

Do social media messages incorporated into television programming impact learning? The effects of disposition to critical thinking

Miwa Inuzuka (minuzuka@u-gakugei.ac.jp)

Department of Education, Tokyo Gakugei University
4-1-1 Nukui-kita-machi, Koganei, Tokyo, 184-8501 Japan

Yuko Tanaka (tanaka.yuko@nitech.ac.jp)

Graduate School of Engineering, Nagoya Institute of Technology
Gokiso-cho, Showa-uk, Nagoya, 466-8555 Japan

Mio Tsubakimoto (mio@fye.c.u-tokyo.ac.jp)

Division of First-Year Education, Komaba Organization for Educational Excellence,
Graduate School of Arts and Sciences, College of Arts and Sciences, The University of Tokyo
3-8-1 Komaba, Meguro-ku, Tokyo, 153-8902 Japan

Abstract

The present study explores the impact on memory and attitude change of social media messages that are incorporated into television programs, and the interaction of such messages with the viewer's disposition to critical thinking. Sixty university students were allocated to one of two experimental conditions and viewed television content: social media messages were included in only one condition. The results showed a significant interaction between participants' disposition (Objectiveness) and the experimental condition: participants with higher Objectiveness scores exhibited larger changes in their attitudes. An analysis of 10 participants' eye fixations suggested participants' tendency to change their allocation of attention to different types of message over time. Additionally, there was a significant correlation between the tendency to focus on these messages and scores for disposition to critical thinking (Objectiveness and Logical thinking). We discuss the possible conclusions on the impact of showing social media messages and the limitations of this study.

Keywords: critical thinking; attitudes; mass media; social media messages; thinking disposition.

Introduction

Learning from television programs and inclusion of social media messages

People learn not only in classrooms, but also from various media sources. Among many, television programs serve as one of the primary resources for everyday learning. Some people even warn that television has gained the power to control education (Postman, 1985). Although times have changed and various new media have appeared, television remains a major source of information.

In the investigation of everyday learning, it is important to consider changes in attitudes as the results of learning as well as memory of the contents. While this topic is less widely considered in the literature on learning, attitude constitute one of the essential results of learning from the perspective of critical thinking. To think critically is "to make reasonable decisions about what to believe and what to do" (Ennis, 1996).

The goal of learning is not only to remember content, but also to form an appropriate attitude that leads to reasonable decisions based on the information obtained. The idea of critical thinking in learning is especially important for learning from television programs, since the issues tackled in television programs are often relevant to viewers' lives and require them to decide what to believe and what to do.

The ways television programs are produced have changed over time, and new features are being used. For example, one new feature is a real-time display of social media feeds. (See Figure 1 for an example of how this feed may be presented.) The inclusion of social media posts in television content is not an issue limited to specific countries and regions since we can find various examples of these television programs (Inuzuka, Tanaka, & Tsubakimoto, 2017; Barra & Scaglioni, 2014) and accessing social media while watching television is widely popular (Maruyama, Robertson, Douglas, Semaan, & Fucett, 2014; Maruyama, Robertson, Douglas, & Raine, 2017).

Learning appropriately from television programs requires viewers to integrate information from multiple media and to examine information critically. These requirements become even more important when television content includes social media messages. Social media messages that mainly consist of text, such as posts on Twitter, are more likely to be incorporated into television programs and can show various types of information: useful facts, critical opinions, and unrelated comments. How do viewers read the messages, and how do the messages impact their learning? How do viewers pay attention to these messages? The present study focuses on these questions.

Learning from multimedia

Learning from multimedia has been studied in educational psychology and learning science. Mayer (2009) suggested the "coherence principle": learners understand the topic better when irrelevant and seductive elements are removed from the learning materials. The coherence principle can be explained by the split-attention effect theory. Sweller and Chandler

(1996) pointed out that a multimedia resource results in less learning when it splits learners' attention. This attention split is more likely to occur when the resource contains information that shares the same modality and is incoherent with the other information presented (Mayer, 2009; Mayer & Moreno, 1998).

