BABEȘ-BOLYAI UNIVERSITY
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PHD THESIS ABSTRACT

THE USE OF FILMS IN TEACHING SCIENCE IN PRIMARY SCHOOL EDUCATION

Author: PhD Student *Doroșin Ana-Simona* (current name: *Ilie*)
PhD Supervisor: Prof. Dr. *Maria-Eliza Dulamă*

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DECLARATION OF ACADEMIC INTEGRITY

I, the undersigned, Ilie Ana-Simona, a PhD student at Babeș-Bolyai University, hereby declare the following:

• The doctoral thesis entitled *"The Use of Films in Teaching Science in Primary School Education"* was developed in strict compliance with the four fundamental principles of academic integrity: honesty, responsibility, replicability, and validity of knowledge**.**

• The similarity check was carried out within the Doctoral School "Didactics. Tradition, Development, Innovation", using the Turnitin platform and the report generated by it.

• The thesis complies with the formatting requirements of the APA Publication Manual (7th edition), except for the 1.5 line spacing.

• All published studies are related to the research topic and have been properly cited in the thesis.

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LIST OF ABBREVIATIONS AND ACRONYMS

A — Activity
APA — American Psychological Association
GE — Experimental Group
GL — Working Group
GDPR — General Data Protection Regulation
M — Mean
Ma — Mean (Animated Films)
Mf — Mean (Films)
p. — Page
pp. — Pages
PÎP — Primary School Teachers
ICT — Information and Communication Technology
vs. — Versus

Keywords: film, instructional models, science, primary education

CHAPTER I. INTRODUCTION

1.1. Premises of the Research

Our research aims, on the one hand, to capitalize on the digital competences and the adaptation of Primary School Teachers (PÎP) and pupils to technological progress, to the volume and diversity of multimedia resources available in the digital space, and, on the other hand, to respond to certain expectations or needs of PÎP, of other teachers and of pupils:

(1) the need to know the most effective ways of integrating films into the learning process in science, as a facilitating tool for pupils' understanding and acquisition of knowledge;

(2) the need to know instructional models in which technology and films are used, suitable for digital natives, which facilitate scientific knowledge, the development of science-specific competences, of scientific research competences and digital competences, as well as their use in other educational contexts.

1.2. Concepts and Classifications Related to Films

Concept of Film

The concept of film has multiple meanings: art genre, cinematographic creation, filmstrip, educational medium or celluloid tape. In the artistic sense, it designates a cinematographic creation intended for projection on the screen, and as a material it refers to the photosensitive film used for recording and reproducing images and sounds (Academia Română, 2016). At present, the term covers not only works on film but also productions transferred to electronic media, video works, TV programs and video games (Turkovic, 2021b). Although the correct term is "audiovisual work," the colloquial use of the word "film" continues to be dominant. In the English-speaking world, the concept is rendered by various terms such as film, movie, moving picture, picture show, and the specialized literature distinguishes between the meaning of "to film," "cinematographic work," and "photographic film" (Pricop, 2006). In Romania, as well as internationally, derived terms such as video clip, videocast or video podcast are used. The video clip is a short audio-visual file, obtained by capturing real-life events, and is characterized by the faithful rendering of visual information (Lowe & Schnotz, 2014; Ploetzner & Lowe, 2012). Internet videos are multimodal artifacts, combining images, speech, gestures and text (Salmerón et al., 2020).

The videocast, respectively the video podcast, represents forms of digital broadcasting, intended for online access and downloading on various devices (Baciu et al., 2022b). These terms are not yet included in Romanian explanatory dictionaries, but they are increasingly used in educational and media environments.

Perspectives on the Concept of Film

The film has multiple functions and meanings in educational sciences and in the socio-cultural field. As an educational medium, it is included in the category of dynamic audiovisual means, having a substitution role and illustrating information through moving images. Over time, it has been classified into various categories depending on sound, pedagogical function or the dynamic character of images (Crețu & Ionescu, 1982; Bontaș, 1995; Ionescu, 2000).

Cinematic genres are classified into several types: feature film, documentary, scientific-educational film, propaganda film, animated film, experimental film, and video games (Turković, 2006). The feature film, an imaginary and communicable artistic work, is based on a convincing narrative idea and seeks credibility rather than veracity. It includes numerous subgenres such as comedy, western, melodrama, adventure film and science fiction. The documentary, by contrast, has as its fundamental principle veracity, faithfully illustrating reality and offering cognitive and educational value. It appears in multiple forms-animated documentary, docudrama, ethnographic, observational, travel, nature, or digital storytelling-having roles of informing, educating, raising awareness and even influencing behaviors. Scientific and educational films complement this range. They are conceived with the support of specialized consultants, in order to support the instructional-educational process, to convey rigorous information in an attractive manner and to stimulate motivation, creativity and pupils' critical thinking.

In addition to these categories, the propaganda film aims to influence public attitudes and opinions, having an educational or narrative structure, depending on its purpose. Animated videos, as visual or multimodal representations, do not faithfully reproduce reality, but select and abstract it, being used both in entertainment and in education. Experimental films explore non-narrative forms and re-evaluate cinematic conventions, constituting alternatives to traditional cinematography. Video games, including 3D ones, integrate fictional narratives and discursive-educational interactions, having informative and formative potential. Comparatively, the documentary focuses on informing the audience, the feature film on emotion and entertainment,

and the educational film on instruction. They differ in budget, content, relationship to reality, type of actors and the way the script is written.

The classification of films according to discursive and observational characteristics highlights a great diversity of cinematographic forms. Turković (2006) proposes distinctions between artistic and non-artistic films, between auteur and commercial films, between engaged and non-engaged films, and between art film, which are addressed to an educated audience, and entertaining film, designed for mass entertainment. Films can also be differentiated according to technology (silent/sound, black-and-white/color, 2D/3D, analog/digital), the way movement is represented (live-action filming or animation), storage medium (film, CD, DVD, internet) or modes of distribution (cinema, television, online platforms). These technical and media criteria combine with thematic (children's, historical, war, religious, political), stylistic (humorous, tragic, sentimental, realistic or unrealistic) and cinematographic (commercial/non-commercial, populist/elitist, television/cinematic, state/independent) ones, confirming the polyvalent and flexible nature of the cinematographic phenomenon.

In conclusion, the multitude of classification criteria allows a film to be included in several categories simultaneously, depending on its characteristics. From the perspective of science education, the most appropriate remain educational and documentary films, due to their informative and cognitive role, but also some videos made by professionals or amateurs can support learning by illustrating experiments, processes and practical activities. Both teachers and pupils must be familiar with the essential characteristics of the films used to prevent the transmission and acquisition of scientifically inaccurate concepts or procedures.

1.3. Theories Regarding Learning through Film Viewing

In our research, we are interested in how learning occurs through watching or making films. In psychology, learning is considered an internal cognitive process, specific to an individual (Côté, 1987). It takes place within the cognitive system (Castro-Alonso, 2013), typically in the context of an exercise or experience, through which the person acquires knowledge or skills, forms attitudes, or changes behavior (Côté, 1987).

When watching a film, the pupil receives images and sounds, which are then processed and stored in long-term memory [LTM]. The way visual dynamic information is mentally processed is explained in numerous theories, from the perspective of: motivation-the theory of motivation

(Bandhu et al., 2024); the self-determination theory of motivation (Sheldon et al., 2003; Gagné & Deci, 2005); the social cognitive theory of motivation (Bandura, 2005); attention-the theory of attentional coherence (Pylyshyn & Storm, 1988); reactive theory (Singer, 1980; Seels et al., 2013); active theory (Anderson & Lorch, 1983; Watt & Welch, 1983; Rice et al., 1983); cognitive processing-the cognitive load theory (Sweller et al., 1998); the cognitive theory of multimedia learning (Mayer, 1997; Schnotz, 2005); schema theory (Miller, 1956; Thorndyke & Hayes Roth, 1979); memory-the dual coding theory (Paivio, 1986); the working memory theory (Baddeley, 1986); theories related to viewing and geovisualization (MacEachren & Ganter, 1990); theories regarding the effects of viewing (Seels et al., 2013); the theory of cognitive development (Vygotsky, 2012); theories related to the approach to learning and teaching through cognitive scaffolding (Wood et al., 1976; Devolder et al., 2012).

1.4. Critical Analysis of the Specialized Literature on the Thesis Topic

To understand the state of research carried out worldwide regarding the use of films in science learning in primary education, we analyzed studies focusing on several aspects: the opinions of current and future teachers on the use of films; pupils' opinions on watching films, the effects of watching videos on pupils' knowledge and inferences in science, and the effects of pupils creating their own films.

Research on Teachers' and Future Teachers' Opinions Regarding the Use of Films

The study of the literature at the global level shows interest in knowing the opinions of teachers from various scientific fields (science, social studies), of future science teachers, and of future Primary School Teachers (PÎP) regarding the use of films in the teaching process. Among the 24 studies addressing this subject, no opinions of PÎP from other countries were identified, only the opinions of future PÎP, compared with those of future science teachers (Izgi, 2017) or with those of science teachers (Çinar & Kurt, 2019). The greatest interest in knowing teachers' and future teachers' opinions about the use of films and their effects in education is shown by researchers from Turkey in 15 studies conducted after 2011.

In Romania, there is an interest in knowing PÎP opinions mainly about digital textbooks and their use (Magdaș & Drîngu, 2016; Magdaș et al., 2017), while information about the use of films is collected secondarily, in studies related to multimedia activities in digital textbooks (Buzilă et al., 2017; Ilovan et al., 2018).

Research on Pupils' Opinions Regarding Film Viewing

Worldwide, three studies were identified on the use of films involving pupils from the fifth grade in Turkey (Topal et al., 2020), eighth-grade pupils in the U.S.A. (Barnett et al., 2006) and Turkey (Seçkin Kapucu et al., 2016). The results of these studies show the effects of science fiction films on pupils' ideas and understanding of scientific concepts (Barnett et al., 2006), the contribution of documentary films to improving pupils' opinions about the nature of science (Seçkin Kapucu et al., 2016), better understanding, more detailed explanation of the subject, more efficient and relevant learning, and the memorization of educational films for several years (Topal et al., 2020).

