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The effect of teacher presence in videos on intrinsic cognitive loads and academic achievements

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ABSTRACT

With the rapid development of information technologies, video-mediated learning has been widely used in education and studied in academia. Whether and how a teacher should be present in a video has drawn the attention of researchers. Via a mixed design involving two teaching experiments and a semi-structured interview, this study concluded that videos with teacher presence could significantly improve academic achievements and increase intrinsic cognitive loads compared with those without teacher presence and that videos with teachers' intermittent presence could significantly improve academic achievements and increase intrinsic cognitive loads compared with those with continuous teachers' presence. Future research could explore intrinsic cognitive loads and academic achievements in video-mediated learning via multimodal and interdisciplinary methods.

KEYWORDS

Video-mediated learning; academic achievements; intrinsic cognitive loads; intermittent teacher presence; continuous teacher presence

Introduction

The new decade has been witnessing dramatic development of information technologies, greatly improving video-mediated education (Calandra & Rich, 2014). Information technologies, e.g., digital memory, advanced hardware, and software, have played an important role in the academic research into video-mediated education (Brunvand, 2010).

Educational videos allowed teachers to access classroom activities more conveniently than face-to-face interactions in class (Welsch & Devlin, 2006) without reducing the instructional effectiveness (Roche & Gal-Petitfaux, 2014). The video-mediated learning provided an alternative instructional medium (Llinares & Valls, 2009), bridging a literature gap between tertiary educational theory and in-class practice (Karsenti & Collin, 2011).

However, little is known about how different modes of teacher presence in educational videos influence intrinsic cognitive loads and academic achievements. The research questions thus focus on whether or not different modes of teacher presence could greatly influence intrinsic cognitive loads and academic achievements.

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Literature review

The effect of different modes of teacher presence on cognitive loads

Definitions

The term 'teacher presence' refers to situations where a teacher appears in a video when delivering a video-mediated lecture. By presence, the teacher can draw learners' attention through body languages, gestures, and facial expressions. The cognitive load is referred to as a multifaceted load carried by the cognitive system during the performance of a certain task. The measured cognitive load at a given time can reveal the amount of information processed in working memory (Yu et al., 2014). Sweller (2010) has studied three cognitive loads, i.e. intrinsic, extrinsic, and germane cognitive loads.

Types

The intrinsic cognitive load, subject to the difficulty of knowledge, refers to the load formed during the process of knowledge acquisition. It processes the information or knowledge dependent on the mental ability (Marcus et al., 1996; Sweller, 2010). The extrinsic cognitive load, subject to teaching approaches and course designs, refers to the cognitive load established in the working memory due to instructional elements (Yu et al., 2014). The germane cognitive load, subject to the intrinsic cognitive load, refers to the cognitive load formed during the construction of schemata (Wiebe et al., 2010). It is also considered the load processed in the working memory to deal with the intrinsic cognitive load during the learning process (Yu, 2019).

Effect

Teacher presence could greatly influence intrinsic, extraneous, and germane cognitive loads of video-mediated online learning. Teacher presence and other instructional methods could increase extraneous cognitive loads, while the schema of knowledge could minimise them (Yu, 2019). The videos without teacher presence could cause significantly higher cognitive loads than those with teacher presence (Chen & Wu, 2015). Videos causing higher intrinsic cognitive loads could draw more attention, while those causing higher extraneous loads could draw less attention (Superfine & Bragelman, 2018). Videos with teachers' intermittent presence could significantly reduce cognitive loads compared with continuous presence (Yi et al., 2019).

Nevertheless, some studies revealed contradictory findings regarding the effect of videos on cognitive loads. The video-mediated students had poorer academic performance and higher cognitive loads than those without videos (C. Wang et al., 2020). Videos with teacher presence could facilitate transfer performance, reduce cognitive loads, and improve learning judgement in terms of difficult questions compared with those without it. Videos with teacher presence could draw students' attention and thus fortify satisfaction of and interest in both easy and difficult questions (J. Wang et al., 2020).

Nevertheless, cognitive loads in previous studies were seldom specified. It is thus meaningful to determine the effect of different modes of teacher presence in videos on the relatively stable load and the intrinsic cognitive load during the learning process.

