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Modeling the mechanisms of interest raising videos in education

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Abstract

The forced online education during the COVID pandemic in 2020 and 2021 showed many teachers how valuable video can be as a teaching tool. Videos have the potential to raise pupils' interest in educational content. The mechanisms of raising interest, however, have hardly been studied in actual materials used in actual classrooms. This study aims to validate the core components of a dynamic model (Film's Interest-Raising Mechanisms [FIRM] model) that describes how pupils' interest in a video and the educational content is the result of their appraisals of video characteristics. The five appraisals in the model represent characteristics of learning materials and activities, of films and videos, and of games that have been found to potentially raise interest: Novelty and complexity, comprehensibility, complex developments, rewarding closure, and absorption. We empirically tested the use of four videos in six 12th-grade science and mathematics classrooms (151 pupils) using pre- and post-tests, and path-modeling. All five appraisals in the FIRM model were found to be significant predictors for the pupils' interest in the video and for their development of interest in the educational content.

KEYWORDS
appraisals, education, film, interest, learning, video

1 | INTRODUCTION

The forced online education during the COVID pandemic in 2020 and 2021 showed many teachers how valuable video can be as a teaching tool. While the use of film and video in educational contexts is increasing worldwide (Fyfield et al., 2020; Thomson et al., 2014), still little is known about how the use of audio–visual media can contribute to learning processes (Hobbs, 2006; McClusky, 1947; Schwartz & Hartman, 2007; Thomson et al., 2014). Prior research suggests that in the context of learning, film, and video are particularly suitable for raising pupils' interest in educational content and for learning in general (Wijnker et al., 2021). In the field of science and mathematics education, raising pupils' interest is one of the core foci of attention in curriculum innovation, because their motivation to learning science subjects is lagging behind other disciplines, in particular, in Western countries (OECD, 2016; Potvin & Hasni, 2014). Many educational innovations such as context- or inquiry-based teaching, and IT usage have been proposed as possible motivators, but intervention studies researching the qualities of specific tools are scarce (Schukajlow et al., 2017) and there is little systematic evidence for effectiveness (Savelsbergh et al., 2016). Video might help in remediating the problem of low pupils' interest, but only when made and used knowledgeably.

The scarcity of theory-grounded good practices of video usage in education inspired us to explore the practice of video usage in educational contexts (Wijnker et al., 2019), and to investigate the

mechanisms underlying films and videos that interest pupils. As part of that investigation, we gathered interest theories from different domains and integrated them in a model (Wijnker et al., 2021). We formulated a theoretical basis for our model from general interest theories (Blakemore & Vuilleumier, 2017; Frijda, 2007, 2009; Izard, 1977, 1992; Scherer, 2010; Silvia, 2005, 2006, 2008), and more specifically from interest theories in the field of educational psychology (Akkerman, 2017; Akkerman & Bakker, 2019; Hidi, 2006; Krapp, 1999; Patrick et al., 2011; Renninger & Hidi, 2016; Schiefele, 1991; Tobias, 1994), and from film studies (Bordwell, 1985; Bordwell et al., 2017; Tan, 1996, 2008, 2018; Tan & Visch, 2018). We named the model FIRM model (Film's Interest-Raising Mechanisms). In brief, the model describes how pupils' interest in the video, as a result of their appraisals of video characteristics influences the development of their interest in the educational content. Inspired by Game theory we subsequently added the appraisal of Absorption. The model and the appraisals are explained in the next section.

The aim of this study was to empirically validate the FIRM model's core mechanisms and to find leads for whether the appraisals in the model represent predictors for the development of pupils' interest in the video and its content.

In this article, we use the term *film* to refer to any kind of audio–visual medium that has a fixed course of development. This excludes, for example, games in which the pupil-players manipulate the course of events while playing. It includes any category of film, be it narrative (development of a fictional story), associational (development of connections and relations), categorical (development of categorization), or rhetorical (development of an argument) (Bordwell et al., 2017). It includes life action and animation. In education, teachers often use a short film clip rather than a complete fiction film or documentary, commonly referred to as a *video*. When discussing actual film material in our study we speak of videos, to distinguish it from the general theoretical notion of the film medium.

