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Article

Modernisation of Fire Protection Education in Elementary Schools

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Abstract: The article deals with the issue of teaching fire protection in elementary schools in the Czech Republic. The area of fire protection is one of the key areas that everyone should be familiar with and it is important to teach children how to prevent fires and how to face fires in case of danger. Thus, this article analyses the current approaches of elementary schools to teaching fire protection and compares the data obtained with approaches in teaching abroad. The obtained comparison is complemented by conducting a questionnaire survey, which underpins the current trends and possibilities of modernising the teaching itself. The results are presented in the form of graphs and the design of a potential application based on the presented mobile applications available on common mobile platforms. The conclusions of the study are summarised in the final chapter, which points to the need to expand fire protection education and the use of modern technologies.

Keywords: application; education; elementary; fire; modernisation; school; protection

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1. Introduction

Fire has benefited the human population since time immemorial, but the saying "good servant, bad master" still applies. According to the statistical yearbook of the Fire Rescue Service of the Czech Republic [1], a total of 17,753 fires occurred in the Czech Republic in 2023. Many people believe that they will never be caught in a fire, but the opposite is true. A fire can occur anywhere and at any time. When a fire occurs, lives, property and the environment can be lost. Awareness of fire protection is very important in every age group. If one is fighting fires, there is a need to have fire protection awareness.

Children are naturally curious, which can lead them to explore their surroundings during a fire, so it is important to teach children about how to prevent and respond to fires. First and foremost, it is important to explain what fire is and how it can be dangerous. Children may not understand that a fire can spread quickly and cause serious damage to life and finances. Therefore, it is important to take an age-appropriate approach to teaching fire safety to children [2]. It is also important to explain 'how fire starts' and how to prevent it. Explain that there are three components of fire (heat, fuel, and oxygen), and that removing any of the elements can prevent a fire from starting or spreading [3]. The next step is to explain the fire evacuation plan, which is especially important to practice so that children learn and remember escape routes.

Regular drills are essential to ensure that pupils know how to react quickly and calmly in the event of an emergency. Exercises should be carried out with different scenarios. It is also important to explain how to move in the event of a fire (avoiding smoke inhalation, keeping low to the ground, etc.). In the field of firefighting, pupils need to be introduced to fire extinguishers, even though they should never handle fire extinguishers themselves, it is necessary to explain how they work.It needs to be explained that fire extinguishers

are suitable for small fires and should only be used when they have been briefed on safety. Last but not least, it is important to make pupils aware of emergency numbers so that they can call for help in time [4].

The teaching of fire protection in the Czech Republic is included in the Framework Educational Programmes, where subjects in which an introduction to fire protection should take place are allocated. In addition, elementary schools can use programmes such as Firefighters for Schools or Hasík. Usually, a visit by professional firefighters takes place once a year, but this is not always the case. Therefore, there is a need to come up with innovations in fire protection so that pupils themselves want to be educated in this area and do not take this issue lightly [5].

The importance and need for the development of teaching is supported by authors such as Moraru R. I. and Sroka M [6], who have addressed the improvement in fire protection teaching. In recent years, there has also been a growing trend in the use of modern virtual and augmented reality technologies. Even with reference to these technologies, more and more projects using one of the mentioned technologies are emerging, such as the development of experiences described by authors Ünal Çakiroğlu and Seyfullah Gökoğlu [7]. An abbreviated survey of this area is presented in Table 1 below, which includes selected academic publications.

Table 1. Publications.

Author and Year	Name	Methods	Output
Slana, J. et al. (2021) [8]	Education in the Area of Human Protection in Emergency and Crisis Situations in the Context of Health Education in the Czech Republic	Explanation, analysis	Results of an analysis of the curricular document governing elementary education in the Czech Republic (Framework Education Programme for Elementary Education), as well as the results of an analysis of a health education textbook focusing on the area of safety issues.
Septikasari, Z. et al. (2024) [9]	Needs assessment: strategy of integration disaster education at elementary schools in disaster prone areas	Explanation, analysis, qualitative research	Maximising integration disaster education strategies.
Sahudra, T. et al. (2024) [10]	The Importance of Elementary Teacher Understanding: A Study of Perceptions of Disaster Education Models in Indonesia	Explanation, qualitative research	The findings of this research can be used as a basis for developing appropriate disaster education processes for elementary school students.
Mystakidis, S. et al. [11]	Design, Development, and Evaluation of a Virtual Reality Serious Game for School Fire Preparedness Training	Explanation, modelling	The results indicate that the VR serious game is appropriate for training, providing challenge, enjoyment, and mastery.
Jang, D. et al. [12]	Development of a safety education program using simulator fire extinguishers in Korea: Focusing on elementary school students	Explanation, qualitative research, modelling	This study demonstrated that the safety education program using the 'simulator fire extinguisher' was effective in improving safety knowledge and problem-solving abilities.
Eslamzadeh M. K. et al. [13]	All Lives Matter: A Model for Resource Allocation to Fire Departments in Portugal	Explanation, metric analysis, modelling	This paper presents a method for optimising RAFD based on performance assessment results, examining its impact on Fire Department (FD) efficiency in Portugal.

Considering the potential of education with the help of modern technology, the aim of this paper is to present a modernised fire protection education connected with modern technologies such as smartphones or tablets which are accessible devices for schools.

2. Fire Protection Education in Elementary Schools

Fire protection is a set of measures and precautions aimed at preventing fire; minimising the harmful consequences of fire; and protecting life, property, and the environment. The issue of fire protection is anchored in Act No 133/1985 Coll., on fire protection. The act stipulates that every person has a duty to act in such a way as to prevent the occurrence of fire and to take the necessary measures to control it when it occurs. Fire protection includes technical and theoretical elements of fire prevention, which are based on regulations and standards in the field of fire safety [14].

Due to the development of new technologies, energy, transport and their subsequent impact on the environment, climate change (tornadoes, earthquakes, forest fires, etc.), it is necessary to keep up with the times and focus on the education of not only the members of the Fire Rescue Service of the Czech Republic, but also on the education of citizens.

Fire safety education for children is important and should not be neglected. In the Czech Republic, education in this field is carried out in accordance with the legislation and the Framework Educational Programme. Teaching is also carried out with the help of experts from the Fire Brigade of the Czech Republic, which also develops various applications and projects for schools. As part of the modernisation of fire protection education with the help of modern technologies, teaching could be made more interactive and children's interest in fire protection could increase.