The effect of incorporation of social media messages is thus to violate the coherence principle; therefore, doing so may cause the split-attention effect. Inuzuka et al. (2017) investigated the impact of social media message presentation using a fake television program. Participants were tested on the content of the video after watching it, and the longer they spent paying attention to the accompanying social media messages, the fewer questions they answered correctly. Thus, we expected the damaging effects on learning of presentation of social media messages to be replicated in the present study.

Attitude formation in learning from television programming with social media messages

The direct effects of presentations of social media messages on attitudes were not clear. Maruyama et al. (2017) revealed that viewers' attitudes were different in the direction of the social media messages. However, it was not clear if the presentation of social messages itself may influence the viewers' attitudes, since Maruyama et al. (2017) did not investigate the condition without social media messages. Although Maruyama et al. (2014) implied that only observing social media messages would not affect viewers' attitudes, a controlled investigation is necessary to clarify the process of viewing and the effects of messages on attitude changes.

While Maruyama et al. (2014) suggested that the viewers would not change their attitudes owing to the unbiased messages, a different prediction is possible. Since people may perceive information differently even when they see the same message, it is highly possible that the viewers may analyze the opinion of the social media messages differently from each other. Thus, the viewers would develop a more positive attitude when they see the presented messages support the claims of the television program. Likewise, viewers would be expected to adopt a more cautious stance when they think the social media messages suggest opposing ideas.

Furthermore, the inclusion of social media messages may impact the learner's attitude indirectly via their disposition to critical thinking. Critical thinking has affective as well as cognitive aspects. Disposition is included in the affective aspect and represents attitude and tendency in thought. The existence and influence of varying dispositions to critical thinking have been demonstrated in several studies (Hirayama & Kusumi, 2004; Stanovich & West, 1997). West, Toplak, and Stanovich (2008) revealed that people's disposition to thinking, such as their Open-minded thinking and Need for cognition, explain performance in reasoning independently of cognitive ability. Participants with a strong disposition to thinking tend to make less heuristics-based judgments and to be less affected by their own bias (West et al., 2008). According to these studies, we expect that a viewer

with a disposition to critical thinking would react more appropriately to the presentation of social media messages. Additionally, we can assume that differences in participants' disposition will also affect the viewing process, such as how they distribute attention when the messages are presented.

Aim of the study

The present study focused on how the incorporation of social media into television programs affects learning. More specifically, we examine the effects of presenting balanced social media messages including supportive, opposing, and neutral opinions. We hypothesized:

(1) The direct impact of message presentation would be seen in retention and attitude changes. The presentation of messages would cause less memory retention by participants because their attention would be disturbed. Participants would change their attitudes based on how they regarded the social media messages. Thus, we expected that participants would develop a more positive attitude when they regarded the messages as supporting, and would become more cautious when they perceived the messages as opposing the program's claims.

(2) The impact of message presentation would be moderated by viewers' disposition to critical thinking, because viewers with a strong disposition to critical thinking would process the messages more appropriately than those with a weaker disposition to critical thinking. In accordance with this hypothesis, we expected interaction effects between the presentation of messages and the learner's disposition to critical thinking. Additionally, participants' eye gaze patterns would differ depending on their level of disposition to critical thinking.

Method

Participants

Sixty undergraduates from two different universities participated in this study after providing informed consent. As a reward for their participation, they received a 1000 Japanese yen (approximately \$9.50) cash voucher.



Figure 1. A frame from the video material used in the present study (condition with social media messages). This material imitates a television program displaying a social media feed saying, "It's nice to have microbes clean the river."

Table 1. Contents of each part of the fake television program and the number of messages presented

Part	Time (s)	Summary of the content	Number of fake messages		
			Supportive	Opposing	Neutral
1	0–374	Introduction: host welcomes the scientists and Scientist A begins to introduce their work.	1	1	21
2	375–554	Scientist A explains what “EM” is and how it works. Scientist B poses questions.	5	4	12
3	555–775	Discussion continues. Scientist B tries to dispute Scientist A’s claims by pointing out the possibility that EM may cause further water pollution.	3	3	10
4	776–914	Discussion continues. Scientist A tries to rebut Scientist B’s claims, and Scientist B claims that EM lacks rationale and evidence.	2	3	16
5	915–1084	Concluding remarks: both scientists summarize their opinion of “EM.” Host makes closing comments.	1	1	4

Materials

Fake television program The video material used by Inuzuka et al. (2017) was also used in this study (Figure 1). The video was produced to mimic a scientific talk show. In the video, a host and two scientists (actually actors) discuss whether “Effective Microorganisms” (EM) are effective for improving water quality. “EM” is a pseudoscience based on the idea that a particular collection of microorganisms can solve virtually all health and environmental problems. We chose the topic because it is relevant to participants’ lives and yet unfamiliar to them.