2 | THEORETICAL FRAMEWORK

Interest refers to a relationship that evolves between a subject and an object (Krapp, 1999; Wijnker et al., 2021). In the case of watching a video for educational purposes, the subject is the pupil-viewer and the object is the video with its educational content (and may be more specifically the general idea of the video, the approach of the topic, the imaging, the structure, etc.). This interesting relationship between a subject and an object is an emotional one (Frijda, 2009). Emotional relationships imply a subject's appraisal (judgment) of the object, which motivates specific actions (Scherer, 2010). With the emotion of interest, the subject's motivated action is to invest more effort on and attention to the object (Silvia, 2006), or—in an educational setting—the willingness to engage with the educational content (Renninger & Hidi, 2016). For as long as the subject is actively engaged with the object, interest might be regarded as a situational emotion, referred to as situational interest. It is assumed that repeated interested engagement may nurture a more sustained interest in the object as well (Renninger & Hidi, 2016).

We applied these theories to our focus on video in education, and formulated an elaborate model (FIRM model; Wijnker et al., 2021), of which the core components that we investigate in this study are presented in Figure 1. With this model, we aim to explain (top left arrow) how pupil-viewers' appraisals of a video determine their interest in the video and their willingness to engage with it and its content. Subsequently, if a video motivates the pupils to action (top right arrow), it may contribute to a more sustained interest in the video's educational content. Indirectly, pupils' positive video appraisals may contribute to their development of interest in the educational content (bottom arrow) via their interest in a video.

Interest theories from the domain of educational psychology and from film studies informed us about the nature of the appraisals that generally evoke interest with pupils and viewers, respectively. Both domains similarly describe a balance between a set of two appraisals: Pupils generally positively appraise learning objectives that they characterize as novel or complex, and yet comprehensible (Krapp, 1999; Silvia, 2008). Interested viewers generally positively appraise complex developments presented through film, and the rewarding closure of these developments (Tan, 1996, 2018). The sets of appraisals from the two domains similarly describe a balance between *challenge* (novelty and complexity; complex developments) and *coping potential* (comprehensibility; rewarding closure). The theories describe how interest only increases when these related characteristics are appraised positively, and when a balance between challenge and coping potential is experienced by the pupil-viewers.

In the next phase of our research project, we decided to add an insight from game theory to the FIRM model. Although like film studies, game theory focuses on audio–visual media, game players' interest develops quite differently from film viewers' interest. One of the most prominent differences between the two media regards the absence of a fixed discursive structure in games (Costikyan, 2000). Games typically engage players in a narrative *space*, rather than a *structure* like film does (Jenkins, 2004). In film, it is precisely this structure that is responsible for the build-up of the interest-raising challenge-coping potential balance (Tan, 1996). Interest theories in game studies do not describe such a balance, but are dominated by the single appraisal of absorption (immersion, transportation) (e.g., in relation to science education; Barab & Dede, 2007). We included absorption as an appraisal additional to the ones in the original FIRM model, resulting in a total of five appraisals.

2.1 | Hypotheses

The primary aim of our study was to assess the validity of the core components of the FIRM model through an empirical investigation of pupils' evaluation of videos in multiple classrooms. To meet this aim, we formulated the following hypotheses: 1. Pupils' appraisals of a video's characteristics predict the pupils' interest in the video (top left arrow in Figure 1); 2. Pupils' interest in the video predicts the development of pupils' interest in the educational content of the video (top right arrow in Figure 1); 3. Pupils' appraisals of a video's characteristics predict the pupils' development of interest in the educational content

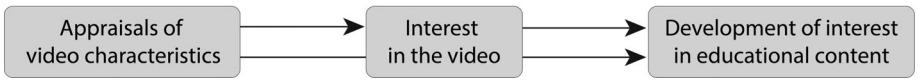

FIGURE 1 Simplified FIRM model, following Wijnker et al. (2021)

