The Effects of Social Cues in Self-Produced Micro Video Lectures on Parasocial Interaction, Motivational Interest, Extraneous Cognitive Load, and Concept Learning Performance: an Empirical Study in a Junior High School

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Abstract

Background and Aim: Videos are popular in the dissemination of knowledge at scale, which can be seen in various video-based platforms and educational disruption. However, inconsistent results were reported in studies. This research is designed to determine the effectiveness of social cues in self-produced micro video lectures on parasocial interaction, motivational interest, extraneous cognitive load, and concept learning performance and the relationship among them.

Materials and Methods: Self-produced videos for learning concepts of morality and the rule of law in junior high schools were used as the treatment. Tests were used to determine concept learning performance and Likert scales were utilized to collect information on the other three variables. 248 students from the eighth grade in a public school were involved in the sample. One-way ANOVA was used to analyze differences among groups, and path analysis as well as was adopted to determine the relationship between variables.

Results: There was no significant difference among the four groups on each variable. Parasocial interaction has a significant positive impact on motivational interest, motivational interest has a negative significant impact on extraneous cognitive load, and extraneous cognitive load has a negative significant impact on concept learning performance.

Conclusion: The effects of the increment of types of social cues can be ignored in 6-minute self-produced video lectures. Students' parasocial interaction can influence concept learning performance via the mediation of the cognition process and motivational factors. The extraneous cognitive load decreases with the stimulation of the motivational interest.

Keywords: Concept Learning, Extraneous Cognitive Load, Motivational Interest, Morality and the Rule of Law, Junior High School.

Introduction

With the increasing access to the internet and portable electronic equipment, videos have become a popular way to deliver information at scale, which can be proven by the massive amount of users of video-based platforms such as MOOCs (Hansch et al., 2015; Guo et al., 2014; Pozón-López et al., 2020), Youtube (Scagnoli et al, 2017; Sherer & Shea, 2011), Bilibili, and Tiktok (Zea & Heekyoung, 2019). With the convenient accessibility of the internet and webcam as well as the popularity of user-provided video-sharing platforms (Sherer & Shea, 2011; Zea & Heekyoung, 2019), self-produced micro video lectures by teachers can be a sustainable way to disseminate knowledge. Additionally, it might contribute to narrowing the gap between regions and people of different economic status (Huang et al., 2020), and to satisfy various individual learning needs that cannot be met in traditional and daily classrooms (Wiese & Newton, 2013).

China's Ministry of Education has come up with policies to stimulate teachers to take the initiative to contribute to the construction of a large-scale online open platform for distance learning, for instance, the project "One Teacher; One Excellent Course; One Lesson, One Excellent Teacher" (more information can be searched on http://www.moe.gov.cn/). It is reported that this program had more than 2.28 million teachers involved until the year of 2019, and a tremendous amount of learning resources produced by the teachers can provide powerful support to online learning (Zhou et al., 2020).

In China, the construction of a massive e-learning environment has achieved great success with the policy "School's Out, But Class's On" during the pandemic of Covid-19, due to the considerable national

efforts on the infrastructural construction for educational digitization and the organization of online public platforms for the massive dissemination of learning and teaching resources aimed for compulsory education (Zhou et al., 2020). These authors further point out that in the era of Educational Informatization 2.0, e-learning has profoundly changed teaching and learning in multiple aspects, which forces teachers to consider the integration of technology, to understand learners and learning from a new perspective, and to make good use of accessible but ever-changing resources.

An increasing number of students acquire knowledge online through video-sharing platforms, while the participators of the internet are empowered and encouraged to share multimedia information (Sherer & Shea, 2011; Hansch et al., 2015; Brecht, 2012). It is reported that the effectiveness of educational videos does not depend on the expense of the production, and it is recommended that the instructors film video lectures in informal settings and produce video lectures at lower cost by themselves (Hansch et al., 2015; Guo et al., 2014). Further, it is claimed that the success of the Khan Academy has proven that, to some extent, the effective information delivery of the video lecture outweighs the instructional reputation of the instructor, the exquisite editing of the video as well as the expensive setting of the instructional scene (Brecht, 2012). In practice, teachers can consider taking advantage of self-produced video lectures, and explore strategies to serve daily instruction with this kind of instructional resources to deliver information more effectively, and therefore, facilitate the development of learners' autonomous and lifelong learning.

Objectives

This research was designed to determine the effectiveness of social cues in self-produced micro video lectures as well as to investigate the interplay of parasocial interaction, motivational interest, extraneous cognitive load, and concept learning performance of junior high school students in quasi-experimental environments. The research was conducted in a junior high school and focused on the effects of videos on concept learning on the subject of morality and the rule of law. The research tools of this study were a test with single-choice questions and a survey with scale items, which means this research acquired both objective and subjective data. The objective data in this research was from tests with questions chosen from the district-wide final examination organized by the governmental departments of each district in Guangzhou city from the year 2018 to 2022 (those of the year 2023 were not released officially when this research was conducted). Besides, the subjective data were collected from a survey with 9 scale items on three aspects. In this study, the research objectives are listed as follows:

1) To determine whether the number of types of social cues significantly affect concept learning performance, parasocial interaction, motivational interest, and extraneous cognitive load.

2) To determine whether motivational interest and extraneous cognitive load mediate the effect of parasocial interaction on learning performance.

3) To determine whether motivational interest has a significant impact on extraneous cognitive load.

