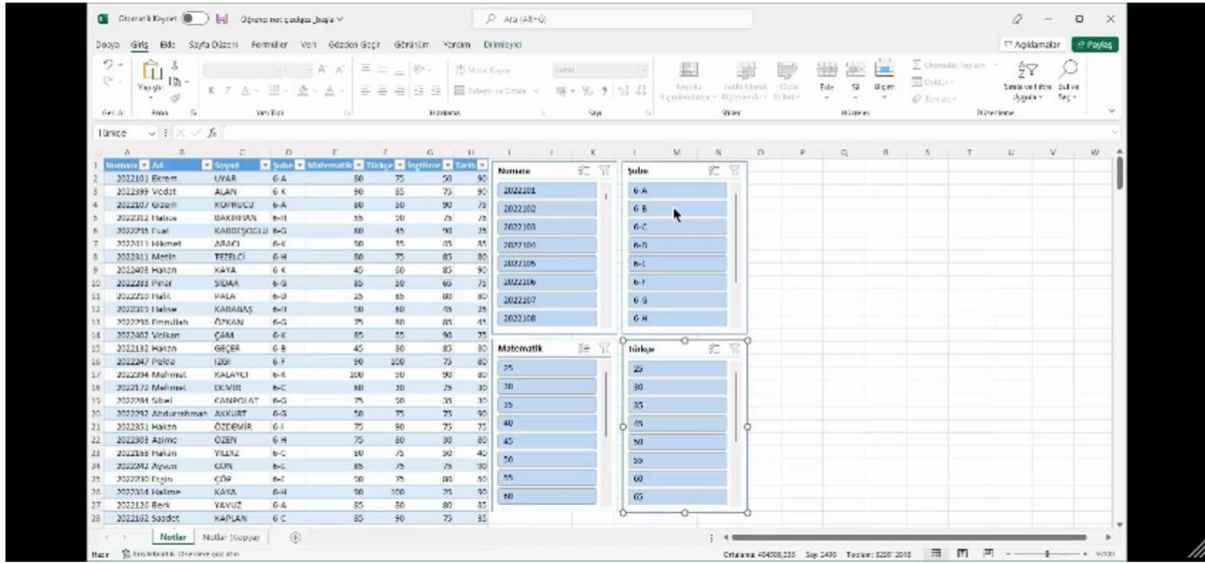


Fig. 12. Screenshots from “Elastic shape tween” (<https://www.youtube.com/watch?v=4FCTkz27vA8>). It demonstrates drag panning. S1: A toolbar is visible at the left side at 00:04; S2: The toolbar was dragged out and the timeline was dragged in and is visible on the top right side at 00:20.

4.2. Full Screen vs. Panning Comparison

The techniques and figures presented so far explain how a source screen can be captured or presented in a video using different panning techniques. They also demonstrate the different moments in time of the same video. However, they do not allow us to understand how the viewer's experience differs when viewing the full-screen video and the panned video on the same device. Therefore, it would also be useful to explain how videos created in full-screen and panning formats would compare in terms of viewer experience in different display sizes. The visuals in Fig. 13, whose creation procedures were explained in the Methodology section, are actual screenshots of the same video produced (saved) in two different ways — one at full screen, the other at panning. That is, the figure shows two different videos with screenshots taken at the same point in time when played.

