The Impact of Product Placement on the Dissemination Effectiveness of Online Education: A Case Study of Science Popularization Short Videos on Bilibili.

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Abstract: New media platforms, represented by Bilibili, have become important tools for disseminating science popularization short videos, which have also become important carriers for product placement. Based on the ELM model, this paper uses content analysis and regression analysis to analyze the dissemination effectiveness of product placement in 511 science popularization short videos on Bilibili. The study found that product placement significantly affects the dissemination effectiveness by enhancing the quality of video dissemination. Different forms of product placement have significant differences in their impact on dissemination effectiveness. It is suggested that creators should focus on the content of short videos, improve the smoothness and integrity of the integration between product placement and video content, in order to improve the dissemination effectiveness after product placement and achieve mutual benefits for users, creators, and brands.

Keywords: Product Placement; New Media; Elaboration Likelihood Model (ELM); Dissemination Effectiveness.

1 Introduction

With the development of the new media era, video platforms represented by Bilibili have become the main battleground for science popularization short videos. Since the launch of the knowledge section on Bilibili in 2020, the growth rate of science popularization short videos has reached 1994%, and general knowledge short videos account for 45% of the total platform views. [1]Meanwhile, product placement, as another form of communication that has emerged in the context of new media, has opened up new pathways for advertising in conjunction with short videos. However, the profit-driven nature of brand capital and the low barriers to entry have also brought unrecognized risks to the dissemination effectiveness and content quality of science popularization videos. Will product placement affect the dissemination effectiveness of science popularization short videos? What kind of impact will different forms of product placement have? Such research is of great significance for balancing video creation, achieving mutual benefits for creators, users, and brands, as well as regulating product placement in short videos. Therefore, this paper focuses on the dissemination effectiveness and influencing factors of natural science popularization short videos on Bilibili that contain product placement. The Elaboration Likelihood Model (ELM) is chosen to analyze the characteristics of product placement and its facilitation or hindrance to dissemination effectiveness.

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2 Theoretical Analysis and Research Hypotheses

2.1 Short Video Dissemination and Advertising Placement

The Value Conflict between Video Content and Advertising Placement in Short Videos Intensifies. On the one hand, scholars have pointed out the increasing visibility of advertising placement, indicating a shift from strategic integration of products or brands and their representative symbols into video content to a more explicit form, suggesting a change in content ownership due to the influence of capital-driven rights transfer. The fundamental reason for this lies in the influence of capital-driven rights transfer. [2]In this process, aesthetic, economic, and cultural values of the content are lost. Additionally, due to significant differences in the age and quality of the short video audience, relying solely on the quality of the creators may harm consumers' legitimate rights and interests and disrupt the development of the advertising industry.

On the other hand, from the perspective of consumer society, some scholars argue that embedded advertising is not only a demand from brands but also a requirement for content creators. [3]Moreover, video users are increasingly accepting the behavior of video creators accepting advertisements and providing economic support to creators by charging or donating while watching videos, expressing their recognition of the videos. Based on the above arguments, scholars have different opinions on whether advertisements should be placed in video content and whether it will have an impact. Therefore, this paper proposes the following hypotheses:

H1: Advertising placement in short videos contributes to the dissemination of the videos.

H2: Advertising placement in short videos improves the quality of video content by incentivizing creators.

2.2 Research on the Factors Influencing the Dissemination of Popular Science Short Videos

From the perspective of research on the effectiveness of popular science short video dissemination, both domestic and foreign scholars have mainly focused on two aspects: video content and video creators. Foreign scholars have conducted in-depth research on the factors influencing dissemination from a technical perspective (such as video style, interdisciplinary themes, and whether the creators are individuals) and from an audience perspective (such as structural integrity, storytelling, and credibility), with a focus on the YouTube platform. [4][5]In contrast, domestic research has considered a more comprehensive range of factors, including video themes, title length, video duration, whether individuals appear in the videos, and the presence of elements that may lead to popularity. [6][7]The research in this area has primarily focused on the Douyin and Bilibili platforms. However, none of the existing studies have explored the impact of advertising placement on the dissemination effectiveness of popular science short videos, assuming that the textual value of the videos remains unchanged. Different forms of embedded advertising, due to their different formats, can also have an impact on the content of the videos. Therefore, this study seeks to examine the relationship between the form of advertising placement in popular science short videos and their dissemination effectiveness, and proposes the following hypothesis:

H3: Different forms of advertising placement in popular science short videos have varying effects on their dissemination effectiveness.