Literature review

Self-produced videos as a kind of learning resource contributing to knowledge denomination at a large scale and self-regulated learning is possible with the advance of the Era of Web 2.0. It is essential for instructors and researchers who wish to explore the value of this kind of learning resource to understand learning with videos in the Era of Web 2.0. Furthermore, many researchers have to pay attention to learning in multimedia environments and make attempts to develop several frameworks to include various aspects in this context. Five theoretical frameworks on multimedia learning are analyzed to develop a conceptual framework and determine four dependent variables for this research. It is noticeable that contradictory assumptions exist in these theories and inconsistent conclusions produced in various empirical studies. All in all, these various aspects of multimedia learning should be further investigated in a concrete educational context to enrich the knowledge in this field.

Learning with Videos in the Era of Web 2.0: Learning with videos in the era of Web 2.0 can prove its success in multiple conventional platforms for knowledge discrimination, websites for user-

provided videos, and the application of educational videos in educational disruption. Noticeably, these facilitate the construction of Open Educational Resources (OERs) and are featured by the empowerment of individuals in the dissemination and learning of knowledge.

One of the important features of Web 2.0 is that the content is mainly produced by users, users' interaction plays an important role in the editing and dissemination of online information, and thus, information can be delivered at a considerably high speed (McGee & Begg, 2008; McGowan et al., 2012).

The impact of Web 2.0 in education can be defined as "Pedagogy 2.0", and three features of this phenomenon are summarized by McLoughlin and Lee (2008). The first aspect focuses on the connection and interaction between users, where individuals can participate in collaborative learning, communicate with other individuals efficiently, and establish learning communities. The second feature is called personalization, which indicates that learners are empowered and the selection of information can be more individual-focused. The last feature is defined as productivity, where users are welcome to take the initiative to make innovations and contributions to the construction and dissemination of knowledge.

In the context of Web 2.0, students are provided with unprecedented convenience to get access to the latest information in a certain field (Sherer & Shea, 2011). Six platforms for online learning are identified as the biggest and the most popular platforms in America and Europe by Hansch et al. (2015). Particularly, it is indicated by these researchers that MOOCs have attracted attention in various research, where video lecture is the main form of information delivery in this platform.

Platforms for user-provided videos provide participants of the internet a chance to contribute to the construction of OERs, which are defined by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) (2019) as open copyrighted learning resources. It is further pointed out by UNESCO that OERs can provide pleasant values with support from information and communication technologies (ICTs). The learning resources can be accessed with convenience with ICTs, and it encourages innovation in knowledge and pedagogy (Rodrigo & Ladrido, 2022).

In China, TikTok and Bilibili are two of the most representative User Generative Content (UGC) platforms. The former platform includes information sharing on skills and disciplinary knowledge, and the latter platform has become a popular website for online learning with videos (Wang & Zhang, 2021). Besides, Bilibili has established a large amount of interest-focus online communities that are similar to the YouTube learning community and are different from traditional learning communities based on physical proximity within a classroom, a school, or an educational district (Sherer & Shea, 2011).

The popularity of online learning videos in China can be partially attributed to the pandemic of Covid-19. The shutdowns of schools and universities forced teachers and students to take part in a large-scale experiment of distance learning via ICTs, in which almost 20 million universities and schools conducted educational activities online (Zhou et al., 2020). It is further indicated by these researchers that since both the teachers and students are involved in this large-scale distance learning practice, the construction of educational informatization in China speeds up, which also leads to more learner-centered education. Noticeably, video-based learning plays an important role in this process. In research based on experiences in China during the pandemic, video lecture is identified as one of the most popular forms of learning resources for distance learning to cope with educational disruption (Huang et al., 2020). For instance, it is reported by these authors that video lectures are utilized in the open online learning resources provided by People's Education Press with electronic textbooks.

Theoretical Framework for Instructional Design and Learning in Multimedia Environments: There are five theoretical frameworks in this part, which include the Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2002), the Cognitive-Affective-Social Theory of Learning with Media (CATLM) (Park et al., 2014), the Cognitive-Affective-Social Theory of Learning with Media (CASTLM) (Stiller et al., 2020), the Integrated Cognitive Affective Model of Learning with the Multimedia (ICALM) (Plass & Kaplan, 2016), the Cognitive-Affective-Social Theory of Learning in Digital Environments (CASTLE) (Schneider et al., 2021). These five theories mainly discuss some/all of the aspects and the

relationship among these aspects in learning with multimedia materials, including cognitive, metacognitive, social, and parasocial, as well as motivational and affective elements.

It's pointed out that studies on parasocial interaction, which is an important theme in multimedia communication in the learning context, are far more than enough (Beege et al., 2017). Positive effects have been reported that parasocial experiences can facilitate the recipient's commitment to social norms (Horton & Strauss, 1957), and parasocial relationships can improve task performance (Gardner & Knowles, 2008).

In terms of the affective and motivational factors in multimedia learning, these are identified as two aspects without clear definitions in most of the theories except for ICALM (Plass & Kaplan, 2016), which take affective factors as the focus while mentioning the motivational effects frequently.

Also, it is indicated that the interaction of these different aspects in multimedia learning calls on more academic scrutiny (Stiller et al., 2020), for instance, the effects of social cues on parasocial interaction, learning motivation, and cognitive load, and the interaction of these three aspects on learning performance, since inconsistent results are reported in various research contexts. Noticeably, research on affective/motivational factors in learning settings is not emphasized, though it is claimed that this aspect exists in the whole learning process and inherently interacts with cognitive processes (Plass & Kaplan, 2016). Additionally, it is also pointed out by these researchers that affective factors can influence learning via motivational processes.

