

## Do the Type of Learning Material and Prior Knowledge Impact Students' Success in Learning and Their Epistemic Emotions?

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### Abstract

The aim of this study was to test the impact of the type of learning material and the level of prior knowledge on students' success in learning and their epistemic emotions. We have conducted two online experimental studies in which half of the participants, university students, were randomly assigned either a video or a textual material condition. In Study 1 ( $N = 165$ ) all the materials were in Croatian; in Study 2 ( $N = 107$ ) they were in English. Croatian was the mother tongue of all participants, and English was the foreign language. The participants were queried about their prior knowledge of the topic they were assigned and their epistemic emotions and were asked to fill out a knowledge exam. The results showed that in both studies students who learned from text and with higher level of prior knowledge scored better at the exam, while interaction effect was not significant. Regarding epistemic emotions, in both studies the type of learning material and the interaction effect were not significant. Only in Study 1, prior knowledge significantly affected epistemic emotions, i.e., students with higher prior knowledge reported higher intensity of enjoyment and curiosity, and lower intensity of negative epistemic emotions. The research gives important insights in the role of the learning material on students' academic outcomes, especially epistemic emotions.

*Keywords:* epistemic emotions, textual learning material, video learning material, prior knowledge, success in learning

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## Introduction

If someone asked us whether we prefer studying from textbooks or from videos, studying from videos would at least sound more fun. Even Thomas Edison, in whose laboratory the first film was made at the end of 19<sup>th</sup> century, strongly supported the idea that film would revolutionise the educational system and replace the use of textbooks very soon (Mayer et al., 2020). Even though textbooks are still very much in use, using educational videos in classrooms has become more prevalent in the last couple of decades (Cruse, 2006).

Educational video is defined as a type of multimedia material for studying which consists of graphics made of pictures in motion, which are recorded via camera or made in a computer program, while words refer to spoken words or sounds recorded via microphone (Mayer et al., 2020). In this paper, the word *video* will be used to denote every educational material presented in digital form, which is primarily a combination of pictures in motion (animations) and spoken words (narration) but can also contain static pictures and written words. The word *text* will denote every educational material which can be presented in a traditional way (textbook, script, notebook) or digital way (Word or PDF document) and is a combination of written words, photographs, and illustrations.

To explain how people process information from video materials, Mayer (2005a) developed the cognitive theory of multimedia learning, which is based on three principles. According to the first principle, the system which processes information consists of two channels - one processing visual information, and the other processing auditive information. This assumption is based on the theory of dual coding by Paivio (1986), according to which the two channels are connected. That is, if information reaches the ear first, it is processed in the auditory channel, but also in the visual channel since it makes a mental image of that information. The second principle is based on the working memory model by Baddeley (1986) and the cognitive load theory by Chandler and Sweller (1991) and assumes that every channel has limited number of information which can be simultaneously processed, and that both channels have their own working memory. According to the third principle, learning will be successful if there is a coordination of different cognitive processes (i.e., directing attention, organisation of incoming information, and integrating new information with prior knowledge). If all three principles are satisfied, that will result in meaningful learning (Mayer, 2002).

## Emotional Experiences as a Part of the Learning Process

Beside cognitive activities which are an inseparable part of learning, in the last few decades the focus has also been on the emotional experience as an integral part of learning and achievement (Pekrun & Linnenbrink-Garcia, 2014). Therefore, Mayer (2020) presented a cognitive-affective model of e-learning, which proposes

that a learning episode can evoke different emotions among learners. Those emotional reactions further impact cognitive processes included in learning, which leads to learning outcomes.

Academic emotions are emotions which students experience in academic context and are related to the learning activities, class activities and achievement outcomes (Pekrun et al., 2002). Further, academic emotions can be differentiated by their valence (positive or negative), activation (activating or deactivating), and object focus (activity or outcome; Pekrun & Perry, 2014). According to the object focus, there are four groups of academic emotions, i.e., achievement, epistemic, topic and social emotions.

In this study, we were specifically interested in epistemic emotions whose object focus is on knowledge and the generation of knowledge (Pekrun & Stephens, 2012). There are seven most commonly examined epistemic emotions, i.e., surprise, curiosity, enjoyment, confusion, anxiety, frustration, and boredom (Pekrun et al., 2016) which will also be assessed in this research.