In Romania, the study conducted in 2024 by Rus & Negru (2025), which involved 552 pupils from third and fourth grades, focused on their media consumption and shows a high interest in the virtual space. 60% of the surveyed pupils stated that they use the internet daily for one hour (22%) or two hours (30%). Most pupils use two social networks that distribute films (YouTube-80% of pupils; TikTok-38% of pupils). Almost half of the pupils watch posts made by others (videos, images), and only a tenth (13.2%) post content (videos, memes, photos, text) (Rus & Negru, 2025). The studies show the interest of Romanian pupils from Generation Alpha in ICT and high media consumption, but they provide little data about watching and making films for educational purposes.

The analysis of these studies shows that, globally, there is very little interest in studying primary school pupils' opinions about watching films and making their own films. The aim of our study is to investigate the practices and opinions of primary school pupils about watching films and making their own films.

Research on the Effects of Watching Videos on Primary School Pupils' Knowledge and Inferences in Science

Worldwide, there are not many studies on the use of films in education. We identified only six studies involving pupils aged 7-12 from various countries: Germany (Beuscher et al., 2005; Michel et al., 2007), Nigeria (Isiaka, 2007), Malaysia (Aziz et al., 2011), Spain (Salmerón et al., 2020), and Indonesia (Koto, 2020). At the national level, three studies we conducted stand out regarding the use of films in primary education in science (Ilie & Cristea, 2020a; Ilie et al., 2023a; Ilie et al., 2020b).

Research on the Effects of Making Films

In the studies identified worldwide, pupils aged 7-13 created various audiovisual products. Among these are: editing a 3-minute short film based on a 40-minute film presenting a lesson on experiments with light and shadows, in which they had participated (Valkanova & Watts, 2007); creating materials to teach parents about the digestive system by filming activities with a smartphone (Toh et al., 2012); filming aspects of people's daily lives (Meager, 2017); creating explanatory videos for mathematics activities (Kuzu & Ratzke, 2024); producing films about themselves (Posner et al., 1997).

Pupils made these films with various purposes: conceiving the script and making the film using software (Posner et al., 1997); selecting, explaining experiments and editing a film using a specific application (QuickTime 5) (Valkanova & Watts, 2007); filming parents with a smartphone (Toh et al., 2012); filming aspects of reality with a video camera (Meager, 2017); making explanatory videos using a storyboard template (Kuzu & Ratzke, 2024). Only one study investigated the effect of film editing on pupils' knowledge in science (movement of light sources, shadows of objects and their effects) (Valkanova & Watts, 2007).

In Romania, no research has been conducted on the creation of films by primary school pupils, but only on film-making by teachers and students (Dulamă et al., 2019; Dulamă et al., 2020a; Dulamă et al., 2020b).

The study of the literature at the national and international level shows little interest in researching the process of film-making by primary school pupils, in a context in which ICT is developing rapidly and Generation Alpha makes extensive use of technology and possesses digital competences. Our study is designed based on the premise that primary school pupils in Romania have the necessary technology (smartphone, laptop) to watch and create certain films, have the competence required to use technology for various purposes, and are interested in watching and making films.

1.5. Relevance of the Research

The relevance of the research lies in the fact that the studies carried out complement and extend the international and national literature regarding the use of film in teaching science in primary education.

Study 1 makes a major contribution by investigating the opinions of primary school teachers

(PÎP) about the selection, preparation, and use of films, compared to the opinions of PÎP about the selection, preparation, and use of animated videos. Worldwide, research has focused mainly on teachers from lower and upper secondary education, as well as on future science teachers. Therefore, this study fills a gap identified in the existing literature. It extends the analysis to other categories of films and facilitates a comparison between how animations and films in general are perceived, considering the sources used, teaching methods, pedagogical purposes, and the perceived effects on pupils.

Study 2 justifies its relevance through its focus on the opinions of primary school pupils, a category almost absent from the international and national literature. While in Turkey or the USA there are a few targeted studies, in Romania there are no investigations dedicated to pupils' perceptions of films. Our study, based on semi-structured interviews, written answers, and follow-ups through WhatsApp/phone, offers an overview of pupils' preferences regarding the categories of films watched and made, their motivations, perceived benefits, and ways of relating to media content. These data are essential for designing relevant teaching activities that respond to the needs and interests of Generation Alpha.

The contribution of Study 3 to the specialized literature lies in the analysis of the comparative effects of watching videos, observing photographs, and listening to texts on pupils' knowledge and inference abilities. Worldwide, there are only a few experimental studies, and replicating them in Romania was difficult due to the lack of access to the materials used. Therefore, our research, conducted with Romanian pupils, directly tests the impact of videos in concrete teaching contexts (discovery learning, "flipped classroom"), highlighting both benefits (increase in knowledge volume, pupils' motivation) and limitations (conceptual misunderstandings in the absence of explanations or oral text).

Study 4 is relevant through its exploration of the effects of film-making by pupils, a field almost nonexistent in the specialized literature at the primary level. The comparative analysis between activities carried out with and without guidance brings new data about the teacher's role in facilitating planning, observation, and learning processes. The study demonstrates that pupils possess digital competences and can transform online time into educational resources, developing multiple competences (digital, cognitive, organizational, and communication). In addition, the research provides models of good practice (guides, worksheets, assessment grids) that can be replicated and adapted in other educational contexts.

Overall, the four studies are relevant because they use original instruments (questionnaires, interview guides, pre- and post-tests, worksheets), explore in a complementary way the opinions of teachers and pupils, and test hypotheses through quasi-experimental research. These investigations, due to their innovative nature and practical applicability, contribute to the theoretical and methodological foundation for using film in teaching science in primary education and provide valuable benchmarks for teachers, researchers, and educational policymakers interested in optimizing the learning process.

CHAPTER II. OBJECTIVES AND GENERAL METHODOLOGY OF THE RESEARCH

2.1. Research Objectives

2.1.1. General Objectives

The purpose of this thesis is to investigate the preparation and use of films in science learning in primary education in Romania from three perspectives: theoretical, methodological, and practical.

To achieve this purpose, the research aims at four main objectives:

(1) to investigate the opinions of primary school teachers (PÎP) regarding the selection, processing, and use of films in science lessons in primary education, compared to the selection, processing, and use of animated films in science learning;

(2) to investigate the practices and opinions of primary school pupils regarding film viewing and the creation of their own films;

(3) to investigate the effects of viewing films on the acquisition of knowledge in natural sciences by primary school pupils;

(4) to investigate the effects of making films on the acquisition of knowledge in natural sciences by primary school pupils.

2.1.2. Specific Objectives

General Objective no. 1 is achieved through our first study, in which the opinions of PÎP are collected and analyzed regarding the selection, processing, and use of films in science lessons in primary education, and compared with the opinions of PÎP on the selection, processing, and use of animated films in science learning in primary education. The aim is to compare the opinions of PÎP about the factors that influence their decisions regarding the selection, processing, and use of films in science learning.

General Objective no. 2 is achieved in the second study, which collects data on the practices and opinions of primary school pupils about watching and making films. The study focuses on five main practical aspects: the types of films watched, their sources, the timing and duration of viewing, the partners with whom pupils discuss the films, and the way they make their own productions. It also aims to identify pupils' perceptions regarding the motivations and benefits of

watching films.

General Objective no. 3 is achieved through the third study, which aims to investigate the effects of watching films on the knowledge and inferences made by primary school pupils, in comparison, on the one hand, with the effects of observing photographs (film stills) and listening to the text of the same film, and, on the other hand, with the effects of listening to the text of the same film.

General Objective no. 4 is achieved through the fourth study, which aims to investigate the effects of film-making by primary school pupils, with or without the help of a guide provided by the PÎP, on the volume and stability of pupils' knowledge in the subject "Natural Sciences." It also seeks to compare the effects of film-making by primary school pupils with the effects of reading a text on the same topic and to compare the effects of using a guide and the absence of such a guide on the content of the films.

2.2. General Methodology

The thesis brings together four complementary studies: a quantitative study conducted through a questionnaire survey (opinions of PÎP on the selection, processing, and use of films in science), a qualitative study using semi-structured interviews (practices and opinions of 4th-grade pupils regarding watching/making films), and two quasi-experimental studies (the effects of watching/re-watching videos vs. photographs and text; the effects of film-making by pupils with/without a guide).

CHAPTER III. ORIGINAL RESEARCH CONTRIBUTIONS

3.1. Study 1: Primary School Teachers' Opinions on the Use of Films and Animated Videos in Science Lessons. A Comparative Study

3.1.1. Introduction

The review of the international literature shows an interest in understanding the opinions of teachers from various scientific fields (science, social studies), of future science teachers, and of future primary school teachers (PÎP) regarding the use of films in the educational process.

In our research, we aim to answer the following research questions:

1. What are the factors that influence the processing of films by PÎP for use in science lessons?
2. What are the factors that influence the selection of films by PÎP for use in science lessons?
3. What are the factors that influence the way films are used by PÎP in science lessons?

3.1.2. Method

Participants

The selection of PÎP for participation in the survey was based on two criteria: (a) being a PÎP; (b) being employed as a teacher in the education system. A total of 102 PÎP with different characteristics (gender, age, educational level, teaching experience, teaching degree, environment) participated in this research.

Data Collection

Data were collected through a survey using a questionnaire adapted from the one created and used by Vereș (2024) regarding the selection, processing, and use of animated films in primary education. The questionnaire, created in Google Forms, was administered online in September and October 2022.

Instrument

The questionnaire includes three sections, correlated with the purpose and research questions. The first section, "Information regarding the selection and processing of films for teaching activity", has 53 items associated with eight factors: "source of films; internet and technology; characteristics of the film; teacher's goals and motivations; teacher's competence; school

subject; learning content; pupils' characteristics" (Vereș, 2024, p. 135). The second section, "Information regarding the use of animated films in teaching activity", contains 63 items associated with eight factors: "access to technology and the internet; purpose of use; viewing time; procedures; pupils' attention, interest, and motivation; understanding; learning/memorization; teacher and pupil competence" (Vereș, 2024, p. 135). For all 113 items, responses are based on a five-point Likert scale (1–5).