Specifically, concerning social factors, it is proposed by Schneider et al. (2021) that future empirical studies should provide more concrete evidence on the effects of social cues on learning, as well as the interplay of social processes with cognitive, metacognitive, motivational, and affective processes and the effects on learning together. Also, these researchers point out that the moderating processes should be investigated in this regard. For instance, motivational factors can perform as mediating variables in the effects of social cues, since it is postulated that social cues can cause cognitive load.

The Number of Types of Social Cues: The number of types of social cues is the independent variable, which refers to four types of social cues in self-produced micro video lectures: the instructor's voice, talking presence, eye contact with the audience, and pointing signs.

In this study, videos with the instructor's talking head refer to a video lecture that contains the appearance of the instructor's talking head (Guo et al., 2014; Wang & Antonenko, 2017). According to the Media Richness Theory (Ishii et al., 2019), the appearance of the instructor's talking head can deliver information via various cues such as facial expressions, gestures, optical cues, and so on. More importantly, the talking head of the instructor might provide effective support since the comparison between the appearance of an animation and a real person in multimedia learning resources indicates that the latter are more welcomed (Baylor & Kim, 2005; Kim & Baylor, 2016). Also, it is reported in an empirical study that the presence of the instructor in educational videos can bring positive effects on information recall in lower-level tasks, and can make students give affective responses positively (Wang & Antonenko, 2017). What's more, in this just-mentioned research, in which participants are not allowed to pause the playing of the video or take notes in a controlled setting, it is indicated that the presence of the instructor demonstrating various nonverbal cues results in more than one-fourth of the total dwell time, which takes up considerable percentage in learners' visual attention. In other aspects, the appearance of the instructor's talking head can increase learner engagement, and it is recommended that the instructor's talking head should appear from time to time or adopt a picture-in-picture format in the production of educational videos (Guo et al., 2014).

In this research, eye contact between the instructor and the audience will be recognized as one kind of social cue in video lectures (Beege et al., 2017; Guo et al., 2014; Fiorella et al., 2019). According to CATLM, social cues can evoke affective responses facilitate learning performance, and add burden to cognitive load (Harp & Mayer, 1998; Beege et al., 2017; Mayer, 2014; Park et al., 2014), and therefore, effects of the affective factors to cognitive process and learning outcomes might need further research. It is pointed out that a high frequency of eye contact as social cues can increase intimacy (Burgoon et al., 1984; Gunawardena, 1995). Also, it is recommended that the instructor in video lectures should face the camera

to provide positive effects on parasocial interaction, which can have impacts on learning (Beege et al., 2017).

In this research, videos with the instructor's pointing signs mean the instructor sitting in front of a screen playing the slides will display pointing signs with pointing sticks (Ouwehand et al., 2015; Wang et al., 2018; Pi et al., 2016). According to CATLM, adding extra information to deliver information can bring cognitive load, however, the pointing signs might help to build the connection between verbal and visual information and foster active engagement. Sato et al. (2009) reported that pointing stimuli, which can be gaze, gestures, and arrows, can cause the shifting of attention. Similar results are reported in video-based learning environments where cues from gaze and gestures can trigger attention shifts (Ouwehand et al., 2015). Specifically, gaze guidance can benefit learning via video lectures on the acquisition of declarative knowledge and procedural knowledge (Wang et al., 2018). Also, the directive gestures of the instructor help deal with high-loaded information in learning with video lectures (Pi et al., 2016).

Concept Learning Performance: In this research, concept learning refers to the acquisition of fundamental units in the thinking process in disciplinary learning and a concept can be illustrated with a word or a few words that indicate specific term(s), relationship(s), and phenomenon(s) (Nakhleh & Mitchell, 1993; Marzano et al., 1993; Klausmeier, 1992). This kind of learning can be categorized as lower-level learning. In terms of concept learning in the video-based learning environment, there is research indicating that learning videos are more suitable for the lower-level acquisition of knowledge, especially declarative knowledge (Brecht, 2012; Hong et al., 2016; Huang et al., 2020).

Parasocial Interaction: Parasocial interaction in this research means the degree of the learner's perceived social connection with the social entity in a video lecture, which will be mainly assessed on the cognitive aspect (Beege et al., 2017; Cummins & Cui, 2014; Schramm & Hartmann, 2008). A comprehensive set of scales aimed to determine parasocial interaction with TV persona was developed by Schramm and Hartmann (2008) according to the analysis of cognitive, affective, and behavioral responses of the recipients. It is encouraged by these researchers that these scale items should be selected based on concrete research purposes and contexts. After that, a short version scale called EPSI was proposed by Hartmann and Goldhoorn (2011) to analyze the cognitive aspect in an experimental research environment. These two scales were adopted by Beege et al. (2017) and they developed a Likert scale based on specific needs in their study. Noticeably, it is proposed that the survey with scale items before the test can affect the score (Beege et al., 2017). In this research, two scale items are selected and slightly modified from the scales of Schramm and Hartmann (2008) on the cognitive dimension, and one scale item is chosen from the scale used by Beautemps and Bresges (2022) on YouTube learning videos.

Motivational Interest: Interest is considered an essential motivational variable (Wang & Adesope, 2016), and learning motivation can refer to the driving power to support efforts on multiple aspects to achieve certain goals (Martin, 2003). A four-dimension model of cognitive-motivational factors in the context of self-regulated learning is studied by Vollmeyer & Rheinberg (2006). In this model, four aspects are recommended to measure motivation, which include challenge, interest, anxiety, and expectancy of success. In the framework proposed by Koumi (2006), the nurturing merits of educational videos are closely linked to motivational factors, which means to increase students' desire to learn, act, and apply techniques. Motivational interest is a kind of motivational factor and is defined as the power to drive and regulate human behaviors in the learning process, and then to affect cognitive engagement (Chen et al., 2001; Hidi & Renninger, 2006). In this research, the cognitive-motivational model will be adopted and 3 scale items will be selected on interest and modified slightly based on the scale developed by Beautemps and Bresges (2022) on self-regulated learning with online videos.