### **Effect of Textual and Video Materials on the Learning Outcomes and Epistemic Emotions**

Mayer (2019a) states that research conducted in the last thirty years shows that adding graphics and animations to text enhances our understanding and learning. Earlier research examined the differences in learning outcomes between different types of learning materials. Mayer (2002) mentions that, in eleven experiments in which he compared learning from texts and illustrations with learning from narration and animation, participants from the second group achieved better results.

Epistemic emotions have a very important role in students' learning experiences, since they can hinder or enhance further learning or deep understanding (e.g., Pekrun et al., 2002), and educational videos have become a frequent tool in modern teaching. Understanding how textual and video materials impact students emotionally can enhance instructional design. However, there is only one research directly comparing the effects of three different learning conditions (virtual reality technology [VR], textual material, and video) on emotions and success in learning (Allcoat & von Mühlhelen, 2018). The results showed that the video and textual conditions showed a decrease in positive emotions.

Bearing those results in mind and the fact that, to the best of the authors' knowledge, there is no research with epistemic emotions specifically, it seems important to test if the type of learning material has impact on the epistemic emotions students experience during learning.

## Effects of Prior Knowledge on Learning Outcomes and Epistemic Emotions

Research showed that the effects of multimedia materials are especially favourable for students with lower level of prior knowledge (Mayer, 1997, 2019a; Mayer & Gallini, 1990). For people who have higher level of prior knowledge it will be easier to create mental images of information they are reading or hearing about. That is, they can simultaneously manipulate both the verbal and visual information in their working memory, while people with lower level of prior knowledge can only manipulate the verbal information.

Regarding the effects on the epistemic emotions, although the theoretical assumptions propose that the perceived novelty of the information which has to be learnt is one of the antecedents of epistemic emotions (Muis et al., 2018), earlier research did not specifically examine the effects of prior knowledge on epistemic emotions, and it was included in the analyses only as a control variable. To explain that relationship, Muis et al. (2018) proposed four conditions under which new information trigger epistemic emotions: (1) when the information is perceived as new and unexpected, (2) if it is inconsistent with prior knowledge, (3) if it is inconsistent with recently processed information, or (4) when it is in contrast or in alignment with students' epistemic beliefs. In a study by Muis et al. (2015) prior knowledge positively correlated with frustration but was a positive predictor of the learning outcomes. In contrast to the earlier studies, we wanted to directly test if prior knowledge has an effect on epistemic emotions which students experience while learning.

### Current Study

To test the effects of prior knowledge and the type of learning material on the success in a knowledge exam and on the epistemic emotions experienced while learning, two studies were conducted. In the first study, the materials were in native language, while in the second study they were in English, which is taught in local elementary and secondary schools as a first foreign language. We wanted to examine whether the same relationships between the variables are present for materials in both the native language and the English language. Namely, today there is a proliferation of available educational videos in English for many areas, greatly outnumbering those available in Croatian. Consequently, it was important to examine these variables for both languages.

We expected that the participants who learned from video materials will, in both studies, have higher scores in a knowledge exam than those who learned from textual materials. Beside this, we expected that the students who have a higher level of prior knowledge about the topic will have higher scores in the knowledge exam in contrast to students with a lower level of prior knowledge. Furthermore, an interaction effect was expected, i.e., those participants who have a higher level of prior knowledge will

not differ in their success in the knowledge exam, regardless of the type of the learning material. On the other hand, those with a lower level of prior knowledge will have a higher success in the knowledge exam when learning from video materials, than those learning from textual materials. Regarding epistemic emotions, since there is a scarcity of earlier research on which we would base our assumptions about significant effects of prior knowledge, type of learning material and interaction effect on epistemic emotions, those hypotheses were exploratory.

## **Study 1**

### **Method**

#### **Participants**

In this study, 165 university students (72.1% female) participated. They were 22.07 years old on average ( $SD = 2.01$ ). Their current grade point average ranged between 2.2 and 5.0 with an average value of 4.00 ( $SD = 0.50$ ). Most of the participants studied psychology (64.8%).

#### **Procedure**

The research was conducted in an online environment, during the COVID-19 pandemic. Psychology students were informed about the study and asked to participate in it and invite students from other faculties to participate. The study was conducted in accordance with ethical principles in conducting psychological research.

When applying for the participation in the study, the participants were informed about the duration of the experiment, that they will be in a situation where they will have to study, do an exam, and fill out questionnaires. The research was conducted over the course of two weeks and the participants were asked to choose a day in the week that suited them the best to access the online experiment. They were asked to access the web link via computer or laptop and to go through the tasks without pauses or interruptions.

