Designing a m-learning methodology to study multimedia in secondary school

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Abstract

Despite the widespread perception of smartphones as a source of distraction in the classroom, their growing impact on the educational environment highlights the need for a pedagogically grounded approach to their purposeful use. This paper explores the potential of integrating mobile devices into the learning process in institutions of lower secondary education. A study was conducted to examine the frequency, purposes, and effects of smartphone use during computer science lessons among students in grades 5–9. The findings revealed a high level of students' digital activity and near-universal access to smartphones, contrasted with their limited educational application. A significant discrepancy was identified between the current content of the "Multimedia" topic in the grade 8 computer science curriculum and students' pre-existing digital skills. In response to these challenges, an original teaching methodology for the topic "Multimedia" was developed, incorporating m-learning technologies and the BYOD (Bring Your Own Device) model. The proposed approach emphasizes the use of smartphones for project-based learning activities focused on the creation and editing of multimedia content. Grounded in activity-based and project-oriented pedagogical principles, the methodology is aligned with students' actual digital competencies and takes into account the constraints of wartime educational settings. The approach has the potential to be adapted to other areas of the computer science curriculum or subjects requiring hands-on engagement with digital technologies.

Keywords

computer science, mobile learning, BYOD, multimedia,

1. Introduction

Modern society is increasingly becoming digital. This has a significant impact on all areas of life, including education. Every year, the speed of these transformations forces educators to look for answers to new challenges. For several years now, one of them has been the use of smartphones in education. On the one hand, mobile devices have long been an integral part of students' daily lives. This is especially true now that most Ukrainian schools have implemented a blended learning format due to the Russian invasion [1, 2, 3, 4]. However, the role of these devices in the learning process is still a matter of debate. In many educational institutions, smartphones are viewed primarily as a distraction that negatively affects concentration and academic achievement. This leads to restrictions or a complete ban on the use of these gadgets.

At the same time, pedagogical practice and scientific research demonstrate the significant potential of mobile devices as an effective learning tool. The introduction of technology contributes to the transformation of traditional teaching methods by diversifying the ways of presenting material, increasing student motivation, and engaging them in active learning activities. Smartphones provide ample opportunities for working with multimedia content, performing interactive tasks, conducting research, and creating their own learning projects. Their use is especially relevant when studying topics related to digital technologies. In this study, we will consider the topic "Multimedia", as it is the most controversial. At the current stage of information technology development, most 8th grade students

CTE 2024: 12th Workshop on Cloud Technologies in Education,
co-located with the 6th International Conference on History, Theory and Methodology of Learning (ICHTML 2025),
May 12, 2025, Kryvyi Rih, Ukraine
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already have basic skills in working with multimedia. Children actively use smartphones, tablets and personal computers, and are familiar with the basic functions of creating, editing and publishing photos, videos and sound.

This gives rise to **the research hypothesis** that there is a significant discrepancy between the content of the topic "Multimedia" in the current computer science curriculum for grade 8 and the existing practical competencies and real needs of students, due to their experience of using modern digital devices (including smartphones). This requires clarification of some of the program material of the secondary school computer science course (Ukraine).

This study aims to analyze the current role of smartphones in the educational process, identify their potential as instructional tools, and develop a methodology for their effective use in Grade 8 computer science lessons on the topic of "Multimedia". There is a considerable amount of research confirming the effectiveness of mobile learning (m-learning). The use of smartphones contributes to the implementation of an individualized approach to learning, the development of independent work skills and the formation of students' digital competence, which is a key requirement of modern education. Despite these advantages, the widespread use of mobile technologies in schools remains limited due to insufficient methodological development of their use.

2. Potential and challenges of using m-learning in education

Mobile learning (m-learning) is one of the types of distance learning in which the process of accessing learning content using portable devices such as smartphones and tablets provides flexibility and the ability to learn anytime and anywhere [5]. The technical implementation of mobile learning (m-learning) varies depending on its educational objectives – be it microlearning, skills training, collaborative activities, or formative assessment. For example, adaptive platforms like *EdApp* or *Duolingo* are suitable for personalized skill development, whereas tools such as *Padlet*, *Jamboard*, or *Google Workspace* support real-time collaboration.

Regardless of its purpose, a typical m-learning system architecture includes the following core components:

- **Learning Management System (LMS)** or mobile application with a responsive interface;
- **Content storage**, either local or cloud-based (e.g., *Google Drive*, *OneDrive*);
- **Communication tools**, including messaging platforms, video conferencing, and discussion forums;
- **Progress tracking tools**, such as integrated quizzes and activity analytics;
- **User interface** designed following principles of minimalism and digital accessibility;
- **Security mechanisms**, including authentication, access control, content filtering, data encryption, and privacy protection in accordance with child data regulations.

One of the most effective approaches to implementing mobile learning in educational institutions is the concept of "Bring Your Own Device" (BYOD) [6, 7], which is widely used in foreign schools and universities. This model allows students to use their own mobile devices for educational purposes, which contributes to the personalization of the learning process, reduces the cost of purchasing school equipment, and increases student motivation to learn [8]. At the same time, the practical application of BYOD requires solving some challenges [9].

Recent international studies confirm the effectiveness of using mobile applications and tablets in early childhood and primary education, particularly in teaching science and mathematics [10, 11]. In Ukraine, mobile learning is gradually being introduced at all levels of education, from pre-school to higher education, ensuring the continuity of the educational process and increasing its efficiency. This is especially true in times of war, when traditional forms of education may not be available. The use of mobile technologies allows students and teachers to adapt to these challenges. At the school level, mobile technologies are actively used in both distance and blended learning formats. One of the key projects is the All-Ukrainian Online School [12]. It provides students in grades 5-11 with access to educational materials through mobile devices. Initiatives are also being implemented to support children in crisis. For example, primary schools use mobile applications such as "Can't Wait to Learn" to help children learn math and reading even in bomb shelters [13].

University education also actively integrates mobile learning into the educational process by developing new methods [14]. At the same time, mobile applications are widely used to teach Ukrainian as a foreign language at medical universities [15]. It demonstrates the effectiveness of digital technologies in specialized education. In addition, smartphones are becoming an essential tool in scientific activities [16, 17].

Based on the above facts and analysis of scientific sources, we will highlight the advantages of mobile learning, such as

1. Mobile devices, as an important client component of cloud technologies, provide access to educational resources anytime, anywhere [18]. This is especially important for students in remote areas or with limited access to educational materials [19].
2. Multimedia content and interactive technologies increase the effectiveness of learning [20, 21, 22, 23, 24]. Educational applications, virtual simulations, and gamified quizzes make complex concepts more visual, promote a deeper understanding of the material, and increase student motivation [25].
3. An important advantage of mobile learning is uninterrupted communication between students and teachers. Thanks to messengers and collaboration platforms, children can get advice, work on projects, and participate in discussions [26]. Mobile learning can foster a sense of connection and community for children studying remotely [27].
4. Adaptive educational applications that use artificial intelligence algorithms allow for personalized learning, taking into account the individual needs and pace of each student [28, 29, 30, 31]. If a student has difficulty understanding a certain topic, the app can offer additional materials or tasks to consolidate knowledge. It also facilitates learning for children with special educational needs [32].
5. Mobile learning contributes to the development of digital literacy. It is essential for successful integration into the modern digital society. Students who actively use mobile technologies in their learning acquire skills in working with digital tools, analyzing information and critical thinking [33].

