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The Influence of Different Timings of Video Advertisements on Users' Learning Performance and Degree of Perceived Intrusiveness in Online Learning

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Abstract: With the popularization of online education and the development of artificial intelligence, more and more people are choosing to use a faster online method to learn. With a single device, users can learn anytime and anywhere. The survey finds that in the process of online education, there are a lot of interference items for users, among which advertisements, as a common means of communication, often appear on web pages. Previous studies have not reached a definitive conclusion on whether different timings of advertisements will affect users' learning performance. This study aims to investigate the impact of different advertisement timings on users' online learning performance and perceived intrusiveness of video advertisements. Based on this background, the experimental method is adopted in this study, with 18 young people as the research subjects. The independent variable is the time when video advertisements appear, and the dependent variable is a subjective reporting method to investigate the influence of online learning on users and the degree of perceived intrusiveness of video advertisements for users. The results show that different timings of advertisements have no significant impact on the learning outcomes of users but has a significant effect on the degree of perceived intrusiveness by users. Specifically, when the advertisement appears in the middle of the video, users felt more intrusive than when the advertisement appears at the beginning of the video. Based on the above research, this paper puts forward the following suggestions from the perspective of online video application development: reduce advertisements in the middle of courses or adjust the timing of advertisements so as to avoid causing strong perceived intrusiveness for users, thus minimizing the negative impact of advertisements and improving the focus of online learning users.

Keywords: online learning, video advertisements, different timings of advertisements, perceived intrusiveness

1. Introduction

With the advancement of mobile devices, the development of online higher education has become an unstoppable trend. This paper aims to investigate the impact of advertisement timings on users' online learning performance and perceived intrusiveness of video advertisements within the context

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of the growing popularity of online higher education. Online education refers to remote video teaching through virtual classrooms on the Internet, sharing electronic documents so that teachers and students form a kind of teaching and learning interaction on the network. It offers a new way for students to learn through online education platforms. Online learning creates a new learning environment composed of multimedia network learning resources, an online learning community, and a network technology platform. Compared to traditional learning modes, online learning offers several advantages. The emergence of the 5G era will make online learning more convenient. Users can access online learning from both computers and mobile devices. At the same time, wireless networks make everyday interactions more effective. According to an October 2019 report on education informatization and network security,98.4% of primary and middle schools (including teaching centers) have access to the Internet (according to Huawei's online Education Research Insight Report) [1].Online education has become an important supplementary tool for schools and extracurricular training institutions. An increasing number of educational institutions will offer online education programs.

However, online education also has some disadvantages. This section discusses the disadvantages of online education, particularly the impact of advertisements on users' learning experience. Users often encounter various factors that can interfere with their online learning experience. Studies have shown that online learning has a direct impact on learning results. The investigation into the causes of insufficient online learning activities shows that these interfering factors mainly include self-factors, teaching resource factors, learning environment factors, and learning feedback. Among them, users attracted by online entertainment platforms or interfered with by online hot news and other information, which can lead to low efficiency in online learning, make up about 21%; users limited by the application level of computers or other mobile terminal devices and the network environment (low network speed, traffic restrictions, device support, etc.) account for approximately 4% according to a study by Gong Jinghe and Li Rong [2].As a common way of media communication, advertisement has a high click-through rate among users in real life, but this does not mean that advertisement brings users a more perfect experience. In fact, pop-up advertisements may have negative effects, and users will have different attitudes according to their degree of perceived intrusiveness.

As a common form of Internet interference, advertisements have a much higher information richness than traditional media. It is known that the brain's limited information processing capacity causes people to select only a small amount of input for effective processing at any given moment. This is mainly due to attentional selection, namely, people's selective attention. Complex operations and information can lead to the user's attention being distracted, thereby reducing the learning performance. A survey found that students felt overwhelmed by pop-up notifications from the many different platforms used for online learning, such as Canvas, Zoom, or Google Classroom, which resulted in an increase in their workload [3]. The presence of advertisements in the online learning process will occupy part of the user's attention. Considering the potential negative impact of advertisements on users' learning experience, this study investigates how different advertisement timings affect users' online learning performance and perceived intrusiveness.