The Framework Educational Programmes are issued and updated by the Ministry of Education, Youth and Sports of the Czech Republic in consultation with the relevant ministries. The Ministry of the Interior and the Fire Brigade of the Czech Republic are involved in teaching fire protection (located in the chapter Man, and his world). The Framework Curriculum for Elementary Education was updated in 2023, and the update focused mainly on the specific educational needs of foreign pupils. In 2021, the Ministry of Education, Youth and Sports revised the Framework Curriculum and the aim was to modernise the content to match the dynamics and needs of today. It focuses mainly on the field of computer science and the development of digital literacy of pupils [5].

2.1. School Education Programmes

Another important document is the School Curricula, which must be in line with the above mentioned Framework Curriculum. It is issued by the head teacher of the school or educational establishment, who must place it in an accessible place in the school so that anyone can consult and take copies and extracts from it. The different areas of education and their content are listed below.

Man, and his world

Fire protection education in elementary schools is located in the educational area of the Framework Educational Programme Man and his world. This area is designed only for the first stage of elementary education. The educational field is divided into five headings:

1. The place where we live.
2. People around us.
3. People and time.
4. The diversity of nature.
5. Man and his health.

In these chapters, students learn how to behave in hazardous environments, where to play, hazardous substances, road signs, and how to prevent risky situations in traffic and vehicles. Another area of education is summoning help in the event of a threat to physical or mental health or learning about emergency lines and emergency numbers. An important part for this work is learning in the context of emergencies and the risks of danger associated with them. Here, pupils are introduced to warning signals, evacuation,

and sirens. Fire protection education where the focus is on the cause and prevention of fires, protection and evacuation in case of fire [5].

Man, and nature

In this educational area, the emphasis is primarily on understanding natural facts and their laws. This includes the subjects of physics, chemistry, natural history, and geography. These subjects enable students to understand natural processes and thus realise the usefulness of natural knowledge and its application in life. The aim of this unit is to introduce the student to the following:

1. Natural facts and their context (empirical methods—observation, measurement, experiment).
2. Asking questions about the process and causes of natural processes that are related to the protection of health, lives, environment and property.
3. Activities designed to get pupils to behave in an environmentally friendly way, respecting the health of themselves and others.
4. The relationship of people and their activities that affect nature and the environment.
5. The use of energy sources in practice (renewable and non-renewable sources).
6. How to behave in crisis situations that threaten life, health, property or the environment.

An important part of this area for teaching fire protection is the subject of chemistry and in it, specifically the section Chemistry and Society, where students should be introduced to the principles of firefighting and continue to apply this knowledge to model situations in practice [5].

2.2. Modern Trends in Fire Protection Education

Below are projects and applications that are new and beneficial to the teaching of fire protection in elementary schools or are available for children online. This section is based primarily on resources available for fire protection education in the Czech Republic.

Firefighters for Schools

This is a project created in cooperation between the Fire Rescue Service of the Ústí nad Labem Region and the Fire Rescue Service of the Zlín Region. The project is aimed at pupils of the second level of elementary schools (6th–9th grade). The target group is chosen because these pupils are already able to cope with the issue of dealing with emergencies. Another group targeted by this project are teachers who pass on information to pupils. The project offers presentations that are suitable for interactive whiteboards. The content is processed digitally with a high technological and graphic level. It also offers a worksheet where, based on information from the presentations, pupils are further engaged and have to reflect on the situations. Lastly, there is a Theoretical Guide for Teachers, which mainly contains the theoretical basis of the subject.

In this project, fire protection issues are focused on the following topics:

1. Types of fires.
2. Firefighting.
3. Fires in the house.
4. Fires in nature.
5. Burns/skin injuries.

The teaching materials are available for free download at www.hasiciproskoly.cz. Educators can download a teaching presentation, a handbook, a worksheet and a worksheet with a completed solution [15].

Figure 1 shows one of the slides from the fire protection presentation. The presentation is adapted to interactive whiteboards to make it more interesting and entertaining for the students. The slide shows four images (industry and energy, transport, household, social and cultural events) each of these images can be clicked on by the pupil and then a specific menu of the selected area is shown.

Figure 1. Use of fire—presentation.

Sparky the Fire Dog

This program was founded in 1951 by the NFPA [16]. Sparky the dog is recognised as a fire safety icon known by children and adults alike. It is associated with the public through educational programs and a website that allows children to explore fire protection in a safety environment. At the same time, a mobile or tablet app can be downloaded for children. The website offers materials for teachers to conduct fire protection lessons in a fun way, while emphasising the seriousness of the issue. Children have made their own website where they can learn fire protection through videos, games (both for learning on a computer and on a mobile device or tablet), and colouring pages [17].

Smokey Bear

This is a program founded in 1944 that educates all generations in forest fire prevention. Of the main characters in this program is Smokey Bear, who is known as a character all over the world. The website offers educational materials for the general public, for children and also for educators. There is a SMOKEY for Kids component, which includes forest fire prevention study material, campfire rules, a Smokey's Scouts app, and a challenge created just for kids. In the Smokey's Scouts app, the user is tasked with helping Smokey prevent forest fires and remove fire hazards along the way. As part of the challenge, Smokey Bear tries to engage in reading books on the subject. The motivation for the children is various rewards [18].

2.3. Fire Protection Mobile Apps

This subsection describes the apps available for children in the field of fire safety education. These apps are not used in elementary schools in the Czech Republic, but children can freely download them to their smart devices and learn about fire protection through games.

The '**House fire safety knowledge**' app is available on the App store platform (for IOS devices). The app is free, but the downside is that it is unfortunately only in English and Chinese. The game simulates three scenes (kitchen, hallway and living room). Here, different situations take place, such as a fire or a gas leak. The user thus learns how and what to do to put out a fire in the kitchen when there is no fire extinguisher available or what to do when there is a gas leak. Although the graphics give the impression that the app is suitable for lower grade, the knowledge and use is also suitable for older children and second grade elementary school students [19]. In Figure 2 below, a collage from the app is created, showing the game.

Figure 2. House fire safety knowledge.

The app is suitable for younger ages, as its controls are designed to appeal to young children in particular. The app is very simple and provides basic knowledge on how to handle fire, firefighting, and fire prevention.

Other applications are simulators for firefighting exits. These are the applications "Fire Truck Simulator 2024" [20], '**Firefighter: Car fire truck sim**' [21], and many others. All these games are basically the same. The player is in the role of an engineer, where he has to arrive at the scene of a fire and then starts to extinguish the fire. While driving, he can turn on the light and sound alarms, he also has to watch the fuel tank and then the amount of fire water in the tanker. The firefighter character is dressed in emergency clothing, in some applications the player can choose specific armament and equipment. The apps work on both IOS and Android operating system. Unfortunately, not all of these apps are free (e.g., Firefighter: Car fire truck sim). In Figure 3 below, a collage from the app is created, showing the game.