The participants were randomly assigned either to a situation in which they learned from video material, or to a situation where they learned from textual material. All the materials and educational videos were in native language. When choosing the videos, we were guided by the criteria that they were understandable, lengthy enough and that the students have some prior knowledge about the topic. The educational videos were “Blood” (Eduvizija video, 2019a) and “Heart, blood vessels, and lymph” (Eduvizija video, 2019b). Both videos were taken from the web portal Eduvizija. The textual material was made in such a way that a literal transcript of the

narration from the video was used. The images and photographs that were put into the text were screenshots of the animations from the video, except for the parts that were of poor quality. For those parts, pictures and photographs were found on other internet portals that were in the native language.

At the beginning of the experiment, the general instructions given to the participants were repeated on the screen. After that, the participants were instructed to read the text or watch the video, respectively, and to try to learn as much information as possible without taking notes. They were allowed to go back and forth in the text/video and read/watch parts of it again. They were instructed to learn at their own pace as they normally do when studying for oral or written exams. Then the interface proceeded with the knowledge exam, and after that, the participants filled out items about epistemic emotions and answered short questions about their demographic characteristics and the question about the prior knowledge of the specific material used in the study.

## Measures

Epistemic emotions were assessed with the translation of the Epistemically-Related Emotion Scales (Pekrun et al., 2016) into local language (Balaž, 2021). It measures the intensity of seven distinct epistemic emotions on a 5-point scale (1 = *not at all*, 5 = *very strong*). Each emotion was examined with three items i.e., surprise (e.g., surprised), curiosity (e.g., interested), enjoyment (e.g., happy), confusion (e.g., puzzled), frustration (e.g., irritated), anxiety (e.g., worried), and boredom (e.g., dull). The total result was calculated separately for each emotion as an average of all answers on the three items. Cronbach's alpha ranged from .74 to .92 for both text and video condition.

The knowledge exam about the heart, blood vessels, lymph, and blood consisted of 30 questions. Fifteen of the questions were short answer questions (e.g., *What are the two functions of blood cells*) and 15 were gap-filling questions (e.g., *Lymph is formed by leakage of \_\_\_\_\_ from capillaries to surrounding cell spaces.*). The number of possible points ranged from 0 to 35. Cronbach's alpha was .87 in the text condition, while in the video condition it was .85.

The self-assessed prior knowledge was examined with one item after the presentation of the material the participants have studied (*How would you assess your prior knowledge of the material you have just studied (heart, blood vessels, lymph, and blood)?*). The participants answered on a scale from 1 (*I did not remember almost anything from before*) to 7 (*I remembered almost everything from before*). Based on the median of those answers, we divided the participants into two categories: (1) low level of prior knowledge, for all results lower than the median, and (2) high level of prior knowledge, for all results above the median.

The examined demographic characteristics included sex, age, university, faculty, study, year of study and the current grade point average.

## Results and Discussion

In Study 1 we were specifically interested in preliminary analyses of the effects of the prior knowledge and the type of the learning material on the success in the knowledge exam and epistemic emotions experienced while learning, since there is a scarcity of earlier research examining those relationships. Therefore, we conducted two analyses in both of which the type of the learning material and level of prior knowledge were independent variables. We conducted a two-way independent ANOVA to test if those variables affect success in the knowledge exam, and MANOVA to test if they affect epistemic emotions. Missing data were minimal, with less than 2% missing values across the variables. Thus, we used listwise deletion, guided by the assumption that the missing data were missing completely at random.

### *Effects of Prior Knowledge and Learning Material on Success in the Knowledge Exam*

Descriptive statistics are presented in Table 1 according to participants' perception of their prior knowledge regarding the studied material. The maximum number of points was 35, and the average number of points among participants with higher level of prior knowledge was  $M = 23.56$  ( $SD = 4.58$ ), while among those with lower level of prior knowledge was  $M = 17.95$  ( $SD = 6.78$ ). In text condition, the average number of points on knowledge exam was  $M = 22.13$  ( $SD = 6.36$ ) in contrast to video condition where it was  $M = 19.60$  ( $SD = 6.16$ ).