Data Analysis

Preliminary analyses-at the level of the instrument used

The following coefficients were calculated: Cronbach's Alpha, Spearman-Brown, and Guttman Split-Half coefficients.

Main analyses-at the level of the research questions

To answer the three research questions, descriptive statistical analysis was conducted. Descriptive statistics were calculated for unidimensional data (mean, standard deviation). The analysis includes data summarization in tables, comparison, and textual description. The results were compared with those obtained by Vereș (2024) regarding animated films.

3.1.3. Results

Preliminary Results-at the Level of the Instrument Used

For our questionnaire (113 items; 102 respondents), the Cronbach's Alpha reliability coefficient has a value of 0.974, indicating excellent internal consistency of the entire questionnaire and coherence among questions. The Spearman-Brown coefficient has a value of 0.974, indicating very good reliability. The Guttman Split-Half coefficient has a value of 0.949, showing high internal consistency.

Main Results-at the Level of the Research Questions

Table 1.1 presents the means and standard deviations for all questionnaire items referring to the selection and processing of films and animations by PÎP, with the purpose of using them in classroom activities.

Results Regarding the Selection of Films and Animated Films for Teaching Activities

PÎP mainly select science films from YouTube and via Google, and only rarely from parents or pupils. The main difficulties are related to the technological context: costs (viewing/downloading/using), the lack of suitable didactic films, and, paradoxically, the

overabundance of materials, to which are added issues related to product quality (scientific and technical errors, lack of Romanian subtitles, incomplete coverage, absence of narration). In selection, PÎP prioritize scientific accuracy, clarity, and text structure, as well as the amount of information. The dominant purposes are alignment with objectives, improving lesson quality and attractiveness, despite the considerable time required for preparation. The teacher's digital competence is considered critical (alongside didactic and content competence). The school subject strongly influences selection (top: science, biology, environmental studies/geography, with relatively greater openness than animations toward personal development, history, and visual arts). The content is selected primarily based on the lesson topic; pupils' characteristics (age, level of understanding and knowledge) remain very important, though slightly below the levels reported for animated films.

Results Regarding the Processing of Films and Animated Films for Teaching Activities

Access to certain applications that allow the processing of films and animated films is considered by PÎP to be a major problem, along with the availability of equipment that enables the production of didactic films. Teacher competence is an important factor influencing the processing of films for didactic purposes. Sequencing of animated films and films was considered a problem by both groups, and inserting text into an animated film was regarded as a bigger problem than the same action reported by the group surveyed regarding films.

Table 1.1

Descriptive Statistics Regarding the Selection and Processing of Films and Animated Films for Teaching Activities

Factors	Items/Indicators	Animated Films Mean	Animated Films Std. Dev.	Films Mean	Films Std. Dev.
Source of films	1. The specialized school inspector	4.03	1.19	2.83	1.47
	2. The ISJ methodologist	3.88	1.18	2.81	1.46
	3. Colleagues	3.73	1.14	3.21	1.27
	4. Parents	2.46	1.35	2.04	1.15
	5. Pupils	2.64	1.32	2.31	1.15
	6. School textbooks	4.12	1.13	3.81	1.16
	7. Google.com	4.15	1.06	4.05	0.99
	8. YouTube.com	4.26	1.02	4.13	0.99
	9. Created by me (teacher)	3.81	1.37	2.96	1.48

Table 1.1

Descriptive Statistics Regarding the Selection and Processing of Films and Animated Videos for Teaching Activities (continued)

Factors	Items/Indicators	Animated Videos Mean	Animated Videos Std. Dev.	Films Mean	Films Std. Dev.
Internet and technology	10. The lack of films on the internet is a problem.	3.99	1.20	3.40	1.41
	11. The multitude of films available on the internet is a problem.	3.90	1.24	2.89	1.19
	12. The cost of films is a problem.	4.00	1.17	3.76	1.38
	26. Access to applications for processing films is a problem.	4.14	1.06	4.01	1.09
	27. Equipment for producing films is a problem.	4.06	1.15	3.93	1.29
Film characteristics	13. Its length/duration	4.08	1.16	3.56	1.22
	14. The presence of the soundtrack (oral text)	4.29	1.03	3.35	1.19
	15. The speech rate in the film	4.16	1.10	3.11	1.30
	16. The amount of information in the film	3.91	1.26	4.01	1.01
	17. The narrator in the film and their role	4.16	1.17	3.31	1.31
	18. The absence of the soundtrack (oral text) in the film is a problem.	4.29	1.02	3.28	1.18
	19. The incomplete representation of the subject in the film is a problem.	4.52	0.82	3.63	1.11
	20. The text in the film (language, sentence length, concepts, clarity, etc.)	3.78	1.30	4.03	1.08
	21. Accuracy of information	3.94	1.27	4.59	0.82
	22. Soundtrack in a foreign language is a problem.	4.55	0.93	3.06	1.22
	23. The lack of Romanian subtitles is a problem.	4.49	0.92	3.58	1.22
	24. Scientific errors in the film are a problem.	3.93	1.26	4.32	1.18
	25. Technical errors in the film are a problem.	3.85	1.37	3.88	1.17
Teacher's purposes	28. The long time required for viewing is a problem.	3.95	1.20	3.41	1.20
	29. Making lessons attractive for pupils	4.32	0.95	4.53	0.89
	30. Improving the quality of learning	4.36	0.99	4.54	0.83
	31. Impressing pupils	4.19	1.01	3.87	1.16
	37. Achieving the proposed objectives in the activity	4.52	0.86	4.56	0.78

Table 1.1

Descriptive Statistics Regarding the Selection and Processing of Films and Animated Videos for Teaching Activities (continued)

Factors	Items/Indicators	Animated Films Mean	Animated Films Std. Dev.	Films Mean	Films Std. Dev.
Teacher's competence	32. In the didactics of science	4.49	0.89	4.44	0.92
	33. In science	4.44	0.86	4.42	0.94
	34. Level of digital competence	3.70	1.40	4.56	0.81
	35. Sequencing the film is a problem.	3.66	1.43	3.43	1.23
	36. Inserting text in the film is a problem.	4.53	0.88	3.32	1.15
School subject	38. School subject	4.51	0.88	4.50	0.92
	39. For science	4.50	0.82	4.27	1.04
	40. For Romanian language/communication in Romanian	4.10	1.22	3.83	1.37
	41. For environmental studies/geography	4.40	0.91	4.25	1.12
	42. For biology	4.45	0.84	4.26	1.06
	43. For history	4.03	1.17	4.12	1.26
	44. For visual arts	3.61	1.49	3.74	1.39
	45. For personal development	3.90	1.30	4.18	1.02
	46. For mathematics	4.03	1.22	3.48	1.40
Learning content	47. According to the topic/theme of the lesson	4.47	0.97	4.53	0.80
	48. Phenomena/processes not fully captured in reality	4.47	0.96	4.29	1.01
	49. Phenomena/processes not captured in other illustrative materials	4.54	0.89	4.30	1.00
	50. According to the degree of difficulty of the film content	4.52	0.90	4.06	1.02
Pupils	51. Age	4.62	0.79	4.50	0.81
	52. Level of understanding	4.75	0.72	4.49	0.82
	53. Level of knowledge	4.73	0.72	4.34	0.92

Results Regarding the Use of Films and Animated Films in Teaching Activities

Overall, primary school teachers (PÎP) report more consistent use and more positive perceptions for films than for animations, although with some technical obstacles: internet connection at pupils' homes and classroom equipment. Films are mainly used to increase interest and motivation, to form accurate representations, and to illustrate or consolidate content. The optimal moment for viewing is usually at the beginning of teaching and during lessons, in short sequences interrupted by discussions, but also at the end or through full viewing. Preferred

methods include questions asked by the teacher and questions formulated by pupils after viewing, along with discussions and problem-solving; questions during the film and comments overlapping the original audio are avoided.

Attention and interest increase when the content has a narrative form with characters (ideally with a voice/narration, which is more effective than subtitles) but decrease as pupils' age and the length of the film increase. Understanding is facilitated by practical activities, storytelling, and dynamic images accompanied by oral and, if applicable, written text. Memorization benefits from short clips and visually uncluttered screens with few simultaneous elements; longer materials do not improve retention. A decisive factor is the teacher's digital competence, which is perceived as more influential than either didactic or disciplinary competence and pupils' digital skills, in both the decision to use films and the quality of their implementation (Table 1.2).

Table 1.2

Descriptive Statistics Regarding the Use of Films and Animated Films in Teaching Activities

Factor	Indicators	Animated Films		Films	
		Mean	SD	Mean	SD
Access to technology and the Internet	1. The equipment for projecting films in the classroom is a problem	2.76	1.53	3.56	1.40
	2. The equipment for watching films at home is a problem	2.74	1.49	3.50	1.38
	3. Internet connection at school is a problem	2.63	1.47	3.21	1.58
	4. Internet connection at pupils' homes is a problem	2.85	1.38	3.63	1.35
Purpose of use	5. Capturing pupils' attention	3.85	1.21	4.34	0.90
	6. Increasing pupils' level of interest	3.98	1.17	4.50	0.84
	7. Increasing pupils' motivation	3.93	1.20	4.49	0.87
	8. Observing and understanding phenomena and processes	4.09	1.15	4.48	0.87
	9. Developing accurate representations of reality	4.02	1.19	4.49	0.81
	10. Illustrating theoretical aspects	3.83	1.27	4.17	0.98
	11. Consolidating new knowledge	3.78	1.22	4.27	0.93
Moment of viewing	12. At the beginning of teaching new knowledge	3.50	1.28	3.93	0.99
	13. During the teaching of new knowledge	3.21	1.27	3.62	1.13
	14. During the lesson, in several sequences, by interrupting the animation	3.39	1.29	3.81	1.07

	15. During teaching, in several learning activities	3.46	1.26	3.89	1.14
	16. At the end of teaching new knowledge	3.22	1.32	3.69	1.14

