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Effects of instructor-present videos on learning, cognitive load, motivation, and social presence: A meta-analysis

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Abstract
Although instructional videos with on-screen instructors have become prevalent in various learning contexts, their effect has been questioned because of mixed findings in the literature. This meta-analysis study aimed to elucidate the overall effect of instructor-present videos on learning, cognitive load, motivation, and social presence and to indicate potential moderators. It analyzed 20 experimental studies where participants watched an instructional video with or without an on-screen instructor. According to the findings, the effects of instructor presence on learning and social presence were not statistically significant. However, instructor-present videos had a significant impact on increasing cognitive load and motivation. Furthermore, moderator analyses for knowledge acquisition outcome revealed (marginally) significant differences in effect sizes based on human embodiment and study setting, favoring instructional videos featuring only the instructor's hand and being watched in laboratory settings. Based on these findings, the present study provides important directions for future research and practices.

Keywords Instructional video · Educational video · Instructor presence · Embodiment · Meta-analysis

1 Introduction

An instructional video conveys multimedia messages through the use of words in the form of on-screen text or the instructor's narration and visuals in the form of slides or animation (Mayer, 2021). Video lectures recorded for online courses, video demonstrations on how to do a specific task, educational TV shows, or documentaries are examples of instructional videos (Fiorella & Mayer, 2018; Mayer et al., 2020).

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People have easy access to instructional videos in both informal (e.g., Youtube and TED Talks) and formal learning contexts (e.g., online college courses) as we live in the Internet video age (Mayer et al., 2020). Online systems that store instructional videos can also help developers, researchers, and practitioners obtain both exact data about their videos and interval data with uncertain observations; apply classical and neutrosophic statistics (Aslam, 2019; Shahzadi et al., 2021); analyze the audience's video watching behaviors, and draw conclusions about their engagement (Yoon et al., 2021).

In recent years, instructional videos with on-screen instructors or instructor-present videos have become popular in higher education and private industries (Chen & Wu, 2015; Chorianopoulos, 2018; Henderson & Schroeder, 2021). In this type of video, instructors' hands, talking heads, or full bodies appear while giving lectures or demonstrating a procedural task. However, it is equivocal whether showing an instructor is an effective instructional technique that benefits learners (Henderson & Schroeder, 2021). While on-screen instructors as a social cue promote social presence, motivation, and learning, they can also cause split attention and extraneous cognitive load (Colliot & Jamet, 2018).

In response to conflicting results in the literature, a meta-analysis study is required to compile existing empirical evidence about videos with on-screen instructors and provide conclusions about their overall effect. Furthermore, to specify the boundary conditions of the implications on instructional video design, it is necessary to determine when and for whom instructor presence can be more effective or detrimental to learning. (Henderson & Schroeder, 2021; Mayer, 2021; Mayer et al., 2020). To fill these knowledge gaps, the current study conducts a meta-analysis on the effects of instructor-present videos on cognitive and affective outcomes. Moderator analysis is also used to explain the role of certain variables (video length, domain, human embodiment, study setting, and study location) in the impact of such videos.

2 Background

This section first explains the beneficial and harmful impact of instructor presence in videos with the social-cue and interference hypotheses proposed by Colliot and Jamet (2018). The paper then summarizes previous related systematic reviews and meta-analyses and discusses their limitations. Potential moderators of the effect of instructor-present videos are also indicated. Finally, the aim and research questions of this study are revealed.

2.1 Instructor presence in instructional videos: The social-cue hypothesis

According to social agency theory, social cues in multimedia messages can activate learners' social conversation schema; as a result, learners can behave as they communicate with another individual in a social environment (Mayer et al., 2003). Social cues can either be verbal (e.g., using standard accented voice) or visual (e.g., using signals with gaze, gesture, and facial expressions) (Atkinson et al., 2005). Visual cues that promote student engagement in learning are used by on-screen instructors in videos with nonverbal behaviors (Colliot & Jamet, 2018). Learners regard them as intelligent agents who engage the learner in a conversation (Mayer et al., 2003). According to social agency theory, these agents may result in more deep processing of verbal and visual modes of information, which helps students apply or transfer the acquired information to new situations (Mayer et al., 2003).

Instructor presence in videos as a social cue is also one way to enhance students' social presence and motivation in learning (Colliot & Jamet, 2018). Social presence is "the salience of the other in a mediated communication and the consequent salience of their interpersonal interactions" (Short et al., 1976, p. 65). Richardson et al. (2017) discovered moderate and positive correlations between social presence, satisfaction, and perceived learning in online environments after conducting a meta-analysis. Therefore, social presence promoted through instructors' social cues in videos can also be associated with enhanced student satisfaction and learning. Concerning motivational factors, Moreno and Mayer (2007) proposed that these factors mediate learning by promoting or reducing cognitive engagement in the cognitive-affective theory of learning with media. When learners do not have the motivation to learn, they might not make sense of new information even if they possess adequate cognitive capacity (Moreno & Mayer, 2007). Hence, instructor presence as a social cue might be one motivational factor that can also increase cognitive engagement with instructional videos.

2.2 Instructor presence in instructional videos: The interference hypothesis

According to the interference hypothesis, instructor presence in videos becomes an extraneous or irrelevant element (Colliot & Jamet, 2018). Similarly, the image principle of the cognitive theory of multimedia learning suggests that instructors' images have no educational value in supporting students' learning because they can divert students' attention away from the lesson's content (Mayer, 2021). Furthermore, according to the seductive details principle, "people do not necessarily learn better when an interesting but extraneous video is added to a multimedia lesson" (Mayer et al., 2020, p. 849). Including a window with a talking head can also be a seductive detail that divides attention between the instructor and visual information (Chen & Wu, 2015). As a result, experimental studies using eye-tracking technology revealed that when an on-screen instructor was available, students fixated less on learning content (van Wermeskerken et al., 2018b) and allocated more visual attention to the instructor in videos (Pi & Hong, 2016). Learners' focus on the instructor rather than the relevant visual content of the lesson wastes their limited working memory capacity (Fiorella & Mayer, 2018; Mayer et al., 2020). It causes the extraneous cognitive load, which reduces mental sources for processing relevant information, especially in complex learning tasks with high element interactivity (Sweller, 1994).

Overall, based on social agency and cognitive load theories and multimedia learning principles, two contradictory hypotheses about the effect of instructor-present videos are proposed. Similarly, the literature contains conflicting empirical findings regarding the impact of these videos (Henderson & Schroeder, 2021). Therefore, a meta-analysis study is required to provide compelling evidence about whether on-screen instructors in videos are beneficial or harmful to students.

2.3 Prior systematic reviews and meta-analyses

In a multimedia learning environment, an actual human in instructional videos can be regarded as a pedagogical agent (Heidig & Clarebout, 2011). Therefore, the current study included recent systematic review and meta-analysis studies on pedagogical agents. First, Heidig and Clarebout (2011) examined 26 studies regarding the effect of pedagogical agents on learning and motivation. Only five of 15 reviewed studies showed a learning benefit from on-screen pedagogical agents, and three of four studies indicated a nonsignificant effect on motivation. Then, using 43 studies, Schroeder et al. (2013) investigated the impact of pedagogical agents on learning. They found that pedagogical agents had a small but significant effect on learning. Castro-Alonso et al. (2021) obtained a similar result in a recent meta-analysis. In addition, they found that 2D agents were more effective than 3D agents, but the impact of pedagogical agents did not vary depending on agents' characteristics, study domain, and learner characteristics in the meta-analysis.

The aforementioned review studies on pedagogical agents mostly involved non-humanoid (e.g., object and animal) and cartoon characters without nonverbal communication. For example, Schroeder et al. (2013) reported only three studies conducted with pedagogical agents in the actual human form. Moreover, in a considerable number of the reviewed studies, the voice of pedagogical agents was absent or computer-generated. Hence, drawing conclusions about the effects of real human instructors with narrations in videos is difficult. Henderson and Schroeder (2021) conducted a systematic review study to investigate the influence of instructional videos with on-screen instructors on cognitive and affective outcomes, which is more closely related to the current research. The authors discovered mixed results in their descriptive analysis of 12 studies regarding the effect of instructor presence on learning and cognitive load. However, they found research that supports on-screen instructors in enhancing student satisfaction. Despite providing a snapshot of the current state of the relevant literature, this study has some limitations. This narrative study was conducted with limited resources. Furthermore, the authors gave equal credence or weight to the reviewed studies to make overall inferences and disregarded how the impact of instructor-present videos changed as a function of study-level covariates. These limitations can be addressed by a meta-analysis study that includes a comprehensive review of the literature and moderator analyses (Borenstein et al., 2009). However, there is no current meta-analysis of the effects of instructor-present videos in the literature.