3 Research Design

3.1Model Specification

The Elaboration Likelihood Model (ELM) is a psychological model that suggests individuals choose different processing routes when faced with information. [8]According to this model, individuals engage in either central route processing or peripheral route processing. Central route processing involves deep thinking, evaluation, and analysis of the content and logic of the information, while peripheral route processing involves simple perception and attention to the information (Petty & Cacioppo, 1986).

Therefore, based on the Elaboration Likelihood Model (ELM), this study aims to examine the factors that may influence the dissemination of popular science short videos by considering the central route processing (elaboration) and peripheral route processing (surface level) aspects. Elaboration factors include the content theme and content quality, while surface-level factors include video title, video thumbnail, video presentation, and creator identity. Moderating factors include whether the video content includes embedded advertising and the type of advertising placement. The specific model is illustrated in Figure 1.

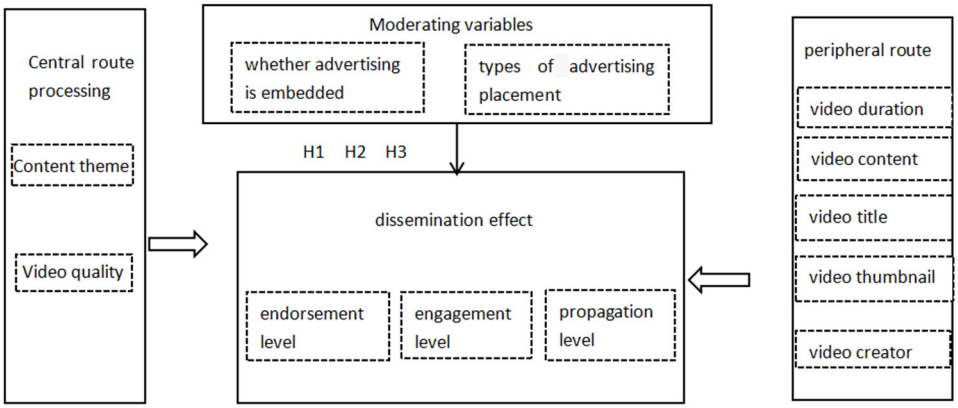

Figure 1: Research model on the factors influencing short video advertising placement

3.2Variable Construction Description

3.2.1 Independent Variables

The independent variables include content topic、content quality、video title、video thumbnail、video content presentation、 creator identity、 presence of advertising in the video content and types of advertising embedded in the video content. The specific measurement indicators are shown in Table 1.

3.2.2. Dependent Variable

In this study, the researchers utilized the Analytic Hierarchy Process (AHP) and invited experts to set weights for three elements representing the effectiveness of communication: recognition, dissemination, and engagement. This resulted in the calculation formula for the effectiveness of a science popularization video with embedded advertising, denoted as

$$Cn=\ln[0.5P+0.3(L+M+S)+0.2(B+R)], \text{ where } n>=1 \quad (1)$$

In the formula, C represents the communication effectiveness, P represents the number of views, L represents the number of likes, M represents the number of coins/tips, S represents the number of favorites, B represents the number of bullet comments, and R represents the number of comments. As shown in Equation (1).

Table 1 Variable Descriptions

Dimension	Variable Name	Content Explanation
Central route - Information content	Video content theme	1. Animal Science Popularization 2. Daily Life Science Popularization 3. Plant Science Popularization 4. Astronomy Science Popularization 5. Ecology Science Popularization
	Video quality	0. Regardless of evidence 1. Based on evidence
Peripheral route - Situational factors	Video duration	1. Within five minutes 2. Five to ten minutes 3. More than ten minutes
	Video title	1. Declarative sentence 2. Interrogative sentence 3. Exclamatory sentence
	Video cover	1. Text-only 2. Image-only 3. Combination of text and images
	Video content presentation	1. Live demonstration 2. Video editing with voice-over 3. Animated explanation
	Video creator identity	1. Amateur content creator 2. Top 100 content creator 3. Official account
Advertising implantation	Whether advertising implantation	0. No advertising implantation 1. Advertising implantation
	Form of advertising implantation	1. Advertisement links in the comment section 2. Pop-up advertisements 3. Advertisement buttons 4. Insert advertisements 5. Contextual advertising 6. Subtle advertising 7. Hybrid advertisements
Dependent variable	Dissemination effects	The weights for agreement, dissemination, and engagement are 0.5, 0.3, and 0.2 respectively.