**Table 1**

*Descriptive Statistics for Success in the Knowledge Exam Considering Levels of Prior Knowledge and Type of Learning Material*

	Lower level of prior knowledge			Higher level of prior knowledge			Total		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
Text	41	19.46	7.17	42	24.74	4.09	83	22.13	6.36
Video	38	16.32	6.00	44	22.43	4.79	82	19.60	6.16
Total	79	17.95	6.78	86	23.56	4.58	165	20.87	6.38

ANOVA showed that the main effect of the type of the learning material was significant,  $F(1, 161) = 9.73$ ,  $p = .002$ ,  $\eta_p^2 = .057$ , indicating that the participants scored better in the exam when studying from the textual material rather than from the video. These results are not in line with our hypothesis but are in line with the earlier study (Allcoat & van Mühlenen, 2018). One of the possible explanations could be the fact that students primarily learn from textual materials throughout formal education which makes them more accustomed to textual material than to learning from videos. Videos, documentary films and TV shows are used during

classes or individual preparations for exams, but those materials are still a lot less prevalent than the traditional, textual materials.

Furthermore, the main effect of prior knowledge was also significant,  $F(1, 161) = 42.46$ ,  $p < .001$ ,  $\eta_p^2 = .209$ , i.e., the students who had higher level of prior knowledge scored better at the exam than those who had a lower level of knowledge. These findings are in line with our hypothesis and with the results from an earlier study (Mayer & Gallini, 1990).

Although expected, the interaction effect was not significant,  $F(1, 161) = .23$ ,  $p = .631$ ,  $\eta_p^2 = .001$ . Students with low and high prior knowledge did not differ in their scores in the knowledge exam considering the type of the learning material. We will further elaborate on this in Study 2.

### *Effects of Prior Knowledge and Learning Material on Epistemic Emotions*

Descriptive statistics for epistemic emotions regarding the types of the learning material and the prior knowledge are presented in Table 2. The results were very similar for all conditions. That is, frustration was experienced the least intensively, and curiosity the most intensively in situations of learning from text and video, and regardless of their prior knowledge.

**Table 2**

*Descriptive Statistics for Epistemic Emotions Regarding Types of Learning Material and Prior Knowledge*

	Learning material	Prior knowledge	<i>N</i>	<i>M</i>	<i>SD</i>
surprise	text	lower	41	1.98	0.85
		higher	42	1.85	0.78
		total	83	1.91	0.81
	video	lower	38	2.18	0.96
		higher	44	1.96	0.79
		total	82	2.06	0.87
	total	lower	79	2.07	0.90
		higher	86	1.91	0.78
		total	165	1.99	0.84
curiosity	text	lower	41	3.46	1.04
		higher	42	3.67	0.88
		total	83	3.56	0.96
	video	lower	38	3.04	0.99
		higher	44	3.40	0.73
		total	82	3.23	0.87
	total	lower	79	3.25	1.03
		higher	86	3.53	0.81
		total	165	3.40	0.93



	Learning material	Prior knowledge	<i>N</i>	<i>M</i>	<i>SD</i>
enjoyment	text	lower	41	2.09	0.86
		higher	42	2.40	0.81
		total	83	2.24	0.85
	video	lower	38	1.97	0.99
		higher	44	2.33	0.94
		total	82	2.17	0.97
	total	lower	79	2.03	0.92
		higher	86	2.36	0.87
		total	165	2.21	0.91
confusion	text	lower	41	1.91	0.77
		higher	42	1.48	0.66
		total	83	1.69	0.74
	video	lower	38	2.19	0.94
		higher	44	1.54	0.60
		total	82	1.84	0.84
	total	lower	79	2.05	0.86
		higher	86	1.51	0.62
		total	165	1.77	0.79
anxiety	text	lower	41	1.68	0.98
		higher	42	1.29	0.58
		total	83	1.48	0.82
	video	lower	38	1.75	0.90
		higher	44	1.47	0.66
		total	82	1.60	0.79
	total	lower	79	1.71	0.94
		higher	86	1.38	0.63
		total	165	1.54	0.81
frustration	text	lower	41	1.62	0.99
		higher	42	1.28	0.68
		total	83	1.45	0.85
	video	lower	38	1.68	0.89
		higher	44	1.44	0.70
		total	82	1.55	0.80
	total	lower	79	1.65	0.93
		higher	86	1.36	0.69
		total	165	1.50	0.83
boredom	text	lower	41	2.50	0.98
		higher	42	2.02	0.78
		total	83	2.25	0.91
	video	lower	38	2.64	0.93
		higher	44	2.22	0.81
		total	82	2.41	0.89
	total	lower	79	2.57	0.95
		higher	86	2.12	0.80
		total	165	2.33	0.90