2.4 Potential moderators

Based on cognitive load theory, multimedia learning principles, and previous research and reviews, this study focused on five potential moderators of the effect of instructor-present videos. They were video length, learning domain, human embodiment, study setting, and study location.

First, video length may act as a moderator of the effect of instructor presence in videos (Zhang et al., 2021). Guo et al. (2014) measured students' engagement by analyzing students' video viewing duration and attempts to respond to assessment questions in four MOOCs in EdX. Data were obtained from 6.9 million video-watching sessions. Guo et al. (2014) recommended that instructors produce videos shorter than six minutes because students' median engagement time was found to be six at most, regardless of video length. Similarly, Dart (2020) found that the average percentage of videos viewed by engineering students in online college courses decreased when videos became longer, implying less attention to lengthy videos. Afify (2020) also revealed that interactive instructional videos shorter than six minutes were more effective in increasing students' cognitive achievement and retention of learning and decreasing cognitive load than those lasting more than six minutes. Overall, these studies imply that long videos can have a deleterious impact on student engagement, attention, learning, and cognitive load. If instructors' dynamic image is also incorporated into long videos, students' working memory capacity might be overloaded more because the instructor's presence can be considered as a seductive detail that wastes working memory capacity and causes divided attention (Chen & Wu, 2015; Colliot & Jamet, 2018), as stated in the interference hypothesis section. Consequently, students might suffer from more severe extraneous cognitive load resulting from the poor instructional design according to the cognitive load theory (Sweller, 1994). Correspondingly, Pi and Hong (2016) indicated an increase in students' blink duration after watching 10 min of the instructor-present video, which implied that students experienced mental fatigue or tiredness after a while.

The second moderator can be the learning domain of instructional videos. Prior research on the design of instructional videos primarily focused on the topics in the science, technology, engineering, and math (STEM) domain (Mayer et al., 2020). Board-centric videos prioritizing visual information were more common in STEM videos; conversely, speaker-centric videos prioritizing oral information of human speakers were more widespread in the humanities domain (Santos-Espino et al., 2016). Due to such a difference in the video styles, the effect of instructor presence might vary across learning domains of videos. In the related meta-analysis studies, Schroeder et al. (2013) indicated the higher impact of pedagogical agents in science and math materials, although Castro-Alonso et al. (2021) could not find a significant difference between STEM and non-STEM multimedia materials with pedagogical agents. Schroeder et al. (2013) explained that pedagogical agents' demonstration of tasks and signaling of important concepts in videos with gestures could facilitate learning abstract science and math constructs and procedures. Embodied instruction theory also recommends instructors' movements, gestures, and use of instructional tools to support the processing of texts and pictures with embodied modes of information and enhance the construction of meaning in complex topics (Jewitt et al., 2016). Moreover, attentional cues provided by embodied instruction can facilitate students' attention to the relevant visual information in STEM videos, which can yield higher cognitive engagement and learning (Stull et al., 2021). However, in the humanities domain, such cues might not be too critical since oral information is regarded as more substantial in the instructional videos of this domain (Santos-Espino et al., 2016).

Human embodiment is another potential moderator of the effect of instructor-present videos. The range of human embodiment includes the hand, talking head, and instructor or its full body (Chorianopoulos, 2018). Fiorella and Mayer (2016) indicated that students viewing either the instructor's full body or only hand during drawing outperformed the control group who watched already-drawn diagrams in experiments 1 and 2. Furthermore, in experiment 4, they found that showing only the instructor's hand was more effective for learning transfer than showing the instructor's full body. Thus, they proposed that the visibility of the instructor's hand during drawing can enhance deep learning. Also, van Wermeskerken and van Gog (2017) and van Wermeskerken et al. (2018a) indicated that learners allocated more attention to the demonstration area in the videos when only the instructor's hand was visible. As the image principle suggests, mere instructor presence in instructional videos is insufficient to enhance learning (Mayer, 2021). According to the embodiment principle, social and attentional cues provided by instructors are more important in orienting learners to follow the presented information (Mayer, 2021). Instructors' use of hands for drawing and modeling can provide both cues, but the effect of instructor presence without gaze guidance, gestures, and facial expressions might not be substantial (Fiorella & Mayer, 2016; van Wermeskerken & van Gog, 2017). Consequently, this study predicted that human embodiment would be a significant moderator and that the effect of instructor presence would be stronger in the group that included only the instructor's hand to show or highlight learning content.

The study setting can also act as a potential moderator. Instructional videos are primarily distributed online so that students can watch them whenever and wherever they want. Therefore, online environments students access at their convenience are prevailing learning settings. However, the laboratory environment, which the researchers could control and prepare for the study, was a common context in most previous research on instructional video design (Mayer et al., 2020). The transferability of laboratory research findings into classrooms and online settings may be questionable because of concerns about ecological validity. Moreover, previous meta-analysis studies on the impact of multimedia learning principles revealed the moderator effect of the study setting. For example, Alpizar et al. (2020) indicated that the effect of the signaling principle (i.e., the use of cues guiding learners' attention to learning content) on learning was significantly higher in laboratory studies compared to classroom studies. The negative effect of seductive details was also found greater in the laboratory setting (Sundararajan & Adesope, 2020). In the meta-analysis of the impact of pedagogical agents, Schroeder et al. (2013) revealed significant differences between studies applied in classrooms and those conducted in laboratories, favoring the classroom setting. Considering all these meta-analyses, the effect of instructor presence in videos may vary depending on the study setting.

The final potential moderator is the study location. Pi and Hong (2016) attributed the mixed results regarding the effect of instructor-present videos to the different cultures of the participants. While Asian cultures prioritize individuals' relatedness to each other, American cultures emphasize individuals' independence from others (Hofstede et al., 2010). Accordingly, Pi and Hong (2016) speculated that instructor presence in videos could be more beneficial for Chinese students as they might be more relation-oriented with others and more sensitive to social cues in the learning environments than more task-oriented western students. However, no cross-cultural research involving participants from different countries exists to support this claim. Prior meta-analysis studies on multimedia learning principles revealed that study location or culture was not a significant moderator of the effect of these principles on learning (e.g., Alpizar et al., 2020; Wong & Adesope, 2021). This meta-analysis study can also provide evidence to show whether study location is a critical variable differentiating the effect of instructor-present videos.

2.5 Research aim and questions

Instructor-present videos have become prevalent in various learning settings, but existing research presents contradictory findings regarding their effect (Chen & Wu, 2015; Chorianopoulos, 2018; Henderson & Schroeder, 2021; Yuan et al., 2021). Although some studies support on-screen instructors as they provide social cues that can enhance information processing and motivation, some reveal concerns due to students' divided attention and cognitive load (Colliot & Jamet, 2018). However, no meta-analysis study has systematically and comprehensively examined their impact on various outcomes. Consequently, instructor presence in videos has remained a debatable issue that needs to be resolved to provide conclusive results. Moreover, existing research comparing instructor-present and instructor-absent videos differed in terms of video length, learning domain, human embodiment, study setting, and study location that can change the influence of these videos. Nonetheless, researchers and practitioners do not have an adequate understanding of the optimal conditions that promote learning from instructional videos based on sound evidence (Mayer, 2021). Hence, moderator analysis with study-level variables can enhance understanding of the effect of different designs and study conditions in instructor-present videos and present more specific design suggestions regarding when to integrate on-screen instructors into videos.

Considering conflicting findings in the literature and the impact of potential moderators, this study aimed to perform a meta-analysis to elucidate whether instructor presence in videos significantly affects learning, cognitive load, motivation, and social presence. Moreover, moderator analysis was applied to determine in which conditions instructor presence has a beneficial or detrimental effect on students. More specifically, this meta-analysis sought to answer the following research questions:

1. Do instructor-present videos affect students' learning?

2. Do instructor-present videos affect students' cognitive load?
3. Do instructor-present videos affect students' motivation?
4. Do instructor-present videos affect students' social presence?
5. How does the effect of instructor-present videos differ by video length, domain, human embodiment, study setting, and study location?