Extraneous Cognitive Load: According to cognitive load theory (CLT), the capacity of working memory is limited, and in this sense, cognitive load can refer to the load of working memory (Schmeck et al., 2014). A learner's cognitive load can be categorized into three types according to CLT: intrinsic cognitive load (IL), extraneous cognitive load (EL), and germane cognitive load (GL) (Sweller et al., 1998; Leppink et al., 2013). Sweller et al. (2019) further proposed a model that retains these three elements but

attaches the same weights to EL and IL and considers GL as another aspect that should be investigated separately. These researchers proposed that IL is determined by the challenges of the task and the learner's prior knowledge, EL is mainly caused by the presentation of a learning task and instructional procedures and can bring negative effects to the learning process, and GL is the cognitive load required by the learning task. The reconsideration of Sweller and his colleagues (2019) indicates that the decrease in EL can allow more cognitive resources to deal with IL and therefore, GL performs redistribution from EL to IL. Extraneous cognitive load means the perceived cognitive load reported by the learner on the presentation and the learning procedures of the learning task (Sweller et al., 2019; Leppink et al., 2013). In this research, this variable is measured with scale items modified from the scale developed by Leppink et al. (2013).

Conceptual Framework

It is supported by empirical evidence that the increment of social cues can foster parasocial interaction and learning performance. For instance, the facing direction and the eye gaze of the instructor can lead to an increment in parasocial interaction and learning outcomes (Beege et al., 2017), and the eye contact between the instructor and the audience can result in the growth in parasocial interaction (Dibble et al., 2016). Schneider and colleagues (2021) point out that future research should study the interplay among different aspects more specifically, such as the effects of the number of social cues. In terms of the effects of social cues on motivation and cognition, a contradictory situation is proposed that social cues can benefit learning by stimulating motivation on the one hand, and can result in negative effects on learning processes via adding cognitive load to the learner's cognitive process on the other hand (Schroeder & Adesope, 2014). However, it is reported in empirical research that the lecture capture added in slides produces extra cognitive load (Chen & Wu, 2015), and the appearance of the instructor in video lectures on the acquisition of procedural knowledge can increase cognitive load (Hong et al., 2016). As a result, the first research question is to determine whether the number of types of social cues significantly affect concept learning performance, parasocial interaction, motivational interest, and extraneous cognitive load. The corresponding hypothesis is proposed as follows.

H_a1: The number of types of social cues significantly affects concept learning performance, parasocial interaction, motivational interest, and extraneous cognitive load.

As an aspect that is closely linked to learning performance, motivation can either facilitate or jeopardize the learning process (Martin, 2003). Though motivation is an important dimension included in multimedia communication in CATLM (Moreno, 2006), CASTLM (Stiller et al., 2020), and CASTLE (Schneider et al., 2021), the motivational processes are not explicitly explained in some frameworks such as the first and the last theory. It is pointed out that there are no adequate theories and explanations for motivational elements in multimedia learning environments (Plass & Kaplan, 2016). Further, these authors claimed that the emotional/motivational factors should be studied and applied to multimedia learning materials to trigger beneficial emotions for learning without bringing emotional overload. According to the facilitator's assumption, the instructional formats can evoke positive emotional responses and then lead to the stimulation of cognitive load, motivation, and learning (Um et al., 2012). Based on the extraneous load assumption, those desirable emotions can increase the load in a learner's working memory (Seibert & Ellis, 1991), however, inconsistent empirical results are provided by Um et al. (2012). Also, it is pointed out that the research on the effects of PSI on learning motivation is not explicit and adequate (Beege et al., 2022), though some researchers try to directly focus on this relationship in educational videos (Beautemps & Bresges, 2022). The hypothesis of the seductive detail effect combines the extraneous load assumption and the facilitator assumption. In conclusion, the seductive details, which are irrelevant but interesting elements in instructional design, can bring different influences to learning via various mechanisms. On the one hand, as mentioned, seductive details might foster extraneous cognitive load and be detrimental to the cognitive process of learning; on the other hand, the interest in learning materials and the activation of the learner will increased by seductive details and therefore, resulting in longer persistence and better learning outcome (Schnotz et al., 2009).

The relationship among social cues, motivation, and cognition is illustrated in theoretical assumptions and empirical studies. The hypothesis of social mediation processes in CASTLM assumes that social cues that can trigger social and parasocial responses can have an impact on motivational factors and then positively or negatively affect cognitive progress (Stiller et al., 2020). Evidence that supports the effects of parasocial interaction on motivation can be found in empirical studies (Beege et al., 2022; Baylor, 2009).

It is claimed by Alemdag (2022) that the presence of the teacher can bring increment in cognitive load and motivational factors without affecting learning outcomes and self-reported social presence, and the researcher further explains that the non-significant effect on learning performance might be neutralized by the distraction (the increment on extraneous cognitive load) and the growth of motivation (more cognitive engagement). In the study conducted by Mou et al. (2022), it is also confirmed that parasocial interaction has no significant impact on learning outcomes but impact on cognitive load. However, it is proved in empirical research on learning with videos on a platform called Study With Me that parasocial interaction does not cause a lower percentage of completion and longer duration of distraction (Wang & Zhang, 2021). In terms of the effects of social cues, the presence of the streamer can facilitate the learner's productivity and parasocial interaction.