However, many scholars also discuss the challenges of this learning format. Among them, we can distinguish the following themes.

- Cell phones are a significant distraction during school, negatively impacting academic performance. Multitasking leads to lower test scores and memory impairment [34].
- Unequal access to the Internet and devices creates a digital divide, especially in rural areas. This exacerbates educational inequalities by limiting students' opportunities [35].
- Mobile phones can be used for cyberbullying and the dissemination of inappropriate content. There are risks to data privacy [36].
- Teachers lack the expertise to use mobile technologies effectively. Many are wary of this type of learning [37]. Therefore, it is advisable to introduce effective models for training future and retraining practicing teachers.

3. Development of a methodology for studying the topic "Multimedia" based on m-learning

As the above studies show, mobile devices are widely used by students in everyday life. However, their potential as a learning tool remains underutilized [38]. This is especially true for teaching computer science, where a significant number of topics related to digital technologies can be effectively supplemented by mobile applications [39]. One of these topics is “Multimedia”. It is currently taught in 8th grade in Ukrainian schools. The curriculum involves familiarizing students with digital images, audio and video files, their formats, processing principles, and the use of appropriate software. The traditional approach emphasizes the use of desktop computers, while modern mobile devices already contain built-in tools for working with multimedia. This opens up the possibility of creating an interactive and practice-oriented learning process that can be implemented even in schools with limited technical equipment. Before developing a methodology for teaching the topic “Multimedia” in grade 8, a study was conducted to identify the current state of use of mobile devices in the educational process and to determine effective approaches to their integration into computer science education. The study used methods such as analysis of curricula and textbooks, observation of the actual learning process, student surveys, and statistical methods for processing questionnaire data.

3.1. Study of the impact of smartphones on the educational process

To identify the current problems, a questionnaire was developed that included general data collection (age, gender, smartphone ownership, etc.), educational aspects (use of smartphones in general and in computer science classes, self-assessment of distraction, etc.), and the current level of knowledge on the topic of Multimedia. The results of the survey are available at the link https://docs.google.com/spreadsheets/d/1bo5i6BB21MoAksytIK2zjJd1AMFUo_FYWsC7OREiaoI.

The survey involved 202 students (Ternopil district, Ternopil region, Ukraine), with an average age of 12.46 years, mode and median of 13. All respondents study at a basic school (grades 5-9). The availability of smartphones among students is almost total (99.5% of students have their own device). Two participants reported that they were only allowed to use a smartphone at home. Despite this, almost all respondents have access to mobile devices, which creates potential opportunities for their use in the educational process. Diagram (figure 1) shows that only 6% of students use a smartphone for less than 1 hour a day. In addition, smartphones are ranked first in terms of daily use (98.5%). This shows that this device plays an important role in children’s lives. The second and third places are taken by laptops and personal computers. We believe that students use these devices for more complex tasks that require larger screens and multitasking.

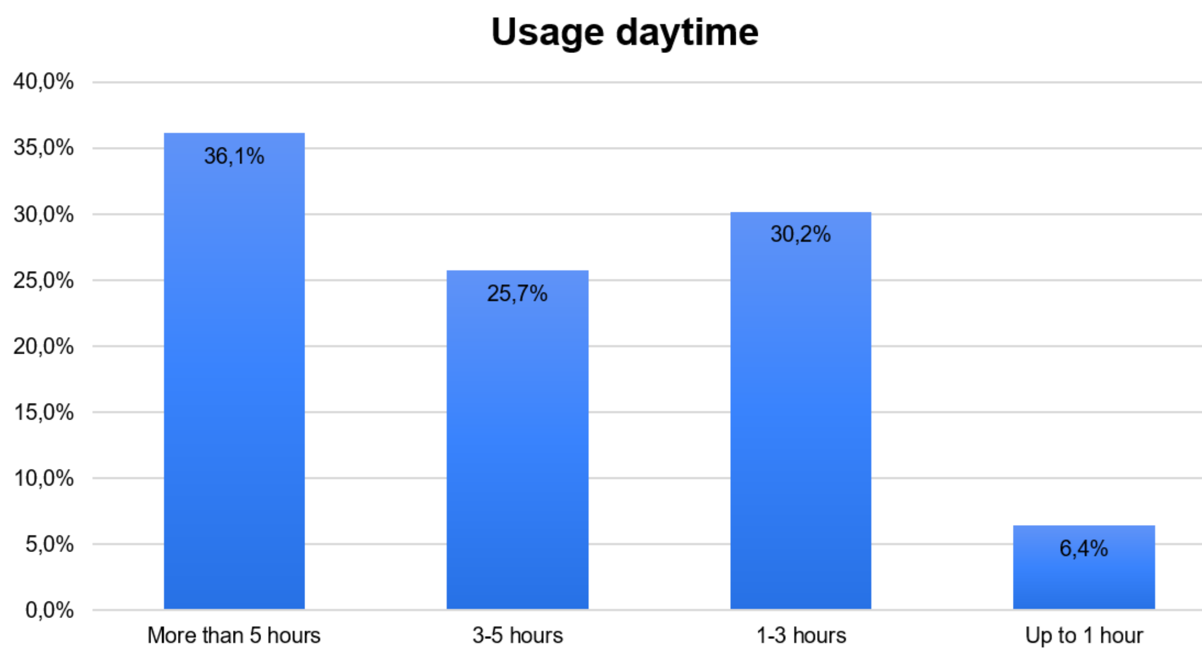

Figure 1: Time students use a smartphone during the day.

We analyzed the purposes of using smartphones by students in each of classes (table 1).

Table 1
Frequency of using smartphones.

Grade	Social networks	Study	Games	Content creation	Watch videos	Listening to music
5	0.906	0.406	0.563	0.344	0.750	0.750
6	0.667	0.500	0.548	0.262	0.619	0.619
7	0.943	0.543	0.629	0.286	0.657	0.657
8	0.880	0.580	0.580	0.340	0.640	0.640
9	0.860	0.442	0.674	0.326	0.698	0.698

The table 1 shows that the most respondents use smartphones for social networking. Only the 6th grade shows a moderate frequency of this choice. Also, everyone who uses a smartphone to watch videos also uses it to listen to music.

The next stage of the analysis was to study the use of smartphones in the educational process. Based on student responses, a rating of the most used apps was compiled. NaUrok was the leader among students' responses, with 78.2% of them choosing it, and Vseosvita with 49.5%. These Ukrainian services specialize in online testing in various subjects. Thus, we can say that students most often use smartphones for educational purposes to take tests. This is also confirmed by the histogram of smartphone use in computer science classes (figure 2). According to this histogram, taking tests and searching for information are the two main and most obvious uses of smartphones.