3 Method

3.1 Eligibility criteria

The following criteria were determined to select the studies for this meta-analysis:

- The study is an empirical research article or dissertation.
- The study had at least one experimental condition where an instructor appeared in an instructional video and a control condition without an on-screen instructor.
- Learning materials of the experimental and control conditions are instructional videos similar in their content. The only difference is the instructor's presence in the videos.
- The study measured learning (e.g., knowledge acquisition and transfer), cognitive load, social presence, or motivational variables that make students willing to pursue learning (e.g., engagement, satisfaction, and interest) (Kim, 2012). Moreover, it compared the experimental and control conditions in regard to these variables.
- The instructor is a human, not a pedagogical agent or animated character.
- The study reports effect size or enough information to calculate the effect size (sample size, means, standard deviations, *F*, *t*).
- The study was written in English.
- The full text of the source is available.

3.2 Information resources and study selection

To find the relevant journal articles, four essential databases in the education and psychology fields were searched: Web of Science, ERIC, PsycInfo, and Education Source. In addition, the ProQuest database was used to access dissertations/theses. The following keywords and Boolean operators were written in the title, abstract, and keyword fields of the database search engine: video and (instructor or lecturer or teacher) and (presence or image or visibility). The article search was limited to peer-reviewed journals and English articles. The study selection process was completed on November 10, 2021. The procedure to identify the relevant sources is summarized in the PRISMA flow diagram (Moher et al., 2010) (Fig. 1). First, searching the aforementioned databases yielded a total of 1492 records. Moreover, four additional documents published as a journal article were

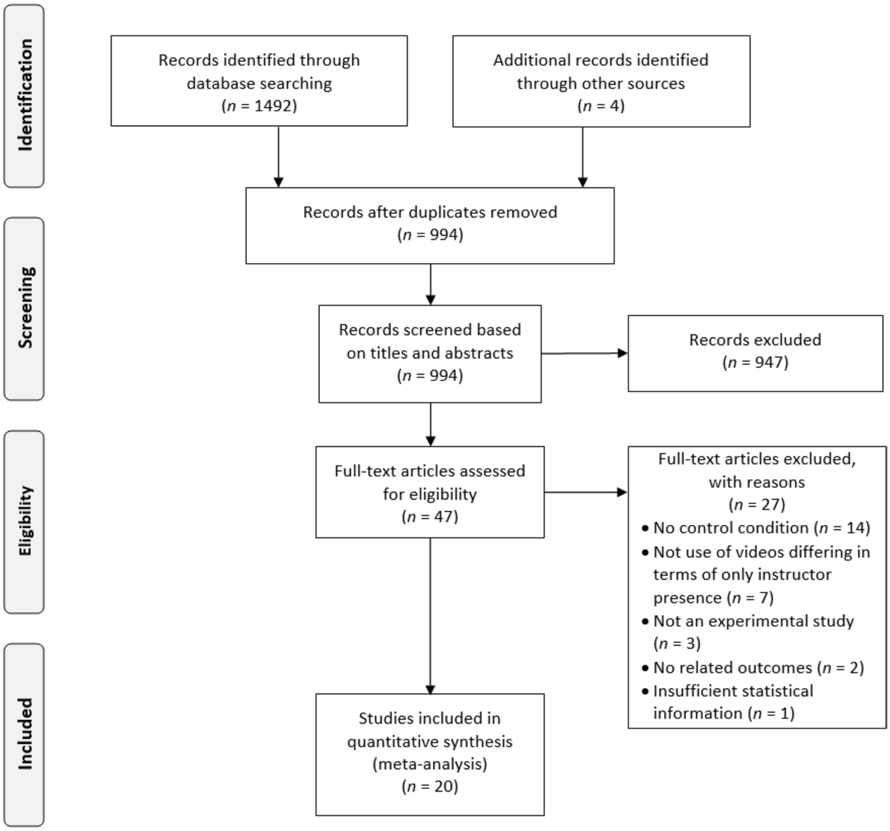


Fig. 1 PRISMA flow diagram

identified when the researcher conducted a manual literature search on instructional video types and embodiment in the Google Scholar search engine and examined the reference list of the relevant sources. After selecting unique sources ($n = 994$), their titles and abstracts were screened to find those that met the eligibility criteria. Then, the full texts of the eligible sources ($n = 47$) were analyzed, and some were excluded from the dataset for a variety of reasons (Fig. 1). For example, Kizilcec et al. (2015) did not include a control group in which the instructor was not present in the videos. Colliot and Jamet (2018) utilized a multimedia document rather than an instructional video. As a result of this process, 20 studies met the eligibility criteria for meta-analysis.

3.3 Coding of studies and data extraction

The selected studies were analyzed to obtain five main types of information: (1) demographic information (authors, year, and type of source), (2) participant

Table 1 Characteristics of the studies in the meta-analysis

Author	Source	Location (Continent)	Target group	Video length	Domain	Human embodiment	Type of knowledge	Instructional media	Setting	Outcome
Carlson et al. (2014)	Journal	USA (1)	Higher education	N/A	STEM	Hand	Declarative	Pictures	Lab	A
Fiorella et al. (2019) Exp. 1 and 2 combined	Journal	USA (1)	Higher education	> 6	STEM	Instructor	Declarative	Whiteboard	Lab	A, T, CL, M
Homer et al. (2008) Exp. 1	Journal	USA (1)	Higher education	> 6	HSS	Instructor	Declarative	Slides	Lab	A, T, CL, SP
Hong et al. (2018), declarative knowledge	Journal	China (2)	Higher education	> 6	STEM	Talking head	Declarative	Slides	Lab	A, CL
Kokoç et al. (2020), picture-in-picture vs. voice-over	Journal	Turkey (3)	Higher education	< 6	STEM	Talking head	Declarative	Slides	Lab	A
Ng and Przybylek (2021)	Journal	Poland (3)	Higher education	> 6	HSS	Talking head	Declarative	Slides	Online	A, CL, SP
Pi and Hong (2016)	Journal	China (2)	Higher education	> 6	HSS	N/A	Declarative	Slides	Lab	A
Pierson (2017)	Dissertation	USA (1)	Higher education	> 6	HSS	Instructor	Procedural	Slides	Online	M
Rosenthal and Walker (2020) Exp. 1, picture-in-picture vs. voice-over	Journal	Singapore (2)	Higher education	> 6	Mixed	Talking head	Declarative	Slides	Lab	A, M, SP
Rouan (1995)	Dissertation	USA (1)	Higher education	> 6	HSS	Instructor	Declarative	Slides (HyperCard stack)	Classroom	A

Table 1 (continued)

Author	Source	Location (Continent)	Target group	Video length	Domain	Human embodiment	Type of knowledge	Instructional media	Setting	Outcome
Schroeder (2016)	Journal	USA (1)	Higher education	> 6	STEM	Hand	Declarative	Slides, pentip	Lab	A
Schutt (2007)	Dissertation	USA (1)	Higher education	> 6	HSS	Instructor	Declarative	Slides	Online	A, SP
van Wermeskerken et al., 2018b	Journal	Netherlands (3)	Higher education	> 6	STEM	Instructor	Procedural	Slides	Lab	A, T
Wang and Antonenko (2017), easy topic	Journal	USA (1)	Higher education	> 6	STEM	Instructor	Declarative	Slides, pentip	Lab	A, T, M
Wang et al. (2020a), easy topic	Journal	USA (1)	Higher education	< 6	STEM	Instructor	Declarative	Slides, pentip	Lab	A, T, CL, M
Wang et al. (2020b)	Journal	USA (1)	Higher education	< 6	STEM	Instructor	Declarative	Slides, pentip	Lab	A, T, CL
Wilson et al. (2018) Exp. 1 and 2, audio vs. audio and instructor	Journal	USA and Canada (1)	Adults	> 6	STEM	Instructor	Declarative	No media	Online	A, M
Yu (2021), combined groups	Journal	China (2)	Higher education	NA	HSS	Instructor	Declarative	Slides	Online	A, CL
Yuan et al. (2021), original vs. no image	Journal	China (2)	Higher education	> 6	HSS	Talking head	Declarative	Slides	Online	A, T, M, SP

Table 1 (continued)

Author	Source	Location (Continent)	Target group	Video length	Domain	Human embodiment	Type of knowledge	Instructional media	Setting	Outcome
Zhang et al. (2021), combined groups	Journal	China (2)	Higher education	< 6	HSS	Talking head	Declarative	Slides	Lab	A, M

1 = North America, 2 = Asia, 3 = Europe, N/A = Not available, HSS = Humanities and social sciences, STEM = Science, technology, engineering and math, A = Acquisition of knowledge, T = Transfer of knowledge, CL = Cognitive load, M = Motivation, SP = Social presence

characteristics (target group and location), (3) video characteristics (length, domain, human embodiment, instructional media, and setting), (4) outcomes (learning, cognitive load, motivation, and social presence) and (5) quantitative data regarding each outcome. They were noted in a coding scheme (Table 1). The learning outcome was divided into knowledge acquisition and transfer categories. While the acquisition referred to retention, recall, comprehension, or use of knowledge in video, the transfer category was for the learning outcomes that required participants to apply knowledge in a different context. The author reviewed all data four times at different time points to ensure data accuracy for meta-analysis.