The results of MANOVA showed that the main effect of the type of the learning material was not significant,  $V = .079$ ,  $F(7, 155) = .191$ ,  $p = .071$ ,  $\eta_p^2 = .079$ , as well as the interaction effect,  $V = .026$ ,  $F(7, 155) = .59$ ,  $p = .766$ ,  $\eta_p^2 = .026$ . On the other hand, the main effect of prior knowledge had significant effect on epistemic emotions,  $V = .196$ ,  $F(7, 155) = 5.41$ ,  $p < .001$ ,  $\eta_p^2 = .196$ . The results showed that the levels of prior knowledge had a significant effect on the intensity of all epistemic emotions, except surprise (Table 3). More precisely, the intensity of positive epistemic emotions (curiosity and enjoyment) was higher among the students who had higher level of prior knowledge than among those who had lower level of prior knowledge. In contrast, the intensity of all negative epistemic emotions (confusion, anxiety, frustration, and boredom) was higher among those students who had lower level of prior knowledge.

**Table 3**

*Results of Testing the Main Effect of Levels of Prior Knowledge on Epistemic Emotions*

	$F(1, 161)$	$p$	$\eta_p^2$
surprise	1.681	.197	.010
curiosity	4.131	.044	.025
enjoyment	5.641	.019	.034
confusion	21.675	.000	.119
anxiety	7.415	.007	.044
frustration	5.102	.025	.031
boredom	10.922	.001	.064

The results showed that the type of the learning material did not have a significant effect on epistemic emotions, neither was the interaction effect significant. On the other hand, the prior knowledge had a significant effect on all epistemic emotions, except surprise. The students who already had higher level of prior knowledge were probably more interested in the topic they learned about. Usually, students will experience curiosity when they want to learn something new (Litman & Jimerson, 2004), and enjoyment when the new information is in line with their prior knowledge (Muis et al., 2015) or as a consequence of successfully solving the task (D’Mello & Graesser, 2012). On the other hand, they will experience confusion, frustration, and anxiety when information they are learning about is not in line with their prior knowledge (Chevrier et al., 2019; D’Mello & Graesser, 2012), and boredom if they do not find the material interesting (D’Mello & Graesser, 2012). Since students self-assessed their prior knowledge about the topic they were learning about and they did not get the immediate feedback about their success in the exam, even if they were wrong about some ideas, they did not know that, since they did not see their exam scores. From that perspective, it is not surprising that those who perceived their prior knowledge as higher, at the same time experienced positive epistemic emotions more intensively, while they experienced the negative ones less intensively.

## Study 2

### Method

#### Participants

In the study, 107 university students (68.2% female) participated. They were 22.59 years old ( $SD = 2.03$ ) on average. Most of the participants studied psychology (55.1%). The participants were included in this study only if they indicated that their English language level was B2 or more.

#### Procedure

The procedure in this study was similar to the procedure in Study 1, but all of the materials and educational videos were in English. We chose the videos “Human Body 101” (National Geographic, 2017) and Genetics 101 (National Geographic, 2018) from the YouTube channel of the National Geographic magazine.

#### Measures

As in Study 1, epistemic emotions were assessed with the translation of Epistemically-Related Emotion Scales (Pekrun et al., 2016) into local language (Balaž, 2021). Cronbach’s alpha ranged from .63 to .91 for text condition, and from .55 to .96 for video condition.

The knowledge exam about the human body and genetics consisted of 17 questions. Ten of the questions we finally selected for the test were multiple-choice questions, where only one answer was correct (e.g., *The endocrine system is a series of? a) nodes, b) glands, c) tendons, d) cartilages*). The other seven were gap-filling questions (e.g., *The other name for the urinary system is \_\_\_\_\_*). Each correct answer to the question awarded 1 point, so the number of points ranged from 0 to 17. Cronbach’s alpha for this exam was .69 for the text condition and .66 for the video condition.

As in Study 1, the self-assessed prior knowledge was examined, after the presentation of the material the participants have studied, with the item: *How would you assess your prior knowledge of the material you have just studied (human body and genetics)?*. As in Study 1, the answers of the participants were divided into two categories based on the median value – low and high level of prior knowledge. The same demographic characteristics as in Study 1 were assessed.