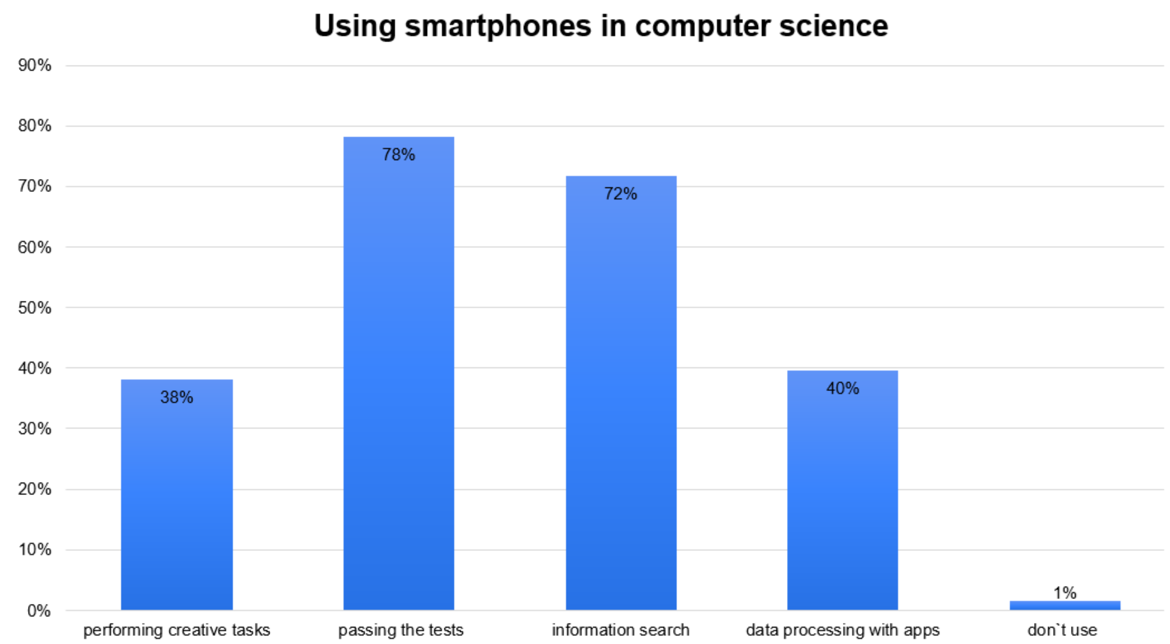

Figure 2: Using smartphones in computer science lessons.

To assess statistically significant differences in smartphone use policies among students of different grades, χ^2 tests and analysis of adjusted residuals were conducted. The following χ^2 test results were obtained $\chi^2 = 36.17$, p-value = 0.003 for degrees of freedom df = 16. This allows us to accept the alternative hypothesis that a relationship exists between class and permission to use smartphones in education. Additional Cramer's V was used to determine the strength of this relationship (effect size). Its value of 0.212 indicates a weak relationship.

To determine in detail the impact of each of the indicators of policy ("All", "All except control", "Several", "Only in computer science", "Not allowed at all"), the analysis of adjusted residuals was used.

The results were visualized using a heat map (figure 3).

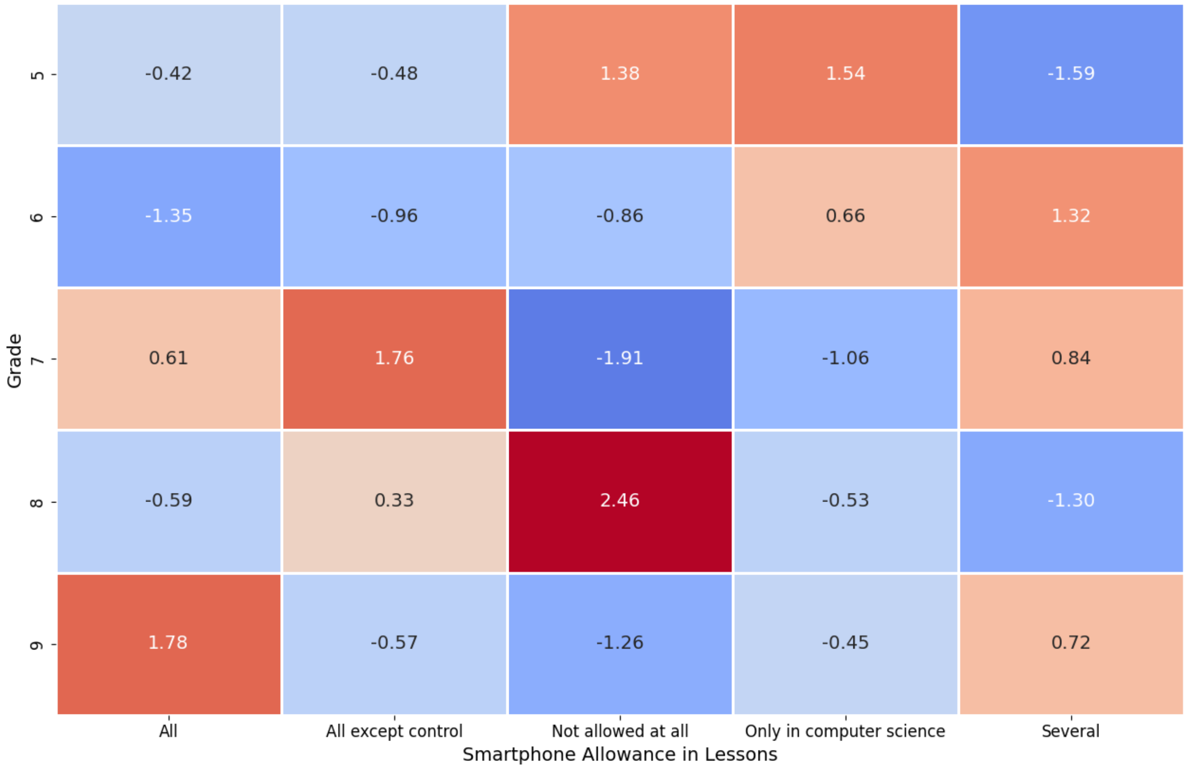

Figure 3: Heatmap of adjusted residuals (significance in smartphone allowance by grade).

In it, the numerical values of the residuals reflect the deviation of the actual number of responses from the expected number under conditions of random distribution. In other words, the heat map shows how the rules (policies) for using smartphones change from junior to senior high school. Positive (red squares) values indicate that the value of the indicator exceeds the expected value, and negative (blue) values indicate a decrease.

Analyzing the heat map (figure 3), we conclude that in the lower grades there is a higher level of outright bans on smartphone use, which is weakened by grade 7. However, this policy is not observed in grade 8. This is due to a strong positive residual for the indicator "Not allowed at all" (+2.46). Then, in grade 9, the trend toward a decrease in the total ban on smartphone use continues. Similar nonlinear fluctuations in residuals are observed for the indicators of full permission and use in several or control lessons.

These results can be explained by the fact that the surveyed students study in different schools with different policies on smartphone use. Therefore, children have different experiences of using smartphones in learning, which is confirmed by statistically significant differences in the results. Even within the same school, teachers of different parallel classes have different approaches to the use and control of digital devices, due to the lack of an approved unified policy on the rules of their use. In addition, students have different experiences with smartphones, which also affects their answers to this question.