Users will inevitably encounter some advertisements while watching online learning videos. From an attribute perspective, advertisements usually include theme, meaning, language, image, and shape. When new advertisements are inconsistent with existing schemas, users need to adjust. They must invest additional cognitive resources to change their old schema to integrate it with new knowledge [4].In fact, the timing of advertisements can be adjusted by the operating system. A study found that the timing of an advertisement's appearance influence users' perceived intrusiveness of users. The earlier the pop-up advertisement appears in the video, the fewer times

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users look at it, and the shorter the duration. In contrast, for pop-up advertisements that appear later, users will have higher fixation times and duration [5].

Previous studies on the influence of advertising on learning performances only discussed the influence of the timing of pop-up advertisements on users' learning performances and perceived intrusiveness. In fact, video advertisements are also a common form. So far, we have found no studies focusing on the impact of video advertisements on online learning.

With the popularization of broadband and the advancement of video compression technology, video advertising has developed rapidly, and network video is increasing day by day. The development of video advertisements on vast video-playing platforms is inseparable from the rapid development of network video. Now, due to the spread of broadband and the advancement of video compression technology, anyone can create and share online videos anytime and anywhere. This is no longer a special job for professionals. The spread and convenience of the Internet around the world have given these professional and amateur video uploaders a huge audience. Technological advancements have also fueled the growth of online video advertising. More importantly, the hundreds of millions of videos and viewers on the network provide a broad platform and development opportunity for the broadcast of network videos. Previous research on video advertising has focused on achieving relevance and determining the length of video advertisements [6].Advertisements presented on online learning sites or applications come in various forms, including different physical shapes, contents, and timings. However, previous studies have focused less on the different timings of video advertisements.

Although people's click-through rate and attention to advertisements are high, the appearance of advertisements will inevitably have some negative effects on users. Therefore, it is necessary to measure the effect of these negative effects on people's attitudes. Li, Edwards, and Lee defined perceived intrusiveness as "the perceptual or psychological consequences of the audience when their cognitive process is interrupted", which is one of the most important reasons for advertising avoidance behavior [7].

To sum up, this study examines the influence of different timings of advertising on users' learning performances through online experiments. Specifically, we examine the presence of advertisements at different times during the presentation of learning videos, their interference with learning, and their impact on users' degree of perceived intrusiveness.

Two hypotheses are proposed in this experiment:

1. Different timings of video advertisements has an impact on users' learning performance.
2. Different timings of video advertisements has an impact on users' perceived intrusiveness.

2. Method

2.1. Subjects

A total of 20 participants were recruited for this study. However, data from two participants were excluded from the analysis due to incomplete or unserious responses. Therefore, the final analysis included data from 18 participants, consisting of 10 males and 8 females between the ages of 18 and 25 years old, reported having normal eyesight and hearing and were in good health. The experimental environment was quiet, and the Internet connection was stable.

2.2. Materials

2.2.1. Learning Materials

We select a popular science video from Wikipedia, which includes understanding the early forms of the Earth, human modification of the Earth into a new geological era called the Anthropocene, and

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the definition of the temperature difference between the tropics and the cold zone of the Earth. Each video is about 1 minute long. Five questions are asked after each video to evaluate the learning performance on the participants.

2.2.2. The Questionnaire about Perceived Intrusiveness

We used the "wenjuan.com" website to assess the perceived intrusiveness of participants. The scale of perceived intrusiveness uses the scale developed by Li, Edwards, and Lee [7]. Participants were asked to rate their emotions regarding the video ads that appeared, such as feeling bad, stupid, bored, angry, deceived, offended, distracted, interested, or other emotions." in the questionnaire. A value of 7 was defined as indicating the highest intensity of emotion, 1 as the lowest level, and 4 as moderate intensity.

2.2.3. Video Advertisements

In this study, we selected three 20-second video advertisements in Chinese from the Internet to use as materials for as a source of interference during learning. The advertisements were for Huawei mobile phones, Master Kong instant noodles, and Yili QQ Star Milk.

2.3. Experimental Design

In this study, we employed a within-subject design with a single factor. The factor is different timings of video advertisements, which are the internal variables of the subjects. The dependent variables are users' learning performances from popular science videos and the degree of perceived intrusiveness in their subjective evaluations. The experiments were conducted under the following conditions: good Internet access, a quiet environment, and the use of a computer to answer questions.

To balance the relevance of advertisement timing and video content, three conditions were set in this experiment, corresponding to the beginning of the video, the middle of the video, and the end of the video. The videos were presented in Latin square order.