The application is already more demanding compared to the first mentioned game House fire safety knowledge, as can be inferred from the graphics presented in Figure 3. The game simulates the real procedures of firefighting units when fighting fires. The game simulates all steps from leaving the fire station, to arrival, to deploying fire hoses, to frying fires and handling other firefighting equipment. The application thus offers an insight into the profession of firefighting and is a means of education on how to proceed in real life interventions.

The '**Firefighters 112 Operations Centre**' application is a simulation game where the user creates their own dispatch centre and it is up to them where (just mark it on the map). It is up to the user which component of the integrated rescue system they choose or if they combine them together. The user creates their own crews, which must have passed the necessary course and then buys fire tankers, ambulances and police cars. Since the establishment of the operations centre, the user is given tasks for which they receive coins with which they can buy additional equipment for their centre. The app is very realistic and shows a realistic view of how the operation centres send the integrated rescue system forces to intervene and what forces and resources are needed to intervene. The app is on both IOS and Android and is free. Micro transactions are also possible in the app [22]. In Figure 4 below, a collage from the app is created, showing the game.

Figure 3. Firefighter: Car fire truck sim.

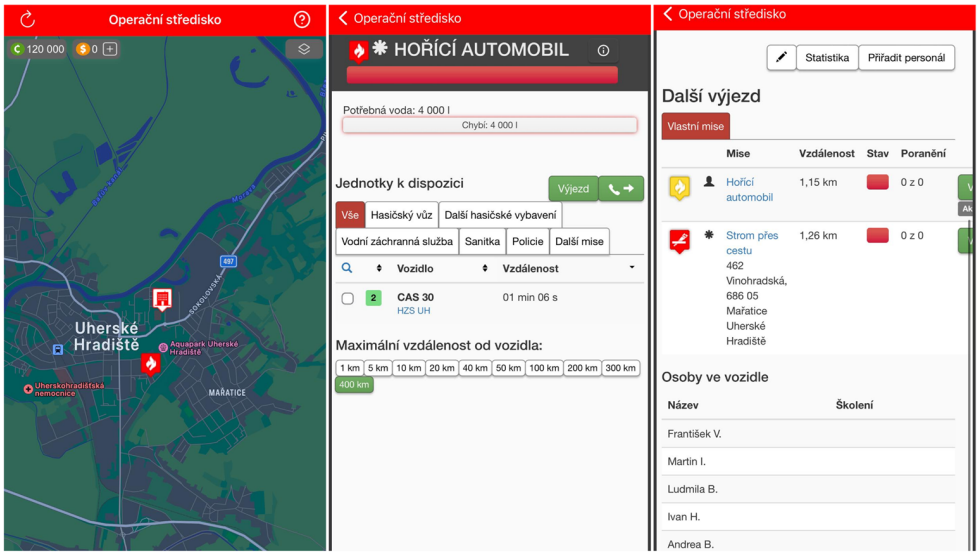

Figure 4. Firefighters 112 Operations Centre.

Of this selection of apps, the most difficult to use is the Firefighter Operations Centre 112 app. Of this selection of apps, the most difficult to use is the Firefighter Operations Centre 112 app. It is an operations information centre simulator in which the user, after the initial start, has to build a network of operations centres, call bases and training facilities

in order to be able to carry out the tasks, which are represented here by emergencies and crisis situations. The user, in the role of the dispatcher, must evaluate each situation and, at their own discretion, select and choose the number of intervening units, the necessary material, and set up the correct logistics. The application is thus a unique tool to try out decision-making processes when dealing with, for example, fire outbreaks, and teaches how to evaluate situations that can be encountered in everyday life. Due to its difficulty, it is more suitable for older age groups. Because of the automatic orientation of the server based on location, the Czech language is automatically selected. Therefore, the pictures are presented in Czech. The application supports a number of languages from the selected ones such as English, French, Japanese, German and many others. Unfortunately, however, it is not possible to switch between languages spontaneously.

Young Firefighter is an app created for young firefighters, youth, and their leaders. It is created for Android operating system and is free. It contains study materials and tests. It works similarly to the program from the Fire Brigade of the Zlín and Ústí Region. In the settings, you can set for whom the set of questions and tests is taught. The user continues to choose in which given issue they want to be educated. I think that this application can be used as a study material for elementary schools [23].

This application probably contains the best study material of all the selected applications. The app itself is oriented towards the education of young firefighters, where the user can choose the age category from pre-school to youth and the content is created according to the category. The whole application is unfortunately only in the Czech language and so, also for this reason, Figure 5 is presented in the Czech language. The application also allows the selection of content according to expertise and the selection of the area of interest. For example, the user can go through the test from the category of silent calls, technical means of fire protection units, and others. The application is thus suitable as a support tool for teaching fire protection in primary schools. A great advantage is that the whole application is completely free and can be used at home on any smart device with Android operating system. Unfortunately, there is no version for Apple's iOS operating system yet. In Figure 5 below, a collage of the app is created, showing the game.

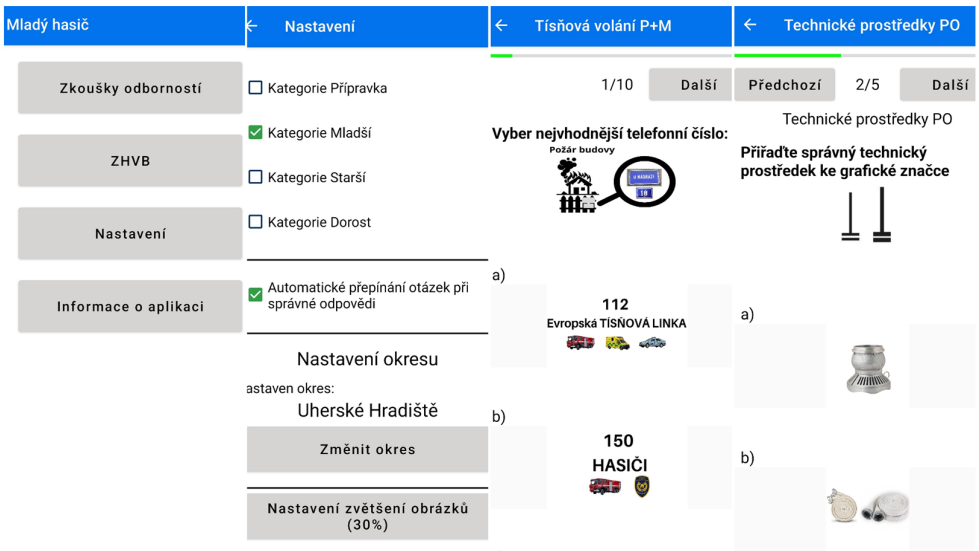

Figure 5. Young Firefighter.