3.4 Synthesis of results

Data analysis was conducted via Comprehensive Meta-Analysis version 3. To analyze the effect of instructor presence in instructional videos, the standardized mean differences between experimental and control groups were calculated by using $S_{sm} = (M_{G1} - M_{G2})/s_p$ formula (Lipsey & Wilson, 2001). Hedge's g formula, $1 - (3/(4N - 9))ES_{sm}$, was employed to correct bias due to small samples (Hedges & Olkin, 1985; Lipsey & Wilson, 2001). The following statistics were used for this calculation: mean, standard deviation, and sample sizes of two groups. If descriptive statistics were not provided, F or t values were used to calculate effect size by using Borenstein's (2009, p. 228) formulas: $t\sqrt{(n_1 + n_2)/(n_1 n_2)}$ and $\pm\sqrt{F\left(n_1 + n_2\right)/(n_1 n_2)}$. Cohen's (1988) thresholds for small (d=0.20), moderate (d=0.50), and large (d=0.80) effect sizes were used to interpret Hedge's g.

Some studies included more than one experimental and control condition and learning task. First, when there were one control group and multiple treatment groups, the researcher paid attention to whether the content of videos in experimental and control conditions matched. The groups that did not have the same visual items in videos except for the instructor's image were eliminated from the analysis. For example, in the first experiment of Wilson et al. (2018), the audio+text group was not considered one control condition because the instructor-present video did not include text. The only audio group was the control condition of this study for the meta-analysis. However, when instructor presence changed in terms of position and duration (e.g., Yu, 2021; Zhang et al., 2021), data from treatment groups were combined instead of making multiple comparisons between experimental and control groups. This decision was made because multiple comparisons violate the independence assumption of effect sizes in meta-analysis studies (Borenstein et al., 2009). The formula provided by Higgins et al. (2021) was used to calculate combined summary statistics. It must be noted that experimental groups in one study (Rosenthal & Walker, 2020) involved talking-head and full-body videos. As human embodiment is a potential moderating variable in this meta-analysis, groups were not combined, but one experimental group (i.e., talking head video) was randomly selected. Second, when there were two subgroups in both experimental and control conditions, such as low and high sustained attention (Kokoç et al., 2020), two comparisons and effect sizes were added to the meta-analysis. This decision was applied since data in those studies were collected from independent groups comprising different participants.

Finally, three studies had crossover trials that enabled participants to watch first an instructor-absent video and then an instructor-present video, or vice versa. The videos in those studies also differed in terms of the type of knowledge and difficulty level of the topic. They created different effect sizes for each video. The effect size for the first video was included in this meta-analysis because the type of knowledge and difficulty level moderated the effect of instructor presence, and the same participants were involved in the second video.

Another issue with the independence of effect sizes was related to multiple outcomes from one study. The effect sizes of those studies were not independent because some studies reported results for more than one outcome regarding learning, cognitive load, motivation, and social presence from the same group of participants (Borenstein et al., 2009). Thus, data were separately extracted for each outcome in this meta-analysis. Moreover, two studies measured multiple motivation-related constructs. As suggested by Borenstein et al. (2009), their mean was calculated and combined in the meta-analysis for motivation.

In the current meta-analysis, a random-effects model was selected. This model assumes that there is no one true effect size; on the contrary, the true effect varies from one study to another because of sampling error and potential moderators such as characteristics of participants and intensity of intervention (Borenstein et al., 2009; Raudenbush, 2009). Therefore, the random-effects model "allows the conclusions to be generalized to a wider array of situations" (Borenstein et al., 2010, p. 107).

Heterogeneity in effect sizes was first identified using a statistical test named the Q statistic (Hedges & Olkin, 1985). However, this test has low power in meta-analyses with few studies and excessive power in meta-analyses with a large number of studies (Borenstein et al., 2009; Higgins & Thompson, 2002). Higgins and Thompson (2002) suggested one alternative measure, I^2, that does not depend on study size and quantifies the proportion of the real differences in effect size to the observed variance (Borenstein et al., 2009). This study used both Q statistic and I^2 to assess heterogeneity. The tentative benchmarks for I^2 (Higgins et al., 2003) were used to determine whether heterogeneity was low (25%), moderate (50%), or high (75%).

3.5 Publication bias

While research studies with significant results tend to be published more frequently, those with nonsignificant results are kept in file drawers (Rosenthal, 1979). Meta-analysis studies are more likely to include the former; consequently, bias in the literature can result in publication bias in meta-analysis (Borenstein et al., 2009). Controlling whether studies are distributed symmetrically about the mean effect size in funnel plots is one way to check for publication bias (Borenstein et al., 2009). In asymmetric funnel plots, Duval and Tweedie's trim and fill method adds imputed studies necessary to make the plots symmetric, and minor changes between observed and adjusted effect sizes imply validity of the reported effect (Borenstein et al., 2009). However, it is difficult for meta-analysis with a low number of studies to create a visual display of a funnel (Lipsey & Wilson, 2001). Orwin's (1983) fail-safe

N proposes the number of missing studies required to move the overall effect to a specific trivial effect size. If this number exceeds $5k+10$ (k is the number of effect sizes in meta-analysis), it is more likely to suggest the robustness of the reported effect size (Rosenthal, 1979).

This meta-analysis also inspected extreme effect sizes or outliers outside the range of -2 to +2 of the overall effects in forest and funnel plots. The researcher tested whether removing the outliers would considerably change the overall effect size results (Borenstein et al., 2009). If they are not identified as influential cases that substantially change results, the robustness of conclusions can be suggested (Viechtbauer & Cheung, 2010).

3.6 Moderator analysis

This meta-analysis had potential categorical moderators that can explain heterogeneity across the studies. Since they were categorical independent variables, subgroup analysis or moderator analysis similar to analysis of variance was performed (Borenstein et al., 2009; Lipsey & Wilson, 2001). Significant differences in the effect sizes between the categories imply that the mean effect sizes between groups vary more than by sampling error (Lipsey & Wilson, 2001).

There were subgroups for each moderator variable in this meta-analysis. The moderators and their subgroups were video length (<6 min or >6 min), domain (humanities and social sciences (HSS) or STEM), human embodiment (hand, talking head, or instructor), study setting (laboratory, online, or classroom), and location or continent of the study (North America, Asia, and Europe). The mixed-effects model was used because the variation of effect sizes within groups was assumed and tested (Borenstein et al., 2009). The between-group Q test results for heterogeneity were checked to decide whether there were significant differences in the mean effect sizes of the subgroups.

4 Results

4.1 Study characteristics

There were 20 information resources eligible for this meta-analysis, of which three were dissertations and 17 were journal articles. In terms of participant characteristics, nearly all of them ($n=19$) were higher education students. They were mainly from the United States ($n=11$) and China ($n=5$). Regarding video characteristics, the instructional videos were mostly longer than six minutes ($n=14$), in the STEM domain ($n=10$), and declarative knowledge type ($n=18$), they included slides ($n=16$) and instructors' full body ($n=11$), and they were watched in a laboratory setting ($n=13$). This meta-analysis resulted in 52 comparisons between experimental and control conditions concerning the effect of instructor presence in videos. They were related to mean differences in terms of knowledge acquisition ($k=22$)

Table 2 Main effects of the instructor-present videos on knowledge acquisition and transfer, cognitive load, motivation, and social presence

Outcome	Sample		Effect size				Heterogeneity		
	n	*k*	Hedges' g	95% CI	*Z*	*p*	*Q*	*p*	I^2
Acquisition	1863	22	0.171	[-0.042, 0.383]	1.573	0.116	101.481	0.000	79.307
Transfer	368	7	-0.011	[-0.321, 0.299]	-0.069	0.945	13.593	0.035	55.860
Cognitive load	479	7	0.319	[0.112, 0.525]	3.021	0.003	7.392	0.286	18.837
Motivation	776	8	0.431	[0.110, 0.753]	2.629	0.009	31.506	0.000	77.782
Social presence	687	6	0.042	[-0.107, 0.191]	0.553	0.580	2.920	0.712	0.000

and transfer ($k=7$), cognitive load ($k=7$), motivation ($k=8$) and social presence ($k=8$) (Table 2).