Another factor that influences the results is the New Ukrainian School. It is the reform that is currently underway in Ukraine. Students in grades 5-7 are now studying under it. One of the key provisions of the reform is the implementation of interactive tasks for which children use smartphones and increasing the autonomy of using a smartphone with each class for students. As can be seen from the heat map (figure 3), there is a connection between classroom and smartphone use permissions in computer science classes. It indicates a certain consistency within our sample of the requirements of teachers who teach computer science in different schools and grades.

The next task is to study the level of distraction from smartphones during studying. Analyzing the questionnaire data, we conclude that almost half of the students (47.5%) claim that smartphones do not affect their concentration during studying, while 3% constantly feel that gadgets prevent them from concentrating. We also analyzed the impact of the classroom on the level of distraction. The calculated value of the $\chi^2 = 11.46$, $p = 0.490$ shows no relationship between class and distraction. This is also evidenced by the graphical representation (figure 4). The chart shows a tendency to increase ("sometimes" in grades 6 and 7) or decrease the frequency of distraction by smartphones ("sometimes" in grades 7 and 8) with the increase in grade level. Lower grade students (5th grade) are more likely to report that they are never or rarely distracted, while upper grade students (8th and 9th grade) are much more likely to report that they are rarely or sometimes distracted.

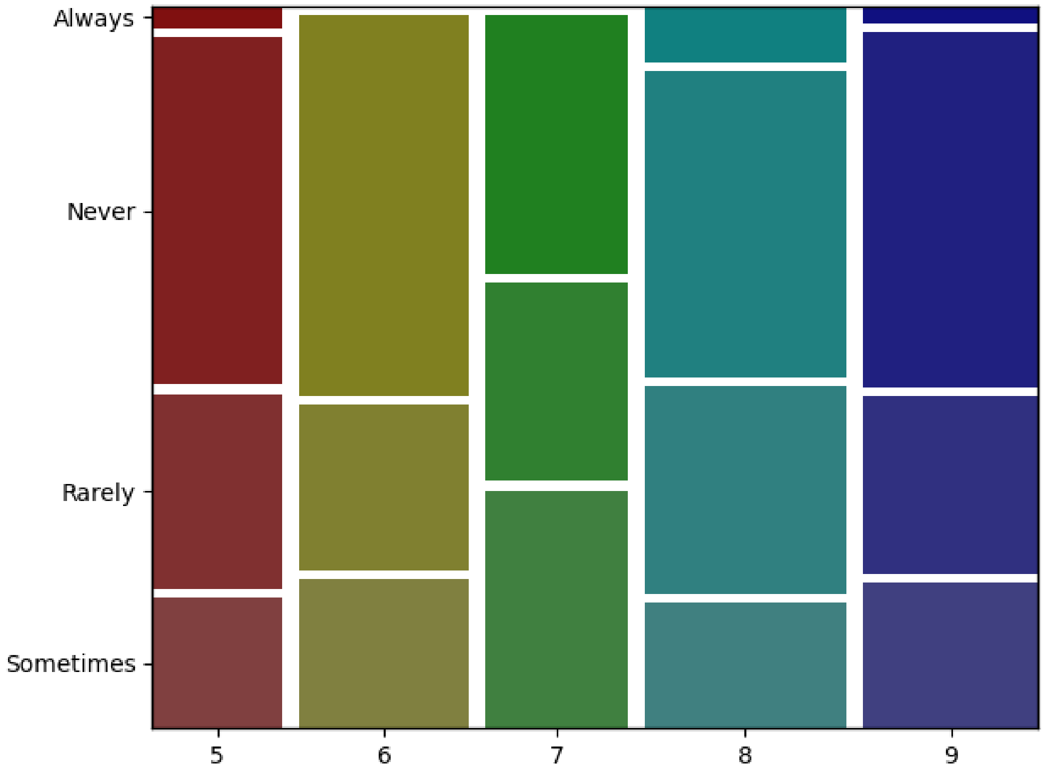

Figure 4: Ratio of student distraction levels at each grade.

At the same time, the category "always" remains the least common answer for all age groups represented in the graph. These results can be explained by the fact that students are generally not inclined to recognize their "addiction" to gadgets. In our opinion, a separate study is needed to investigate this effect.

A scatter plot (figure 5) was created to test the relationship between the level of distraction and the frequency of smartphone use in computer science classes. We transformed the answers to the question "How often do you get distracted in class?" into a numerical format (0 – "never distracted", 3 – "always distracted").

The figure 5 shows that the highest level of distraction is observed in the group of students who use smartphones "Very often (every lesson)". The average distraction rate for this group is the highest (M = 1.22) compared to the others. Gadgets have the least impact on the students who use them once a month (M = 0.55). The groups of students who use smartphones "Often (every second lesson)" and "Sometimes (2-3 times a month)" showed intermediate average levels of distraction (M = 0.84 and M = 0.78, respectively). The variability of responses in these groups was also significant (ranges 0-2 and 0-3, respectively), although somewhat less than in the "Very often" group. Summarizing, we conclude that there is a positive relationship between the frequency of smartphone use in computer science classes and the level of overall distraction. This phenomenon may be due to the lack of proper

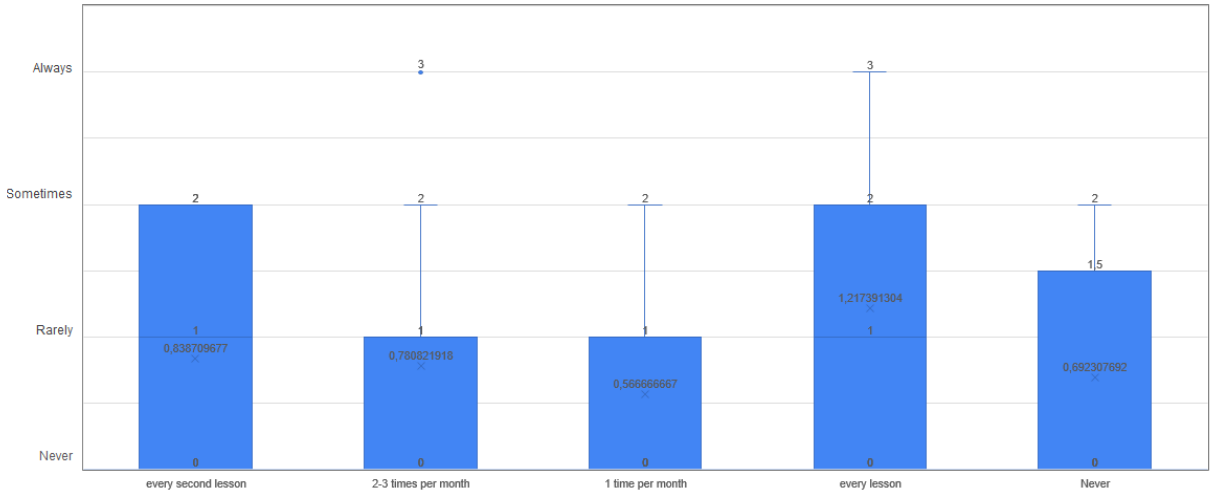

Figure 5: Ratio of student distraction levels in each classroom.