The effect of different modes of teacher presence on academic achievements

The effect of different modes of teacher presence in a video has been explored by several researchers on academic achievements. Videos with teacher presence could cause significantly better academic achievements than those without it (Ilioudi et al., 2013). The former could also produce significantly better understanding of contents and difficult topics and more accurate course notes than the latter (Wiese & Newton, 2013). Videos with teachers' intermittent presence could significantly improve academic achievements compared with continuous presence (Yi et al., 2019). Despite these related findings, plentiful evidence has not been collected regarding the effect of different modes of teacher presence on academic achievements. It is thus meaningful to further explore this field.

Research hypotheses

The evidence reviewed here seems to suggest a pertinent role for various modes of teacher presence in intrinsic cognitive loads and academic achievements. Four null hypotheses were thus proposed as follows.

H1. Videos with teachers' presence could not significantly improve academic achievements compared with those without the presence.

H2. Videos with teachers' presence could not significantly increase intrinsic cognitive loads compared with those without the presence.

H3. Videos with teachers' intermittent presence could not significantly improve academic achievements compared with the continuous presence.

H4. Videos with teachers' intermittent presence could not significantly increase intrinsic cognitive loads compared with the continuous presence.

Research methods

The ethical form of approval was obtained for the research by an institutional Ethics Committee. This study adopts a mixed design by integrating quantitative into qualitative research methods.

Participants

A total of 131 undergraduate students majoring in the English language were randomly selected and divided into Cohorts A (N = 32), B (N = 35), C (N = 33), and D (N = 31) for two pedagogical experiments. They share similar educational backgrounds and received formal English education for around 10 years. They also share the same age, ranging from 20 to 22 years old (M = 20.89; S.D. = .761). Females (N = 92) outnumbered males (N = 39) since much more females enrolled in linguistic courses than males. All of them

reported that they were normally literate and voluntary to participate in the study, where their personal information remained confidential and was merely used in this study.

The learning context

Participants could watch different kinds of online videos of the course 'An Introduction to Linguistics'. They had the freedom to choose the time and venue to watch online videos in the learning context where they feel convenient. Cohort A had access to the videos with teacher presence, Cohort B to those without teacher presence, Cohort C to those with continuous teacher presence, and Cohort D to those with intermittent teacher presence (Figure 1). All the cohorts were required to finish the video-mediated online learning within a semester (24 February 2020– 3 July 2020).

Research instruments

A scale to identify academic achievements

In this study, academic achievements were operationally defined as the linguistic knowledge gained after participants received one-semester video-mediated education. Academic achievements were measured based on pre and post tests and daily performances. Participants' linguistic knowledge was measured in both tests at the beginning and end of the semester respectively. Both tests included blank filling, linguistic term definition, and question answers, totalling 100 points. Daily performances were calculated through five assignments for both tests, 4 points for each, totalling 20 points. The assignments were composed of multiple choices, definitions of terms, and question answers.

A scale to identify participants' intrinsic cognitive loads

The intrinsic cognitive load scale includes six dimensions, i.e. mental demand, physical demand, temporal demand, effort, and frustration level (Hart & Staveland, 1988). Five question items were used to determine each scale, followed by a five-point Likert scale ranging from *strongly disagree* to *strongly agree*.

A semi-structured interview

The semi-structured interview consisted of three sections. Section A included demographic information questions and an ethical statement. Section B aimed to collect data

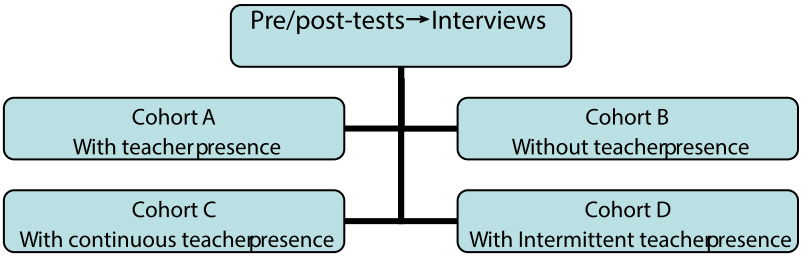

Figure 1. Research procedure.

regarding interviewees' intrinsic cognitive loads and academic achievements. It includes questions to collect data of interviewees' perceptions about the academic achievements and intrinsic cognitive loads and an open-ended question. Section C extended gratitude to interviewees.