The **AR Safetify** application is for simulating firefighting using augmented reality. It is free and can be downloaded for both IOS and Android devices. The user selects the location where the fire will be extinguished. They then select three options:

1. Evacuation.
2. Calling the emergency number 112.

3. Extinguishing the fire with a fire extinguisher [24].

The content of the application is very limited. In case of selecting the fire extinguishing task, it offers an excursion into the handling of fire extinguishers. In the first phase, the user uses a smart augmented reality device to place a fire on the scene to extinguish. The app instructs the user how to manipulate the extinguisher and how to successfully extinguish the fire. Thus, the application can be used as an alternative to extinguishing a real fire outbreak and to educate primary school students on how to behave in such a situation and how to manipulate the device. In Figure 6 below, a collage of the app is created, showing the game.

Figure 6. AR Safetify.

Lifesaving circle

The organisation Lifesaving Circle has come up with an app of the same name, which is designed to educate during emergencies. Lifesaving Circle has created four apps that can be purchased together or separately. These apps are traffic education, Little Rescuer, first aid, and "Tísňomat"—training on the call. Fire protection is included in the app Little Rescuer, "Tísňomat"—training on the call. The app is more for first grade students [25].

There are no fire protection applications directly for teaching in elementary schools. However, there are apps that can develop interest in this issue in a playful way or show directly what to do in a model situation. In Table 2 below, a comparison of selected applications is made, in which the exact parameters to the applications are given, on which operating system they are created, whether they are in the Czech language, and whether the application contains study materials. Most of the applications listed are aimed at first grade students. The Little Firefighter and AR safetify apps are aimed at all age groups of elementary school but are not adapted to elementary school teaching. In Figure 7 below, a collage from the application is created, showing the game.

Table 2. Comparison of applications.

Application	Fire Safety Knowledge	Fire Truck Simulators	Operation Centre	Small Firefighter	AR Safetify	Rescue Ring
Android	×	✓	✓	✓	✓	✓
IOS	✓	✓	✓	×	✓	✓
Czech	×	×	✓	✓	×	✓
Game	✓	✓	✓	×	×	✓
Study materials	✓	×	×	✓	✓	×

Figure 7. Examples of the pictures from the application "Tísňomat".

Table 2 below provides a brief comparison table of the presented applications.

3. Comparison of Fire Protection Teaching

In this section, the elementary schools that responded to the following questions will be compared in Table 3:

1. Does your elementary school teach or introduce fire protection to pupils?
2. Does your elementary school use a smartphone or tablet for teaching?
3. Do you consider the current state of teaching fire protection in elementary schools to be sufficient?
4. Would you like to teach fire protection using modern technology?

Table 3. Comparison of selected states.

Country	Question 1	Question2	Question 3	Question 4
Czech Republic	Yes	Tablet	Yes	Yes
Australia	Yes	Tablet	No	Yes
Philippines	Yes	Tablet, Smartphone	No	Yes
Italy	Yes	Tablet	No	Yes
India	Yes	Tablet	No	Yes
Ukraine	Yes	Tablet	No	Yes
USA	Yes	Tablet	Yes	Yes
Germany	Yes	Nothing	No	Yes

In Table 3 it can be seen that all the elementary schools surveyed teach fire protection, but each in a different way. The data in the table for the **Czech Republic** are from a questionnaire where 30 elementary schools were contacted. The teaching of fire protection in the Czech Republic is in the subjects of chemistry and science, according to the Framework Curriculum. In addition, each school must organise a fire drill once a year. Elementary schools in the Czech Republic can still use the project Hasík or the project Firefighters for Schools [26]. In most cases, members of the Fire Brigade of the Czech Republic or other fire protection units are approached on project days. Tablets are used to a greater extent in teaching. In total, 23 schools answered "yes" to the third question, so they consider the current situation to be sufficient. The last question deals with modernisation in this area, where it was found that the schools surveyed are interested in teaching fire protection using modern technology.

In **Australia**, fire protection training/familiarisation is conducted as part of fire drills. They use tablets for education, and in some classes Chromebooks, which they use all day.

Modernising fire protection using modern technology, according to the school contacted, would be of great interest as visuals could help children remember what to do in the event of a fire.

In elementary school in the **Philippines**, there is a separate subject called "Emergencies" where students learn fire safety measures and procedures. Regular fire drills and classroom discussions on the subject continue to take place. Smartphones, tablets and other technologies are used for learning purposes. The elementary school contacted believes that fire safety teaching could be modernised with more interactive and engaging activities that could retain important information for pupils. They also believe that modern technology today is beneficial as it could take learning to a better level.

The school in question in **Italy** runs a compulsory safety course every three years. This course is designed for teachers who have the task of walking the evacuation routes of the school with the pupils every year to familiarise them with fire protection issues. Fire drills are carried out throughout the year. Tablets, electronic whiteboards and computers are used in teaching. The school contacted would certainly welcome the education and familiarisation of pupils using modern technology.

In **India**, in elementary schools, the pupils are introduced to the issue of fire through fire drills and visits by firemen who conduct fire drills. The school contacted continues to consider fire safety education to be sufficient and does not need to be expanded in any way. Tablets are used for teaching, but modern technology is not discouraged.

Guided conversations were held with representatives of the countries of the Federal Republic of Germany, Ukraine, and the United States of America, where the same questions were asked as for the previous countries. The interviewed teacher from an elementary school in **Ukraine** teaches both second and first grade students. At the first level, fire protection is taught through games and colouring books, but without modern technology. At the second level, fire protection is taught within the subject of chemistry and physics, thus using a similar system as in the Czech Republic. There are no fire drills in either the first or second levels [27].

In the **United States**, fire protection is taught by trained educators and the main areas of focus are evacuation procedures and the use of appropriate fire extinguishers. Members of the fire service or other fire protection professionals are also invited to schools to participate in workshops, presentations, and practical demonstrations. In the second level, tablets are used for teaching but are not specifically used for teaching fire protection. In the context of safety, according to the interviewed teacher, fire protection in elementary schools is sufficient, but certainly the development of teaching on this issue using modern technology would be a step towards success to inspire and better educate pupils in an interesting way.