Table 2
Self-assessment of students' multimedia skills.

Grade	Finding an idea	Scenario writing	Shooting video clips	Trimming video	Adding animation	Adding transitions	Adding text	Creating video intro	Recording audio	Applying sound effects	Nothing of this
5	0.656	0.500	0.438	0.688	0.500	0.563	0.750	0.219	0.438	0.344	0.094
6	0.619	0.405	0.476	0.810	0.524	0.381	0.810	0.333	0.524	0.548	0.048
7	0.571	0.371	0.400	0.886	0.571	0.543	0.943	0.343	0.600	0.657	0.029
8	0.680	0.380	0.520	0.860	0.620	0.600	0.840	0.420	0.620	0.800	0.160
9	0.791	0.442	0.465	0.884	0.465	0.605	0.814	0.442	0.581	0.512	0.047

organization and control over the use of smartphones for educational purposes. As you can already see from figure 2, the most common ways to use smartphones are to take tests and search for information. These activities usually take different amounts of time for different students, and if the tasks are set incorrectly, it is quite common for some children to have already completed the task and spend time at their own discretion. This is confirmed by the significant variability of indicators in the "Very often" category.

The third part of the questionnaire included the experience of using smartphones specifically for creating/editing multimedia. Since this topic was chosen because of the hypothesis that the content was not relevant, the Ukrainian State Standard and curricula were analyzed before developing the questionnaire. On this basis, the expected outcomes of this topic were identified, such as building a video sequence, cropping individual elements, adding transitions and simple animations between video fragments, adding text, recording sound, changing the length of an audio track. The frequencies of answers to the questionnaire about students' mastery of these skills are shown in table 2.

According to the table, we see that in most areas, students' awareness of the stages of creation increases in each grade. However, if we consider separately the 7th grade (these students have not yet studied this topic at school) and the 8th grade (students who took it less than 2 months ago), it is noticeable that the increase in values is very small, or absent altogether. This is especially noticeable in the areas of trimming videos and adding text. At the same time, the positive increase is very evident in the area of shooting video fragments, applying effects and searching for ideas. We believe that children tend to choose these answers more often due to attempts to use these skills in computer science lessons. Most teachers ask to use their own video and sometimes audio fragments as evidence that this is really the student's work. Adding simple video fragments is part of the expected skills according to the current curriculum, and the search for ideas, as can be seen, is also growing in the 9th grade, so we assume that this variable depends not so much on the specific computer science lessons as on the involvement of students in school parliaments, the school press and in general the general activity of students and their inclusion in various spheres of social, cultural and personal life. The fact that approximately 16% of 8th grade students after completing this topic claim that they do not have any of the listed skills is also thought-provoking. The lack of motivation of 8th grade students for this course after studying it is also evidenced by the highest rate of the answer "Not at all interesting" among all grades to the question about interest in studying this topic (figure 6). Considering this figure, we can assume that this is due not so much to students' awareness in this area as to the lack of motivation to study due to previous experience.

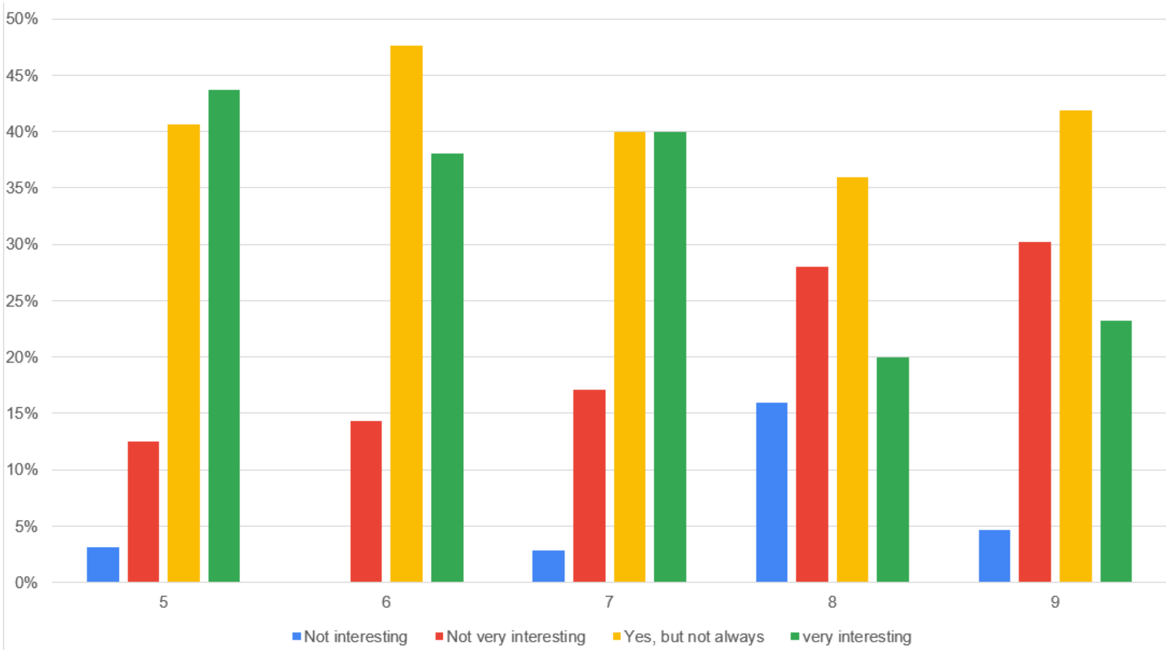

Figure 6: Student interest in learning multimedia.

To study in more detail the impact on students' interest in learning multimedia, regression was used as a method of analyzing the questionnaire data. In this case, interest in learning the topic was considered as a dependent variable, and class, use of smartphones in computer science lessons, and previous experience of using them were independent variables. We used linear regression. In it, all variables were transformed to numeric as follows:

- interest_ordinal from "Not interesting" is 1 to "Often" is "very interesting";
- experience_ordinal from "No" is 1 to "Often" is "3";
- using_CS_ordinal from "Never" is 1 to "every lesson" is "6".

The tidyverse library of the R language was used to build a linear regression. A summary of fitting linear models is given in table 3.

As can be seen from table 3, there is a positive effect of the frequency of smartphone use in computer science lessons on students' interest in learning multimedia. For example, an increase in the frequency of using a smartphone by 1 unit on the nominal scale of the independent variable using_CS_ordinal results in an increase in interest by 0.067 units on the ordinal scale of the dependent variable. This value is relatively small. We can assert a statistically significant, albeit small, effect of this factor.

Table 3
Summary fitting of liner model.

	Estimate	Std.Error	P-value
using_CS_ordinal	0.067	0.032	0.042
experience_ordinal	0.015	0.087	0.862
grade	-0.177	0.045	0.000

As the second row of the table shows, there is no significant effect of students' experience with video editing on their interest in learning multimedia. The reason for this may be the fact that students' interest in learning multimedia is driven by other factors (desire to get a good grade, to go to university) rather than by previous experience with smartphones. The third row of the table shows the negative effect of the class factor on interest. That is, for each increase in the class number, interest decreases by about 0.18 units on the scale of the interest_ordinal variable. Despite the overall significance ($p < 0.001$) of the multiple $R^2 = 0.080$ model, the summary shows that only 8% of the variance of the dependent variable is explained by the selected factors. This is a rather low figure, indicating limited predictive power. Other unmeasured factors (e.g., teaching style, peer influence, access to tools, etc.) may have a greater impact on student engagement as well.