The video was approximately 18 minutes long. We divided the video into six parts of roughly the same duration (Table 1). We analyzed participants’ eye fixations during the parts in which more than two supportive and opposing messages were presented (parts 2 to 4).

We presented fake social media messages that simulated Twitter posts. The messages consisted of text, with each containing one or two short sentences. We designed messages to agree or disagree with a particular argument made by either character (Scientist A or Scientist B). Messages were either supportive (of the effectiveness of EM) or opposing. For example, a supportive message could be one that agreed with a clear and supportive statement on EM made by scientist A. The rest of the messages were designed to be neutral to the discussion. All the messages were inserted approximately five seconds after the appearance of the relevant topic or incident. As a result of this manipulation scheme, 66 fake social messages (12 supportive, 12 opposing, 42 neutral) were selected and inserted into the video. These messages were placed at the bottom of the screen (Figure 1).

Critical thinking disposition scale The critical thinking disposition scale by Hirayama and Kusumi (2004) was administered to participants. On the basis of factor analysis by Hirayama and Kusumi (2004), we selected four items for each of four subscales: Awareness of logical thinking (e.g.,

“I am confident in thinking things through accurately”), Evidence-based judgment (e.g., “When I draw conclusions, I place importance on the existence of evidence”), Objectiveness (e.g., “I keep an objective attitude when I make a decision”), and Inquiring mind (e.g., “I am interested in people with different ways of thinking”).

Attitude questionnaire We measured participants’ attitudes toward the topic (the effectiveness of EM) before and after watching the fake television program. The attitude questionnaire contained two subscales with three items each: positive attitude (e.g., “I think EM will somehow do some good”) and careful attitude (e.g., “We need more investigation on the effectiveness of EM”).

Retention test A retention test with six quiz items (e.g., “What was the name of the river that Scientist A claimed that EM cleaned up?”) was developed and administered after participants had watched the video.

Apparatus

We collected eye-tracking data using the Tobii X2-60 eye-tracker for half of the participants and the Tobii Pro TX300 for the other half. We used different devices because the experiment was conducted in two different locations. The present paper reports the analysis for the latter half of the eye-tracking data. Because of the differences between the two experimental settings, we judged that it would be inappropriate to combine the data from the two different experimental setups. The eye-tracker for the latter half of the participants was paired with a 24" LCD monitor that was set at a resolution of 1920×1080. The eye-tracker sampled the position of participants’ eyes at a rate of 300 Hz and with an accuracy of 0.4°. The video was shown at a size of 1280×720 pixels. The Tobii Studio software package logged gaze data. We performed a 5-point calibration for each participant before he or she watched the video. The area of interest was set to the screen area where the fake social-media messages

were presented in order to measure eye-fixation duration on the messages. The corresponding part of the screen was set as the area of interest for the participants who did not see the social media.

Procedures

Each participant was tested individually in a laboratory at one of two different universities. Each session lasted approximately 45 minutes. After participants had signed a consent form, the experimenter asked them to complete the critical thinking disposition scale and the attitude questionnaire. Subsequently, the experimenter demonstrated the apparatus to measure eye fixations, and participants were told to keep their head position as stable as possible. After completing the calibration, the experimenter instructed the participant to watch the television show and learn from it. Each participant was randomly assigned to a video with or without social media messages. No instruction regarding the social media messages was given, so the participants were not aware of the difference between the conditions. After watching the video, participants responded to the retention test and attitude questionnaire. There was no time limit for completing questionnaires, but participants did so within 10–15 minutes.

Results

Scoring

Retention test scores were calculated as the total number of correct answers to the test. Scores for change in both positive and careful attitudes were defined as the difference between the participant’s scores on the questionnaires taken before and after the video (pre-test score minus post-test score). Scores for each subscale of critical thinking disposition were calculated based on Hirayama and Kusumi (2004). The average scores and SDs are shown in Table 2.