In the **Federal Republic of Germany**, fire protection is not taught as part of regular education, only as part of fire drills. Fire protection as such is taught in clubs, but these are not compulsory. In elementary schools, tablets or smartphones are not used in lessons at all. The teacher interviewed is of the opinion that teaching fire protection is insufficient and that teaching with the help of modern technology alone is not enough. A combination of modern technology and professional officers on project days would be best [28,29].

3.1. Methods

A questionnaire was used to collect the necessary information and answers. It is the most suitable method for obtaining data to investigate our questions. A survey questionnaire is an important part of the interaction between the respondent and the interviewer. Clear and simple questions were chosen for the best return on inquiries. The questionnaire responses were collected between January and April 2024. The selection of countries was mostly random but, in some cases, also based on contacts abroad. A total of 37 elementary schools were contacted. The countries contacted included the Czech Republic, Australia, the Philippines, Italy, India, Ukraine, the United States of America, and the Federal Republic of Germany.

The respondents were teachers who offered to answer the questions posed and also agreed to a guided interview.

3.2. Comparison Results

The questions asked are aimed at finding out whether the selected elementary schools teach the issue of fire protection. In the Czech Republic, this issue is not directly anchored in the framework educational plans, but it is part of subjects where only a small number of hours is reserved for this issue. For this reason, the questions determine whether the selected schools teach this area and, if so, whether they also use any of the smart devices for the teaching itself, such as smartphones, tablets, etc. The answers found can help determine trends and point out, for example, the absence of technology in teaching.

In response to the question "**Does your elementary school teach or introduce fire protection to pupils?**" all schools surveyed answered that they teach fire protection, but each in a different way. Some use chemistry, physics, and science subjects to teach fire safety, some teach fire safety only in fire drills and last but not least, fire safety education is taught by fire brigade members.

According to the authors' assumptions, it was found that all the elementary schools surveyed teach fire protection issues. The results are therefore positive and reflect the fact that this issue is important and primary schools consider it one of the necessary areas of pupils' education.

Question 2 "**Does your elementary school use a smartphone or tablet for teaching?**" All but one of the schools surveyed (Federal Republic of Germany) use tablets or smartphones during lessons.

The results obtained and presented in Chart 1 produced a variety of responses. The authors' assumption was that primary schools would not make much use of technology for teaching fire protection. This response was ultimately demonstrated by only 13 percent of the schools surveyed. The highest proportion presents the answer of using tablets. This fact thus presents opportunities to expand the elements of applications that support, for example, augmented reality technology. Pupils could thus acquire practical knowledge using interactive elements with the help of models and simulations created. The last option, the use of tablets/smartphones, also brought similar possibilities. The answers to this question again yielded positive responses and thus provide further opportunities to improve the effectiveness of fire protection education in primary schools.

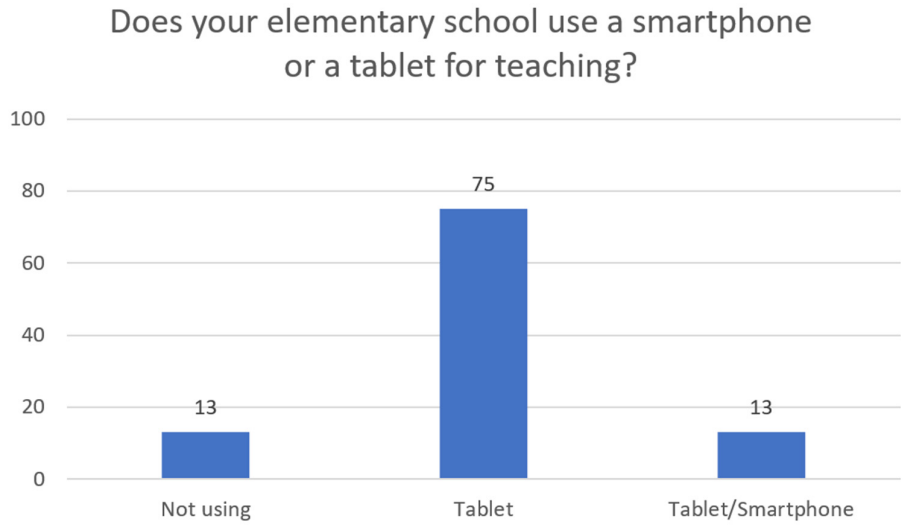

Chart 1. Question 2.

In response to the question 3 "**Do you consider the current state of fire protection teaching in elementary schools to be sufficient?**" representatives from five elementary schools believe that fire safety teaching is sufficient but added in the interview that updating

and modernisation is welcome. Representatives of three schools believe that fire safety teaching in their elementary schools is insufficient and should definitely be updated and modernised (see Chart 2).

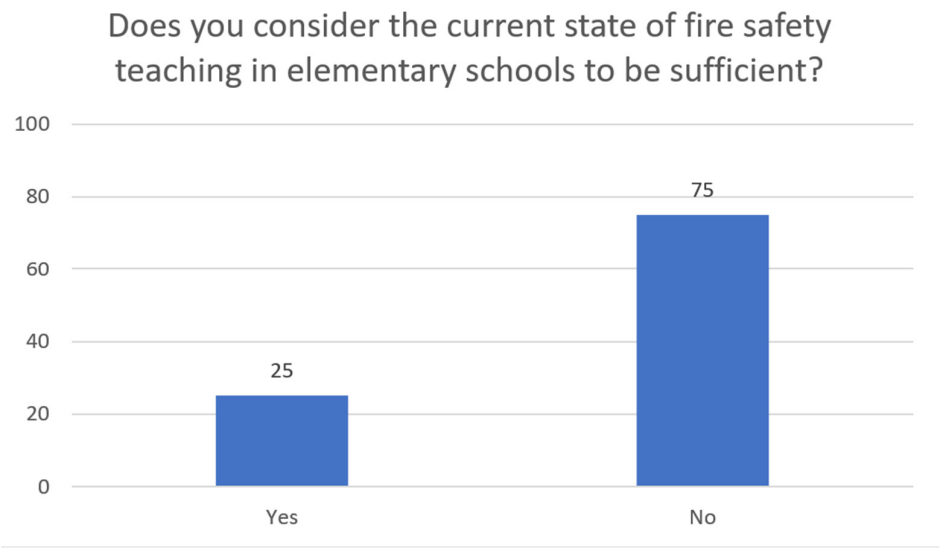

Chart 2. Question 3.

The answer to question 3 could be described as unequivocal. In total, 75 percent of the primary schools surveyed answered that they considered the current state of fire safety education to be inadequate, i.e., the answer was no. The answers thus follow on from the next question, which asked whether teachers would welcome the use of advanced technology for teaching. The issue of teaching is also complex because not all of the primary schools surveyed have the resources to modernise their teaching.