The interview questions focused on the effect of different types of videos on cognitive loads and academic achievements. Examples are 'do you think teacher presence in the video can improve your academic achievements compared with no teacher presence?' and 'do you think teacher presence can increase your cognitive loads?'. Face-to-face interactions were conducted in a quiet office between the interviewees and the interviewer who acted as a facilitator.

Research procedure

The research consisted of two pedagogical experiments and a semi-structured interview (Figure 1). The participants were organised into four classes, each receiving video-mediated linguistic education. Videos were designed with different scenarios of teacher presence to test the research hypotheses.

The first experiment, comparing Cohorts A and B, aims to test the first two research hypotheses. Videos for Cohort A were designed with the teacher's presence, while those for Cohort B without the teacher's presence (Figure 2). The second experiment, comparing Cohorts C and D, aims to test the third and fourth research hypotheses. Cohorts C and D received videos with the teacher's continuous and intermittent presence respectively.

At the beginning and the end of each experiment, students' linguistic knowledge and cognitive loads were tested respectively. Both pre and post-tests were carried out in classrooms under similar conditions. The same experienced researcher carried out the teaching process. After the experiments, volunteers (N = 47) were randomly selected to join the semi-structured interviews for qualitative data collection.

The semi-structured interviews were carried out in a quiet office, where 47 interviewees joined the face-to-face interviews. The interviewers were not associated with the students in the study. They asked questions closely related to video-mediated intrinsic cognitive loads and academic achievements. The possible source of bias might include students' self-censorship and their catering to the interview purpose.

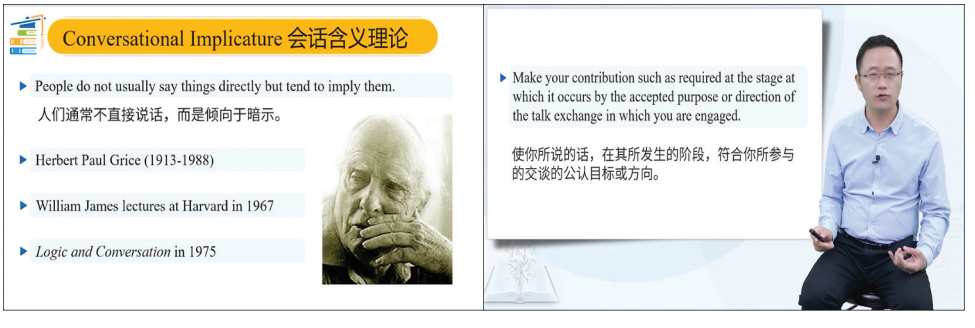

Figure 2. Different types of videos.

The face-to-face interviews were individually conducted. The interviewers, without any purposeful hint, encouraged interviewees to freely voice their opinions on different types of videos. As a facilitator, the researcher would invite them to bravely utter their viewpoints in case they paused. If the interviewees did not know how to say, the researchers would encourage them to proceed. If the interviewees strayed away from the topic, the researcher would draw them back and keep the interview smoothly going on. The interviews were all recorded and transcribed for further analysis.

Results

Results of both experiments

To decide the specific programme to analyse the data, the normality of data distribution was firstly tested.

Test of normality

The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to test goodness of fit to the normal distribution. The data in Table 1 were obtained through 'analyse → descriptive statistics → explore → plots → normality plots with tests.'

As shown in Table 1, data of pre-post academic achievements and intrinsic cognitive loads in four cohorts are all not normally distributed. Thus, Kruskal Wallis Tests, not requiring the normal distribution of data, were adopted to test the research hypotheses.

Results of Kruskal Wallis Tests

Kruskal Wallis Tests were conducted to determine whether there were significant differences in pre-post academic achievements and intrinsic cognitive loads (Table 2).

Results of that analysis indicated that there was no significant difference with students on pre-academic achievements *($x^2 = .642$, $p = .887$)* and pre-cognitive loads *($x^2 = 2.034$, $p = .565$)* in four cohorts, while significant differences were found in post-academic achievements *($x^2 = 11.489$, $p = .009$, MR of Cohort A = 76.27, MR of Cohort B = 54.00)* and post-cognitive loads *($x^2 = 17.472$, $p = .001$, MR of Cohort D = 82.44, MR of Cohort C = 56.59)* in four cohorts. No significant differences in pre-tests provided a solid foundation for post-tests comparison where significant differences were revealed. It indicated that videos with teachers' presence could significantly improve academic achievements and increase intrinsic cognitive loads compared with those without the presence, and videos with teachers' intermittent presence could significantly improve academic achievements and increase cognitive loads compared with the continuous presence. The four null hypotheses were thus rejected.