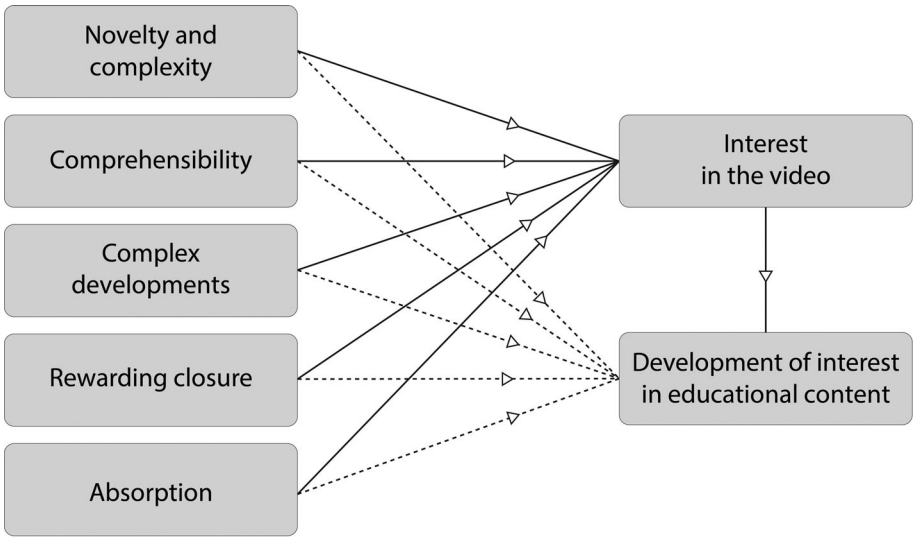

FIGURE 2 Illustration of the expected direct effects (solid lines) and indirect effects (dashed lines) between the variables as formulated in the hypotheses

of the video indirectly via their interest in the video (bottom arrow in Figure 1).

We reformulated our hypotheses into measurable terms of direct, indirect, and total effects. A direct effect is an effect measured from one variable on the other. An indirect effect is measured from one variable, via a second *mediating* variable, on a third one. The product of the direct effect of the first variable on the second and the second variable on the third, added to the indirect effect of the first variable on the third one, makes up the total effect of the first variable on the third one. This reformulation resulted in four new hypotheses:

1. There are significant direct effects from the pupils' appraisals of the video on their interest in the video (see Figure 2, solid lines running from left to right);
2. There is a significant direct effect from the pupils' interest in the video on their development of interest in the educational content (see Figure 2, solid line running from top to bottom);
3. There are significant indirect effects from the pupils' appraisals of the videos on their development of interest in the educational content via their interest in the video as a mediator (see Figure 2, dashed lines);
4. There are significant total effects from the pupils' appraisals of the video on their development of interest in the educational content (calculated from direct and indirect effects).

This empirical investigation allowed us to identify whether the key appraisals we found in film theory, educational psychology, and game theory represent significant predictors for pupils' interests.

3 | METHODS

In this study, three science videos and one mathematics video were evaluated in six classrooms (one video per classroom). We measured the pupils' appraisals for the videos, their interest in the videos, and their development of interest in the educational content. We used a pre- and post-viewing questionnaire to measure change.

3.1 | Participants

Four science and mathematics teachers (aged 33–59) from four different secondary pre-university schools in the Netherlands who showed interest in evaluating the use of videos in their educational practice took part in our study. We evaluated the video use in six classes that consisted of 12th-grade pre-university pupils (aged 16–18). In total, 151 pupils participated in the study of whom 60.3% were female. Data from the seventh class from a fifth teacher was omitted from the study due to irregularities in the procedure (see below).

3.2 | Procedure and design

A protocol was formulated to ensure that videos were introduced in the same way in each classroom. To judge treatment fidelity, the first author attended all lessons. The first author introduced herself to the class and explained the purpose of the research as an inquiry into how viewer interest develops while watching a video. The teacher introduced the video, taking into account the researchers' instruction not to make any remarks to direct the pupils' attention while watching the video, and not to interrupt the video or to speak while the pupils were watching. The pupils filled in the pre-viewing questionnaire after the teacher's introduction of the video, just before watching the video in a plenary setting. Directly after watching the video the post-viewing questionnaire was filled in by the pupils. After that, the teacher continued the lesson as usual. The treatment was implemented as intended in six classes. In the seventh class, the teacher did not start

the video right after the pre-viewing questionnaire was filled in but presented an application first. The data from this class was therefore omitted from the study.

3.3 | Videos

All teachers selected one video they had planned to use in September–October 2019 to increase their pupils' interest in the content of the lesson (see Table 1). The videos were proposed by the teachers themselves, to match their curriculum during the period in which data collection took place. By having the teachers select the videos, we tried to minimize our interference with the natural course of video usage in a classroom setting, and to safeguard the representative design of this study as much as possible (Araujo et al., 2007). Only videos were included that the teachers selected with the aim to increase their pupils' interests for learning. The length of the videos was limited to 12 min to minimize diversity in interest development over the different videos due to the time spent on watching. Furthermore, the videos had to be suitable for use without the teacher making any remarks to direct the pupils' attention while watching the video, because this is assumed to interfere with the pupils' course of interest development (Wijnker et al., 2021). All teachers selected a video they had used before, so they were familiar with the content and were confident it matched the topic of the lesson. In this study, we use the term *video case* for each video used in one or multiple classrooms.