To the last question 4 "**Would you like to teach fire protection using modern technology?**" all schools surveyed are in favour of new modern teaching in this area.

The fourth question provided an unambiguous answer to the question of whether teachers would welcome modernisation of teaching with modern technology. All the answers were yes, and so there were positive responses here as well. Modernisation would be welcomed by all primary schools surveyed. Equally, as mentioned, the problem is the ability of individual schools to afford this modernisation, where not all schools can afford it. Another problem may be the adoption of new technologies by teachers. However, it is important to note that educators are interested in technology, and this is a benefit for the future, when new technologies and applications could be applied to develop fire protection education and make education more effective.

According to the questionnaires and interviews with the states interviewed, fire protection education is introduced into the regular curriculum during the year. The most frequent introductions are in fire drills, chemistry, and physics. The use of modern technology is nowadays already included in the curriculum in most states. The use of modern technology in teaching fire protection is very sympathetic to the states interviewed and would certainly lead to fire prevention or a quick response on what to do when a fire occurs. Certainly, a subject on emergencies or public protection should be added to the curriculum as it is in the Philippines. This will prepare the students for an emergency or crisis situation given what is happening in the world.

4. Design of the Application

In this part, an application for teaching fire protection in elementary schools will be proposed. First, the teaching materials from which the structure of the application is assumed will be outlined. Next, the operating system will need to be specified. In the next section, the modules of the application and their principle will be proposed.

One of the important steps of application design is researching the resources. It is necessary to include and verify the data in the content of the application. In Figure 8, we can see a flow chart of which sources the content will be drawn from. The programs, Firefighters for Schools and Fireman, are chosen because of their credibility and traditional nature. The programs, as written in the previous chapters, were created by representatives of the Fire Brigade of the Czech Republic. The Young Rescuer's Handbook was created by the Association of Firefighters of Bohemia, Moravia, and Silesia and aims to prepare young firefighters for inclusion in the units of the volunteer fire brigades. The Association also organises a rescue camp, which prepares and introduces young firefighters to the work of firefighters (work at height and above free depth, work on water, basic first aid, fire protection and protection of the population). Last but not least, foreign resources such as Sparky the dog, Smokey the Bear and professional publications are selected. Countries such as the Federal Republic of Germany and the USA are modernising the training of firefighters, especially with the help of modern technology; this is the reason why these materials will be helpful in designing an application for teaching fire protection.

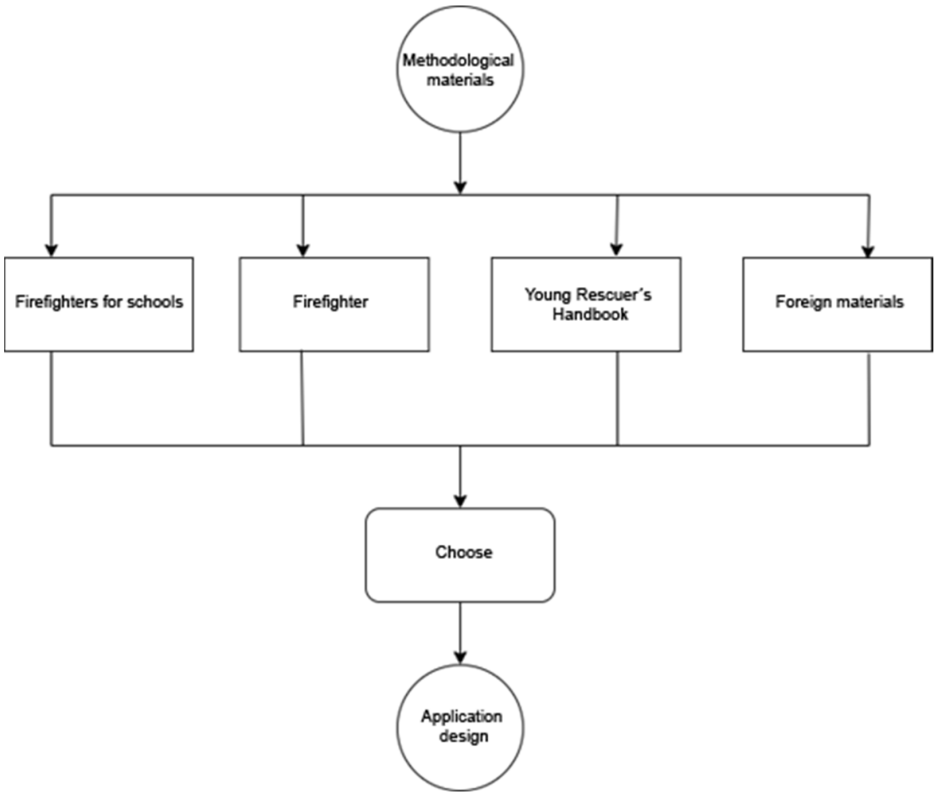

Figure 8. Design of the application.

The app design will be created on Android operating system due to cost and availability. Devices with this operating system are often more affordable than devices with other operating systems, which may be one of the criteria for selecting elementary schools on a limited budget. Another reason is integration with Google services, where the Android operating system is developed by Google, which means that it interacts with Google services (Gmail, Google Drive, Google Classroom, etc.). It continues to offer compatibility with hardware, where there is a wide range of Android devices from different manufacturers, allowing you to choose devices with different features and price ranges according to your needs.

According to the information obtained from the questionnaires, 60% of the schools surveyed that answered question 5 "**What operating system do you use for your smart devices?**" use the Android operating system (see Chart 3).

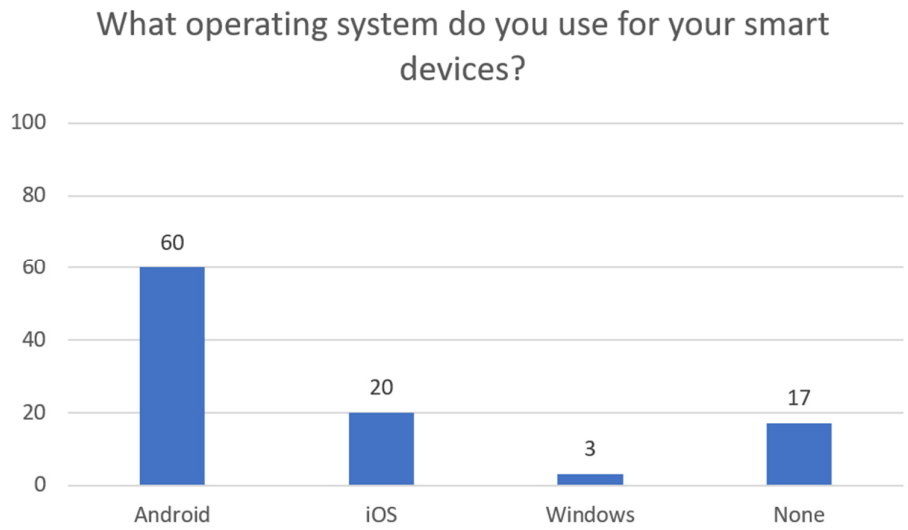

Chart 3. Question 5.