Table 1. Tests of normality.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-academic	.115	131	.000	.967	131	.003
Post-academic	.144	131	.000	.965	131	.002
Pre-cognitive	.147	131	.000	.961	131	.001
Post-cognitive	.148	131	.000	.971	131	.007

[a]Lilliefors Significance Correction

Table 2. Results of Kruskal Wallis Tests.

Item	Cohort	N	Mean Rank	Chi-Square	df	Asymp. Sig.
Preacademic	A	32	63.42	.642	3	.887
	B	35	69.66			
	C	33	67.03			
	D	31	63.44			
Postacademic	A	32	76.27	11.489	3	.009
	B	35	54.00			
	C	33	56.70			
	D	31	78.85			
Precognitive	A	32	60.41	2.034	3	.565
	B	35	62.76			
	C	33	71.95			
	D	31	69.10			
Postcognitive	A	32	77.44	17.472	3	.001
	B	35	49.86			
	C	33	56.59			
	D	31	82.44			

Results of the semi-structured interview

The results of the semi-structured interview were generally consistent with those from both experiments. Most of the interviewees (N = 42) believed that videos with teacher presence made them feel like a real class instructed by a teacher. They, however, thought that videos without teacher presence seemed like a 'technically fake' product aiming to catch their attention and deliver 'boring knowledge'. The majority of them (N = 45) believed that the continuous teacher presence more likely tired them compared with the intermittent since the former visually and cognitively bored them while the latter refreshed them and enhanced their curiosity. One of the interviewees said 'I prefer the intermittent to the continuous teacher presence because I want to relax when watching the video. The continuous teacher presence makes me feel kind of nervous, while the intermittent makes me feel easy and relaxed.'.

They tended to expect something new each time when they watched a new video or a different episode. Some of them (N = 29) assumed that videos with teacher presence made them focus on the topic more and thus caused more cognitive effort than those without it, while others (N = 18) reported that they did not know whether their cognitive effort changed in different conditions. The intermittent teacher presence, as reported by 41 of them, could relax them and enhance their effort of cognition, while the continuous could have intensified their nerves and exhausted their cognitive effort. Most of them (N = 44) were not sure about changes in their intrinsic cognitive loads since they were elusive and intangible.

Discussion

The findings in this study are generally consistent with previous studies (e.g., Chen & Wu, 2015). Computers-as-social-actors paradigm (Reeves & Nass, 1996) argues that with social cues such as teacher presence, the video-mediated lecture seems like a real in-class one, motivating learners to respond to the teacher. The personalisation principle, aiming to motivate learners to engage in academic activities, suggests that teacher presence may

facilitate learning via generative processing (Clark & Mayer, 2011). Learning effect is subject to other social cues, e.g., politeness (Kizilcec et al., 2015), conversational speech (Kartal, 2010), human voice (Mayer et al., 2003), and polite style (McLaren et al., 2011). Social cues in online learning could also improve academic achievements and enhance student satisfaction (Richardson & Swan, 2003). With the presence of the teacher, watchers may feel socially associated and satisfied with the teacher and learning contents (Richardson & Swan, 2003). Students' academic achievements may be enhanced due to socially connected settings (Yu & Wang, 2016).

It is reasonable to find that videos with teacher presence could lead to significantly higher academic achievements and intrinsic cognitive loads than those without teacher presence. Teacher presence in the video could have provided a simulated physical classroom situation, where the teacher could regulate students' learning behaviour (Kizilcec et al., 2015). Absence of a teacher in the video could have possibly made students assume that it was merely a video and they were not supervised by the teacher. Therefore, they would have deviated from the contents of the video, leading to poorer academic achievements and less intrinsic cognitive loads. The teacher present in the video could also catch learners' attention by the body language or eyesight orientation. They could also guide students to important knowledge points by using proper gestures. Students may feel bored with facial expressions or body languages if they are excessively presented. Teachers should, therefore, limit their facial expressions and body languages to a certain extent.