2.4. Procedure

Our experiment recruit participants over the Internet. Participants are instructed to watch and memorize these popular science videos carefully. The instructions are as follows:

"This is a memory and comprehension test. In the following task, you will watch a total of three popular science videos in their entirety, followed by a quiz question. Now, please find a quiet place to memorize and understand the main content of the videos while watching. Since all the videos will only be played once, please remember and understand as much as possible. You do not need to take notes during the process; the quiz question can only be answered once. There are two stages in this experiment: the first is the learning stage, and the second is the testing stage.

Once you understand the above instructions, the learning video will play. At the end of the video, we were given a test consisting of two parts. The first part was an objective question, and the second part was a test of perceived intrusiveness degree. Multiple-choice and fill-in-the-blank questions in the objective section are worth 20 points each. All correct answers to multiple choice questions receive full marks, correct answers receive 10 points, and incorrect answers receive no points. You have two minutes to answer."

Finally, we asked participants to complete a perception scale. The experiment was conducted in a quiet room in the form of an online Tencent conference and took about 20 minutes to complete.

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2.5. Data Analysis

Since this experiment is conducted online, the length of the questionnaire was controlled in the design stage in order to ensure that the participants could answer carefully. We use the following centralized methods to filter questionnaire data:

1. Set trap questions
2. Whether to answer carefully
3. Set the response time within 2 minutes
4. All questions must be answered in full, with no fewer than a certain number of words in gap fillings.
5. Eliminate the data with the same perceptual intrusion degree options and eliminate the interference of prior knowledge: This experiment considers whether the participants have prior knowledge of the video content that could interfere with the experiment. Through this method, we excluded 2 pieces of data, and 18 pieces of data were actually included in the analysis.

3. Results

3.1. Analysis of Repeated Measures of Variance

Table 1: Mean performances on learning performances and perceived intrusiveness(M±SD).

	learning performances	perceived intrusiveness
Start	65.00±12.719	37.50±11.025
Middle	64.72±20.398	50.11±7.388
End	67.78±17.083	35.17±11.413

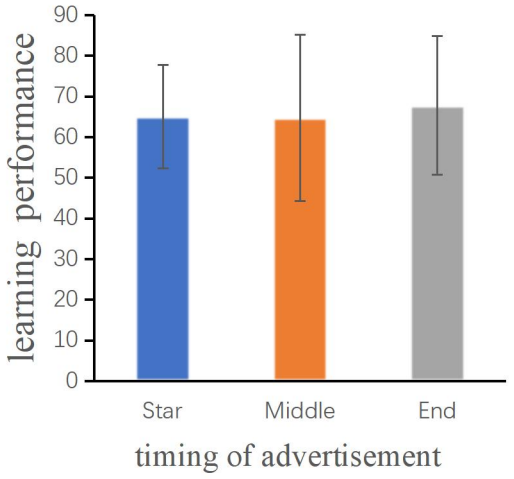

Figure 1: Learning performances.

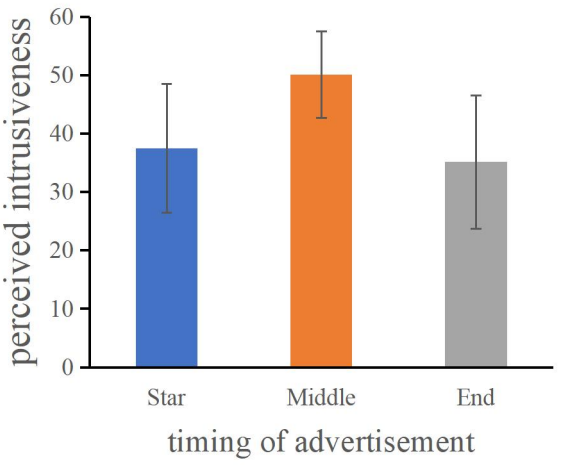

Figure 2: Perceived intrusiveness.

3.1.1. Learning Performance

The analysis also showed that the main effect of perceived intrusiveness is significant. The results indicate: F (2, 16) = 0.36, $p = 0.553$. As shown in Table 1, when the advertisements appear at the beginning, middle, and end of the video, the participants' average scores are 65, 64.72, and 67.78, respectively. As illustrated in Figure 1, this set of data reveals that the participants' performance is

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lowest when the advertisement timing is in the middle of the video, followed by the beginning and end of the video.