3.4 | Pupil questionnaires

We used a pre- and post-viewing questionnaire to measure pupils' interest in the educational content prior to and directly after watching the video. The procedure we used to define that content was as follows: We asked the teachers to describe (a) the topic of the entire course, (b) the topic of the lesson in which the video was to be used, and (c) the topic of the video. In consultation with the teacher, the researcher formulated a description of the educational content in the questionnaires that would be close to the topic of the lesson (b), but keeping in mind the broader topic of the course (c) and the more specific topic of the video (a). In this way, we tried to keep the description of the content specific and relatable to the video, and at the same time clearly connected to the broader educational content of the course. For example, in the biology course about *DNA and protein synthesis* (a), to introduce the lesson about *Cell processes* (b) the teacher used a video about *Life inside the cell* (c). The description of the educational content we used in the questionnaire was *DNA and processes in the cell*.

The pre-viewing questionnaire consisted of five statements to measure the pupils' interest in the educational content that was taken from validated questionnaires to measure situational interest (Rotgans & Schmidt, 2014). The statements of their situational interest questionnaire (SIQ) were designed to identify change in interest levels and therefore match the aim of our study. The items that were most fit to measure the pupils' interest in the educational content were: "I think [the educational content] is interesting," "I want to know more about [the educational content]," "I enjoy working on [the educational content]," "I expect to master [the educational content] well," and "I am fully focused on this topic, I am not distracted by other things." For each video case, we adjusted the statements to fit the educational content of the video, lesson, and course.

The post-viewing questionnaire started with the statement: "The video I just saw was interesting" to measure the pupils' interest in the video. Next, the questionnaire measured the pupils' appraisals of the videos' characteristics from the FIRM model. The items used are represented in Table 2. It concluded with the same items as in the pre-viewing questionnaire to measure change in the pupils' interest in the educational content.

The questionnaires were handed out in class on paper. The items of the questionnaires were accompanied by a 10 cm Visual Analog Scale (VAS) ranging from *Totally not true* to *Completely true*. The center of the VAS was indicated with a small gap in the 10 cm line. Still images of the video were placed above the items measuring the appraisals in the post-viewing questionnaire to stimulate the pupils' recall of the video. The pupils' marks on the 10 cm VAS lines were transcoded into one decimal numbers (0.0–10.0).

4 | STATISTICAL ANALYSIS

4.1 | Data preparation

To examine the degree of dependence within the classes we calculated the intraclass correlation coefficient (ICC) for interest at pre-test

TABLE 2 Items in the questionnaire

Statement	Appraisal
I saw, heard or learned something new	Novelty and complexity
I was well able to follow the video	Comprehensibility
I wanted to continue watching the video	Complex developments
The video felt like a whole	Rewarding closure
While watching I felt engaged in the video	Absorption

TABLE 1 Videos used in the study

Video case	Video title	Duration (min:s)	Discipline	No. of classes	No. of students
1	The inner life of the cell	3:12	Biology	2	51
2	Bubble boy	2:07	Biology	1	31
3	Ehrlich's magic bullet: selective staining	3:03	Chemistry	2	43
4	The Brachistochrone	10:34	Mathematics	1	26

using the statistical program Mplus version 8.3 (Muthén & Muthén, 1998–2018). The ICC was 0.09 for the mean measure of interest in the educational content, meaning that 9% of the observed variance in pupils' mean interest scores is due to systematic between-classroom differences compared to the total variance in mean interest scores. This very low ICC value makes it acceptable to believe that the data was not nested within the classes.

We detected two extreme outliers (Q3: more than three box lengths from the hinge) in the measures for all cases taken together using box plotting in SPSS version 26. We compared all values belonging to the pupils that showed the extreme outliers to the other pupils and found strongly deviating values for most of their reports, indicating that they diverge a great deal from the average pupil. We decided to remove them from the dataset.