3.3 Data Sources and Selection:

In order to investigate the impact of embedded advertising on the dissemination of science popularization videos, we selected science popularization videos in the Knowledge Zone of Bilibili as the research object. Using python software, we randomly collected 1000 science popularization video data with a cut-off date of September 30, 2023. After data cleaning, we finally selected 511 science popularization videos as the original samples for data analysis.

As shown in Table 2, the content of science popularization videos on Bilibili is primarily focused on life science and animal science, accounting for 67.1% and 23.6% respectively. In terms of content quality, 88.6% of science popularization videos have complete and logical content. The majority of short videos range from five to ten minutes in length. The titles of science popularization videos are predominantly in the form of interrogative sentences, accounting for 49.5%. 79.8% of video covers combine text and images. The presentation of content in short videos is mainly through video editing and voice-over, accounting for 66.5%. 70.3% of UP hosts are amateurs. Regarding the forms of embedded advertising, pop-up ads and hybrid ads are the main types, accounting for 41.3% and 36.3% respectively.

Table 2 Descriptive Statistics Results

Variable	Type	Number of Cases	Percentage	Variable	Type	Number of Cases	Percentage
Video Content Theme	Animal Science Popularization	121	23.6%	Video Content Presentation	Live demonstration	119	23.3%
	Daily Life Science Popularization	343	67.1%		Video editing with voice-over	340	66.5%
	Astronomy Science Popularization	18	3.6%		Animated explanation	52	10.2%
	Plant Science Popularization	29	5.7%	Video Creator Identity	Amateur content creator	360	70.3%
Video Quality	Regardless of evidence	58	11.4%		Top 100 content creator	132	26.8%
	Based on evidence	453	88.6%		Official account	15	2.9%
Video Duration	Within five minutes	146	28.5%	Whether there is advertising implantation	Advertising implantation	275	53.9%
	Five to ten minutes	195	38.2%		No advertising implantation	236	46.1%
	More than ten minutes	170	33.3%	Form of advertising implantation	Advertisement links in the comment section	34	12.3%
Video Title	Declarative sentence	144	28.2%		Pop-up advertisements	113	41.3%

Video Thumbnail	Interrogative sentence	253	49.5%	Advertisement buttons	0	0
	Exclamatory sentence	114	22.3%	Insert advertisements	17	5.8%
	Text-only	61	11.9%	Contextual advertising	12	4.3%
	Image-only	42	8.3%	Subtle advertising	0	0
	Combination of text and images	408	79.8%	Hybrid advertisements	100	36.3%

4 Research Findings

4.1 Regression Analysis Results

We employed the Ordinary Least Squares (OLS) regression model to conduct hypothesis testing on the factors influencing the dissemination effect of embedded advertising in science popularization videos on Bilibili. The results indicate that the variance inflation factor (VIF) of the independent variables in the study of the impact of embedded advertising on the dissemination effect is less than 10, indicating the absence of multicollinearity issues. Therefore, regression analysis can be conducted. Table 3 represents the regression results of the dissemination factors of science popularization videos without embedded advertising.

Table 3 Regression Results for Factors Influencing the Spread of Science Short Videos on Bilibili