## Results and Discussion

After the preliminary analysis on these rarely studied effects in Study 1, in this study we wanted to test those assumptions with a second sample of participants and with different learning materials to see if the results will be in line with each other. The procedure and the analyses were the same as in Study 1. Missing data were also less than 2%, and we used listwise deletion.

### *Effects of Prior Knowledge and Learning Material on the Success in the Knowledge Exam*

The descriptive statistics for the success in the knowledge exam at all types of the learning material and levels of prior knowledge are presented in Table 4. The maximum number of points in this exam was 17, while participants with lower level of prior knowledge scored on average  $M = 10.59$  ( $SD = 2.98$ ), and those with higher level of prior knowledge  $M = 12.11$  ( $SD = 2.60$ ). In text condition, the average number of points was  $M = 12.00$  ( $SD = 2.79$ ), while in video condition  $M = 10.70$  ( $SD = 2.85$ ).

**Table 4**

*Descriptive Statistics for Success in Knowledge Exam Considering Levels of Prior Knowledge and Type of Learning Material*

	Lower level of prior knowledge			Higher level of prior knowledge			Total		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
Text	27	11.59	3.07	26	12.42	2.47	53	12.00	2.79
Video	27	9.59	2.56	27	11.81	2.73	54	10.70	2.85
Total	54	10.59	2.98	53	12.11	2.60	107	11.35	2.89

To test if there are significant differences, we conducted a two-way independent ANOVA. The main effect of the type of the learning material was significant,  $F(1, 103) = 6.15$ ,  $p = .015$ ,  $\eta_p^2 = .056$ , indicating that students scored better in the exam when studying from the textual material than from the video. Furthermore, the main effect of the prior knowledge was also significant,  $F(1, 103) = 8.43$ ,  $p = .005$ ,  $\eta_p^2 = .076$ , that is, the students who had higher level of prior knowledge scored better at the exam than those who had lower level of prior knowledge. The interaction effect was not significant,  $F(1, 103) = 1.75$ ,  $p = .189$ ,  $\eta_p^2 = .017$ .

We can see that these results are the same as the results from Study 1. That is, the students who were learning from the textual material again had higher scores at the knowledge exam. The reason for this may be that in text readers can quickly scan and locate specific information (Furnham et al., 2002) and repeat the process to enhance learning. Although in our study the participants were allowed to navigate

back and forth in the video and rewatch specific segments, this approach can be more time-consuming compared to scanning a written document.

Regarding the non-significant interaction in both studies, the reason could be in the type of information presented in the videos. In his research, Mayer (1997, 2019b) usually uses the assignment in which participants learn how a certain mechanical device works (e.g., a pump), after which they have to answer problem solving tasks. It is possible that the type of topics which participants need to learn and the means by which their knowledge is tested affect their results. If the topic can be more easily visually presented (e.g., how a pump works), we can assume that the positive effect of combining verbal and visual information will be higher than it would be in a situation with a topic that can be harder to present visually (e.g., genetics).

### ***Effects of Prior Knowledge and Learning Material on Epistemic Emotions***

To test if there is an effect of the prior knowledge and the type of the learning material on the intensity of epistemic emotions experienced during learning, we conducted MANOVA, with prior knowledge and learning material as independent variables, and all epistemic emotions as dependent variables. Table 5 presents descriptive statistics regarding epistemic emotions at all levels of both independent variables.

**Table 5**

*Descriptive Statistics for Epistemic Emotions Considering Levels of Prior Knowledge and Type of Learning Material*

	Learning material	Prior knowledge	<i>N</i>	<i>M</i>	<i>SD</i>
surprise	text	lower	27	1.75	0.71
		higher	26	2.06	0.92
		total	53	1.91	0.83
	video	lower	27	1.83	0.74
		higher	27	1.94	0.67
		total	54	1.88	0.70
	total	lower	54	1.79	0.72
		higher	53	2.00	0.80
		total	107	1.89	0.76
curiosity	text	lower	27	3.37	1.11
		higher	26	3.71	0.77
		total	53	3.53	0.96
	video	lower	27	3.22	1.03
		higher	27	3.52	0.97
		total	54	3.37	1.00
	total	lower	54	3.30	1.06
		higher	53	3.61	0.87
		total	107	3.45	0.98