The relationship between motivation and cognition is discussed in previous research which claimed that motivational factors are postulated to influence the cognitive processes. Park et al. (2014) proposed the affective-mediating hypothesis in CATLM that motivational factors are considered mediating variables in learning via discouraging or encouraging cognitive engagement, which is regarded as the affective assumption in CTML (Rudolph, 2017). Mayer (2014) asserted that social cues can improve motivation and then cognitive engagement. On the one hand, it is postulated that motivational factors can influence the arrangement of cognitive resources in GL (Stiller et al., 2020). On the other hand, these researchers further propose that motivation can facilitate learning persistence when the learner is faced with overload in IL and EL. Also, they assume that learning motivation can improve test performance. In this research, the relationship between learning motivation, cognitive load, and learning performance will be investigated.

Motivational interest can have an impact on extraneous cognitive load, which is in line with the assumption proposed by Um et al. (2012) in research on emotional factors in multimedia learning. Empirically, it is reported that the extraneous cognitive load is negatively correlated with situational interest, and it is reported that extraneous cognitive load declines with the increment of situational interest in online reading tasks (Drobisz, 2017). Also, this author claimed that extraneous cognitive load is involved in a negative correlation with learning performance measured by multiple-choice questions on recalling and understanding. What's more, it is claimed that parasocial interaction might positively facilitate learning through its impact on cognitive processes (Beege et al., 2022). Those results demonstrate the interplay of parasocial interaction, cognitive factors, motivational elements, and learning performance to some extent. However, more research is needed to provide more comprehensive insights in this regard. Conclusively, combining the facilitator assumption and the extraneous load hypothesis to investigate the relationship between motivational factors and cognitive load to provide more clues for emotional design in multimedia learning environments, the second and third research questions are proposed as follows.

H_a2: *Motivational interest and extraneous cognitive load mediate the effects of parasocial interaction on learning performance.*

H_a3: *Motivational interest has a significant impact on extraneous cognitive load.*

All in all, a conceptual framework is developed based on frameworks including CTML, CATLM, CASTLM, ICALM, and CASTLE and existing empirical studies on multimedia learning (see Figure 1).
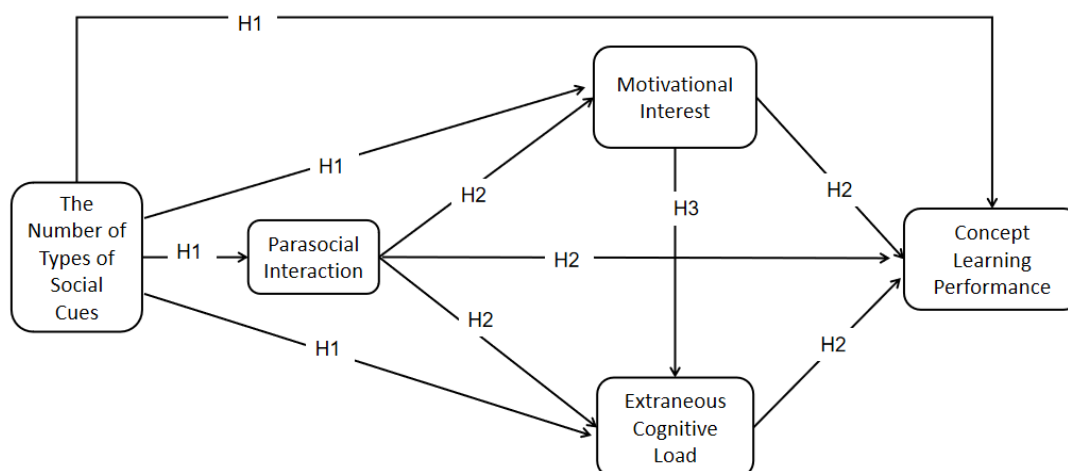
Figure 1 The conceptual framework

Methodology

Research Design: This is quantitative research that intends to determine the effectiveness of the number of types of social cues. To determine the effectiveness of the treatment towards concept learning performance, a test was implemented in the classrooms on students from 8 classes. Before the formal data collection, video lectures were shown to students, and pre-tests and post-tests were conducted before and after the exposure of the video lecture respectively. After that, a paired-sample t-test will be utilized to analyze the data of the pre-test and post-test to confirm the effectiveness of self-produced video lectures used in this research.
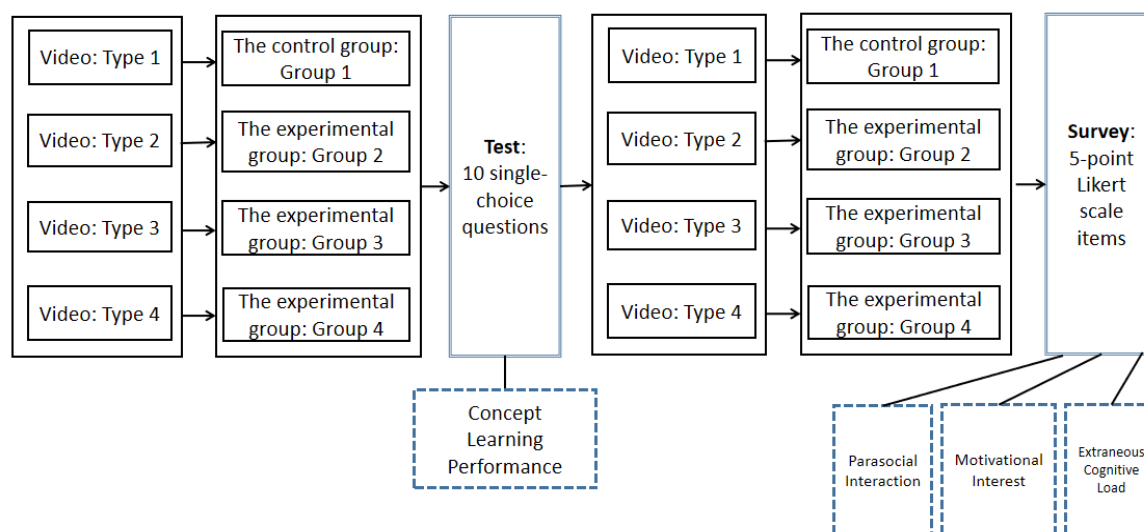