Table 1.2

Descriptive Statistics Regarding the Use of Films and Animated Videos in Teaching Activities (continued)

Factor	Indicators	Animated Films		Films	
		Mean	**SD**	**Mean**	**SD**
Procedures	17. We watch films only under the teacher's guidance.	3.67	1.30	4.00	1.11
	18. I involve pupils in learning activities based on the film, under the teacher's guidance.	3.89	1.21	4.21	1.03
	19. I provide information about the film's content before viewing.	3.31	1.39	4.00	1.08
	20. I provide information during the viewing of the film.	3.18	1.43	3.67	1.22
	21. I make comments over the film's narration.	2.62	1.47	3.00	1.42
	22. I provide information after viewing the film.	3.80	1.23	4.20	1.03
	23. I explain what pupils see in the film during viewing.	2.91	1.39	3.38	1.40
	24. I ask questions before viewing the film.	3.20	1.41	3.61	1.26
	25. I ask questions during the viewing of the film.	2.63	1.44	2.83	1.32
	26. Pupils formulate questions during the viewing of the film.	2.69	1.40	3.04	1.35
	27. I ask questions after viewing the film.	4.06	1.15	4.50	0.84
	28. Pupils formulate questions after viewing the film.	4.09	1.12	4.46	0.84
	29. I organize group discussions based on the film.	4.02	1.16	4.31	1.02
	30. Pupils solve problems based on the film.	3.87	1.19	4.08	1.20
	31. Pupils analyze cases based on the film.	3.82	1.23	3.94	1.22
Pupils' attention, interest, and motivation	32. Pupils' interest in animated films decreases with age.	2.90	1.35	2.91	1.25
	33. Pupils are attracted to the film's content if it is presented by a character with whom they identify	3.82	1.18	4.14	0.95

	and empathize.				
	34. Attention is captured through the film's narration.	3.71	1.20	4.00	1.02
	35. Attention is captured if the character introduced in the film fulfills the teacher's role.	3.32	1.19	3.67	1.01

Table 1.2

Descriptive Statistics Regarding the Use of Films and Animated Films in Teaching Activities (continued)

Factor	Indicators	Animated Films		Films	
		Mean	**SD**	**Mean**	**SD**
Pupils' attention, interest, and motivation	36. Attention is drawn more to the film's soundtrack than to the subtitles.	3.32	1.26	3.60	1.11
	37. Attention is maintained when information is presented in the form of an adventure.	3.82	1.18	4.22	0.87
	38. Interest and attention are stimulated/maintained when information is conveyed by an animated character.	3.88	1.16	4.13	1.01
	39. A long film duration represents a problem.	3.47	1.28	3.82	1.07
Understanding	40. Understanding is facilitated by a study guide based on the film.	3.17	1.26	3.45	1.05
	41. Understanding is facilitated by teacher-centered instructional strategies.	2.88	1.44	3.29	1.30
	42. Understanding is facilitated by practical activity.	3.91	1.17	4.14	0.93
	43. Understanding is facilitated through representation in stories/tales.	3.93	1.12	4.11	0.97
	44. Understanding is difficult when animation represents real systems and processes.	3.02	1.22	3.14	1.08
	45. Understanding is difficult when several objects move simultaneously on the screen in different directions.	2.85	1.25	2.96	1.23
	46. Understanding is difficult when animation illustrates natural processes.	2.92	1.20	3.09	1.06
	47. Understanding is facilitated by visual markers (e.g., arrows).	3.66	1.26	3.88	1.00

	48. Understanding is facilitated when the film represents a single concept (unidimensional message).	3.69	1.16	3.93	0.87
	49. Understanding a larger volume of information is facilitated when the film presents multiple concepts (multidimensional messages).	3.44	1.17	3.61	0.92
	50. Understanding is facilitated when dynamic images are presented (without oral text).	3.25	1.20	3.64	0.98
	51. Understanding is facilitated when dynamic images and oral texts are presented.	3.85	1.16	4.06	0.91
	52. Understanding is facilitated when dynamic images, written texts, and oral texts are presented.	3.84	1.19	4.09	0.91
Learning / Memorization	53. A long film duration facilitates the acquisition of a larger amount of information.	2.78	1.29	2.81	1.19
	54. A short animation length facilitates the memorization of its content.	3.68	1.21	3.82	1.03

Table 1.2

Descriptive Statistics Regarding the Use of Films and Animated Videos in Teaching Activities (continued)

Factor	Indicators	Animated Films		Films	
		Mean	**SD**	**Mean**	**SD**
Learning / Memorization	55. Learner-centered strategies facilitate the memorization of the film's content.	3.90	1.20	4.24	0.90
	56. A small number of elements on the screen facilitates the decoding of information and the formation of visual representations.	3.67	1.22	3.93	0.95
Teacher's and pupils' competence	57. Teacher's competence in science didactics.	4.07	1.18	4.46	0.87
	58. Teacher's competence in science.	4.07	1.17	4.43	0.89
	59. Teacher's digital competence.	4.11	1.14	4.47	0.91
	60. Pupils' digital competence.	3.71	1.23	4.06	1.04

3.1.4 Discussions and Conclusions

Primary school teachers (PSTs) mainly obtain films from YouTube/Google, and less frequently from digital textbooks, colleagues, or their own productions. In the selection process,

the scientific accuracy, text quality, and amount of information are the primary criteria, while the main difficulties relate to costs or licenses, the time required for selection, the insufficient or excessive offer, scientific or technical errors, and the lack of subtitles. The decision is strongly influenced by the subject area, the lesson topic, and the pupil profile (age, level of knowledge and understanding). The teacher's digital competence weighs at least as much—often more—than their subject or didactic competence.

In film editing and processing, the greatest obstacles concern access to applications and equipment, although the use of smartphones could reduce such barriers. Sequencing and inserting text are perceived as less problematic.

In classroom use, films are employed to increase interest and motivation, build accurate representations, observe processes and phenomena, and reinforce knowledge. The preferred moment of use is at the beginning of the lesson and/or in short sequences, with interruptions for discussion. After viewing, teachers tend to emphasize questioning (both by teachers and pupils), group work, problem-solving, and case analysis, while questions during the film and comments over the soundtrack are generally avoided. Attention increases in narrative contexts, with characters and oral messages (subtitles are less helpful for primary pupils). A long film duration reduces attention, whereas understanding and memorization are enhanced through practical activities, unidimensional messages, uncluttered screens, and short clips. The study highlights certain limitations, such as the possible subjective interpretation of items, uneven sample distribution, and the lack of correlation between teachers' profiles and their responses. Nevertheless, it offers concrete directions for refining the instrument and extending research to include other types of films and different educational levels or disciplines.

3.2 Study 2: Pupils' Practices and Opinions Regarding Film Viewing and the Production of Their Own Films

3.2.1 Introduction

To select, prepare, and use the most suitable films for learning science, and to design and organize learning activities based on films that facilitate understanding and knowledge acquisition, teachers need to be familiar with pupils' practices and opinions regarding both the viewing of films and the production of their own films.

The purpose of our study was to investigate the practices and opinions of primary school pupils concerning the viewing of films and the production of their own films. To achieve this aim, seven research questions were formulated:

1. What types of films do primary school pupils watch?
2. What are the sources of the films watched by primary school pupils?
3. What are the reasons why primary school pupils watch films?
4. What is the timing and duration of film viewing among primary school pupils?
5. What are the benefits of film viewing for primary school pupils?
6. With whom do pupils discuss the films they watch?
7. How do primary school pupils make their own films?

3.2.2 Method

Participants

The study involved 14 fourth-grade pupils (mean age 11 years; 5 girls, 9 boys) from *"Gh. Ruset Roznovanu" High School*, Neamț County. Participants were selected based on eight criteria: regular attendance, enrollment in fourth grade, belonging to a selected class, home access to devices and the Internet, use of technology for various purposes, interest in film viewing, voluntary participation without rewards, and informed consent.

After the approval of the school's Board of Administration, 29 pupils were recruited through invitations sent via WhatsApp. The procedure followed GDPR and confidentiality principles, including full information for both pupils and parents and the collection of written consent.

Instrument

Data were collected using an *"Interview Guide"*, designed by the researcher based on the specialized literature (Popa et al., 2009), classroom observations, and discussions with pupils. The questions included in the *Interview Guide* were reviewed and validated by two experts in educational sciences. The guide contained 14 open-ended questions grouped into seven content categories: types of films watched by pupils (Q1, Q2); sources of films (Q3, Q4); reasons for watching films (Q5, Q11b, Q12b); timing and duration of viewing (Q6, Q7, Q11, Q12); benefits of viewing (Q8); discussions about films (Q9, Q10); and pupils' own film production (Q13, Q14a, Q14b).

Data Collection Procedure

Data were collected in August 2024. Ten pupils, accompanied by their parents, were invited to school to participate in the interview, which took place in the classroom. Pupils received the *Interview Guide* in printed form, and their written responses about films were collected.

Data Analysis

The analysis of interview data followed the four stages described by Marton (2004): identifying data related to the studied phenomenon; sorting the data by similarities and grouping them into categories with the same meaning ("meaning groups"); classifying data based on contrasts and generating and describing categories; verifying reliability through expert evaluation by psychologists and educational science specialists, who coded or verified the coding of data.

3.2.3 Results

Most pupils reported that they watch films on YouTube and television. They did not report watching films from CDs/DVDs, school textbooks, or TikTok. At the group level, pupils fell into two categories: those who watch and those who re-watch films. Individually, four pupils reported watching a film once, while ten pupils watch films multiple times or have re-watched at least one film.

Most pupils stated that they watch action films, documentaries, and comedies, some of them covering a wider range of genres (films classified into 3-4 categories). Interviews showed that 77% of pupils preferred feature films, distributed into several subcategories. The most frequently mentioned genres were action (42%), comedy (28%), and horror (21%).

Most pupils watch films on YouTube and Netflix. An analysis of the titles and topics of the films mentioned revealed that pupils name few specific films or subjects for each source

(television, website, CD/DVD, digital textbook), though the actual number of films watched is certainly much higher.