V1.S1



V2.S1

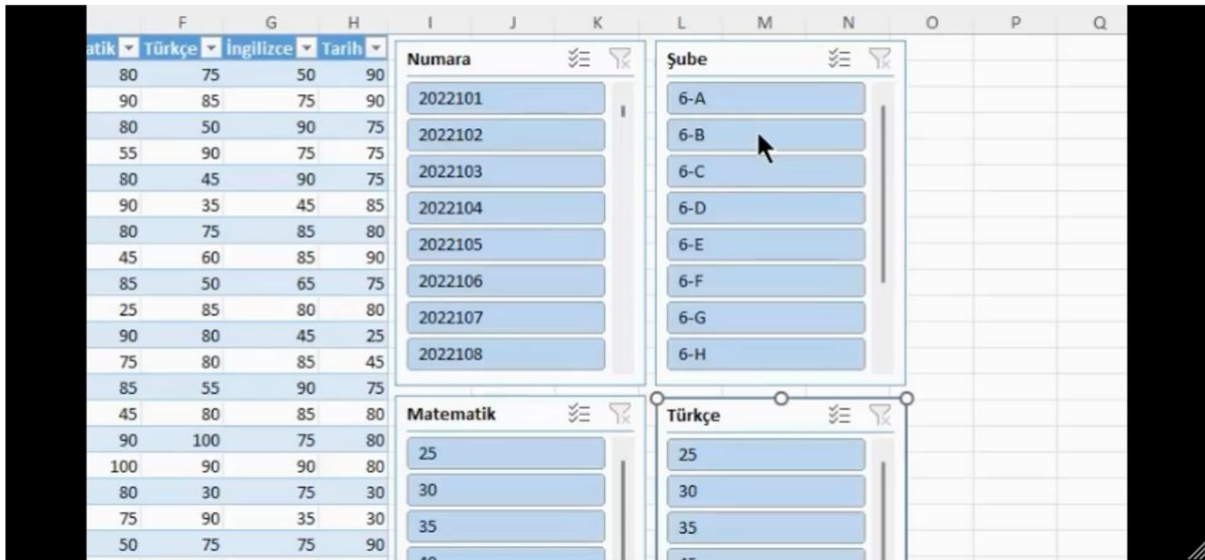


Fig. 13. Based on a video tutorial on Microsoft Excel, V1.S1: Screenshot of the full screen version of the video (1592×856 pixels); V2.S1: Screenshot of the panned version of the video (796×428 pixels). Device model and size where the video was tested: iPhone 11 Pro IOS 14.6 simulated in Mozilla Firefox version 112.0.2 (64 bit) for macOS.

As depicted in Fig. 13 V2.S1, the text and icons offer a significantly better viewer experience. It is almost impossible to read the information in Fig. 13 V1.S1. Although the captured area in the panned video (Fig. 13 V2.S1) is twice the size of the actual video (Fig. 13 V1.S1) in both height and width, the area covered in the panned video is four times greater when viewed on the same device. Consequently, panning provides enhanced readability, particularly when viewing on mobile devices.

However, in terms of comprehension, the big picture is not visible in the panned video (Fig. 13 V2.S1). Excel's tabs and buttons are not fully visible, so viewers must rely on their understanding based on previous or subsequent visual information if the creator chooses to navigate the entire screen and include all necessary details in the video.

5. Discussion

The advancement in monitor technology has led to an increase in screen resolutions and physical dimensions, with 1920×1080 pixels becoming the standard for larger screens. While such resolutions are suitable for viewing computer software education videos on computers, they pose challenges when viewed on smaller devices such as smartphones. One solution to this problem is the use of panning to create videos specifically tailored for small screens. Panning can be advantageous in comparison to full-screen recording, particularly in terms of coherence, redundancy, and signaling.

Trypke et al. (2023) discuss redundancy in terms of two perspectives: (1) content redundancy and (2) working memory channel redundancy. Both perspectives suggest that there is extra material doing the same job as already-presented material. However, these perspectives do not directly address the redundancy effect a full-screen video presents. A full-screen video shows all parts of a screen, whereas only a certain part of the screen is needed to show the necessary action or content. In other words, seeing the rest of the screen throughout the whole video becomes redundant. This point can also be addressed from the coherence point of view, which supports that all extra information other than that needed for learning outcomes should be excluded from a learning material (Cavanagh & Kiersch, 2023). Therefore, from the point of redundancy and coherence, panning is a positive method against full-screen recording.

Moreover, signaling advocates the inclusion of elements that draw the viewer's attention to important parts of a learning content (Mayer, 2009). According to Alpizar et al. (2020), research on signaling has produced mixed results in terms of its impact on learning performance. Nonetheless, it is considered a good practice to help viewers locate relevant information as their meta-analysis yielded positive learning results with varying effect sizes. There are different ways to signal information, such as using arrows, different colors, highlights, and even non-visual cues like vocal intonations (Alpizar et al., 2020). Panning, visually, accomplishes this by moving/restricting the viewer's attention to the framed point and excluding other parts of the screen. Thus, from this perspective, panning can be considered an effective way to signal information in comparison to full-screen recording.