The effects of message presentation and individual differences

Participants allocated to the condition with social media messages rated on an 11-point scale to what extent the social media messages favored the person claiming that EM was effective (1) or the person who rebutted this view (11). The mean score on this scale was 7.33 (SD = 2.02). The correlation between the rating of social media messages and attitude change was negative. It was also significant for positive attitude change ($r = -.365, p < .05$) but not significant for careful attitude change ($r = .234$).

Next, the impact of message presentation and disposition to critical thinking were analyzed. A generalized linear model was constructed for each of the three dependent variables: retention test score and change in both careful and positive attitude scores. The maximum likelihood method was used to determine parameters. We included a parameter for the interaction between experimental condition (with or without message presentation) and critical thinking disposition

subscale scores. The results showed no significant effects of experimental condition or individual differences on retention test score and change in careful attitude. In contrast, the analysis of change in positive attitude reached the level of significance (pseudo $R^2 = .26$), indicating that the effect of message presentation was marginally significant, and that the presentation of messages facilitated a decrease in positive attitude ($\beta = -0.21$; 95% CI = $[-0.43, -0.01]$). Additionally, the interaction between message presentation and Objectiveness subscale score was significant ($\beta = -0.32$; 95% CI = $[-0.60, -0.04]$). Objectiveness subscale score affected attitude change only when the participants allocated to the condition with social media messages (Figure 2).

Table 2. Average scores on the retention test, change in attitude, and critical thinking disposition scales for each experimental condition.

	Mean score (SD) with messages	Mean score (SD) without messages
Retention test	3.90 (1.32)	4.28 (1.07)
Positive attitude change	-0.64 (0.71)	-0.30 (0.69)
Careful attitude change	0.76 (0.50)	0.67 (0.56)
Critical thinking disposition score		
Awareness of logical thinking	2.90 (0.76)	2.97 (0.63)
Evidence-based judgment	3.92 (0.79)	3.86 (0.60)
Objectiveness	3.77 (0.70)	3.66 (0.59)
Inquiring mind	4.21 (0.70)	4.25 (0.53)

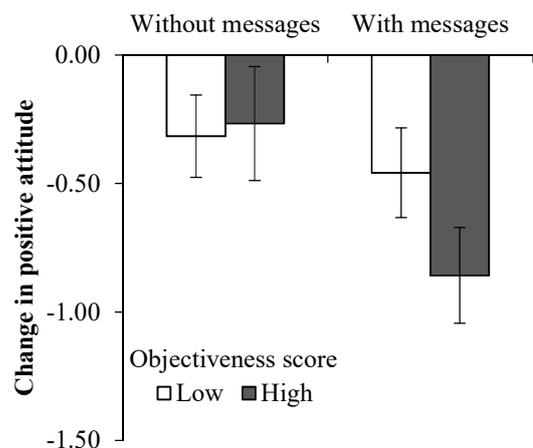


Figure 2. Change in positive attitude as a function of message presentation and Objectiveness score. Participants were divided by the median and shown into high and low groups. Error bars represent standardized errors.

Table 3. Correlation between gaze fixation and critical thinking disposition scores

	Supportive messages	Gaze data	
		Opposing messages	Neutral messages
Awareness of logical thinking	-.612†	-.581†	-.564†
Evidence-based judgment	-.697*	-.668*	-.654*
Objectiveness	-.002	-.040	.098
Inquiring mind	-.099	-.084	-.074
	.628†	.577†	.609†
	.638*	.605†	.603†
	.201	.058	.238
	.325	.194	.386

* $p < .05$; † $p < .10$

Note: Upper figures represent correlations with fixation frequency, and lower figures represent correlations with fixation duration.