The results of the questionnaire survey were as expected by the authors, with more than half of the respondents using the Android operating system. Compared to other operating systems, its advantage is its diversity in devices. Although the top brand is Apple with its iOS operating system, Android is more affordable for most users, especially from a financial point of view. Also, for this reason, apps should be oriented towards all platforms and not just iOS.

Modules will be uploaded and created in the application according to the methodological materials. They will be described in a way that makes them understandable, interesting, and fun for pupils in grades 6 to 9. The specific modules are recorded in Figure 9.

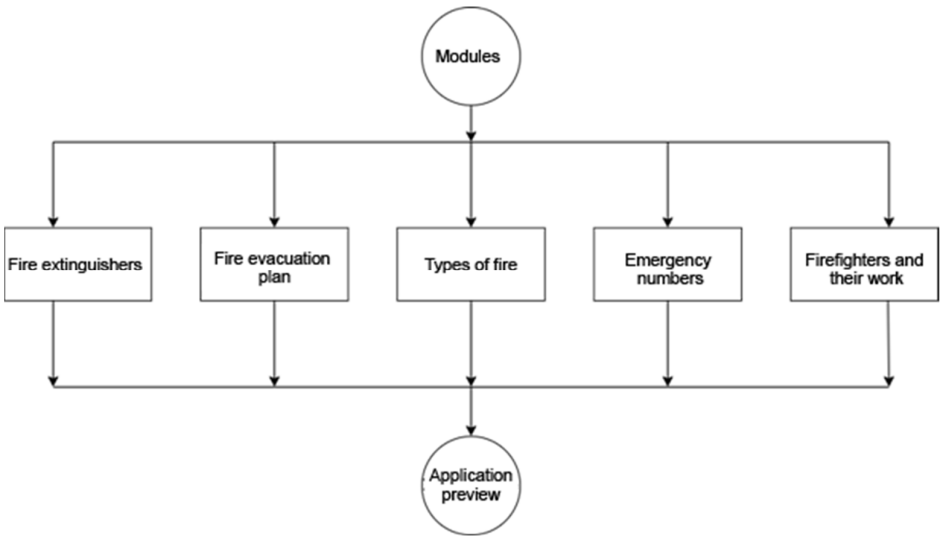

Figure 9. Modules.

Module: Fire extinguishers

In this module, data about fire extinguishers will be uploaded. It will describe the types of extinguishers, classes of fire, and the extinguishing procedure. The user will navigate through the uploaded pictures of extinguishers to find out the following:

1. Type of extinguisher.
2. Appropriate use.
3. Prohibited use.
4. Classes of fires.

Furthermore, there will be model situations using photographs or videos to show how to use the extinguisher correctly.

Module: Type of fire

The circuits in this module will be, as in the previous module, mainly visual, where the user will click through the images created. For the fire triangle chapter, there will be a description first and then the user will try to complete the triangle. The next chapter will explain the difference between fire and conflagration. Next, a chapter on the cause of fire will be uploaded. Model situations will be uploaded to give the user a better idea and to better memorise and educate the user on the subject.

The Fire Extinguishers module and the Fire Type module will be linked within model situations (fires-photos/videos) with information on fire classes.

Module: Fire Extinguishers and Fire Types

Figure 10 shows a preview of the application. The user first logs in to the main page where the modules are displayed. The modules will consist of icons that will be created from images of the issue. The images will be selected to match the age group of the target. The picture shows a situation where a user clicks on the Fire extinguishers module and other icons will be displayed (depending on the content of the module). Subsequently, he/she can click on the module Type of fire in the given chapters, as the two modules are linked.

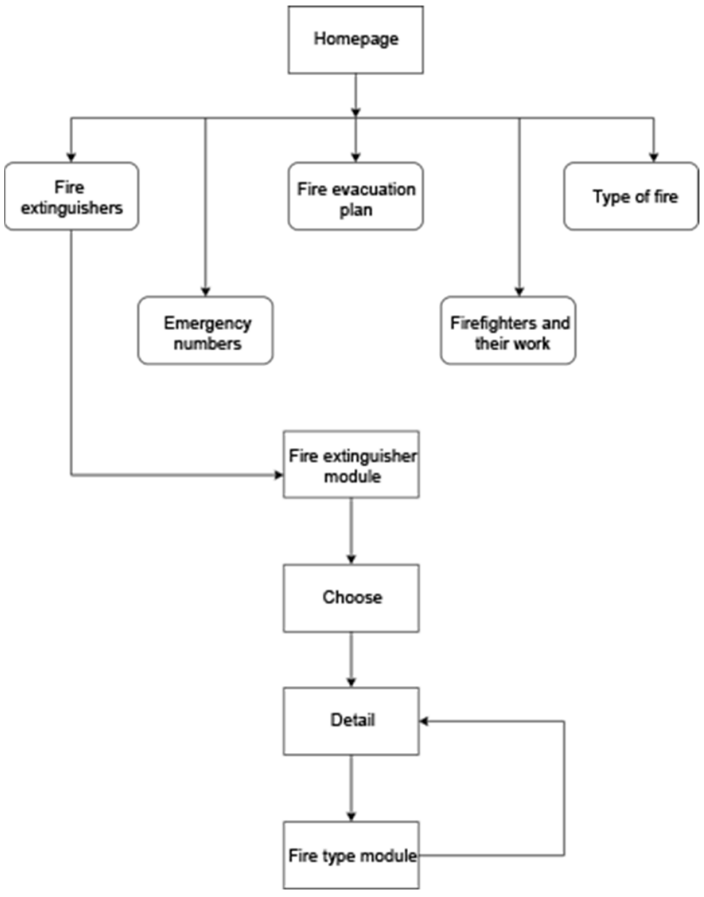

Figure 10. Preview of the application.

Figure 11 shows the interconnection of the extinguishers module and the Type of fire module. They are linked by ID_HP, ID_HP and ID_Photography/video.

Figure 11. Interconnection of the Extinguisher modules and the Type of fire module.