	Learning material	Prior knowledge	<i>N</i>	<i>M</i>	<i>SD</i>
enjoyment	text	lower	27	2.17	0.88
		higher	26	2.65	1.00
		total	53	2.41	0.96
	video	lower	27	2.22	0.94
		higher	27	2.36	0.96
		total	54	2.29	0.94
	total	lower	54	2.20	0.90
		higher	53	2.50	0.98
		total	107	2.35	0.95
confusion	text	lower	27	1.54	0.67
		higher	26	1.32	0.50
		total	53	1.43	0.60
	video	lower	27	1.43	0.44
		higher	27	1.58	0.71
		total	54	1.51	0.59
	total	lower	54	1.49	0.57
		higher	53	1.45	0.63
		total	107	1.47	0.60
anxiety	text	lower	27	1.46	0.72
		higher	26	1.40	0.72
		total	53	1.43	0.71
	video	lower	27	1.25	0.42
		higher	27	1.46	0.67
		total	54	1.35	0.57
	total	lower	54	1.35	0.59
		higher	53	1.43	0.69
		total	107	1.39	0.64
frustration	text	lower	27	1.40	0.69
		higher	26	1.23	0.60
		total	53	1.32	0.65
	video	lower	27	1.26	0.56
		higher	27	1.52	1.06
		total	54	1.39	0.85
	total	lower	54	1.33	0.62
		higher	53	1.38	0.87
		total	107	1.36	0.75
boredom	text	lower	27	2.31	0.84
		higher	26	1.88	0.72
		total	53	2.10	0.81
	video	lower	27	2.44	1.04
		higher	27	2.20	0.99
		total	54	2.32	1.01
	total	lower	54	2.38	0.94
		higher	53	2.04	0.88
		total	107	2.21	0.92

Students perceived the highest intensity of curiosity while learning from either text or video, and regardless of their prior knowledge. In contrast, frustration had the lowest perceived intensity in all situations, except when learning from video material, in which anxiety was perceived as least intensive.

The results of MANOVA showed that none of the effects are significant. That is, the main effect of the type of the learning material,  $V = .032$ ,  $F(7, 97) = .46$ ,  $p = .864$ ,  $\eta_p^2 = .032$ , the level of prior knowledge,  $V = .060$ ,  $F(7, 97) = .88$ ,  $p = .523$ ,  $\eta_p^2 = .060$ , and the interaction effect,  $V = .058$ ,  $F(7, 97) = .85$ ,  $p = .547$ ,  $\eta_p^2 = .058$ , did not have a significant effect on the intensity of epistemic emotions the students experienced during learning.

In contrast to the first part of the results, we can see that the results of the effect of the type of the learning material, the level of prior knowledge and the interaction effect were not completely the same in Study 1 and Study 2. Specifically, the main effect of prior knowledge was significant in Study 1, but not in Study 2. One possible reason could be in the fact that in Study 2 the sample of students was quite smaller than the sample of students in Study 1. Another possible reason could be related to the amount of information that had to be learned, which differed between the studies. In Study 1, the participants learned about the cardiovascular system, which was described in more detail than the human body and genetics, which was the topic in Study 2. The video used in Study 1 lasted 10:53 minutes, and thus the text was also longer, while the video in Study 2 lasted 7:03 minutes. It is possible that because of the more detailed materials, part of the participants in Study 1 did not remember many of the facts they might have learned at some prior point in their life and consequently the topic might have seemed newer to them. This had an effect on several epistemic emotions, unlike in Study 2.

Beside this, it is interesting that in both studies the type of the learning material did not have an effect on the intensity of epistemic emotions. An earlier study showed that video-based multimedia learning material leads to a better learning performance and a positive emotion, specifically for verbalizers (a type of cognitive learning style; Chen & Sun, 2013). It could be expected that new ways of delivering instruction, such as video material, could evoke surprise or curiosity among students, but this was not the case in these two studies. One explanation for these results might be that the videos in both studies were not designed along the principles of optimal multimedia material. In a series of experiments Mayer (2005b, 2019a, 2019b) tried to find which principles are important while designing a multimedia material if the goal is to achieve the best learning outcomes. He lists a series of different principles which can be grouped into principles that refer to reduction of redundant information, principles for managing key learning processes and principles for encouragement of generative processes. Those principles need to be followed if we want our multimedia material to be as efficient as it can be in the transfer of information and to alleviate the process of learning.

## General Discussion

The main goal of these two studies was to test if the level of prior knowledge and the type of learning material impact students' success in a knowledge exam and epistemic emotions they experienced while learning those materials. Regarding the success, in both studies the students who learned from the text, in contrast to those who were learning from the video, as well as the students who had a higher level of prior knowledge, in contrast to those who had a lower level of prior knowledge, scored better at the knowledge exam. Beside this, the interaction effect of learning material and prior knowledge on the success in the exam was not significant.