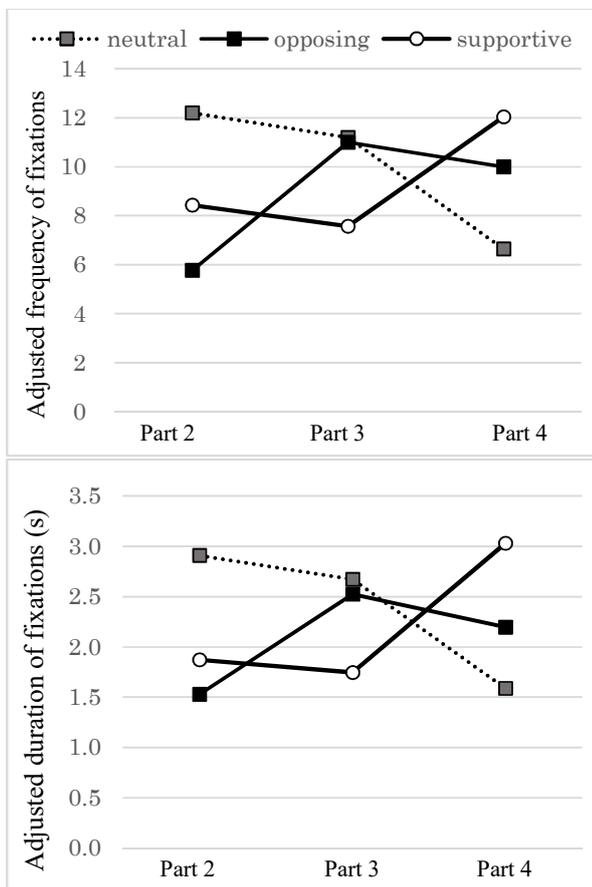


Figure 3. The time course of participants' frequency of fixations and duration in the area of interest.

Analysis of gaze data

Frequency and duration of fixations The gaze data of participants allocated to the condition without social media messages were not analyzed here, since they rarely fixated their gaze within the area of interest. From the participants allocated to the condition with social media messages, five

were excluded because of insufficient sampling (below 85%); thus, the gaze data of the remaining 10 participants were analyzed in the following. The number of fixations within the area of interest (frequency) and duration of these fixations between parts 2 and 4 of the video, during which multiple tweets of each message type were shown, were entered into this analysis. Fixations on the messages varied among the participants in both frequency ($M = 610.90$, $SD = 204.96$), and total fixation duration ($M = 149.04$ s, $SD = 58.19$). Correlations in both frequency and duration of fixations between different types of message (supportive, opposing, and neutral) were significant and strong ($r_s > .80$).

Correlation between fixations on messages and disposition to critical thinking The correlations between fixation measures for each type of message and critical thinking disposition scores are presented in Table 3. The correlations between awareness of logical thinking score and fixation were negative and significant or marginally significant. On the other hand, correlations between objectiveness score and fixation (both frequency and duration) were positive and marginally significant.

Changes in gaze over time To further investigate gaze patterns, we compared gaze data from each part (2 to 4) of the video. Since the number of messages presented differed for each part, the frequency and the duration were divided by the number of messages to calculate the average frequency and duration. One-way analyses of variance on eye gaze data, with part of the video as the independent variable, reached a significant level for each message type and for each dependent variable ($F_s(2,16) > 4.00$, $p_s < .05$). The results showed a decreasing tendency over time to fixate on neutral messages, and an increasing tendency to fixate on opposing and supportive messages (Figure 3). There was no difference between the groups with high and low thinking disposition scores, based on the size of the standard deviations.

Discussion

The present study investigated the effects of including social media messages in television programming and of participants' disposition to critical thinking. The results partly supported our hypothesis that the presentation of social media messages would directly affect learning. The retention scores and the changes in attitude were not significantly different between conditions. However, we found that the participants who regarded the social media messages as being more supporting developed more positive attitudes.

The results also show a significant interaction between message presentation and disposition to critical thinking, as we hypothesized. In the experimental condition where social media messages were presented, participants with higher objectiveness scores tended to show a decrease in positive attitude toward the topic at issue, while there was no such variation by objectiveness score in the condition without social media messages on the screen. This result suggests that when the viewers are aware of the importance of treating

information in an objective manner, the presence of social media messages may possibly foster the formation of appropriate attitudes in learning from television.

Since the claims about the effectiveness of EM in the video material lack reliable evidence, and this was pointed out by the other scientist, it is appropriate for the viewers to become more skeptical of EM after watching the video. Thus, in the present study, participants with higher objectiveness scores were more successful in forming an appropriate attitude with the help of the social media messages.