Within the complete dataset, we missed out on data from two pupils in two different cases in the post-viewing questionnaire for the items measuring Interest in the educational content. Full information maximum likelihood estimation (FIML) in Mplus was used to fill these missing values.

With SPSS, we calculated Cronbach's alpha for the results of the five measures of Interest in the educational content in the pre- and post-viewing questionnaires of all video cases taken together to evaluate their reliability as measures for this variable. Both indicated the internal consistency was high ($\alpha_{pre} = .84$, $\alpha_{post} = .85$).

4.2 | Data analysis

To test our hypotheses, in Mplus we path modeled the five appraisals as independent variables, and interest in the video and development of interest in the educational content both as dependent variables. Given the presumed interaction between appraisals in the interest theories, the appraisals cannot be accounted as unrelated defining factors. This relatedness was confirmed by the high and significant correlations between the appraisal variables we found in our empirical data (see Table 4 in Section 4). To account for these correlations, we ran the SEM analysis in Mplus for each appraisal separately. We thus set up five different path models: M1 for Novelty and complexity (see Figure 3), M2 for comprehensibility, M3 for complex developments, M4 for rewarding closure, and M5 for absorption.

5 | RESULTS

5.1 | Descriptive analysis

Per video case and for all video cases together, the means and standard deviations of the pupils' interest in the videos were calculated, as well as the mean change in the pupils' interest in the educational content (see Table 3). Over all video cases the pupils rated their interest in the videos at 5.7 ($SD = 0.2$) points, and their mean interest in the content increased with 0.4 ($SD = 0.1$) points. The overall correlation between Interest in the video and development of interest in the educational content is 0.45 ($p < .001$).

5.2 | Model fit

The calculated correlation matrix of the variables measured in the current study is presented in Table 4. The analysis of the values

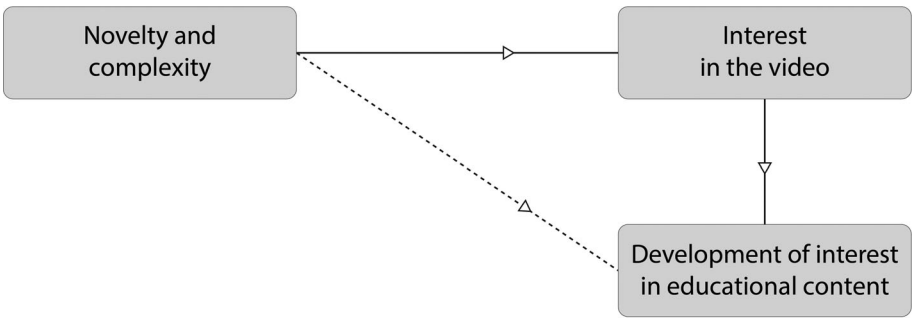

FIGURE 3 Illustration of the expected direct effects (solid lines) and indirect effect (dashed line) in path model 1 (M1), between the independent appraisal variable Novelty and complexity, the mediating dependent variable Interest in the video, and the dependent variable Development of interest in the educational content

TABLE 3 Pupils' interest in the videos and the educational content

Video case	Mean pre-interest in educational content (*SD*)	Mean post-interest in educational content (*SD*)	I. Mean Δ pre-post interest in educational content (*SD*)	II. Mean interest in the video (*SD*)	*r* between I and II	*p* (one-tailed)
1	5.5 (0.2)	5.8 (0.2)	0.3 (0.1)	5.8 (0.3)	0.50	.000
2	5.8 (0.3)	6.0 (0.3)	0.2 (0.1)	5.5 (0.4)	0.49	.003
3	5.2 (0.3)	5.5 (0.3)	0.3 (0.1)	4.8 (0.4)	0.34	.014
4	4.2 (0.4)	5.1 (0.4)	1.0 (0.2)	7.4 (0.3)	0.32	.058
All	5.3 (0.1)	5.6 (0.1)	0.4 (0.1)	5.7 (0.2)	0.45	.000

Note: Pearson's *r* was used.

showed that all the correlations are in the expected direction (all correlations are positive and significant). The highest correlations were found between interest in the video and development of interest in the educational content, interest in the video, and the appraisal of complex developments, interest in the video and the appraisal of absorption, and between the appraisals of complex developments and absorption. The model fit for each of the five path models is presented in Table 5.