The study revealed two categories of motives for watching films: cognitive and affective. These belong to the broader group of factors determining intrinsic motivation, alongside biological, socio-cognitive, and spiritual factors (Bandhu, 2024).

Most pupils watch films during weekends and holidays. The daily time allocated to film viewing ranged from one hour to five hours. Regarding attentive viewing duration, five pupils reported watching attentively for up to three hours, while nine pupils (63%) watched the entire film.

As for those who recommend films to them, many pupils (42%) watch films recommended by friends, who may or may not be classmates.

Regarding pupils' own film production, results show that they are particularly interested in the visible development of plants (e.g., the blooming of a rose) and in the movement of animals (frog, lizard, deer, brown bear) that they observe in their natural environments.

3.2.4 Discussions and Conclusions

At the end of our study, several research limitations were identified, along with directions for future research. A limitation of this study may be the small number of primary school pupils, all from the same school and class (fourth grade), which limits the generalizability of the findings. However, some findings are similar to those reported by Rus & Negru (2025) in their study involving 551 pupils from grades III and IV. To enhance the generalizability and relevance of the conclusions, future research could include a larger number of primary pupils from different grades and schools, both urban and rural, across various counties in Romania.

3.3 Study 3: The Effects of Watching Videos, Observing Photographs and Listening to Texts on Pupils' Knowledge and Inferences

3.3.1 Introduction

This study comparatively investigates the effects of three presentation modalities: watching videos, observing photographs accompanied by audio text, and only listening to a text- on the knowledge and inferences of primary school pupils. International literature consistently indicates advantages of videos compared to static materials, lectures, or texts, and often stronger effects at older ages and after re-viewing (Beuscher et al., 2005; Michel et al., 2007; Isiaka, 2007; Aziz et al., 2011; Salmerón et al., 2020; Koto, 2020). Our studies show that films without narration do not improve performance, poor synchronization between image and explanation may hinder understanding of complex contents, but well-guided viewing (including discovery-based) substantially increases correct answers. Additionally, results obtained by Vereș (2024) indicate the superiority of animations compared to static visuals, including for learning stability (Ilie & Cristea, 2020a; Ilie et al., 2020b, 2021, 2023; Vereș, 2024). Against the background of the massive supply of online video resources, time constraints, and the variability of PSTs' digital competences, as well as the high media consumption of primary pupils (Rus & Negru, 2025), the present study clarifies, under controlled conditions, which of the three modalities optimizes the formation of knowledge and the making of scientific inferences.

The purpose of this research is to investigate the effects of watching videos on the acquisition of knowledge in the subject "Natural Sciences" by pupils and to compare them with the effects of observing photographs (video captures) and listening to the texts from the videos and with the effects of listening to the texts from the videos.

The variables of our study are as follows: watching videos (independent variable), observing photographs (video captures) and listening to the text from the video (independent variable), listening to the text from the video (independent variable), the volume of pupils' knowledge (dependent variable), the scientific inferences made by pupils (dependent variable).

The following research hypotheses were formulated:

H1-The volume of knowledge acquired by pupils through watching the video is greater than the knowledge acquired through observing photographs (video captures) and listening to the text from the video.

H2-The volume of knowledge acquired by pupils through watching the video is greater than the

knowledge acquired through listening to the text from the video.

H3-The volume of inferences made by pupils through watching the video is greater than the volume of inferences made through observing photographs (video captures) and listening to the text from the video.

H4-The volume of inferences made by pupils through watching the video is greater than the volume of inferences made through listening to the text from the video.

H5-The volume of knowledge acquired by pupils through re-watching the video is greater than the knowledge acquired through watching the video.

H6-The volume of knowledge acquired by pupils through re-watching the video is greater than the knowledge acquired through re-observing photographs (video captures) and listening to the text from the video.

H7-The volume of knowledge acquired by pupils through re-watching the video is greater than the knowledge acquired through re-listening to the text from the video.

3.3.2 Method

Participants

The study was conducted during 2023-2024 in 10 schools from Neamț County: six from urban areas and four from rural areas, selected according to their location, IT equipment (computers, video projectors) and internet access. From each school, one fourth-grade class was chosen. Ten PSTs (tenured teachers, first teaching degree, medium digital competence, voluntary participation with consent) and 322 fourth-grade pupils (average age 11 years) participated, selected according to class inclusion, attendance, informed consent, and voluntary participation in all stages (pre-tests, interventions, post-tests), in compliance with GDPR and written parental consent; based on pre-test results (October–November 2023), GE1 (n=109), GE2 (n=100) and GE3 (n=113) were formed.

Procedure

The activities were carried out under the conditions mentioned in the collaboration protocols signed with the class teachers involved in the experiment. Pupils from each group participated in three teaching activities (“The Pineapple”, “The Banana Tree”, “Dragonflies”), which took place between March and June 2024. The activities were carried out by the PSTs of each class, after regular lessons, based on a teaching plan designed and provided by the

researcher. For each experimental group, each activity consisted of five stages lasting 50 minutes, on the same day: the pre-experimental stage (pre-test), formative intervention 1, post-experimental stage 1 (post-test 1), formative intervention 2, post-experimental stage 2 (post-test 2). Each stage lasted about 10 minutes.

After the pre-test, during formative intervention 1, pupils from GE1 watched a video projected on the screen using a video projector. For the three activities, three videos made and posted by Cătălin Zăvoianu on the YouTube channel "Supercat" were selected: "The Golden Fruit-The Pineapple" (Zăvoianu, 2021); "Top 50 Facts about Bananas" (Zăvoianu, 2019a); "Top 50 Facts about Dragonflies" (Zăvoianu, 2019b). Pupils from GE2 observed three photographs (video captures, A4 format) displayed on the board and listened to the video text read by the teacher. Pupils from GE3 listened to the video text read by the teacher. After post-test 1, during formative intervention 2, pupils from GE1 re-watched the video projected on the screen, pupils from GE2 re-observed the three photographs and re-listened to the video text read by the teacher, and pupils from GE3 re-listened to the video text read by the teacher. In post-experimental stage 2, post-test 2 was applied.

Instruments

The data were collected through 10 knowledge tests, designed by the researcher: one initial test, 3 pre-tests, and 6 post-tests. The maximum score for the initial test was 10 points, and for the other tests 20 points. No points were given by default. For each test, the score was calculated for each pupil.

The initial test included 50 items of different types and difficulty levels: 15 short-answer items, 5 multiple-choice items, and 30 true/false items. The test targeted science contents studied in the 3rd grade, in "Natural Sciences".

Pre-tests: each pre-test had two parts and included 12 items. Part I included 10 multiple-choice items targeting knowledge identification, and Part II included 2 open-ended items targeting the identification of inferences that could be drawn by pupils from each video.
Post-tests: post-tests had the same number of items as the pre-tests and were similar in type, difficulty, and scoring.

The film analysis sheet was adapted from Vereș (2024), who used it for the analysis of animated films. The adapted sheet included: general film data, film production characteristics, auditory characteristics, and visual characteristics.

Data Analysis

Preliminary Analyses

To decide which type of analysis is the most appropriate to use for testing the hypotheses, in the preliminary phase of analysis, we tested the normality of the distribution of the dependent variables for each group of pupils (independent variable). For testing normality, we used the Kolmogorov-Smirnov test.

Main Analyses-Testing of Hypotheses

For testing six of the seven hypotheses of the study, we performed Quade's ANCOVA analyses for nonparametric data. For the analysis of hypothesis 5, we performed a Wilcoxon test for paired groups, in the case of nonparametric data. For conducting Post Hoc analyses, we used the Scheffé test, because the three experimental groups were unequal (N1=109, N2=100, and N3=113).

Secondary Analyses-Content of the Verbal Data from Videos

The analysis of the film texts followed the steps of Vereș (2024, p. 233): viewing/listening, transcription, defining the categories, establishing the criteria, extracting and tabulating the information, interpretation; and the selection of data was based on four criteria taken from Vereș (2024) ('duration of the film', 'number of words', 'number of pieces of information/statements', 'number of proper names') and on new categories proposed here ('number of known concepts', 'descriptions', and 'explanations').

Secondary Analyses-Content of the Visual Data from Videos and Photographs

For the analysis of images from videos and photographs (captures), we followed the stages: viewing/observing the material, identifying structures, component elements and categories of visible characteristics (correlated with the descriptions in the texts), followed by the extraction and systematic insertion of this information into comparative tables.

Secondary Analyses-Characteristics of the Videos

The characteristics of the videos were analyzed using the 'Film Analysis Sheet', adapted after Vereș (2024). In the analysis of the videos, we followed the following steps: viewing the video and listening to the text; identifying general data about the video and filling them in the sheet; identifying the production characteristics of the video and filling them in the sheet; identifying the auditory characteristics and identifying the visual characteristics of the video and filling them in the sheet; comparing the results; interpreting the results.

3.3.3 Results

Preliminary Results

Preliminary analyses of data collected from the three experimental groups showed that we have non-parametric data, as the Gaussian normal distribution was violated. The Lilliefors-corrected significance (p) of the Kolmogorov-Smirnov test, with a p-value = .000, indicates that the data are not normally distributed, and non-parametric data analysis methods are required.

Main Results-Testing of Hypotheses

The Quade's ANCOVA analysis revealed significant differences between the three groups, and the Wilcoxon test results showed differences between the two time points. The data confirm hypothesis number 5: the volume of knowledge acquired by pupils through re-watching the video is greater than the knowledge acquired through watching the video.

Secondary Results-Verbal Data Content from Videos

Quantitative results about the texts of the three films used in this study were included in data tables: video duration, number of words, number of information statements conveyed by the films, number of known concepts, number of unknown concepts, number of descriptions, number of explanations.

Secondary Results-Visual Data Content from Videos and Photographs

In analyzing images from videos, only visible aspects in films and described in texts were considered. Visible structures analyzed included plants and their components, dragonflies and their body parts. In the video images, characteristics of plants, dragonflies, and the environment (aquatic, terrestrial) were visible.