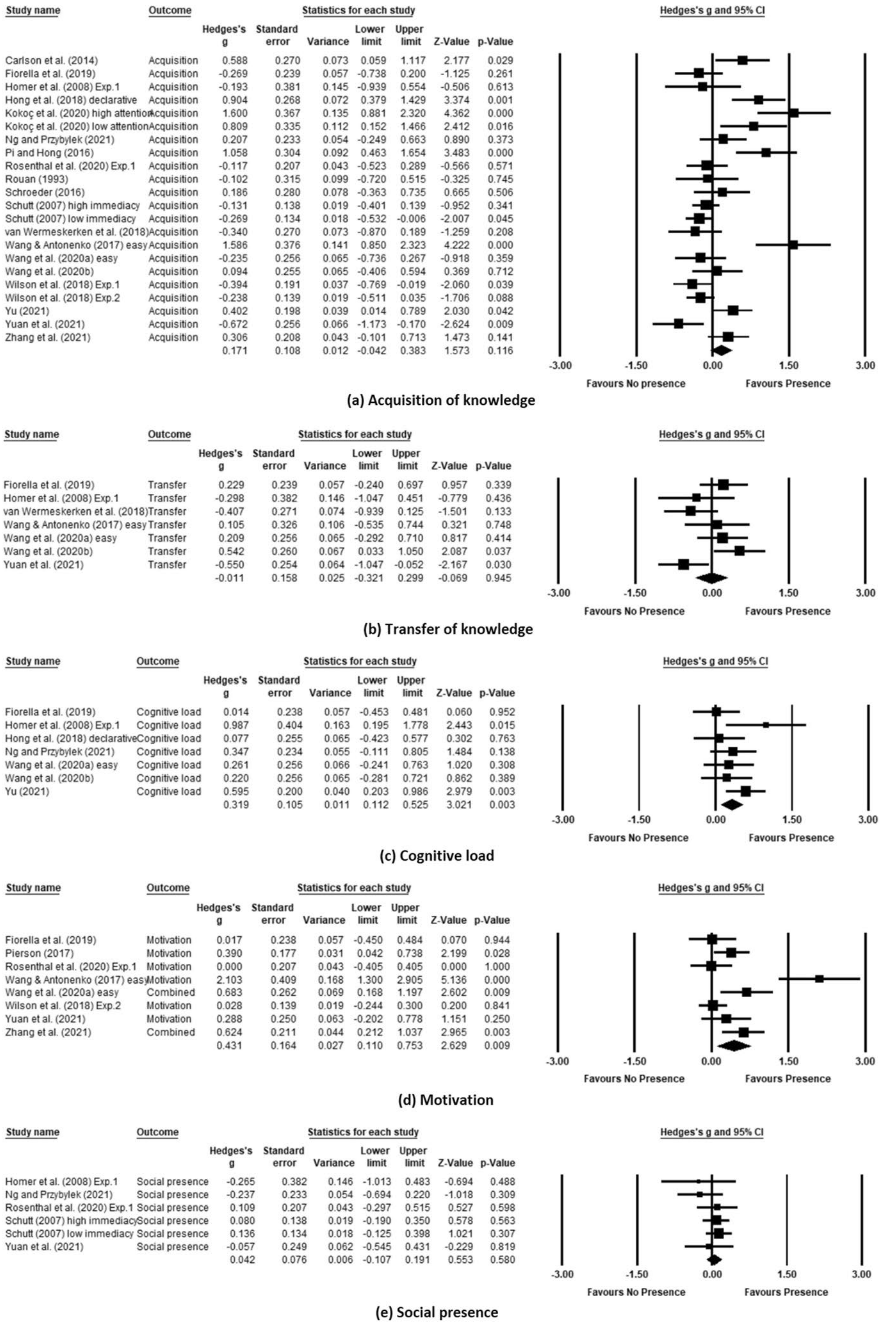
4.2 Overall analysis

Random effect models indicated the overall effect of instructor presence in videos (Table 2). Although effects of instructor presence on knowledge acquisition (Hedges' $g=0.171$, $p=0.116$) and transfer (Hedges' $g=-0.011$, $p=0.945$) and social presence (Hedges' $g=0.042$, $p=0.580$) were not statistically significant, instructor-present videos had a significant impact on increasing cognitive load (Hedges' $g=0.319$, $p<0.01$) and motivation (Hedges' $g=0.431$, $p<0.01$). The effect sizes were small to medium according to Cohen's (1988) criteria. Figure 2 presents forest plots of individual effect sizes regarding four outcomes.

The heterogeneity tests resulted in significant values for knowledge acquisition ($Q=101.481$, $I^2=79.307\%$, $p<0.01$) and transfer ($Q=13.593$, $I^2=55.860\%$, $p<0.05$) and motivation ($Q=31.506$, $I^2=77.782\%$, $p<0.01$) (Table 2). These results implied moderate and high heterogeneity of effect sizes for transfer and knowledge acquisition and motivation outcomes, respectively (Higgins & Thompson, 2002). Therefore, moderator analysis was necessary to determine potential sources of heterogeneity across studies. However, there was a low number of effect sizes for transfer ($k=7$) and motivation ($k=8$), which could bring about unreliable results from moderator analysis. Thus, moderator analysis was conducted for the only knowledge acquisition outcome.

4.3 Moderator analysis

The groups that did not provide information regarding moderator variables or included only one effect size were not considered in the moderator analysis. Table 3 presents moderator analysis results for knowledge acquisition. The within-group Q values for all moderators were significant ($Q_{\text{video length}}=82.506$, $p=0.000$; $Q_{\text{domain}}=94.566$, $p=0.000$; $Q_{\text{human embodiment}}=73.103$, $p=0.000$; $Q_{\text{setting}}=78.266$, $p=0.000$; $Q_{\text{location}}=84.176$, $p=0.000$), which implied variation of effect sizes



Study name	Outcome	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Carlson et al. (2014)	Acquisition	0.588	0.270	0.073	0.059	1.117	2.177	0.029
Fiorella et al. (2019)	Acquisition	-0.269	0.239	0.057	-0.738	0.200	-1.125	0.261
Homer et al. (2008) Exp.1	Acquisition	-0.193	0.381	0.145	-0.939	0.554	-0.506	0.613
Hong et al. (2018) declarative	Acquisition	0.904	0.268	0.072	0.379	1.429	3.374	0.001
Kokoç et al. (2020) high attention	Acquisition	1.600	0.367	0.135	0.881	2.320	4.362	0.000
Kokoç et al. (2020) low attention	Acquisition	0.809	0.335	0.112	0.152	1.466	2.412	0.016
Ng and Przybylek (2021)	Acquisition	0.207	0.233	0.054	-0.249	0.663	0.890	0.373
Pi and Hong (2016)	Acquisition	1.058	0.304	0.092	0.463	1.654	3.483	0.000
Rosenthal et al. (2020) Exp.1	Acquisition	-0.117	0.207	0.043	-0.523	0.289	-0.566	0.571
Rouan (1993)	Acquisition	-0.102	0.315	0.099	-0.720	0.515	-0.325	0.745
Schroeder (2016)	Acquisition	0.186	0.280	0.078	-0.363	0.735	0.665	0.506
Schutt (2007) high immediacy	Acquisition	-0.131	0.138	0.019	-0.401	0.139	-0.952	0.341
Schutt (2007) low immediacy	Acquisition	-0.269	0.134	0.018	-0.532	-0.006	-2.007	0.045
van Wermeskerken et al. (2018)	Acquisition	-0.340	0.270	0.073	-0.870	0.189	-1.259	0.208
Wang & Antonenko (2017) easy	Acquisition	1.586	0.376	0.141	0.850	2.323	4.222	0.000
Wang et al. (2020a) easy	Acquisition	-0.235	0.256	0.065	-0.736	0.267	-0.918	0.359
Wang et al. (2020b)	Acquisition	0.094	0.255	0.065	-0.406	0.594	0.369	0.712
Wilson et al. (2018) Exp.1	Acquisition	-0.394	0.191	0.037	-0.769	-0.019	-2.060	0.039
Wilson et al. (2018) Exp.2	Acquisition	-0.238	0.139	0.019	-0.511	0.035	-1.706	0.088
Yu (2021)	Acquisition	0.402	0.198	0.039	0.014	0.789	2.030	0.042
Yuan et al. (2021)	Acquisition	-0.672	0.256	0.066	-1.173	-0.170	-2.624	0.009
Zhang et al. (2021)	Acquisition	0.306	0.208	0.043	-0.101	0.713	1.473	0.141
		0.171	0.108	0.012	-0.042	0.383	1.573	0.116