Figure 2 The research framework

In the formal data collection stage, the four groups will be arranged to take part in the research in four days within one week. Since the scale items were expected to determine the effect of the video lectures, the questionnaires of scale items were distributed to the students as soon as they finished watching the second video lecture. To avoid the disturbance brought by the scale to test scores, each group of students was exposed to two video lectures. The first video lecture was followed by a test, and the second one was followed by a survey.

Research Treatments: The length of each self-produced micro video lecture was 6 minutes and was filmed and edited by the instructor with accessible devices including mobile phones and computers. The format of video lectures was lecture capture without students on the scene in the classroom setting. Four types of video lectures (see Figure 3) have been produced by the researcher to control the investigated variables.
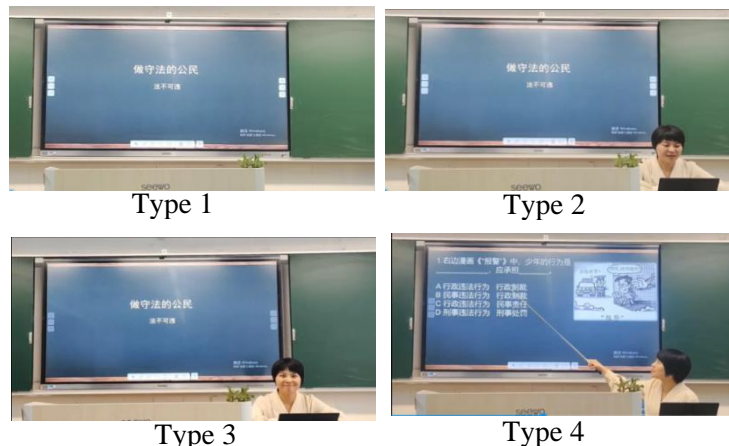

Figure 3 The four types of formats of video lectures

Population and Sample: The population of this research was the students in a public junior high school in Guangzhou city in China. Guangzhou is a metropolitan that is featured by its villages in the city due to rapid urbanization. There were 1240 students from 27 classes in three grades in the population. This school was located in a suburban town and the students mainly consisted of migrant workers' children and local teenagers who lived in the suburban areas of the city. In other words, compared with students in public schools in the downtown areas, the students of the population were of relatively disadvantaged socioeconomic status and might benefit from convenient access to information in the Era of Web 2.0.

As for the sample, 248 students were chosen from the eighth grade, whose parents had signed the consent form to agree their children be involved in this research. These students were randomly distributed into four groups at first and then selected to form four groups whose average scores from the latest midterm examination showed no significant difference.

Research Instruments: Each test consisted of 10 single-choice questions. To ensure the validity of the test questions, all questions were chosen from the district-wide exams of each district in Guangzhou City from the year 2018-2022. To acquire information on students' parasocial interaction, extraneous cognitive load, and motivational interest, a 5-point Likert scale with 9 scale items was designed and implemented after the students' exposure to the second video lecture of each group. The Cronbach's Alpha levels of scale items on parasocial interaction (0.743), motivational interest (0.719), and extraneous cognitive load (0.737) were obtained in the pilot test, which indicate that the scale items on the three variables were of good internal consistency reliability according to the criteria proposed by Hair et.al. (2010).

Data analysis: The difference between the four groups on concept learning performance, parasocial interaction, extraneous cognitive load, and motivational interest was analyzed with one-way ANOVA. After that, path analysis was adopted to detect the relationship between these four variables. Based on the significant correlations identified in the path analysis, bootstrapping was used to confirm the mediation function.

Results

Descriptive Statistics: As indicated in Table 1, most students in eighth grade in this school were 13 and 14 years old, and male students were slightly more than female students. Further, the number of students with a registered permanent residence in Guangzhou city was also slightly more than those without this identity. Surprisingly, though approximately half of the sample students in this research were without a registered permanent residence in Guangzhou city, only a small percentage (3.6%) of them had not studied for the past seven years in Guangzhou city. Also, though the sample students, as mentioned, can be categorized as disadvantaged groups in metropolises, more than 70% of them were equipped with a personal smartphone/ a household computer with internet access. What's more, it is reported that more than 80% of the sample students had learned with video lectures before, which confirmed the accessibility of video lectures and the willingness of students to use this kind of learning material to some extent.