In the three photographs, fewer aspects were distinguished than in videos. Structures observed included: pineapple and banana plants with their leaves and fruits; pineapple and banana plantations; dragonflies' bodies and their components.

Secondary Results-Video Characteristics

The three videos were created by an amateur author who provides them for free on YouTube. The duration of the videos is short (under 9 minutes), and the frame rate is normal (12–24 frames per second). These videos are non-interactive, being at level 1 of interactivity (Schulmeister, 2003), but can be watched in cinema format, full-screen, or in mini-player format. The videos are embedded in multimedia applications, associated with advertisements.

3.3.4 Discussions and Conclusions

The study found that watching the video produced stronger effects on pupils' knowledge and inferences than observing photographs (video captures) or listening to the accompanying text. Re-watching the video further increased of knowledge acquisition compared to re-observing photographs (video captures) or re-listening to the text.

Although in educational sciences research, formative intervention is often carried out on several topics or content elements in order to increase study validity, the fact that in our study pupils watched three videos could rather be considered a disadvantage, as the different characteristics of the contents of the three videos influenced the results in different directions. Based on this finding, for future similar research, it would be more appropriate to address a single topic.

Study 3.4: Making Films by Pupils With or Without the Help of Guides. Effects on Pupils' Knowledge

3.4.1 Introduction

This study aims to compare the effects of making films by primary school pupils with the help of a guide provided by the primary education teacher on acquiring knowledge in the subject Natural Sciences, with the effects of making films without such a guide, and with the effects of reading a text on the same topic.

The variables of the study are as follows: making a film with the help of a guide (independent variable); making a film without the help of a guide (independent variable); pupils' knowledge volume (dependent variable); and pupils' knowledge stability (dependent variable).

The following research hypotheses were formulated:

H1-The volume of knowledge in natural sciences acquired by primary school pupils through making films with the help of a guide is greater than the knowledge acquired by making films without a guide.

H2-The content of the films made by primary school pupils with the help of a guide is more relevant (systematic, complete, and includes more essential information) than the content of the films made by pupils without a guide.

H3-The stability of knowledge in natural sciences acquired by primary school pupils through making films with the help of a guide is higher than the stability of knowledge acquired by making films without a guide.

H4-The volume of knowledge in natural sciences acquired by primary school pupils through making films is greater than the knowledge acquired by reading a text on the same subject.

3.4.2 Method

Participants

The study involved 100 fourth-grade pupils (average age 11 years), both boys and girls. The participants were selected from the classes included in Study 3 and from pupils who attended a summer school. The selection was based on three criteria: being enrolled in the fourth grade, providing informed consent, and voluntary participation with ranking and small rewards.

The pupils were divided into two groups based on their results from the initial test, which

had been applied during October-November 2023 (as part of Study 3) and during August-September 2024. The experimental group (EG) consisted of 50 pupils from "Gh. Ruset Roznovanu" High School in Roznov, Neamț County. The control group (CG) consisted of 50 pupils: 20 from "Lucian Blaga" Gymnasium School in Jibou, Sălaj County; 14 from "Gh. Ruset Roznovanu" High School in Roznov, Neamț County; 5 from the Gymnasium School in Tămășeni, Neamț County; 4 from "Mihai Eminescu" Gymnasium School in Roman, Neamț County; 4 from Gymnasium School No. 2 in Piatra-Neamț, Neamț County; and 3 from the Gymnasium School in Borlești, Neamț County. The primary education teachers (PETs) who taught in these classes also participated in the research.

Procedure

The experimental design followed a pre-test–post-test model with EG and CG. The experimental activity took place during the summer holiday and at the beginning of the 2024-2025 school year, from August to October 2024. Pupils who had participated in Study 3 had already completed the initial test in 2023. The teaching activity was structured into five stages: 1. pre-experimental stage 1-administration of the initial test; 2. pre-experimental stage 2-administration of the pre-test; 3. formative intervention stage-during which pupils made their films; 4. post-experimental stage 1-administration of post-test 1; 5. post-experimental stage 2-administration of post-test 2. At the end of the activity, an online Questionnaire on Pupils' Film-Making Process was administered.

Instruments

The research instruments included a questionnaire and four knowledge tests: one initial test, one pre-test, and two post-tests. The initial test aimed to assess the knowledge specific to the subject Natural Sciences-3rd grade and consisted of 50 items of various difficulty levels and types: 15 completion items, 5 multiple-choice items, and 30 True/False items. Each item was worth 0.2 points, with no points granted by default, and final scores were calculated individually for each pupil.

The pre-test "The Tomato Plant" assessed the initial level across two components: Part I. Plant characteristics and Part II. Environmental conditions, diseases, and reproduction. Each part contained 10 T/F items (1 point/item; maximum 10 points/part), designed according to the dependent variables. Part I verified categorization (I1, I2) and the characterization of plant parts: root (I3, I4), stem (I5, I6), leaf (I7, I8), flower (I9), and fruit (I10), while Part II focused on

environmental conditions (I1-I5), pests, taste and classification (I6-I8), reproduction (I9), and harvesting/storage-use (I10). The two post-tests had the same structure, typology, and scoring as the pre-test, being correlated with the dependent variables and the studied content.

The self-evaluation/evaluation grid of the films made by pupils included: author details, general information (duration, length of oral text, image-text correspondence), and specific content (21 indicators for root, stem, leaves, flowers, and fruits). The third column indicated the maximum scores per indicator (e.g., duration ≤3 minutes; text ≥300 words), and the fourth column recorded the score given during self-evaluation or by the teacher (PET).

The questionnaire on film-making included 19 dichotomous-choice items regarding previous experience and current film editing (2 items), text preparation (9 items), and film-making (8 items), as well as 18 Likert-scale items (1=very little … 5=very much) concerning activities perceived as difficult (7 items) and those enjoyed by pupils (11 items).

Teaching Activity (Formative Intervention)

After being divided into the two groups, all pupils participating in the study solved the pre-test items administered in printed format. During the formative intervention stage, each pupil from each group made a film about the tomato plant (Solanum lycopersicum). Pupils in the experimental group (EG) were instructed to make the films with the help of a guide designed and provided by the teacher-researcher, while pupils in the control group (CG) made the films according to their own plans and strategies, without guidance from the teacher.

Each EG pupil received a text about "The Tomato Plant" so that all pupils would be exposed to the same information. The text contained all the necessary information for correctly answering the test items (pre-test, post-test 1, and post-test 2). Each EG pupil also received a Worksheet on the topic "The Tomato Plant," which included three parts: (1) the task and requirements the film must meet; (2) the stages to be followed in making the film; (3) the method of evaluating the films and the self-evaluation/evaluation grid to be completed after making the film.

Each CG pupil, immediately after completing the pre-test, received from the teacher the oral task of making a film about "The Tomato Plant." The teacher explained the following conditions: to film independently; to present and film the plant in reality; not to add photos or animations to the film; to keep the film under 3 minutes; and to send the film to the teacher. The teachers were instructed not to give pupils any additional guidance.

Data Analysis

Preliminary analyses-Initial test level

To test normality, the Kolmogorov-Smirnov test was used. Since the data were nonparametric, except for one case, the equivalence of the two study groups (EG and CG) was verified using the Mann-Whitney U test for independent samples and nonparametric data.

Main analyses-Testing the hypotheses

Given the equivalence of the groups, it was decided to use nonparametric tests for two groups (paired samples-Wilcoxon Signed-Rank Test; independent samples-Mann-Whitney U Test, as applicable) rather than covariance analyses (e.g., Quade's ANCOVA).

Analysis of pupils' films

The films created by pupils in both groups were evaluated using a grid designed for this study. The procedure included downloading and watching each film, checking the pupil's self-assessment, assigning scores for general characteristics and content, entering the scores in the grid and in an Excel file, calculating the total score per pupil, per indicator and group, performing statistical processing, comparing, and interpreting the results. For the general characteristics, 1 point (no partial scores) was given for each fulfilled eliminatory condition, and for the tomato plant content, 21 pieces of information were assessed.

Analysis of questionnaire data

The questionnaire was completed by 46 pupils from EG and 32 pupils from CG. For dichotomous items, the total number of responses (Yes/No) for each group was calculated, as well as their percentages relative to the number of pupils who completed the questionnaire and to the total number of pupils in each group who made the films. For Likert-scale items, the total number of pupils and their percentages were calculated for each level, relative to the total number of pupils in each group who completed the questionnaire. For each item, the weighted mean and standard deviation were also computed.

3.4.3 Results

Preliminary Results-at the level of the initial test

In the case of normality testing, the *Kolmogorov-Smirnov* test reported statistically significant data in 21 out of the 22 cases analyzed. Except for a single case (the EG score for the evaluation of the relevance of the produced film), all other cases present nonparametric data.

Main Results-Testing the Hypotheses

Analysis of Hypothesis 1. The *Mann-Whitney U* test shows that before the implementation of the experimental conditions (pre-test 1), there were no significant differences between the two groups in terms of natural science knowledge (u=1155.5; p=.50). After the implementation of the experimental conditions, at the moment of applying post-test 1, the statistical analysis identifies significant differences between the two groups (u=630.0; p=.000). Checking the mean ranks shows that the significant differences are in favor of the group that created films with the help of the guide provided by the teacher (MR_{GE}=62.9; MR_{GC}=8.1). Thus, creating films with the help of a guide developed by the teacher and made available to the pupils seems to be a more effective method than creating films without a guide for acquiring knowledge in the Natural Sciences discipline.

Analysis of Hypothesis 2. The *Mann-Whitney U* test shows that there are statistically significant differences between the products of the two groups of pupils (u=5.000; p=.000). The significant difference appears in favor of the group of pupils who created films using the guide provided by the primary school teacher (MR_{GE}=75.4; MR_{GC}=25.6).

Analysis of Hypothesis 3. The *Mann-Whitney U* test shows that, at the level of post-test 2, there are significant differences between the two experimental conditions (u=227; p=.000). The differences are in favor of the group of pupils who benefited from the condition in which they made the film with the help of a guide provided by the teacher (MR_{GE}=70.96; MR_{GC}=30.04). Moreover, the difference between the two experimental conditions is one of high intensity (r=.72).