To visualise the regression model, a graph of the dependence of predicted interest on the frequency of smartphone use in computer science lessons for each class (figure 7).

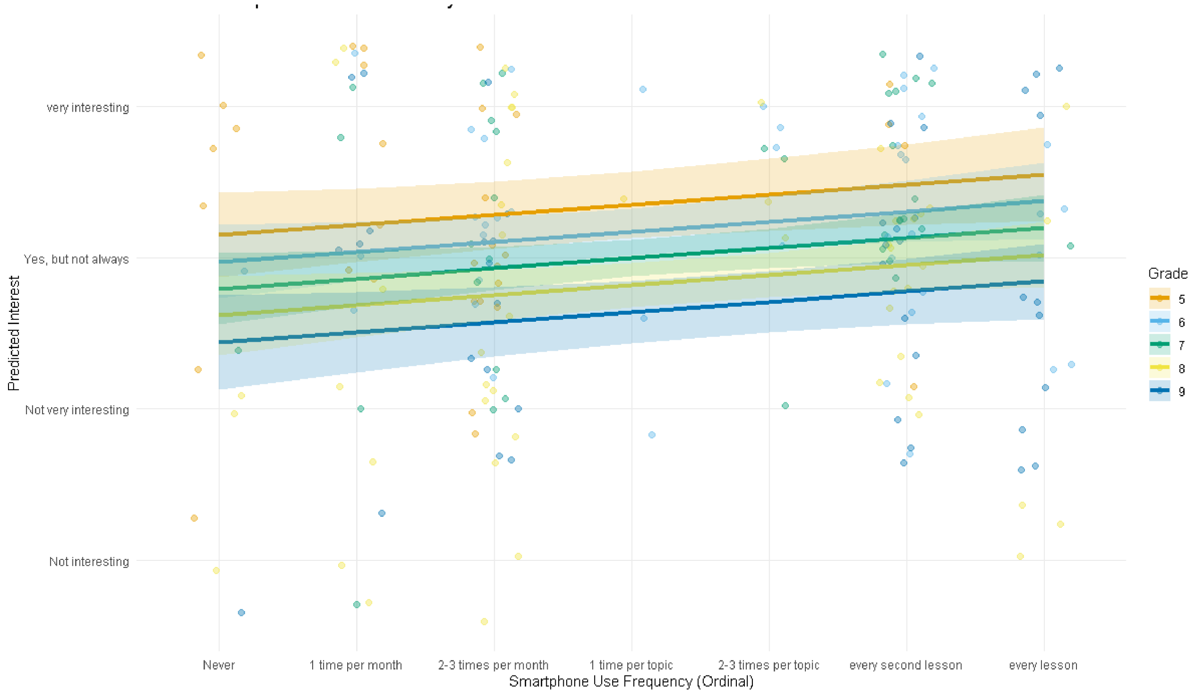

Figure 7: Effect of smartphone use on interest by grade.

As can be seen from figure 7, all of the level lines have a slight upward slope. This indicates that more frequent smartphone use in computer science lessons is associated with a slightly higher interest in multimedia learning. Students in grade 5 (orange line) show the highest predicted interest in learning across all measures of smartphone use. Grade 9 students (dark blue line) typically have the lowest predicted interest. The graph is consistent with the regression model, in which grade has a negative coefficient (older students show lower predicted interest). The lighter shading of the areas adjacent to the lines indicates some uncertainty in the model. The intervals widen somewhat in extreme cases (e.g., for the indicators "Never" or "Every lesson"). This uncertainty indicates a small number of respondents who chose an extreme value. The figure also shows outliers related to students in grades 8-9, who indicated a high level of smartphone use but a low level of interest in learning multimedia. In general, the scatter plot and regression lines indicate that neither the "frequency of use" nor the grade are reliable predictors of interest in learning multimedia.

3.2. Development of a methodology for studying the topic "Multimedia"

The analysis of the current 8th grade computer science curriculum and the results of the survey revealed a significant discrepancy between the expected goals of studying the topic of "Multimedia" and the educational needs and actual level of digital literacy of modern students. In order to overcome the identified contradictions and increase the effectiveness of learning, an alternative teaching methodology was developed that does not reject the requirements and goals of existing curricula, but changes the approaches by which they are achieved. The methodology is based on the principles of an activity-based approach [40], project-based learning [41], universal learning design [42], and the integration of mobile learning technology [43, 44, 45, 46, 47]. The pedagogical feasibility of the proposed methodology is to shift the emphasis from reproducing technical operations to developing key competencies in a context close to real-life situations and potential interests of students. Based on these data, we developed each lesson's purpose, expected results, and general plan (table 1). Most class time (about 75%) is spent on practical skills. Unlike performing isolated exercises, students work on creating a comprehensive multimedia product (short video narrative, training videos using scribing, audio works). Work on the project includes all stages, from generating an idea and writing a script to shooting/recording, editing, and post-production. Studying this topic aims to develop students' key and subject competencies by familiarizing them with the basics of working with multimedia technologies and developing skills in their practical application for creating, editing, and presenting multimedia content.

The table 4 contains components of the methodology we have developed for using mobile technologies in teaching the topic "Multimedia".

Table 4: Component of authors' methodology.

#	Lesson topic	Summary	Forms of organization	Methods	Tools	Knowledge Test
1	Definition of multimedia, their importance in the modern world	Types of video files, their formats, features of use. Overview of video editors. Analysis of common mistakes in video works.	Frontal (discussion, demonstration), Group (video analysis), Individual (completing test tasks, registering on platforms)	Discussion, problem-search method, demonstration, analysis of examples	Web page, video with examples of errors (YouTube)	Practical analysis of errors in videos, search for information about basic video requirements, reflection (discussion of the importance of the topic). GR1, GR4.
2	Basics of creating video works	Learn how to plan an idea for a video. Features of shooting for different purposes (blogs, presentations). The basics of shooting on a smartphone (camera settings, lighting). Search for copyright-free videos.	Frontal (discussion, explanation), pair work (video shooting), group reflection (analysis of classmates' videos)	Explanatory and illustrative (demonstration of examples), interactive (discussion, self-assessment), problem-search (video analysis), practical (video shooting).	Web page, Video snippets for demonstration, Wordwall, smartphone cameras	Self-assessment and analysis of videos, determination of emotions by viewers, discussion of the choice of technical settings. GR2, GR3.