(a) Acquisition of knowledge

Study name	Outcome	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Fiorella et al. (2019)	Transfer	0.229	0.239	0.057	-0.240	0.697	0.957	0.339
Homer et al. (2008) Exp.1	Transfer	-0.298	0.382	0.146	-1.047	0.451	-0.779	0.436
van Wermeskerken et al. (2018)	Transfer	-0.407	0.271	0.074	-0.939	0.125	-1.501	0.133
Wang & Antonenko (2017) easy	Transfer	0.105	0.326	0.106	-0.535	0.744	0.321	0.748
Wang et al. (2020a) easy	Transfer	0.209	0.256	0.065	-0.292	0.710	0.817	0.414
Wang et al. (2020b)	Transfer	0.542	0.260	0.067	0.033	1.050	2.087	0.037
Yuan et al. (2021)	Transfer	-0.550	0.254	0.064	-1.047	-0.052	-2.167	0.030
		-0.011	0.158	0.025	-0.321	0.299	-0.069	0.945

(b) Transfer of knowledge

Study name	Outcome	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Fiorella et al. (2019)	Cognitive load	0.014	0.238	0.057	-0.453	0.481	0.060	0.952
Homer et al. (2008) Exp.1	Cognitive load	0.987	0.404	0.163	0.195	1.778	2.443	0.015
Hong et al. (2018) declarative	Cognitive load	0.077	0.255	0.065	-0.423	0.577	0.302	0.763
Ng and Przybylek (2021)	Cognitive load	0.347	0.234	0.055	-0.111	0.805	1.484	0.138
Wang et al. (2020a) easy	Cognitive load	0.261	0.256	0.066	-0.241	0.763	1.020	0.308
Wang et al. (2020b)	Cognitive load	0.220	0.256	0.065	-0.281	0.721	0.862	0.389
Yu (2021)	Cognitive load	0.595	0.200	0.040	0.203	0.986	2.979	0.003
		0.319	0.105	0.011	0.112	0.525	3.021	0.003

(c) Cognitive load

Study name	Outcome	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Fiorella et al. (2019)	Motivation	0.017	0.238	0.057	-0.450	0.484	0.070	0.944
Pierson (2017)	Motivation	0.390	0.177	0.031	0.042	0.738	2.199	0.028
Rosenthal et al. (2020) Exp.1	Motivation	0.000	0.207	0.043	-0.405	0.405	0.000	1.000
Wang & Antonenko (2017) easy	Motivation	2.103	0.409	0.168	1.300	2.905	5.136	0.000
Wang et al. (2020a) easy	Combined	0.683	0.262	0.069	0.168	1.197	2.602	0.009
Wilson et al. (2018) Exp.2	Motivation	0.028	0.139	0.019	-0.244	0.300	0.200	0.841
Yuan et al. (2021)	Motivation	0.288	0.250	0.063	-0.202	0.778	1.151	0.250
Zhang et al. (2021)	Combined	0.624	0.211	0.044	0.212	1.037	2.965	0.003
		0.431	0.164	0.027	0.110	0.753	2.629	0.009

(d) Motivation

Study name	Outcome	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Homer et al. (2008) Exp.1	Social presence	-0.265	0.382	0.146	-1.013	0.483	-0.694	0.488
Ng and Przybylek (2021)	Social presence	-0.237	0.233	0.054	-0.694	0.220	-1.018	0.309
Rosenthal et al. (2020) Exp.1	Social presence	0.109	0.207	0.043	-0.297	0.515	0.527	0.598
Schutt (2007) high immediacy	Social presence	0.080	0.138	0.019	-0.190	0.350	0.578	0.563
Schutt (2007) low immediacy	Social presence	0.136	0.134	0.018	-0.125	0.398	1.021	0.307
Yuan et al. (2021)	Social presence	-0.057	0.249	0.062	-0.545	0.431	-0.229	0.819
		0.042	0.076	0.006	-0.107	0.191	0.553	0.580

(e) Social presence

Fig. 2 Forest plots of effect sizes in the random effect models for **a** knowledge acquisition, **b** knowledge transfer, **c** cognitive load, **d** motivation, and **e** social presence

Table 3 Moderator analysis results for knowledge acquisition

Variable	Sample		Effect size				Heterogeneity	
	n	*k*	Hedges' *g*	95% CI	*Z*	*p*	*Q*	*p*
Video length							2.108	0.147
< 6	317	5	0.468	[-0.068, 1.004]	1.712	0.087		
> 6	1359	15	0.033	[-0.205, 0.272]	0.275	0.783		
Domain							2.186	0.139
HSS	1141	10	0.018	[-0.228, 0.264]	0.144	0.885		
STEM	630	11	0.371	[-0.027, 0.768]	1.828	0.068		
Human embodiment							5.853	0.054
Hand	106	2	0.394	[0.000, 0.787]	1.961	0.050		
Instructor	1224	12	-0.064	[-0.276, 0.149]	-0.588	0.557		
Talking head	485	7	0.397	[-0.085, 0.879]	1.613	0.107		
Setting							7.936	0.005
Laboratory	808	14	0.394	[0.081, 0.708]	2.463	0.014		
Online	1016	7	-0.155	[-0.374, 0.063]	-1.393	0.164		
Location							3.034	0.219
North America	1145	12	-0.017	[-0.237, 0.202]	-0.155	0.877		
Asia	516	6	0.299	[-0.160, 0.757]	1.277	0.201		
Europe	202	4	0.536	[-0.217, 1.289]	1.395	0.163		

within groups and justified the use of a mixed-effects model rather than fixed-effect model in moderator analysis.

The effect size of instructor presence approached a statistically significant value and became higher when the instructional videos were less than six minutes ($g = 0.468$, $p = 0.087$), related to the STEM domain ($g = 0.371$, $p = 0.068$), and with the instructor's hand ($g = 0.394$, $p = 0.050$). Nonetheless, the between-group Q values indicated that mean effect sizes did not differ significantly in terms of video length ($Q = 2.108$, $p = 0.147$) and domain ($Q = 2.186$, $p = 0.139$). However, the effect of the human embodiment moderator was almost significant ($Q = 5.853$, $p = 0.054$). In addition, the study setting had a significant effect ($Q = 7.939$, $p < 0.01$). More particularly, a higher and statistically significant effect size was obtained in the videos watched in a laboratory setting ($g = 0.394$, $p < 0.05$) rather than online ($g = -0.155$, $p = 0.164$). Finally, study location was not a statistically significant moderator of the effect of instructor-present videos ($Q = 3.034$, $p = 0.219$). Participants from North America, Asia, and Europe were not significantly influenced by on-screen instructors in the videos.