5.3 | Hypotheses testing

The aim of our study was to test the validity of the core components of the FIRM model through empirical investigation of multiple videos in actual classrooms. To meet this aim, we set up four hypotheses.

Concerning hypothesis 1, all found estimated effects are significant, indicating that the pupils' appraisals of the video characteristics do indeed predict the pupils' interest in the video (see Figure 4). With

TABLE 4 Correlation matrix of all variables

Variable	Mean (*SD*)	1	2	3	4	5	6	7
1. Interest development	0.4 (0.1)	—						
2. Interest in the video	5.7 (0.2)	0.45	—					
3. Novelty and complexity	5.3 (0.2)	0.40	0.35	—				
4. Comprehensibility	5.5 (0.2)	0.21	0.45	0.20	—			
5. Complex developments	5.2 (0.2)	0.41	0.74	0.32	0.43	—		
6. Rewarding closure	5.8 (0.2)	0.30	0.27	0.23	0.38	0.37	—	
7. Absorption	4.9 (0.2)	0.38	0.71	0.35	0.35	0.74	0.27	—

Note: $p < .001$ for all correlation (standardized, one-tailed). Pearson's r was used.

TABLE 5 Model fit for the five path models

	Interest in the video		Development of interest in the educational content	
Path model	R^2	*p* (one-tailed)	R^2	*p* (one-tailed)
M1 Novelty and complexity	0.12	0.009	0.27	.000
M2 Comprehensibility	0.21	0.001	0.21	.000
M3 Complex developments	0.54	0.000	0.22	.000
M4 Rewarding closure	0.07	0.058	0.24	.000
M5 Absorption	0.51	0.000	0.21	.000

Note: All path models were saturated with RMSEA = 0, CFI = 1, chi-square $p = .000$, SRMR = 0.000.

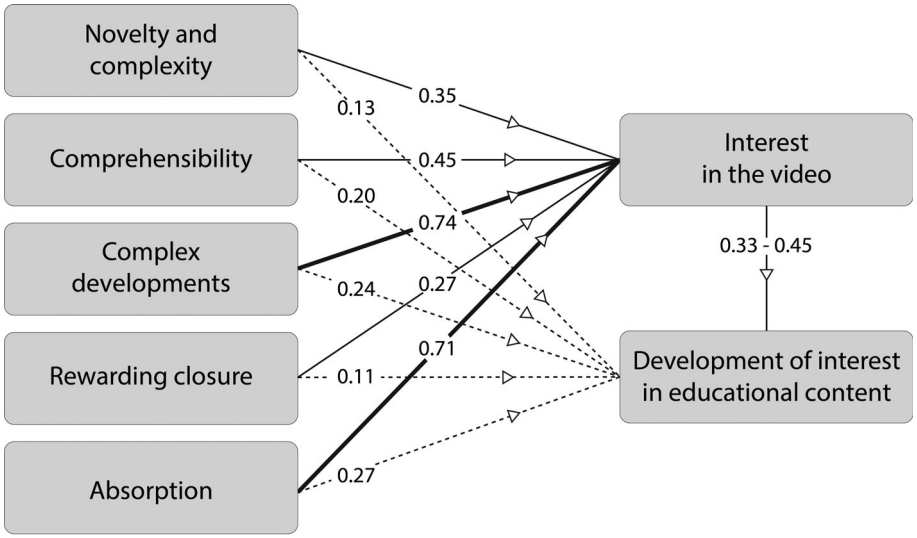

FIGURE 4 Estimated regression values of direct effects (solid lines) and indirect effects (dashed lines) in the hypothesized path models. *Note*: $p < .001$ for all regression values (one-tailed)

regard to hypothesis 2, all found estimate effects are significant, indicating that the pupils' interest in the video does indeed predict the development of pupils' interest in the educational content. With regard to hypotheses 3 and 4, for the five path models, the estimated total effects from the appraisals on the development of interest in the educational content ranges between 0.22 and 0.41. Again, all found estimate effects are significant, indicating that the pupils' appraisals of video characteristics do indeed predict the pupils' development of interest in the educational content indirectly via their interest in the video.