3	Installation basics	The main tools of the video editor. Working with video fragments: cropping, applying effects, transitions. Use of UGC content and copyrights.	Frontal (analysis of video instructions), group work (video creation), presentation of works (analysis and evaluation)	Inverted class, explanatory and illustrative, practical.	Web page, video instructions, video editor, school supplies (objects for video review)	Presentation of ready-made videos, self-assessment and mutual evaluation according to criteria, discussion of difficulties in work
4	Audio in multimedia	Sound recording basics: types of microphones, features of sound recording for video. Overview of sound editors. How to record clear sound at home. AI as one of the ways to create sound.	Frontal (explanation, demonstration), group (creating audio fragments), individual (working with audio effects)	Demonstration (microphones, AI generators), practical (audio creation and editing), partial search (audio quality analysis), project (creation of a joint product).	Web page, Microphones (if available), online voice generation services, VN editor (to add audio effects)	Self-assessment of recording quality, presentation and analysis of the created audio fragments, discussion of the choice of dubbing methods
5	Scribing as a method of explaining complex concepts	The concept of scribing, its meaning. Text and audio visualization.	Frontal (explanation, demonstration), Individual (work in Canva)	Demo (scribing samples), practical (video creation)	Canva webpage, service or app, Audio recordings from the previous lesson	Presentation of finished works, Self-assessment of the quality of scribing
6	Project activity: development of a video idea	Forming groups, discussing ideas for video projects, creating scripts.	Group work. GR1	Project method, brainstorming	Smartphones, online documents, video editors, audio and video files	Comprehensive project assessment according to the established requirements
7	Project activity: shooting	Shooting video materials for projects, using multimedia technologies.	Practical work. GR4.	Observation method, exercise method	Smartphones, online documents, video editors, audio and video files	Comprehensive project assessment according to the established requirements
8	Project activity: installation	Video editing, adding sound, effects, titles.	Practical work. GR3	Project method, interactive method	Smartphones, online documents, video editors, audio and video files	Comprehensive project assessment according to the established requirements

9	Completion of the project. Publishing videos on streaming platforms	Completion of projects, preparation for presentation.	Practical work. GR3	Project method	Ready-made video projects, YouTube service	Comprehensive project assessment according to the established requirements
10	Project presentation and thematic evaluation	Presentation of projects, evaluation of works. Reflection: what you learned, what tools were the most interesting.	Group work, presentation. Comprehensive work on all 4 groups of results.	Method of reflection, method of mutual assessment	Multimedia projects of students, projector	Comprehensive project assessment according to the established requirements

The assessment of academic achievements has also undergone changes. Starting next year, eighth-graders will study according to the New Ukrainian School reform. Therefore, in this methodology, we focus on assessment by groups of results. Instead of assessing only the final product, we use a comprehensive approach that considers the development of student competencies at different stages of their work on the project. The practical tasks that students perform during the lessons are divided into the groups of outcomes that students develop during practical work, and an assessment table has been designed for project activities (table 5). This table is also available to students as a guide to the main requirements for the activity.

Table 5
Criteria for assessing students' learning achievements according to the author's methodology.

Evaluation criterion	Score
GR1. Works with information, data, models.	
The scenario of the video is logically structured, has an introduction, a main part and an ending.	2
The created scenario is based not only on selected fragments of the text, but also on your own thoughts on the topic. In the video, the student not only expresses his opinion, but also confirms it with scientifically proven facts.	2
GR2. Creates information products.	
All technical aspects are done with high quality (correctly adjusted video contrast, lighting, framing).	2
Editing effects are appropriate, they emphasize the overall mood of the video.	2
It is advisable to use animation elements, displays, stickers, etc. to emphasize the narrative.	1
GR3. Works in a digital environment.	
The student can explain all the stages of video creation, disassemble the finished project into separate frames, explain what editing techniques should be used to achieve a certain result.	2
A student can complete all of the above steps.	3
GR4. Safely and responsibly works with information technologies.	
All data used in the video has a verified source.	1
All videos used in the video are created by the child, or uploaded without copyright infringement.	1

The next step in developing the methodology was to select the learning tools. Although the methodology focuses on the use of smartphones, and their use is almost ubiquitous, not only applications but also services accessible from any device were chosen to ensure that the principles of the UDL are implemented. The following criteria were taken into account:

- availability for both iOS and Android systems;
- possibility of online and offline use;
- easy navigation;

- free access to the functionality;
- no ties to the occupying country and the absence of the developer in the list of sanctioned organisations in Ukraine.

VN as an application and Vimeo as a service were selected as video editors. Among the audio editors, we selected the voicegenerator.io service and the Video Voice Changer app. These resources were chosen because they have the ability to change the voice and this is the feature that children will use. Canva was chosen as a tool for creating scribbles, both as a service and as an application, because children are familiar with its functionality and can focus on the process of creating.

The next step was to develop the content of the course such as theory, interactive tasks, instructions for practical work, video work, etc. (figure 8).

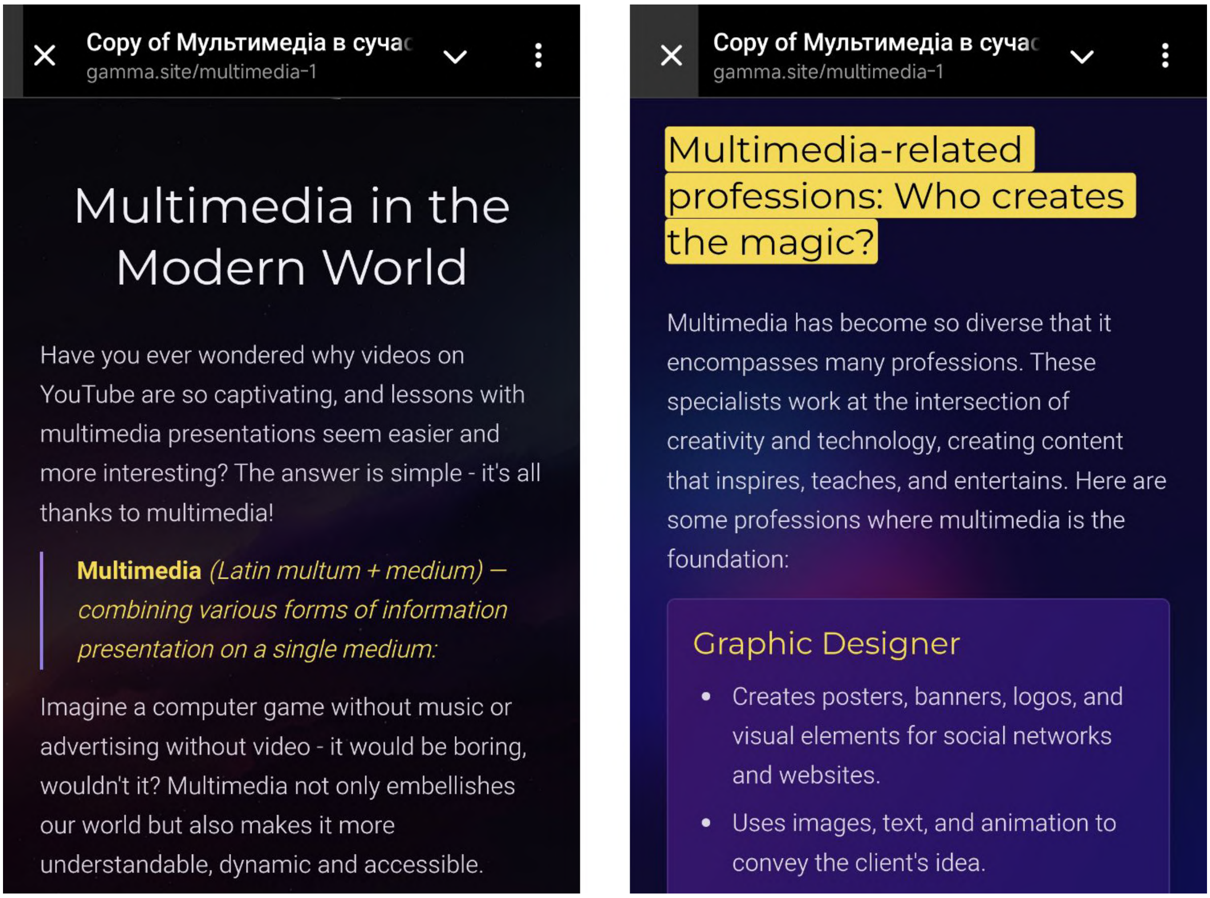

Figure 8: Learning material on a student's smartphone screen.