The present study makes meaningful contributions toward understanding how we learn from a new type of media. The first contribution is an expanded understanding of how social media messages affect individuals. The study investigated the direct and indirect effects of social media messages incorporated into television programs. The results suggested that the ways that viewers consider the content of messages rather than the kind of opinions the messages contain influence their attitude changes. Additionally, it was shown that individual differences affect the viewing process. More specifically, a disposition toward critical thinking affects how a viewer locates his or her attention.

The second contribution is the suggestion that seemingly subtle editing nevertheless affects the viewers' attitude formation. As far as we know, there is no evidence on the effects of editing television programs by adding text except that presented by Sasamoto, O'Hagan, & Doherty (2016). Sasamoto et al. (2016) revealed that the text of "Telop", colorful text subtitles that emphasize the performers' comments and circumstances, reflects the intentions of the program's producers, and that viewers pay a great deal of attention to it and are influenced by it. In line with Sasamoto et al. (2016), the present study adds new evidence showing that this type of editing impacts viewers' learning.

The present study has several limitations, primarily the small number of participants whose eye gaze data were collected and analyzed. Although studies of eye gaze data do not generally include large numbers of participants, a correlational analysis requires a larger sample. We should also stress that the facilitative effects on attitude formation of presenting social media messages may be limited to the kind of video and messages used in the present study. For example, the effects may be different when the television program does not include both sides of the topic or when it presents biased messages. To understand how the new type of media affects our daily learning, further investigation is needed.

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References

Barra, L., & Scaglioni, M. (2014). TV goes social: Italian broadcasting strategies and the challenges of convergence. *VIEW Journal of European Television History and Culture*, 3(6), 110–124.

- Ennis, R. H. (1996). *Critical thinking*. Upper Saddle River, NJ: Prentice-Hall.
- Harp, S. F., & Mayer, R. E. (1997). The role of interest in learning from scientific text and illustrations: On the distinction between emotional interest and cognitive interest. *Journal of Educational Psychology*, 89, 92–102.
- Harp, S. F., & Mayer, R. E. (1998). How seductive details do their damage: A theory of cognitive interest in science learning. *Journal of Educational Psychology*, 90, 414–434.
- Hirayama, R., & Kusumi, T. (2004). Effect of critical thinking disposition on interpretation of controversial issues. *Japanese Journal of Educational Psychology*, 52, 186–198.
- Inuzuka, M., Tanaka, Y., & Tsubakimoto, M. (2017). Students' comprehension of scientific discussion: Using eye-tracking technique to investigate the effects of social-media messages on television. *Proceedings of the 50th Annual Hawaii International Conference on System Sciences (HICSS)*, pp. 2106–2115.
- Maruyama, M., Robertson, S. P., Douglas, Semaan, B., and Faucett, H. (2014). Hybrid media consumption: How tweeting during a televised political debate influences the vote decision. *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW '14)*. Pp. 1422-1432.
- Maruyama, M., Robertson, S. P., Douglas, S., Raine, R., and Semaan, B. (2017). "Social watching" a civic broadcast: Understanding the effects of positive feedback and other users' opinions. *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW '17)*. Pp. 794-807.
- Mayer, R. E. (2009). *Multimedia learning*. New York: Cambridge University Press.
- Mayer, R. E., & Moreno, R. (1998). A split-attention effect in multimedia learning: evidence for dual processing systems in working memory. *Journal of Educational Psychology*, 90, 312–320.
- Postman, N. (1985). *Amusing ourselves to death: Public discourse in the age of show business*. New York: Penguin Books.
- Sasamoto, R., O'Hagan, M., & Doherty, S. (2016). Telop, affect, and media design: A multimodal analysis of a Japanese TV program. *Television & New Media*, 18, 427–440.
- Stanovich, K. E., & West, R. F. (1997). Reasoning independently of prior belief and individual differences in actively open-minded thinking. *Journal of Educational Psychology*, 89, 342–357.
- Sweller, J., & Chandler, P. (1994). Why some material is difficult to learn. *Cognition and Instruction*, 12, 185–233.
- West, R. F., Toplak, M. E., & Stanovich, K. E. (2008). Heuristics and biases as measures of critical thinking: Associations with cognitive ability and thinking dispositions. *Journal of Educational Psychology*, 100, 930–941.