Analysis of Hypothesis 4. The results of the *Wilcoxon Signed-Rank Test* show that making films is more effective, reporting large effect sizes, both when the films are made by pupils using a guide provided by the teacher (r=.84 and .86) and when these films are made by pupils without having a guide available (r=.72 and .81).

Results- analysis of the text provided to pupils for making the films

The text “The Tomato Plant” (Pătlăgeaua roșie), in Part I, has: 356 words, 72 pieces of information, 12 known concepts, 24 unknown concepts, 37 descriptions, and 9 explanations. Part II of the text has: 363 words, 68 pieces of information, 8 known concepts, 20 unknown concepts, 5 descriptions, and 9 explanations. The two parts of the text have a similar number of words, information, known concepts, unknown concepts, and explanations. Significant differences

between the two parts refer to the number of descriptions: 37 descriptions in Part I and 5 descriptions in Part II.

Results-analysis of the films made by pupils

The results show differences between the two groups regarding the general characteristics. All pupils from the CG created films with a duration shorter than 3 minutes, while in the EG, 80% of the pupils made such films. All pupils from the EG created texts longer than 300 words, while in the CG, only 6% of the pupils created such texts. 80% of the pupils in the EG achieved correspondence between image and oral text, while in the CG, only 20% respected this requirement.

In describing the plant in the film, pupils from the EG had lower scores in presenting the color of the flowers (22%), the branching of the stem (40%), and the arrangement of the leaves (44%), flowers (48%), and fruits (34%) on the stem. Pupils from the CG obtained higher scores for listing the parts of the plant (30%), presenting the height of the stem (44%), and the color of the fruits (58%). No pupil from the CG provided information on five aspects (branching of the stem, arrangement of the leaves and flowers, number of petals and sepals), and 4-22% of the pupils presented other information in their films.

Results-analysis of the activities carried out by pupils

Regarding previous experience, it was found that more pupils from the EG had made films using a phone than those from the CG. Concerning the preparation of the text to be used in the film, it was found that almost half of the pupils in each group had discussed with their parents and searched for information on the Internet. Two-thirds of the pupils in the EG practiced reading the text aloud before making the film, while in the CG, less than half of the pupils reported performing this activity.

Results- analysis of the level of difficulty and satisfaction

Regarding the perceptions of the pupils from the EG (N=46) on the level of difficulty of the activities carried out before making the films, two-thirds of the pupils from this group perceived as slightly difficult (2 points) and moderately difficult several activities: writing the text for the film (63%), memorizing the text for the film (63%), speaking and filming (60.8%), making the film at the beginning of the activity (67.3%), and at its end, after completing it (56.5%). For the pupils from the EG, the most difficult seems to be memorizing the text for the film (M=2.69), followed by making the film at the beginning (M=2.54), writing the text for the

film (M=2.30), speaking and filming (M=2.26).

3.4.4 Discussion and Conclusions

The statistical analysis, in the case of testing hypothesis I1, confirms that the volume of knowledge specific to natural sciences, acquired by primary school pupils through the making of films with the help of a guide, is greater than the knowledge acquired through the making of films without the help of a guide.

The results of the pupils from the EG were influenced by the use of the guide, the effect size being of medium intensity (r=.44). The pupils benefited from indirect guidance from the teacher, provided through the guide, which offered them many reference points: the objectives that the pupils should achieve; the requirements they should meet; the steps they should follow in developing the film; the film evaluation procedure; the self-assessment/evaluation grid for the films; a text about "The Tomato Plant".

The guide had the role of helping pupils to go through the stages in a logical order, to draw their attention to important aspects (duration; how to achieve image-oral text correspondence; what information should be included in the film). Thus, it provided them with a way of approaching a problem (metacognitive scaffolds), guided them in the process of tackling the problem and the task (strategic scaffolds) (Hill & Hannafin, 2001), in understanding procedures (cognitive scaffolds), and supported them in focusing and persisting on the task (affective scaffolds) (Rosenshine & Meister, 1992; Yelland & Masters, 2007).

Unlike the pupils from the EG who benefited from the guide, the pupils from the CG were involved in a learning-by-discovery or problem-solving activity. The pupils from the CG independently established the steps they had to take in preparing and developing the films, sought, and discovered by themselves the information about the tomato plant necessary for their film. In the absence of guidance and essential information provided by the teacher, the difference between the results of the pupils from the CG obtained in the pre-test (M=6.16) and post-test 1 (M=7.12) was much smaller than in the EG.

The results of the pupils from the EG were also influenced by the fact that they received from the teacher a text that contained the essential information tested through the three tests. Regarding the use of the text provided by the teacher, 82% of the pupils from the EG stated that they extracted information from it to use in the text of their film. Pupils from both groups had the

possibility to search for information from other sources (from the internet, from family, etc.). Almost half of the pupils surveyed at the end of the research declared that they searched for information on the Internet (40% from EG; 42% from CG), which demonstrates interest in the given task.

Discussions regarding the degree of difficulty of the activities

Although we consider that the task of making films about the tomato plant, proposed to pupils, has a high degree of difficulty, it is surprising that pupils from both groups perceived both the preparatory activities and the making of the films as activities with a low and medium degree of difficulty. At the level of the averages, it was found that the pupils from the EG assessed the activities they carried out as having a medium degree of difficulty, but with higher values than those recorded in the CG, except for the presentation of the text in the film and the filming itself. This perception of the pupils from the EG is explained by the fact that they received a text with a lot of information, a self-assessment/evaluation grid that required them to use a large amount of information in the film, and they were asked to show the parts of the plant they were describing while using a smartphone.

Discussions regarding the pupils' degree of satisfaction

Regarding the pupils' degree of satisfaction with the making of the films, the results show that both the pupils from the EG and those from the CG, at the group mean level, indicate high satisfaction for performing activities stimulated by intrinsic motivation (they learned about tomatoes and how to write a text for a film, they filmed), but also for receiving trophies, which motivated them extrinsically. The fact that their parents helped them make this film generated, for pupils from both groups, a perceived medium level of satisfaction, as opposed to the help from other people, which generated little or very little satisfaction.

Conclusions, limitations, and future research directions

The making of films by pupils was perceived as a challenging project that provided satisfaction to primary school pupils. The results show that the pupils from the EG benefited more from the activity as a result of using guides strongly focused on the essential content that was targeted to be acquired by the pupils.

In situations where pupils make films with content from natural sciences through guides, the results show that teachers can influence the relevance of the content of these films (systematic, complete, with a higher proportion of essential information), the increase of the

volume of knowledge acquired by primary school pupils, and its stability. In situations where pupils receive the same task to make films but do not benefit from a guide, the results show that their films are less relevant, and the volume and stability of the knowledge acquired are lower than in the case of pupils who benefit from a guide.

A limitation of our study could be the comparison of the volume of knowledge acquired by pupils through making films with that of other knowledge acquired by reading texts, since there are differences between the two categories of information. The information used in the film is closely tied to images, making it more specific and therefore more difficult to memorize. In contrast the information in the second part of the text is more general, does not require the use of images, and is easier to retain. This limitation could be overcome by conducting the research with a third group that does not make films but studies the information specific to the sciences (the classification of a plant into plant categories; the characterization of a plant and its component parts) that were used in the films.

CHAPTER IV. CONCLUSIONS

4.1. Conclusions Regarding the Relationship Between Theoretical Premises and the Applied Part

The central element of our thesis is represented by the concept of film. The theoretical premises regarding the use of films in science learning aimed at several directions: clarifying the concept of film, classifying films and describing various types, identifying and presenting the theories that explain learning based on watching and making films.

In our research, it was found that, in Study 3, pupils benefited from three filmic experiences, while in the case of Study 4, pupils created a work based on an epistemological model proposed by the primary school teachers (PÎP) and carried out a multimodal communication activity.

In the research we conducted with primary school pupils, we used as instruments both the "silent" film (in the case of a plant's development) (Ilie & Cristea, 2020) and sound films (Ilie et al., 2020a, 2020b).

4.2 Conclusions on the Achievement of the Research Objectives and the Confirmation of the Hypotheses

In the research undertaken in this thesis, we aimed to achieve four main objectives: investigating the opinions of primary school teachers (PÎP) regarding the selection, processing, and use of films in science lessons in primary education, compared with the selection, processing, and use of animated videos in science learning; investigating the practices and opinions of primary school pupils regarding watching films and creating their own films; investigating the effects of watching films (videos) on the acquisition of knowledge in natural sciences by primary school pupils; investigating the effects of making films on the acquisition of knowledge in natural sciences by primary school pupils.

The first objective was achieved through our first study, which shows that primary school teachers consider films-including educational and animated videos useful in science learning but face difficulties in identifying the most suitable films because of the wide global offer of films with texts in other languages and the limited number of films available in Romanian.

The second objective was achieved through our second study, which shows that pupils most frequently watch action films and, less often, informational films; that they have made

different kinds of films; that they have devices for filming; and that they possess the necessary competence.

The third objective was achieved through our third study, in which we investigated the effects of watching films on the knowledge and inferences made by primary school pupils, in comparison, on the one hand, with the effects of observing photographs (film frames) and listening to the text of the same film, and, on the other hand, with the effects of listening to the text of the same film. The statistical analysis of the results confirms the seven hypotheses we tested.

The fourth objective was achieved through our fourth study, in which we investigated the effects of making films by primary school pupils, with or without the help of a guide provided by the primary school teacher (PÎP), on the volume and stability of pupils' knowledge in the subject "Natural Sciences." The statistical analysis of the results confirms three of the tested hypotheses but does not confirm the hypothesis that making films produced greater effects on the volume of knowledge acquired by pupils than reading a text on the same topic.

4.3. The Implications of the Thesis

Theoretical Implications

A number of relevant theoretical contributions are included in the first chapter of the thesis. A first contribution is represented by the identification and presentation of the terms that have the meaning of "film" and that are used in the global literature, in various scientific and artistic fields. The next theoretical contribution is the selection, clarification, and presentation of the essential attributes of the concept of film and its multiple approaches. Another relevant aspect is the classification of films based on different criteria and perspectives, specified in works published worldwide. We aimed to create as comprehensive a radiography as possible to provide an overview of the films that could be used or recommended to pupils for their valorization in various contexts, formal and non-formal, in science learning.