As many studies have already confirmed, modern learners have difficulty perceiving educational material that is presented orally or in text format. Therefore, it is important to use different types of information presentation. Since this topic focuses on the study and use of multimedia, it is a good approach to use different types of media. In this case, in addition to information about this area, children will receive real examples of application. The central element of the methodology is the 'flipped classroom' model, which optimises the use of class time. Instead of a traditional lecture, students work on the theoretical block outside the classroom using specially prepared training materials posted on the website. These materials are developed with the principles of universal design thinking in mind and are presented in various formats: short video lectures explaining key concepts (e.g. framing, editing transitions); interactive web pages with textual explanations, illustrations and examples; links to external resources. This allows students to work at their own pace and the teacher to devote classroom time to hands-on activities and individual advice.

Modern web page editors make it as easy as possible to organise information and create interesting material without any additional skills. One of these options is the Gamma service, which we chose because of its interactive features and the availability of templates that greatly simplify content structuring and ensure quick adaptation to changes. The main focus was on visual consistency and logical presentation of the material, which allows students to navigate the information better using the blocks. Another advantage is the correct display of the webpage on different devices, including smartphones and PCs (figure 8 and figure 9).

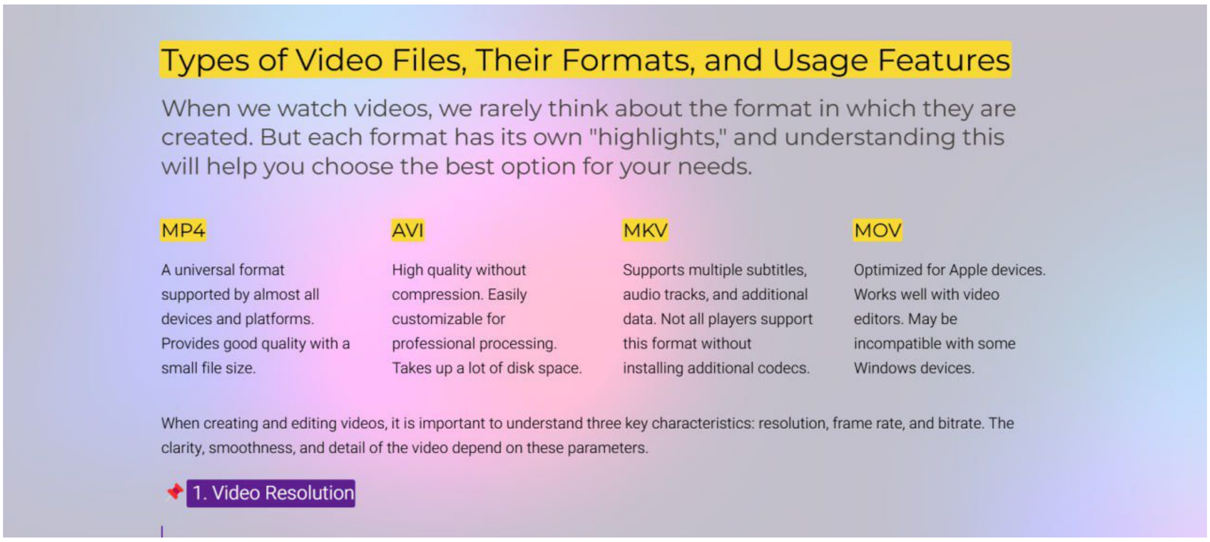

Figure 9: Learning material created with Gamma.

4. Conclusions

The study confirmed the relevance of the problem of integrating mobile devices into the educational process of secondary education and revealed significant shortcomings of the traditional approach to studying the topic of "Multimedia" in grade 8. The analysis of the curriculum and the results of student and teacher questionnaires revealed a gap between the content of education, which often focuses on outdated or already mastered technical skills, and the real needs and interests of modern students. The developed and theoretically substantiated methodology for studying the topic "Multimedia". The technical implementation of the methodology is based on an adapted mobile learning (m-learning) architecture that incorporates the BYOD model. Google Classroom was used as the LMS, providing access to assignments, instructions, and student submissions. Theoretical content was delivered through the Gamma platform, which supports multimedia content, visual consistency, and optimization for mobile devices. Learning materials and student projects were stored on Google Drive (for private interaction within the Google Classroom environment) and published via YouTube, which ensured convenient access and a variety of content formats. The proposed approach has a number of key advantages. In particular, it helps to increase the relevance and motivation of learning by shifting the focus to the practical application of multimedia technologies, introducing modern professions and using mobile devices familiar to students. The effective organisation of the learning process is achieved through the 'flipped classroom' model, which frees up time for active practical work. In addition, important advantages include ensuring individualised learning through the application of UDL principles and bridging the gap between formal education and students' informal digital experience by using their existing smartphone skills as a basis for further development. At the same time, the successful implementation of the methodology requires consideration of potential challenges, such as the development of students' self-organisation skills and adequate methodological and technical training of teachers. The primary task of further work is to experimentally test the developed methodology in real-life conditions of Ukrainian schools to quantify and qualitatively assess its effectiveness compared to traditional teaching. In addition, it is advisable to explore the possibilities of adapting the proposed approach to study other topics of the computer science course or other subjects.

Declaration on Generative AI

While preparing this work, the authors used ChatGPT by OpenAI to rephrase and improve their own text. Google Gemini was also used to search for relevant literature. All content generated with the assistance of AI tools was reviewed and edited by the authors, who take full responsibility for the article's final version.

Author contributions

Conceptualization, Vasyl P. Oleksiuk and Julia A. Overko; methodology, Vasyl P. Oleksiuk; software, Vasyl P. Oleksiuk and Julia A. Overko; writing – original draft, Julia A. Overko; writing—review and editing, Vasyl P. Oleksiuk. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Data availability statement

New experimental data have been created and shared via Google Drive. Relevant links are provided in the text of this paper.

Conflicts of interest

The authors declare no conflict of interest.

Acknowledgments

The authors express their gratitude to Serhiy Semerikov for many years of scientific, organizational, and technical support of the Workshop on Cloud Technologies in Education (CTE).

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