Table 1 Demographic Information of the Sample Students

Item	Category	Frequency	Percentage
Age	12	2	0.8%
	13	141	56.9%
	14	103	41.5%
	15	2	0.8%
Gender	Female	109	44%
	Male	139	56%
Have a registered permanent residence in Guangzhou city	Yes	137	55.2%
	No	111	44.8%
The learning experience in primary and secondary schools in this city completely	Yes	239	96.4%
	No	9	3.6%
Equipped with a personal smartphone	Yes	215	86.7%
	No	33	13.3%
Equipped with a household computer that has access to the internet	Yes	188	75.8%
	No	60	24.2%
Have learned with video lectures before	Yes	201	81%
	No	47	19%

In terms of the results of the test in this study, the full mark was 100 points. The mean of test scores is 77.05 points and the median is 80 points (see Table 2).

Table 2 Descriptive Statistics of the Test

N	Mean	Median	SD	Minimum	Maximum
248	77.05	80	18.41	20	100

To interpret the data obtained, the following arbitrary level proposed by Norman (2010) is utilized to interpret the mean value for each variable in the scale. Averagely, the students held neutral attitudes on scale items of parasocial interaction (with a mean score of 3.10), disagreed attitudes on scale items of extraneous cognitive load (with a mean score of 1.84), and agreed on attitudes on motivational interest (with a mean score of 3.60).

Table 3 Descriptive Statistics of Variables in the Survey

Variable	Mean	SD	Interpretation
Parasocial Interaction	3.10	0.92	Neutral
Extraneous Cognitive Load	1.84	0.80	Disagree
Motivational Interest	3.60	0.98	Agree

The Effects of the Number of Social Cues: One-way ANOVA is utilized to determine whether there is a significant difference in the effects of the number of types of social cues on parasocial interaction, extraneous cognitive load, motivational interest, and concept learning performance among four groups. First of all, parasocial interaction was analyzed. The ANOVA was not significant, $F(3, 244) = 0.777$, $p = 0.508$. Secondly, the extraneous cognitive load was analyzed. The ANOVA was not significant, $F(3, 244) = 0.323$, $p = 0.809$. Thirdly, motivational interest was investigated. The ANOVA was not significant, $F(3, 244) = 0.744$, $p = 0.527$. Fourthly, concept learning performance was analyzed. The ANOVA was not significant, $F(3, 244) = 1.127$, $p = 0.339$.

Table 4 Means of Variables in the Survey of Four Groups

	Parasocial Interaction	Extraneous Cognitive Load	Motivational Interest
Group 1	3.27	1.85	3.84
Group 2	3.29	1.84	3.76
Group 3	3.16	1.79	3.85
Group 4	3.32	1.74	3.65

All in all, there is no significant difference in the average parasocial interaction, extraneous cognitive load, motivational interest, and concept learning performance among the four groups. Therefore, the number of types of social cues has no significant impact on parasocial interaction, extraneous cognitive load, motivational interest, and concept learning performance, and Ha1 is rejected.

The Relationship of Four Variables: First of all, figures of the goodness of fit for the measurement model are demonstrated in Table 5. As can be seen, this model meets all the criteria and therefore, the model has an acceptable model fit.

Table 5 Goodness of Fit for The Measured Model

Index	Acceptable Values	Values of The Measured Model	Source
CMIN/DF	<3	1.839	Hoe, 2008
GFI	>0.9	0.957	Sica and Ghisi, 2007
AGFI	>0.8	0.921	Sica and Ghisi, 2007
NFI	>0.9	0.915	Marsh and Grayson, 1995
IFI	>0.9	0.959	Hair et al., 2006
TLI	>0.9	0.938	Hair et al. 2006
CFI	>0.9	0.958	Marsh and Grayson, 1995
RMSA	<0.08	0.058	Engel and Moosbrugger, 2003

Remark: CMIN/DF=The ratio of the chi-square value to the degree of freedom, GFI=Goodness-of-fit index, AGFI=Adjusted goodness-of-fit index, NFI=Normed fit index, CFI=Comparative fit index, TLI=Tucker-Lewis index, and RMSA=Root mean square error of approximation.

Further, the results of the path analysis are demonstrated in Figure 8. The parasocial interaction has a significant positive impact on motivational interest (β=0.624, $p<0.005$). The motivational interest has a negative significant impact on extraneous cognitive load (β=-0.425, $p<0.01$). Extraneous cognitive load has a negative significant impact on concept learning performance (β=-0.299, $p<0.005$).
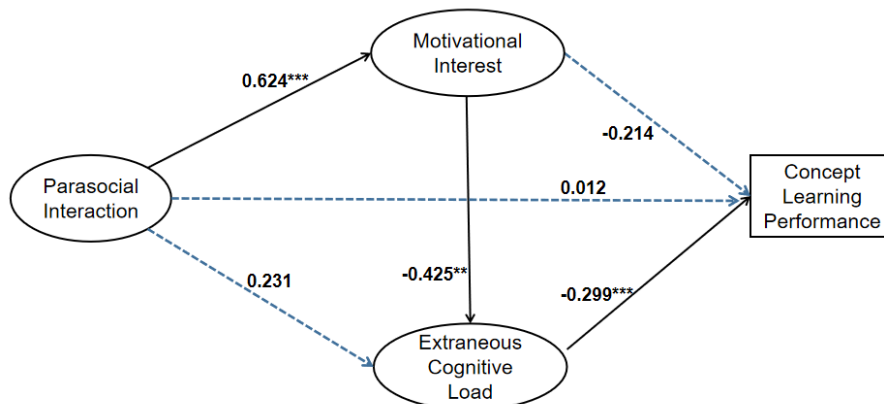
Note: *=p-value<0.05, **=p-value<0.01, ***=p-value<0.001
Figure 4 The results of the path analysis

Concerning the third research question, the mediation effect of motivational interest and extraneous cognitive load on the relationship between parasocial interaction and concept learning performance was investigated in a chain mediation model according to the bootstrap method. Table 6 demonstrates the results of mediation for each path according to the bootstrap method.