In the video, the teacher could keep smiling with confident body languages and make eye contact with the camera. When the teacher looks at the camera, the eyesight will be directly connected to the watcher. The teacher could also start a lecture with something catchy, e.g., a short quiz, a controversial question, or an interesting news item. Teacher presence could easily foster self-efficacy (Karsenti & Collin, 2011) and the teacher could extend his or her teaching enthusiasm of the target subject to students who would be engaged in academic activities. Activities would seem accompanied by the teacher present in the video, which could encourage students to maintain the learning behaviours and improve their learning effectiveness.

Social cues in the video could motivate students to learn and individuals need specific designs rather than one-size-fits-all approaches (Kizilcec et al., 2015). The teacher can manage the teaching procedure based on the students' different responses and can also communicate with students conveniently. Interactions through the video can facilitate teaching effectiveness and learning outcomes. Teacher presence can enable students to physically ask difficult questions or virtually send messages to the teacher which can be seen on the screen. The teacher in the video can underscore the important contents on the transparent board and guide students to the difficult points, by which students' attention will be drawn, together with improved academic achievements and changed cognitive loads. Without the teacher, students might feel hard to form a learning group, join learning activities, or follow the teaching progress, which might distract them and dampen their academic spirits.

Videos with a talking head could significantly improve student engagement more than that without it (Guo et al., 2014; Kizilcec et al., 2014). Head, as an essential part of the human body, may play the most important role in improving student engagement. Through watching the talking head, students may feel it is like a real face-to-face

interaction with the teacher, drawing their attention and regulating their learning behaviours. Facial expressions may also highlight the important knowledge points through various movements, which may guide students' attention to proper directions. The talking head could also deliver the message to the students that the teacher was making efforts to transfer the knowledge. In this way, students may be more interested in learning and obtain better academic achievements. However, those with merely a rigid rather than a talking head may reduce the learning effect.

Relaxation could provide watchers with more room to acquire new knowledge. The continuous teacher presence could also intensify watchers while the intermittent could relax them by showing different pictures on the screen. The intermittent intervals should, however, be irregular and unpredictable. Otherwise, watchers could easily predict teacher presence and feel bored with the screen. Teacher presence could also be varied and eye-catching to relax watchers and engage them in learning activities. To relax watchers, the video should be made short with intermittent teacher presence. Long videos with continuous teacher presence could make watchers fed up with the contents, together with reduced learning effects. This is consistent with reports from the interview. Interviewees (N = 29) preferred short and intermittent to long and continuous teacher presence.

However, contradictory findings were also previously revealed. Cognitive loads and perceived social presence were significantly higher in the videos with intermittent teacher presence than those with continuous, while no significant differences were revealed in academic achievements in both conditions (Kizilcec et al., 2015). The continuous presence of teachers in the video could have drawn students' attention at first, but they might have felt tired of it with time passing by. Intermittent presence of teachers in the video could, however, have relaxed students and prolonged students' attention, which could likely cause favourable academic achievements. Another paradoxical finding is that a favourable method to improve the effectiveness of an instructional design is to free working memory and decrease cognitive loads (Huh et al., 2019). Nevertheless, the intrinsic cognitive load was not included in the influencing factors of instructional effectiveness in Huh, Kim, & Jo's study (Huh et al., 2019). Our study has considered it an important indicator of learning effectiveness and cognitive loads and provided a meaningful example for further research into video-mediated learning.

Conclusion

Major findings

This study finds that videos with teacher presence can significantly improve academic achievements and increase intrinsic cognitive loads compared with those without the presence and that videos with teachers' intermittent presence can significantly improve academic achievements and increase intrinsic cognitive loads compared with those with the continuous presence. The findings are generally in line with previous studies.

Limitations of this study

A single indirect and unidimensional method could not reliably measure cognitive loads, which needs a multimodal method, involving psychometric, eye tracking, and

electroencephalography components (Kruger & Doherty, 2016). The method used in this study was not multimodal to determine the intrinsic cognitive load, which may have limited the reliability of the results.

Future research directions

Other factors, e.g., learners' prior knowledge and task complexity, could greatly influence cognitive loads, which was determined by pupil dilation patterns in video-mediated learning (Huh et al., 2019). Future research could include more influencing factors. Due to paradoxical findings, intrinsic cognitive loads need to be explored via multimodal and interdisciplinary methods in the future.

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