4.4 Publication bias

Regarding knowledge acquisition, transfer, and social presence outcomes, Orwin's fail-safe N (N_{fs}) could not be calculated because instructor presence in videos was

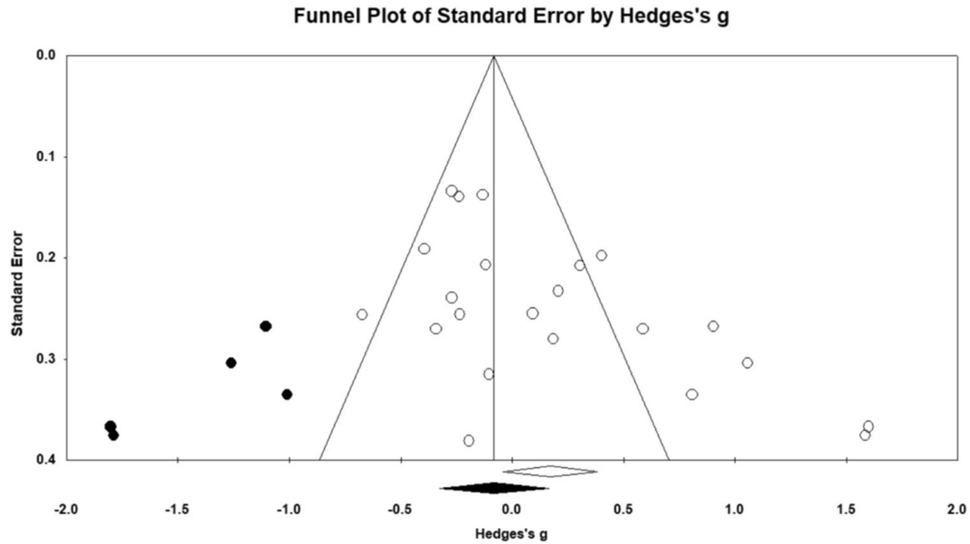


Fig. 3 Funnel plot with the trim and fill method for meta-analysis regarding knowledge acquisition. Open circles indicate observed studies, whereas filled circles indicate imputed studies

found to have a nonsignificant impact on these variables. According to the trim and fill method, although there was no need for hypothetical studies to obtain a symmetric distribution of effect sizes for transfer and social presence outcomes, five studies were suggested for knowledge acquisition (Fig. 3). Even if those hypothetical studies were added, the effect size did not exceed the critical value for a small effect size (0.02).

Regarding the meta-analysis for cognitive load, N_{fs} or the number of experiments necessary to yield the effect size under 0.01 was 217. As this value was substantially larger than 5 $k+10$ ($5•7+10=45$), it was unlikely to have publication bias in the meta-analysis (Rosenthal, 1979). Concerning the meta-analysis for motivation, N_{fs} was found to be 233, higher than 5 $k+10$ ($5•8+10=50$). However, one outlier with Hedges' g of 2.10 (Wang & Antonenko, 2017) was quite above the overall effect size (0.43). Furthermore, there was a need for two hypothetical studies to obtain a symmetric distribution of effect sizes in the funnel plot (Fig. 4). Even though the outlier was omitted or those hypothetical studies were inserted, the effect size was still small to medium. Based on N_{fs} and funnel plots of observed and adjusted values, it was assumed that there was no publication bias for this meta-analysis.

5 Discussion

This meta-analysis investigated the effects of instructor-present videos. To this end, three dissertations and 17 journal articles were used as relevant information resources. This section discusses the impacts of on-screen instructors on different outcomes and moderator analysis results.

5.1 Effects of instructor-present videos on learning, cognitive load, motivation, and social presence

The overall effects revealed that instructor presence had a nonsignificant impact on learning and social presence. On the other hand, on-screen instructors in videos had a significant and positive effect on motivation. In addition, they caused significantly more cognitive load than videos without the instructor's presence.

These findings support both the social-cue and interference hypotheses from different aspects (Colliot & Jamet, 2018). More specifically, they suggest that instructor presence can enhance motivation by providing students with social cues in videos, although they do not improve students' social presence. This finding is in line with social agency theory positing that social cues promote students' motivation for cognitive engagement with multimedia information (Mayer et al., 2003). However, the present study also corroborates the interference hypothesis. It indicates that instructor presence can be harmful because it can increase students' cognitive load and cause divided attention between learning content and the on-screen instructor (Mayer, 2021). Overall, these effects might neutralize the impact of instructor-present videos on learning. As a result, on-screen instructors in videos neither enhance nor hinder learning, particularly knowledge acquisition and transfer, as in this study.

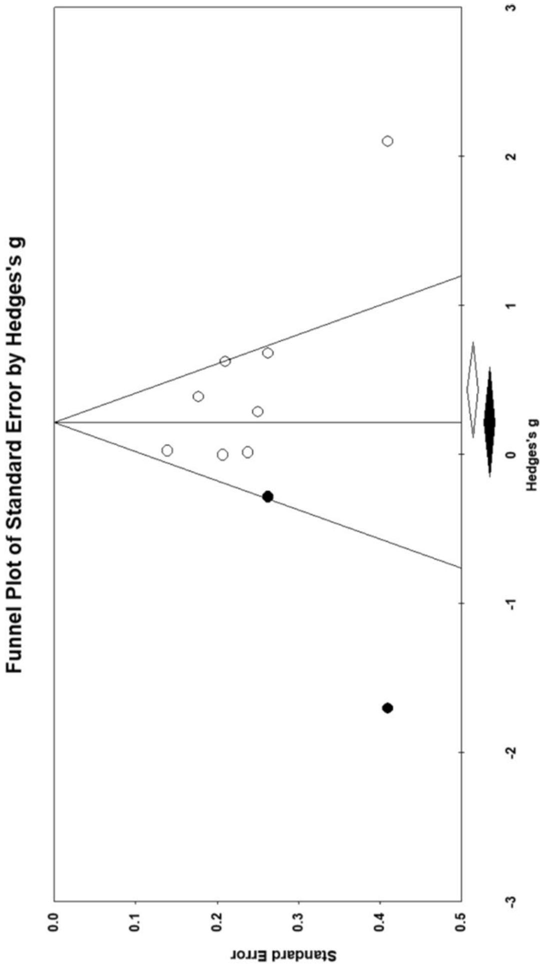


Fig. 4 Funnel plot with the trim and fill method for meta-analysis regarding motivation

This result is consistent with the image principle proposing that "people do not necessarily learn more deeply from a multimedia presentation when the speaker's image is on the screen rather than not on the screen" (Mayer, 2014, p. 345). It is also parallel to the findings of prior meta-analysis studies that indicated a significant but small effect of pedagogical agents in multimedia learning environments (Castro-Alonso et al., 2021; Schroeder et al., 2013). After Henderson and Schroeder's (2021) narrative systematic review of instructor-present videos, this meta-analysis provides more conclusive and elaborative explanations considering the possible interplay among different outcomes.

5.2 Moderating effects

Moderator analysis was applied to the knowledge acquisition outcome because of considerable heterogeneity across 22 effect sizes. Moderator variables were video length, domain, human embodiment, study setting, and study location. First, the effect of instructor presence was higher in the videos shorter than six minutes, but there was no significant difference between the groups in regard to video length. Guo et al. (2014) proposed that instructional videos should not be longer than six minutes because students' engagement decreases after that minute. Students can experience more cognitive load and learn less in long videos (e.g., Afify, 2020). Instructor presence in videos over six minutes might also consume limited working capacity more rapidly due to the aggregated effect of decreased engagement and extraneous cognitive load caused by both video length and the instructor's dynamic image (Chen & Wu, 2015; Zhang et al., 2021). Especially the students with low sustained attention who have less ability to concentrate on a task continuously might suffer from such a situation more intensely (Kokoç et al., 2020). It can also affect students with learning disabilities who were found less successful in summative tests after watching long videos (Slemmons et al., 2018). On the whole, this study suggests that the effect of instructor-present videos on learning can increase in videos less than six minutes.

Second, the effect of on-screen instructors in videos was higher in the videos regarding the STEM domain; nonetheless, there was no significant difference between STEM and HSS domains. The greater impact on the STEM domain was in line with Schroeder et al.'s (2013) study that investigated the effect of pedagogical agents on learning. Most of the studies reviewed in this meta-analysis included slides with textual and pictorial information in both STEM and HSS domains. Therefore, instructional videos were mainly board-centric in this study regardless of the learning domain. In other words, slides were a principal source of visual information for both domains (Santos-Espino et al., 2016). However, visual representations have an essential role in facilitating and promoting learning in STEM (Rau, 2017). The STEM domain consists of interdependent disciplines perceived as more challenging and complex to learn by university students (Tseng et al., 2013). In response to the abstract nature of science and mathematics, an instructor might help students visualize these domains and motivate them to study learning material similar to pedagogical agents (Schroeder et al., 2013). Hence, instructor presence in videos might have a higher effect on learning in the STEM domain.