The bootstrap confidence intervals obtained at the 95% level in the chain mediation path did not contain a zero value. Therefore, the motivational interest and extraneous cognitive load mediated the relationship between parasocial interaction and concept learning performance.

Table 6 Bootstrapping Results on The Mediation Effect

Mediation Path	Estimate	Bootstrap Confidence Interval (95%)		-value
		Lower	Upper	
Parasocial Interaction→ Motivational Interest→Extraneous Cognitive Load	-0.291	-0.736	-0.129	.001
Motivational Interest → Extraneous Cognitive Load →Concept Learning Performance	4.354	1.280	12.278	.002
Parasocial Interaction →Motivational Interest→ Extraneous Cognitive Load→Concept Learning Performance	2.026	0.564	6.594	.001

Note: Bootstrap resampling = 5,000

Discussion

According to the data analysis, the number of types of social cues can not bring a significant impact on parasocial interaction, extraneous cognitive load, motivational interest, and concept learning performance, which is inconsistent with the conclusions of some research that social cues can lead to increment in parasocial interaction (e.g. Beege et al., 2017; Dibble et al., 2016), bring positive effects on learning performance (e.g. Wang & Antonenko, 2017; Mayer, 2014; Beege et al., 2017; Wang et al., 2018),

influence learner's motivational process (e.g. Mayer, 2014; Beege et al., 2022; Baylor, 2009), might result in distraction and cause extraneous cognitive load (e.g. Harp & Mayer, 1998; Gullberg & Holmqvist, 2006). It is possible that the self-produced videos and the experiment period were too short to make a difference in these investigated variables. In other words, in an educational context where short video lectures are used as a kind of complementary learning resource that does not last for a long period, there might be no need to consider the influence of the number of types of social cues on these aspects. Furthermore, this research is on concept learning and the learning task is not as challenging as some other kind of learning, where different results might be generated.

Motivational interest and extraneous cognitive load perform as mediators in the relationship between parasocial interaction and concept learning performance in a chain mediation. Specifically, parasocial interaction positively influences motivational interest, motivational interest negatively affects extraneous cognitive load, and eventually, extraneous cognitive load brings a negative impact on concept learning performance. The relationship between these variables is in line with the affective assumption in CTML that motivational factors perform as mediators to influence the cognitive process in multimedia learning (Rudolph, 2017), the assumption of ICALM (Plass & Kaplan, 2016) on the interplay among emotion, motivation and cognition in multimedia learning assumes that emotional elements produce effects through motivational factors to cognitive process, and the assumption of social processes of CASTLM postulates that cognition and motivation contribute to the effects from parasocial interaction to learning (Stiller et al., 2020). The results imply that researchers should take more aspects and their interplay into consideration to better understand the influence of certain factors in learning video production. The theoretical framework of multimedia learning should be enriched by involving more essential factors and describing the process in detail.

What's more, this research tries to investigate interest as one of the motivational dimensions, and the results reveal that motivational interest can hurt cognitive load, in which the extraneous cognitive load decreases with the stimulation of motivational interest, which is consistent with the affective assumption in CTML that motivational elements can mediate learning via affecting the cognitive process (Rudolph, 2017; Park et al., 2014). However, it is contradictory to the extraneous load assumption (Seibert & Ellis, 1991) and the seductive details theory (Schnotz et al., 2009), which both claim that desirable emotion can increase the burden on cognitive load. In other words, seductive details such as social cues might not have a negative impact on learning performance, since it might influence the allocation of cognitive resources via motivational factors. The effects of seductive details should be further considered and provide detailed guidance for learning video producers.

Conclusion

To sum up, in this research, the number of social cues did not bring significant effects on some aspects of the learning process including parasocial interaction, motivational interest, extraneous cognitive load, and concept learning performance. In other words, in a short, self-produced video lecture that is no more than 6 minutes, there is no need to invest efforts in providing more social cues such as the appearance, the gaze, and the pointing signs of the lecture. Since the effects of this kind of learning resource have been proven in the research, the instructor should concentrate on the content, the display of knowledge, and many other aspects of self-produced video lectures except for social cues. Further, the mediation function of motivational interest and extraneous cognitive load between parasocial interaction and concept learning performance was supported by empirical evidence. What's more, motivational interest does not positively stimulate extraneous cognitive load as predicted in previous assumptions.

Recommendation

In a self-produced micro video lecture that is no more than 6 minutes, more kinds of social cues do not mean higher activation in parasocial interaction, motivational interest, and extraneous cognitive load, as well as do not guarantee higher concept learning performance. This implies that teachers who try to use

self-produced video lectures to improve concept learning can less consider the social cues and attach importance to other factors in the production. Further, the mediation of motivational and cognitive factors in the effects of parasocial interaction on concept learning performance can be considered as assumed in many theories, and motivational interest should not be regarded as a kind of factor that can add burden to extraneous cognitive load.

However, these results are far from enough to explain the interplay of multiple dimensions of the complicated learning process, and therefore, more academic scrutiny is needed on similar research designs in an actual classroom environment. Also, longer research periods in experimental conditions should be taken into consideration in future research to further determine the long-term effects of social cues. Besides, studies should be conducted in a concrete context to suit specific instructional purposes. Furthermore, the number and intensity of social cues can be further investigated. Last but not least, features of teenager's self-regulated learning with OERs can be studied further to provide more empirical evidence for effective instructional design in multimedia learning environments.

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