Study 1 has several theoretical implications. Firstly, it is the first study in Romania and worldwide that investigates the opinions of primary school teachers (PÎP) regarding the factors that influence their selection and processing of films to use them in science learning in primary education. Study 1 is the first to analyze in detail the factors influencing teachers' decisions on how to use films in activities with science-related content, as well as their opinions on the effects

of watching films on stimulating pupils' interest in science and increasing their motivation to learn science. It is also the first comparative study that aimed to identify similarities and differences between the factors influencing the selection, preparation, and use of films and animated films in primary education for science teaching.

Study 2 is the first study in Romania and worldwide that investigates the practices and opinions of Generation Alpha pupils regarding the films they watch, the sources of these films, the moments and duration of viewing, and the people with whom they discuss films. It is the first study that explores pupils' practices related to making their own films. As a result of the findings of this study, within this thesis we conducted Study 4, in which pupils learned science by making films, guided by the teacher or independently.

Study 3 has valuable theoretical implications in science education, represented by the design and implementation of instructional models: the instructional model based on watching and rewatching the film, and the instructional model based on observing and re-observing photographs. We tested and compared the effects of applying these instructional models on the volume of knowledge and inferences drawn from films or photographs by pupils.

Study 4 also has valuable theoretical implications in science education, represented by the design and implementation of instructional models: the instructional model based on making films with the help of a printed guide, the instructional model based on making films without the help of a guide, and the instructional model based on reading a text.

Methodological Implications

In the studies we designed, conducted, and presented in this thesis, we aimed to identify and use the most efficient procedures for selecting and involving participants in our research, to increase the efficiency of data collection and the quality of the data.

In Study 1, we aimed to use the most efficient data collection method in the questionnaire-based survey, through the voluntary participation of primary school teachers (PÎP) as a result of applying the "snowball" method, as described in the literature, and we used an efficient method for data processing. Each item in the instrument (the questionnaire) used for data collection is associated with a Likert scale with values from 1 to 5.

Study 2 provides a way to select pupils from one's own class and to interview them during the summer vacation. The responses were collected in written form, which allowed the collection of a large amount of data in a short period and avoided the need for transcription by

the researcher. When processing the data, the novelty element was that the PÎP-researcher discussed with some pupils on WhatsApp to ask for descriptions, explanations, or clarifications regarding the making of their own films.

Study 3 has several methodological implications. All activities were organized in natural conditions, in the pupils' own classrooms, together with their primary school teachers. To conduct consistent research, we carried out three distinct activities in this study, on different days. In all classes included in an experimental group, the formative interventions were organized based on the same instructional model, and we strictly controlled the visual and verbal content to which all pupils in the experimental groups were exposed.

We tested the effects of watching videos to avoid influencing the results through the teacher's intervention. Our main interest was how much the volume of pupils' knowledge increased through watching videos, observing photographs, and listening to the text from the film, and only by listening to the text from the film. In Study 3, we created conditions similar to those that pupils experience when they independently watch videos they select from the Internet.

Study 4 has several methodological implications. The research is based on several premises: the level of digital competences of Generation Alpha pupils (4th grade) in Romania, pupils' individual access to smartphones, and their interest in making films. On one hand, we were interested in highlighting the role of a detailed guide focused on certain content in acquiring essential knowledge about a science topic (the characteristics of a plant), and, on the other hand, in measuring the effect of using this guide.

Practical Implications

Our thesis has several practical implications. Firstly, the definition of the concept of film and the presentation of similar concepts and various approaches to films, the classification of films from different perspectives, and the description of relevant types of films for their effective use in teaching science by primary school teachers are useful for both teachers and researchers.

Secondly, the comparative presentation of the factors influencing the selection, preparation, and use of films and animated videos by primary school teachers in science learning provides benchmarks for teachers and researchers. These benchmarks guide the choice of suitable films and their effective use, based on scientific criteria and methodological suggestions drawn from the experience and competence of many participating teachers. The two statistically validated instruments used for data collection-the original one created by Vereș (2024) and the

one adapted for Study 2-allow for their easy use in other research.

Thirdly, the original instruments created for data collection (pre-tests, post-tests, film analysis sheet, interview guide, film-making guide, evaluation/self-evaluation sheet of the film made by pupils, and the questionnaire regarding film-making), together with the activity projects carried out during our research, provide valuable benchmarks for primary school teachers wishing to apply them in class and for researchers aiming to conduct similar or identical studies.

Fourthly, the systematic and detailed chronological description of the activities carried out in each of the four studies, together with essential information drawn from the literature, allows for an in-depth understanding of the teaching process and the effects of these activities on the volume and stability of knowledge. This provides solid benchmarks for teachers or researchers to organize similar activities in other educational or experimental contexts.

Finally, presenting research objectives and hypotheses, variables, research design, methods, instruments, and results in data tables allows for the analysis and comparison of activities, as well as identification of differences, strengths, and weaknesses of the studies. This provides the necessary information to replicate the research with larger groups of participants, on other science topics or in other scientific domains.

4.4. Limitations and Future Research Directions

At the end of our thesis, we present several aspects related to the research we conducted, which may be perceived as limitations or vulnerabilities of the studies, but which could be improved in future research. We also present several possible research directions.

In Study 1, collecting the opinions of primary school teachers (PÎP) through a questionnaire created by Vereș (2024), adapted to the objectives of our research, has multiple advantages, but also some limitations. One limitation could be considered the construction of the questionnaire based on the researcher's vision and experience regarding the selection, processing, and use of animated videos in science teaching in primary education (Vereș, 2024). To overcome this limitation, we adapted the questionnaire for our research by replacing the concept of "animated video" with that of "educational video." The questionnaire could be used in other studies to collect information about other types of films, for example, documentary films.

Another limitation could be the smaller number of primary school teachers from Romania

who participated in our survey compared to the survey on animated videos (Vereș, 2024). The vulnerable point of both studies is that no opinions were collected from teachers in some Romanian counties, or only a few participants from these regions were included. To avoid this vulnerability, future research could place more emphasis on the rigorous selection of participants.

Another limitation could be the construction of the questionnaire with items associated with a Likert scale. These items facilitated the statistical processing of results, but teachers were asked to assign a score from 1 to 5 to evaluate personal, subjective opinions. This limitation could be overcome in future studies by adding multiple-choice or open-ended questions.

A future research direction could be the deepening or expansion of certain aspects investigated in our study by selecting certain parts of the questionnaire, refining or adding new items and factors. Other research directions could include using this questionnaire to collect opinions about the use of films in other school subjects, at other educational levels (for example, middle school, high school), both in Romania and in other countries.

A limitation of Study 2 could be the small number of interviewed primary school pupils, all from the same school and class (4th grade). To generalize the conclusions of our study and increase their relevance, the research could be extended by interviewing a larger number of primary school pupils from various classes and schools, located in both urban and rural areas, from several Romanian counties and other countries as well.

Three other possible research directions could be the revision or replacement of the interview guide questions, collecting information and pupils' opinions about certain types of films (animated, science-fiction, historical, documentary, video clips, etc.), and investigating the use of educational films in other school subjects.

A limitation of the quasi-experimental Studies 3 and 4 could be the small number of pupils involved in the experimental groups. Even though the literature mentions that the validity of studies is not affected by the small number of participants in the experimental groups, for the generalization of conclusions, future research could be carried out on randomized samples including more pupils or other participants.

A limitation or disadvantage of Study 3 is the viewing of three videos with different content. In educational science research, formative interventions are often conducted on multiple topics or content elements to increase the validity of the study. However, the different

characteristics of the contents of several films or topics could influence results in different directions. To increase result accuracy, in similar studies, it might be more appropriate to address a single topic.

Another limitation of Study 3 could be related to the design of the tests. Since the items in the three tests were correlated with the objectives aimed at acquiring essential knowledge on the three topics, the entire volume of information that could have been acquired during the viewing of the films, observation of photographs, or listening to the texts was not verified. Another vulnerability could be the number and typology of items used to assess knowledge (nine multiple-choice items, one identification item involving choosing from three photographs, and two open-ended questions). The quality of knowledge assessment acquired through viewing videos or other films could be improved by increasing the number of items (for example, 20-40 items), by using more varied item types, and by assessing different types of knowledge (essential and non-essential; declarative, procedural, and attitudinal).

In Study 4, a limitation could be the comparison between the volume of knowledge acquired by pupils through making a film and the volume of knowledge acquired through reading a text. To overcome this limitation, another study could include a third group that studies a text without making a film on that topic. Another limitation could be the fact that pupils made only one film. In future research, pupils could be asked to make several films on science-related topics (for example, to film the development of a plant from germination to fruiting or the physical phenomenon of sublimation).

4.5. General Conclusions

At the end of our research, the results show that primary school teachers (PÎP) in Romania are interested in using films in science learning, that they associate certain teaching techniques, methods, and strategies with the use of film content to increase learning efficiency, but also that they highlight a series of difficulties and problems that can reduce their interest in organizing learning activities based on film viewing.

The results regarding pupils show that primary school pupils in Romania have access to electronic devices (smartphones and computers) and the Internet. Their digital competence appears to be more developed than their teachers perceive. Pupils devote significant time to media consumption and most often watch action films, primarily for entertainment and very

rarely for informational purposes.

All our studies, both the one presented in this thesis and those conducted previously, show that watching films (videos, documentaries) has led to an increase in pupils' science knowledge, even though not all the results of these activities were statistically significant.

The results show that making films with the help of a guide provided by the teacher leads to the creation of higher-quality films and to the acquisition of a larger volume of knowledge by pupils, compared to making films without guidance from the teacher. The study demonstrates that primary school pupils are capable of making films according to the teacher's requirements and of editing them.

The task of making films, with guidance provided by the teacher, is a more challenging activity, suitable for children from Generation Alpha, who allocate large amounts of time daily to media consumption, and it has more relevant effects on science learning than film viewing alone.

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