Third, the effect of instructor presence differed almost significantly in terms of human embodiment. The effect sizes of hand and talking head groups were larger than that of the instructor group. The videos with the instructor's hand had a marginally significant effect on knowledge acquisition. However, it is essential to note that there were only two studies with the instructor's hand as a human embodiment; therefore, the results should be interpreted carefully. Two hand studies in the meta-analysis had a particular purpose for displaying hand gestures. In one of these studies (Carlson et al., 2014), the hand was used to clarify a principle in the physics of gear movement. Therefore, iconic gestures were used in the experimental group of that study to represent an event and object semantically relevant to the content of the narration (McNeill, 1992). In the other hand study (Schroeder, 2016), the hand was used as a deictic gesture to highlight the key terms in the slides. In contrast, the ones with the full body of the instructor did not explain that gestures existed and had a specific function in instructional videos. It is more likely to suggest that those studies used beat gestures not semantically related to the narrated content (Dargue et al., 2019). Using such gestures with the appearance of a full body can distract students' attention from learning content more and cause split attention (Chen & Wu, 2015). Therefore, they might not have added value to learning. However, demonstrating only the instructor's hand for drawing, modeling, or highlighting (e.g., Fiorella & Mayer, 2016; van Wermeskerken & van Gog, 2017; van Wermeskerken et al., 2018a) might be adequate to enhance learning with instructor presence.

Fourth, the study setting resulted in a significant difference in the effect of instructor presence on knowledge acquisition. Although on-screen instructors in videos had a positive and small to medium effect on learning in laboratory settings, they did not significantly influence learning in online environments. This finding warrants urgent attention to the ecological validity of the laboratory studies. In other words, the transferability of the results of the studies in laboratory conditions to other settings might not be optimal (Frankel et al., 2012). This problem emerges because research participants are placed in a laboratory environment different from their real-life milieu in terms of place, time, roles, and tasks (Bronfenbrenner, 1976). Researchers can rigorously control conditions in a laboratory setting with a short implementation duration. Nevertheless, they might not mimic the authentic learning environment where students confront different distractors or engage with other tasks while watching instructional videos for a long period of learning. Therefore, the effect of on-screen instructors might be limited to the controlled laboratory environments, as this study reveals.

Finally, instructor-present videos did not significantly affect knowledge acquisition regardless of the locations of the participants. Therefore, the insignificant effect of such videos might be generalizable to students from North America, Asia, and Europe. This finding is critical to ensure the external validity of the conclusions of multimedia learning research (Mayer, 2017). Pi and Hong (2016) drew attention to the potential influence of context while interpreting conflicting results regarding instructor-present videos. They explained that Chinese students from the Asian culture gave more priority to relationships with others than western students; therefore, Chinese students could benefit from these videos more. However, this meta-analysis collecting and comparing the studies conducted on different continents indicates that the location of the participants is not a significant moderator. The lack of strong contribution of instructor-present videos to social presence might explain why knowledge acquisition of the students from more relation-oriented cultures was not significantly affected. Cognitive and motivational learner characteristics, such as sustained attention (Kokoç et al., 2020) and technological efficacy (Lyons et al., 2012), can be more critical moderator variables that need further attention in future studies.

5.3 Practical implications

This meta-analysis study has practical implications for the instructional design of videos. Practitioners need to consider their particular aim of integrating on-screen instructors into videos and learning conditions during the design phase of instructional videos. If their primary purpose is to enhance students' motivation, instructor presence may be helpful for this purpose. On the other hand, it might not be substantial to record instructors to increase learning and social presence in instructional videos. More particularly, instructor-present videos might not result in a notable difference in knowledge acquisition of the learners regardless of their continents. Furthermore, in the learning environments intending to decrease cognitive load, providing instructor video might not be an effective design decision; on the contrary, it can consume learners' limited working memory capacity. On the whole, it is crucial to take into account different outcomes of instructor presence while developing and using instructional videos.

Practitioners can also seek optimal ways to balance the advantages and disadvantages of these videos. Learning conditions can help them decide when to integrate on-screen instructors into videos. Sample conditions include video length, domain, human embodiment, and study setting. Videos less than six minutes and in the STEM domain might be more appropriate to obtain learning benefits from instructor presence. Moreover, showing only hand gestures to represent an object or event and highlight some information can enhance knowledge acquisition from an instructor-present video. Among the learning conditions, the primary concern of instructional designers can be where the target group will watch instructional videos with on-screen instructors. If the practitioners or researchers can control the learning environment (e.g., laboratory), it is more likely to improve learning from videos with the instructor's presence. However, such a condition might not be feasible for the instructional material used in informal learning contexts and online courses where students direct their learning. Therefore, more strategic design decisions that motivate students but do not induce cognitive load need to be considered (Wilson et al., 2018). The use of embodiment (e.g., gestures, gaze guidance, and facial expressions) that can facilitate learners' understanding of the concepts and procedures and guide their attention to the relevant content can be more vital to enhancing learning (Mayer, 2021).

5.4 Limitations and future directions

This study has some limitations that warrant attention. First, this meta-analysis included 20 information resources that resulted in a limited number of effect sizes. Small meta-analyses including less than 200 effect sizes should be carefully considered even if they are beneficial to summarize existing information and yield hypotheses for prospective studies (Flather et al., 1997). Second, moderator analysis was not conducted for knowledge transfer and motivation because of the inadequate number of studies, although there was significant heterogeneity for the effect of instructor presence on these outcomes. Third, this study took into account four potential moderators for the knowledge acquisition outcome. Other categorical variables (e.g., target learner group and type of knowledge) could moderate the effect of instructor presence, but they did not have a sufficient sample size for subgroup analysis. When the number of empirical studies designed based on other moderators increases, future meta-analyses on this topic can investigate their influence.

This meta-analysis has further suggestions for the following studies. First, the studies in this meta-analysis were mainly conducted with higher education students and participants in the United States. In addition, it was prevailing to use laboratory environments and instructional videos regarding the topics in declarative knowledge type. There is a need for more research that will involve K-12 students and adults from different countries. It is also recommendable to use online and classroom contexts for students to watch instructional videos about the topics in procedural knowledge type. Second, instructors can support learning when they display suitable gestures, draw on the board, make eye contact during lectures, or use the first-person perspective, which is called the embodiment principle (Mayer, 2021). For the progression of the research on instructor presence, future studies should also focus on investigating specific embodiment cues that might affect cognitive processing and learning outcomes (Fiorella & Mayer, 2018; Fiorella et al., 2019; Henderson & Schroeder, 2021). Third, few studies in this meta-analysis (e.g., Kokoç et al., 2020) investigated the interaction effect of instructor presence and learner characteristics. In the meta-analysis regarding pedagogical agents, Schoeder et al. (2013) found that the impact on learning differed based on learners' prior knowledge. Therefore, prospective studies can investigate how instructor presence affects learning and motivation for students with low and high levels of prior knowledge. Especially, Mayer et al. (2020) recommend that future research be conducted with children and adolescents with low prior knowledge. Finally, the effect of instructor-present videos was calculated with certain or determined data about learning, cognitive load, motivation, and social presence. However, data provided by some online video platforms (e.g., YouTube) can also involve uncertain and imprecise measures (Shahzadi et al., 2021). In the case of utilizing such data in future studies, neutrosophic statistics, such as the neutrosophic analysis of variance to analyze group differences, can yield more informative and effective results by measuring indeterminacy (Aslam, 2019; Aslam & Albassam, 2020).

6 Conclusion

The development of a video lecture is a complex process entailing the planning, implementation, and evaluation stages (Chen & Wu, 2015). The current literature on instructor presence in videos suggests that "including the instructor's image on the screen does not greatly impact student learning" (Fiorella & Mayer, 2018, p. 467). However, no meta-analysis study accumulated empirical evidence regarding videos with real human instructors and provided conclusions about their overall effect and moderating factors. This research analyzed 20 relevant information resources with the meta-analysis method. All these resources except one involved students at the higher education level, and the majority of participants were from the United States and China. The results obtained from the overall analysis of these studies reveal that instructor-present videos neither enhance nor harm the social presence and learning of the students from different continents. However, the current meta-analysis also highlights that on-screen instructors in videos can promote students' motivation while bringing about more cognitive load. Therefore, the effect direction of instructor-present videos might be neutral, positive, or negative based on the specific outcome. In addition, the conditions under which instructional videos with on-screen instructors are watched can moderate the effect on learning. This study favors the following situations to increase the positive impact of instructor presence: videos (1) less than six minutes, (2) in the STEM domain, (3) with only the instructor's hand, and (4) watched in laboratory settings. According to these results, researchers and practitioners can consider whether and when to integrate on-screen instructors into videos, especially if they target higher education students. More generalizable conclusions can be attained in future studies by testing and comparing the effects of these videos among the learner groups from different educational levels and cognitive and motivational characteristics.

Data availability The datasets generated during and/or analyzed during the current study are available from the corresponding author.

Declarations

Conflict of interest The author has no relevant financial or non-financial interests to disclose.

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