	Spread Effectiveness		Spread Breadth		Spread Depth		Spread Engagement	
Popularization	β	VIF	β	VIF	β	VIF	β	VIF
Astronomy Science Education	0.019	1.60	1.373*	1.60	-0.598	1.60	0.647	1.60
Botany Science Education	-0.081	1.90	-0.193	1.90	-0.141	1.90	-0.143	1.90
Lifestyle Science Education	-0.049	3.00	0.083*	3.00	-0.046	3.00	0.052*	3.00
Based on Evidence	1.055***	1.69	-1.38**	1.34	-0.326	1.60	-0.380	1.69
5 to 10 minutes	0.080**	1.84	0.087**	1.84	0.063*	1.84	0.056**	1.84
More than 10 minutes	0.086**	1.78	0.360	1.78	0.07**	1.78	0.046*	1.78
Interrogative Sentence	0.267	12.60	0.046	2.60	0.102	2.60	-0.063	2.60
Declarative Sentence	-0.050	2.29	1.113**	2.29	0.299	2.29	0.218	2.29
Image Only	-0.015	1.59	0.141	1.59	-0.402	1.59	0.108	1.59
Text Only	-0.029	1.47	-1.16**	1.47	-0.286	1.47	-0.173	1.47
Narrated by a Person	-1.919***	2.62	0.650	2.62	-0.040	2.62	-0.006	2.62
Video Editing + Voiceove	-1.174**	2.85	0.153	2.85	-0.039	2.85	-0.169	2.85
Top 100 content creator	0.061	8.17	0.027	8.17	-0.240	8.18	-0.026	8.18
Amateur content creator	0.168	7.52	0.572	8.75	-0.096	7.52	-0.015	7.52

The study found that, in the absence of embedded advertising, other science popularization content does not significantly affect the viewing effect compared to animal popularization videos. However, the quality of the video, specifically its logical clarity, has a significant impact on the dissemination effect of science popularization videos (β=1.055, P<0.001). Another representative factor of video quality, video duration, also has a significant impact on the dissemination effect, indicating that the more complete and logical the science popularization videos are, the better the dissemination effect. In terms of video presentation, compared to animated explanations, videos with live explanations (β= -1.919, P<0.001) and videos with editing and voice-over (β= -1.174, P<0.01) have a significant negative impact on video dissemination. The identity of the video creator does not have a significant effect on video dissemination.

In addition, this study further examines the factors influencing the dissemination breadth, dissemination depth, and dissemination engagement of science popularization videos on Bilibili. The study found that, in terms of video content, astronomy popularization (β=1.373, P<0.05) and daily life popularization (β=0.837, P<0.05) significantly positively affect dissemination breadth. Daily life popularization significantly positively affects dissemination engagement (β=0.524, P<0.05). The quality of video content negatively affects dissemination breadth (β= -1.389, P<0.01). Video duration has a significant positive impact on all three dimensions of dissemination effect. Video titles in the form of declarative sentences significantly positively affect dissemination breadth (β=1.113, P<0.01). Video covers presented as pure text style significantly negatively affect dissemination effect (β= -1.160, P<0.01).

4.2 Analysis of Moderation Effects

The regression results of the moderating variables show that the variance inflation factor (VIF) is less than 10 for all variables, and the models pass the test (P<0.05) with adjusted R2 values ranging from 0.1 to 0.3. This indicates that besides the selected moderating variables, there may be other variables that have an impact on the strength of the relationship. The results analysis is shown in Table 4.

Table 4 Regression Results for Moderating Variables

Variable Name	Category	Advertisement links in the comment section	Insert advertisements	Pop-up advertisements	Contextual advertising	Hybrid advertisements
Video content theme	Animal Science Popularization	0.035	0.019	0.042	0.083	0.079
	Astronomy Science Popularization	0.064	0.045	0.075	-0.063	0.013
	Plant Science Popularization	-0.060	0.045	-0.050	-0.207	-0.137*

	Daily Life Science Popularization	-0.256	0.060	-0.021	0.090**	-0.045*
Video quality	Based on evidence	0.128***	0.085	0.127***	0.121***	0.095**
Video duration	Within five minutes	0.053	0.039	0.039	0.041	0.039
	Five to ten minutes	0.091	0.065	0.093***	0.115***	0.075**
	More than ten minutes	0.098	0.034	0.0954	0.140***	0.109***
Video title	Exclamatory sentence	0.036	0.097	0.036	0.0374	0.041
	Interrogative sentence	0.0225	0.051	0.021	0.042	0.038
	Declarative sentence	0.012	0.031	0.037	0.073	0.479
Video cover	Combination of text and images	0.046	0.025	0.235	0.256	0.0386
	Image-only	0.012	0.013	0.041	-0.038	-0.019
	Text-only	-0.092	-0.063	-0.070	-0.730	-0.734
Video content presentation	Animated explanation	0.050	0.040	0.016	0.026	0.022
	Live demonstration	-0.019	-0.076	-0.218	-0.128***	-0.097***
	Video editing with voice-over	-0.184	-0.0137	-0.037	-0.030***	-0.283***
Video creator identity	Official account	0.023	0.040	0.026	0.0402	0.010
	Top 100 content creator	0.038	0.065	0.039	-0.032	0.041
	Amateur content creator	-0.047	-0.025	-0.0167	-0.234	-0.061