6 | CONCLUSION AND DISCUSSION

The lack of insight into the mechanisms underlying pupils' interest development with the use of audio–visual media such as film and video inspired us to set up the FIRM model that describes the mechanisms underlying the interest-raising potential of film and video. The aim of this study was to test the validity of the core components of that model. The FIRM model was drawn from interest theories stemming from the field of film studies, educational psychology, and game theory. It describes pupil-viewers' appraisals of videos viewed in an educational context: novelty and complexity and comprehensibility, complex developments and rewarding closure, and absorption. When positively appraised by the pupils, the pupils get interested in the video which stimulates the pupils to further engage with the educational content that the video entails: their interest in the content is raised.

The empirical data gathered for this study and analyzed in this article indeed supports the validity of the core components of the FIRM model. Regarding our first hypothesis, from the results, we conclude that there were significant effects from the pupils' appraisals of the videos on their interest in the videos. Our exploration of the data in the descriptive analysis also showed indications for a confirmation of an interaction effect between the appraisals that are paired in the theories from educational psychology and film studies, on the pupils' interest in the video.

Regarding our second hypothesis, we found a significant effect from the pupils' interest in the video on their development of interest in the educational content. In our descriptive analysis, we also found a significant correlation between the pupils' interest in the videos and their development of interest in the educational content. Similar video ratings (video cases 1–3) were associated with similar results for interest development. The highest rating for interest in the video (video case 4) was associated with a larger interest development than the lower ratings for interest in the video (video cases 1–3; see Table 3). These results confirm our belief that the FIRM model properly describes the mechanisms underlying videos that help to raise the interest of pupils for educational content, which motivates them to further engage in this content.

Regarding our third and fourth hypotheses, we found significant effects from the pupils' appraisals of the videos on their development of interest in the educational content.

The results of our inquiry showed a strong correlation between the appraisals of absorption and complex developments, and they similarly correlate to the pupils' interest in the video. These outcomes allow for at least two different interpretation: First, a video's absorbing power and its complex developments are mutually strengthening film characteristics that have a similar effect on the pupils' interest in a video. Secondly, the items in the questionnaire were measuring the same thing. More research is needed to find out how the appraisal of absorption relates to the appraisal of complex developments in film viewing.

The uncertainty about what the items for absorption and complex developments in the questionnaire actually measured forms a first limitation of our study. Other than the items we used for measuring situational interest, we do not know of validated questionnaires to measure specific appraisals. We tried to stay close to the interest theories that lie at the heart of the FIRM model to formulate the statements for our questionnaires. A future study that validates questionnaires to inquire appraisals would be more than welcome. A second limitation is the scale of the study's set-up with a limited number of videos and pupils. A final limitation is that we were unable to test all components that play a role in the mechanisms described in the original FIRM model, which is more elaborated. A prominent missing component in our analysis is the motivated action while watching the video that is directed towards the video's proceedings, rather than after watching and directed towards the educational content. Measuring motivated action towards the video's proceedings implies a constant measure while watching. It is extremely challenging to gather such data without brutally interrupting the flow of the viewing process. There are some promising examples of studies using real-time tracking for example with facial expressions (Tan, 2014) or press buttons (Cañas-Bajo et al., 2019) as measures that might be useful in future research on the FIRM model.

In sum, we believe that the empirical data gathered in this study gives grounds to validate the FIRM model of mechanisms that underlie interest-raising videos in learning contexts. In the practice of making videos for educational use, this could be a starting point to formulate the guidelines teachers and film makers are now missing out on. The results of our study indicate that a video watched in the context of learning is most likely to be found interesting when the video's structural development is complex, yet provides for a rewarding closure; if the content is novel and complex, yet making the pupils feel capable of coping with that novelty and complexity; and if the video is absorbing. The pupils' appraisals of the video are likely to be good predictors of their development of interest in the educational content. Future research is needed to support these possible implications.

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CONFLICT OF INTEREST

There is no conflict of interest.

PEER REVIEW

The peer review history for this article is available at https://publons.com/publon/10.1002/hbe2.314.

DATA AVAILABILITY STATEMENT

The data of our project is in the process of being made permanently accessible through the Data Archiving and Networked Services (DANS) of the joint institute of the Royal Netherlands Academy of Arts and Sciences (KNAW) and the Netherlands Organisation for Scientific Research (NWO), at https://dans.knaw.nl/en. All co-authors had complete access to data supporting the manuscript. Pupil data collection and handling was complied with local ethical guidelines regarding collection and storage of data involving human subjects. The pupil data was anonymized after data collection, and all data was stored on a secured server behind a password.

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