3.1.2. Perceived Intrusiveness

The analysis also demonstrated that the main effect of perceived intrusiveness is significant: F (2, 16) = 506.724, $p < 0.001$. As shown in Table 1, when the advertisements appear at the beginning, middle, and end of the video, the participants' average perceived intrusiveness are 37.50, 50.11, and 35.17, respectively.

As illustrated in Figure 2, this set of data reveals that when the advertisement timing is in the middle of the video, the users' perceptual intrusion level is the highest, followed by the end of the video and the beginning of the video.

4. Discussion

4.1. The Influence of Different Timings of Video Advertisements on Learning Performance

In this study, the different timing of advertisements has no significant influence on the learning performance. Previous findings have suggested that people have a limited cognitive resource when multitasking, leading to reduced cognitive and task performance [8-10]. Scholars believe that performing multiple tasks will reduce task performance due to limited processing capacity [9,11]. The emergence of video advertisements has occupied a part of the users' attention, and distractions activate peripheral routes and increase attention to peripheral cues rather than the central argument [12-13].

In the study conducted by Jeong, S. H., and Fishbein, M. [8], researchers asked participants about their media usage habits and behaviors, including the frequency, duration, and type of media multitasking, and the influence of factors such as the type and frequency of advertisements on media multitasking. For example, one of the questions in the questionnaire was, "Do you use media and other tasks at the same time, such as work, reading, homework, or other?" Another question was, "Do you use other media, such as the Internet, mobile phones, or other electronic devices, while watching TV or movies?" These questions all relate to advertisement.

In this experiment, we adopt the subjective report method to verify the impact of the timing of advertisements on the learning performance of users at the beginning, middle, and end of the learning video. We did not measure eye movement data with precision instruments such as an eye tracker. The results show that the different timing of advertisements has no significant effect on the learning performance. Compared with the study of Jeong, S. H., & Fishbein, M. [8], the research design of this experiment is different. Additionally, this study focused on users' behavior handling video advertisements and did not investigate other behaviors such as browsing social media and sending text messages while watching TV. However, the results of the research are consistent in showing that the different times when advertisements appear will occupy users' cognitive resources.

4.2. The Influence of Different Timings of Video Advertisements on Perceived Intrusiveness

In this study, the scale of perceived intrusiveness is adopted using the scale developed by Li, Edwards, and Lee [7]. We collect experimental data using the subjective report method. The results indicate that advertisements appearing at different times have a significant impact on users' perceived intrusiveness levels.

This study differs from Li, Edwards, and Lee's [7] study, as we used video advertisements that appear in the user's current browsing video, rather than prominent or embedded advertisements that appear on the web page. Additionally, while Li, Edwards, and Lee [7] examined the effects of fixed

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advertisement timing when users open web pages, we investigated the influence of different timing when advertisements appear on users' perceived intrusiveness levels.

The result shows that users' level of perceived intrusiveness is the highest when advertisements appear in the middle of learning videos. Therefore, designers should avoid inserting advertisements in the middle of learning videos in the future.

4.3. Limitations and Directions for Future Studies

According to the research results, even though the advertisements appearing at different timing have no significant influence on the learning performance of users, the advertisements appearing in the middle of the videos still bring strong subjective feelings of aversion to users. In the era of rapid development of the Internet, online education has become an inevitable trend, so the influence of Internet advertising on the learning performance cannot be underestimated.

This experiment also has many shortcomings and needs to be improved. First of all, this study only involves the learning performance and different timings when video advertisements appear but does not consider the impact of other factors such as the contents and forms of video advertisements on users' learning performance and user perception, such as the frequency of users' use of electronic devices and the frequency of exposure to advertisements. Second, the sample in this study is from a specific population, so the results are only applicable to that population. Future studies can further explore the influence of different video advertisement contents and forms, audience characteristics, and other factors on learning performance and user perception intrusion level, so as to better understand the design of online learning.

To sum up, it is worth paying attention to the influence of video advertisement design on learning performance and user perceived intrusiveness level in the learning process. Future online learning design should pay more attention to user experience and reduce the design of advertisements in the middle of videos.

5. Conclusion

The timing of video advertisements during the learning process has been found to have no significant influence on the learning performance, but it does significantly impact perceived intrusiveness. Specifically, when advertisements appear in the middle of the video, users experience a stronger sense of intrusion. This trend is consistent with the data on the impact of video advertisements on students' learning performance. Therefore, in future online learning processes, the design of video advertisements appearing in the middle of learning videos should be minimized.

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