However, panning may have both advantages and disadvantages compared to full-screen recording with respect to Mayer's spatial contiguity and multimedia principles. Spatial contiguity suggests that related text and graphics should be presented closer to each other (Woollacott et al., 2023), implying that instructional designers should place related items close to show their association and unrelated items apart to imply their disassociation. In the context of panning, it may not always be possible to change the placement of most objects during recording. Panning may help focus on a certain part of the screen with related information together, but it may restrict the presenter because the panned part of the screen moves away from other relevant parts, essentially usually the parts of a software screen. In other words, while panning, only a limited part of the screen can be shown as related, potentially missing the big picture. For instance, when an action is taken in one part of the screen, a resulting action may appear in a different part of the screen not visible to the viewer during panning. This aspect is not commonly discussed in the relevant literature. From this perspective, it may also be discussed in terms of temporal contiguity, which suggests that relevant information should be shown simultaneously, not sequentially (Cavanagh & Kiersch, 2023). Thus, it is necessary to acknowledge that panning brings some challenges in terms of contiguity.

Furthermore, the multimedia principle advocates that instructional designers should prefer to present images and text together instead of providing information solely through text (Mayer, 2014). While panning does not directly intervene with the placement of objects, it can enhance multimedia presentations by contributing visual movement and variation. Selecting images that add to the understanding of information for learning is key to this principle.

By employing panning, content creators can ensure that important information is visible and legible on smaller devices, compensating for the limitations imposed by screen size. In contrast, videos created with screen capturing techniques often suffer from reduced content visibility on mobile phones and tablets,

where the shrinking display dimensions limit the viewer's access to relevant information. While zoom-in techniques are commonly used to enlarge specific content of interest in software education videos, panning offers an alternative method to maintain readability while providing a broader context.

This study delved into various panning techniques observed in YouTube videos and categorized them accordingly. Notably, these panning techniques are not limited to educational videos but can be found across different contexts on video-sharing sites and social media. The versatility of panned videos suggests that regardless of their purpose, whether for educational or recreational purposes, content creators have embraced panning as a way to enhance their videos. In this paper, information is presented with reference to the source screen. It is assumed that the person making the recording is comfortable with the size of the objects displayed on the screen and would likely assume that the viewer will have the same experience. However, it is important to acknowledge that the size of objects on the source screen is not the only determining parameter, and panning alone does not guarantee an optimal viewing experience. Other factors, such as resolution and the viewer's device, also influence the overall experience.

Content creators face a trade-off between readability and comprehensibility when deciding on the capture area for their videos. A smaller capture area facilitates reading but may hinder the viewer's ability to grasp the bigger picture. On the other hand, a larger capture area encompasses the entire screen but can present challenges, particularly on small-screen mobile devices. Even small-screen desktops can encounter difficulties when high-resolution videos are viewed at lower resolutions. Therefore, a balanced approach is necessary, considering the specific content being presented and the target audience, using the principles suggested by Mayer (2009).

6. Conclusion

Panning proves to be a valuable technique for presenting content on small screens to overcome screen size limitations in software education videos, allowing viewers to focus on key elements while maintaining readability. However, it comes with a trade-off in that it limits the viewer's ability to see the entire source screen, thereby limiting their access to the big picture. It is necessary to emphasize the importance of using panning judiciously, taking into account the specific content and audience. Depending on the context, content creators may opt for zoom-in techniques that provide a closer view of relevant information while preserving the overall context. By considering principles such as coherence, signaling, spatial contiguity, redundancy, and multimedia principles from the Cognitive Theory of Multimedia Learning (Mayer, 2009), as well as insights from Sweller's Cognitive Load Theory, content creators can strike a balance between engagement and cognitive load, ensuring an effective learning experience in software education videos.

6.1. Limitations

In this paper, it is important to acknowledge a limitation regarding the consideration of video compression techniques and various video formats employed during the storage of videos. Notably, there exist numerous technologies encompassing different compression methods and formats. However, for the purpose of this study, the focus was placed on assuming that the recorded videos accurately capture the quality of the source screen. While this approach facilitates an examination of the panning techniques and their impact on visual representation, it is imperative to recognize that the broader aspects of video compression and format variations were not explicitly accounted for. Acknowledging this limitation paves the way for future research to explore the influence of these factors on overall video quality and viewer experience.

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