Table 4 clearly shows the moderating effects of the variables in hypotheses H1 and H2 on the dissemination effectiveness of science popularization short videos on Bilibili and their influencing factors. In terms of comment section advertisements, the interaction term "comment section ads × presence of evidence" is significantly positively correlated with dissemination effectiveness (β=0.128, P<0.001). In terms of pop-up advertisements, the interaction terms "pop-up ads × presence of evidence" and "pop-up ads × video duration" are significantly positively correlated with dissemination effectiveness (β=0.127, P<0.001), (β=0.093, P<0.001), respectively. In terms of scenario deduction, the interaction terms "scenario deduction × life science popularization" and "scenario deduction × presence of evidence" are significantly positively correlated with dissemination effectiveness (β=0.090, P<0.05) and (β=0.127, P<0.001), respectively. The interaction term "scenario deduction × video duration" is

significantly positively correlated with dissemination effectiveness (β=0.115, P<0.001) and (β=0.140, P<0.001). The interaction term "scenario deduction × video content presentation" is significantly positively correlated with dissemination effectiveness (β=-0.128, P<0.001) and (β=-0.030, P<0.001).

In terms of mixed advertisements, the interaction terms "mixed ads × plant science popularization" and "mixed ads × life science popularization" are significantly negatively correlated with dissemination effectiveness (β=-0.137, P<0.05) and (β=-0.054, P<0.05), respectively. The interaction terms "mixed ads × presence of evidence" and "scenario deduction × presence of evidence" are significantly positively correlated with dissemination effectiveness (β=0.095, P<0.05), (β=0.075, P<0.05), and (β=0.109, P<0.001), respectively. The interaction term "mixed ads × video duration" is significantly positively correlated with dissemination effectiveness (β=0.075, P<0.05) and (β=0.109, P<0.001). The interaction term "scenario deduction × video content presentation" is significantly positively correlated with dissemination effectiveness (β=-0.097, P<0.001) and (β=-0.283, P<0.001).

The study also found significant differences in the impact of different types of advertisements on the dissemination effectiveness of science popularization short videos, as hypothesized in H3. Among them, scenario deduction ads and mixed ads had the most widespread influence. This may be because these two types of embedded ads combine the ad content with the video content, and the transition between the science popularization content and the ad is smooth.Therefore, users do not develop aversion towards such ad placements.

5 Conclusion

Through random sampling, this study selected 511 Bilibili science popularization short videos as research samples and conducted in-depth analysis on the dissemination effects of implanted advertisements in short videos using content analysis and regression analysis. Based on the ELM model, the study examined the influence of the dissemination effects of science popularization short videos under the moderating effect of implanted advertisements. The conclusions of the study are as follows:

From the central route perspective, life science popularization has a stronger dissemination effect under the advertising implantation mode of situational representation, while the mixed advertising mode is not conducive to the dissemination of plant science popularization and life science popularization. The conclusion that video content does not have a significant impact on dissemination is consistent with previous studies. We believe that different video content is favored by different users. However, after implanting advertisements, inconsistent video content or advertisements that hinder user experience may have a negative impact on dissemination. On the other hand, integrating advertisements into the scenario may contribute to the smoothness and interestingness of video content, thereby producing better dissemination effects.

From the peripheral route perspective, except for inserted advertisements, video logic and sufficient arguments are beneficial to the promotion of different types of implanted advertisements. Additionally, video duration, as another factor of video quality, can serve as a verification. Situational representation and mixed advertising are not conducive to the dissemination of videos in the content presentation modes of human explanation and video

editing + voice-over. We believe that under the influence of advertising implantation, the above two content presentation modes will give users the impression of "hard promotion" of the brand, and based on cognitive capacity theory, customers will not generate memories of the products.

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