On the other hand, the results regarding epistemic emotions in the two studies were not completely in line with each other. Specifically, the results of the two studies overlap in that the main effect of the type of learning material and the interaction effect did not significantly affect epistemic emotions. In contrast, the main effect of prior knowledge on epistemic emotions was significant only in Study 1. That is, the students who had a higher level of prior knowledge also experienced curiosity and enjoyment more intensively, while they experienced confusion, anxiety, frustration, and boredom less intensively, in contrast to those students who had a lower level of prior knowledge. The effect was not significant only for the emotion of surprise.

Although much of the results overlap between Study 1 and Study 2, there are substantial differences in the effect of students' prior knowledge about a specific topic on the intensity of the emotions students experience while learning about that topic. The level of prior knowledge was assessed with only one question, in which the students had to self-evaluate their level of prior knowledge about the topic they had learned. This could lead to biased estimations of their level of knowledge since they could overrate their knowledge due to socially desirable responding. Also, in this way of asking we got only their subjective perception of the level of knowledge which is not the proof of their actual prior knowledge since they could have wrong memory of those facts and merely think they remember all that data. We asked for the participants' subjective assessment because we did not want to direct them in advance to how their knowledge would be tested later. However, the results might have been different had we used an objective measure of their prior knowledge which would account for the mentioned shortcomings.

Despite these limitations, there are several important implications. This is the first study, to our best knowledge, that tests the effects of the type of learning material and of the prior knowledge on the intensity of epistemic emotions specifically. Since epistemic emotions are quite a new area of research, this study brings important updates to the field and gives directions for future studies. Regarding the exam score, an important finding is that the students who learned from textual material scored better in both studies. Although our expectations were different, earlier studies also come to conflicting results (e.g., Allcoat & Mühlänen, 2018; Vo et al., 2019). Even



though the results of these studies favour the textual learning material, the use of videos in teaching should not be rejected. Instead, more efficient ways of delivering learning materials in a video format should be devised, and textual and video materials should supplement each other in order to facilitate students' learning and achieving desirable learning goals. Future research ought to compare the effectiveness of learning from textual and video materials across diverse subject areas. This inquiry should delve into identifying specific attributes within text and video content that enhance students' learning outcomes. Furthermore, future studies should examine the relationship between epistemic emotions and learning outcomes for different learning materials. This applies not only to text-based and video-based materials but also to emerging technologies such as virtual reality.

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## Utječu li vrsta materijala za učenje i predznanje na uspjeh studenata u učenju i na njihove epistemičke emocije?

### Sažetak

Cilj je ovoga istraživanja bio ispitati utjecaj vrste materijala za učenje i predznanja na uspjeh studenata u učenju te na njihove epistemičke emocije. Proveli smo dva online eksperimentalna istraživanja u kojima su sudjelovali studenti nasumično raspoređeni u skupine s videomaterijalom ili s tekstualnim materijalom. U Istraživanju 1 ( $N = 165$ ) svi su materijali bili na hrvatskome jeziku, a u Istraživanju 2 ( $N = 107$ ) bili su na engleskome jeziku. Hrvatski je bio materinski jezik svih sudionika, a engleski strani jezik. Sudionici su odgovarali na pitanja o predznanju o temi koja im je dodijeljena i ispunjavali skalu epistemičkih emocija te rješavali test znanja. Rezultati su pokazali da su u obama istraživanjima studenti koji su učili na temelju teksta i imali veće predznanje postigli bolje rezultate na testu znanja, dok interakcijski učinak nije bio značajan. Za epistemičke emocije u obama istraživanjima vrsta materijala za učenje i interakcijski učinak nisu bili značajni. Predznanje je samo u Istraživanju 1 značajno utjecalo na epistemičke emocije, tj. studenti s većim predznanjem izvijestili su o većemu intenzitetu uživanja i znatiželje te o manjemu intenzitetu negativnih epistemičkih emocija. Istraživanje daje važne uvide o ulozi materijala za učenje u akademskim ishodima studenata, posebno u epistemičkim emocijama.

*Cljučne riječi:* epistemičke emocije, tekstualni materijal za učenje, videomaterijal za učenje, predznanje, uspjeh u učenju

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