Module: Fire Evacuation Plan

In this module, data will be uploaded for the general presentation of the fire evacuation plan. The module will provide a graphical representation of the plan and then describe the signage. A model situation will be uploaded where a fire starts in one location and the user tries to navigate the evacuation plan. It would certainly be good to have uploaded data from the fire evacuation plan in the particular school where the application will be used.

For better interest in studying the fire evacuation plan by elementary school pupils, it would be good to have qr codes posted in corridors or classrooms that pupils could scan via smartphone/tablet.

Emergency Numbers module

This module will contain data of telephone numbers and model situations. There will be images of emergency numbers, and the user can click through to the content. For each emergency number there will be situations and examples of when to call that particular number. Subsequently, there will be details of what to say to the emergency operator. The picture shows the emergency numbers used in the Czech Republic.

- 112—the single international emergency number;
- 150—the emergency number for the Fire Brigade of the Czech Republic;
- 155—emergency number for the emergency medical service provider;
- 158—emergency number for the Police of the Czech Republic.

Module: Firefighters and their work

The content of the module will be mainly about information about the work of the Fire Brigade of the Czech Republic, which will be supplemented with photos and videos.

There will be pictures of uniforms (day shift, emergency operator, firefighter on call). Then the suits of the firefighters will be described and shown. Then, the firefighters' jobs will be presented, as many people think that firefighters only put out fires, but the jobs of firefighters are diverse. Last but not least, the equipment at their disposal and their armament will be described. This module is all about introducing the work of firefighters and increasing interest in this essential component of the integrated rescue system. Figure 12 below shows the emergency numbers.

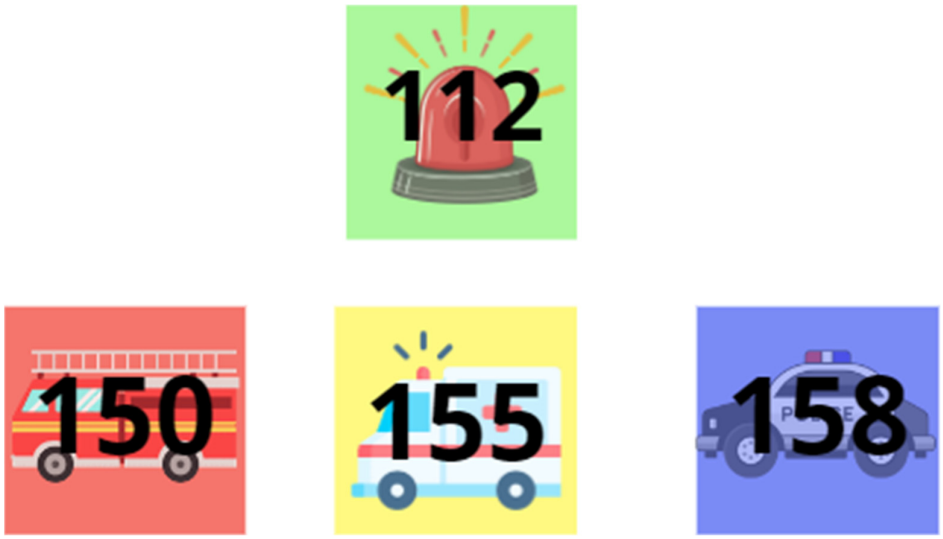

Figure 12. Emergency numbers.

5. Conclusions and Discussion

The main advantage of this application proposal is the increased interest in fire protection. It is primarily about how to behave in a given situation, prevent fire, protect your life and the lives of others, and protect the environment. Another advantage is that so far, no app has been designed for the direct age group (11–15 years). All the apps that are currently available are mainly oriented for children aged 4–8 years or games that increase interest in this issue, but do not contain important information (e.g., how and what to use to extinguish a fire in a given situation).

The downside of this app is the negative attitude of schools in the Czech Republic. The questionnaire created and sent to 280 elementary schools was answered by only 30 elementary schools. Thus, it can be concluded that currently elementary schools are not interested in innovation in this area. Another negative is certainly the time-consuming nature of the proposed application, as it is necessary to create model simulations that should be as realistic as possible. Table 4 below describes the pros and cons.

Table 4. Comparison table.

Pros	Cons
Increased interest in the issue	Funding
No application for this age group	Passive attitude of schools
Universal development (1 team)	Time consuming
Increased interest in learning	Native app development (2 teams)

According to the results of the questionnaire survey and guided interviews, fire protection is taught in elementary schools both in the Czech Republic and abroad. However, each country approaches this issue differently. In the Federal Republic of Germany, fire protection is only taught as part of annual fire drills, which means that children are not taught to prevent and manage fires. In the Czech Republic and Ukraine, annual fire drills

are also held, but pupils are introduced to fire protection in the subjects of chemistry and physics. Pupils are therefore familiar with the fire triangle and are instructed in the occurrence and management of fire. The Philippines has the best approach in terms of emergency education, where fire protection is incorporated in the subject and prepares the pupils for fire prevention and management. All the countries surveyed, except the Federal Republic of Germany, use tablets or smartphones in their teaching, which is positive feedback in terms of modernising teaching on this subject. From the market research, there are not many apps that deal with teaching fire protection and there is only one (Young Firefighter) aimed at second grade students. The app works similarly to the Firefighters for Schools programme. The user first studies the materials and then can complete the worksheet. The Czech organisation Lifesaving Circle has developed the apps Traffic Education, Little Rescuer, First Aid, and "Tísňomat"— training on the call. Although all these apps are well developed, they are not intended for second grade elementary school pupils.

There are also applications in the form of simulations of firefighter interventions or model situations, where a model situation is created and the user has to help himself using a menu of tools. According to questionnaires and guided interviews in elementary schools in the Czech Republic and abroad, teachers are open to modernising fire protection teaching using modern technologies. Therefore, the design of the application "Firefighter" has been created, which focuses on the education of pupils of the second level of elementary school. The design is created on Android operating system which is more accessible than other operating systems.

The application is divided into the modules Fire Extinguishers, Type of fire, Fire evacuation plan, Emergency numbers, and Firefighters and their work. The premise is that the app will primarily use visuals to keep students interested and better able to visualise situations. In each module, data will be uploaded not only with the theoretical part but also with practical demonstrations or tasks. For example, for a fire evacuation plan, a fire simulation can be created in which the student must use the evacuation plan to get to safety outside the building at risk. Also, schools can create their own QR code with the uploaded evacuation plan data. Children are curious and are more attracted to technology than plain paper these days. Therefore, one could argue about developing not only mobile apps, but also connections to virtual reality [30].

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Data Availability Statement: Data are available in the Sections 1–5.

Conflicts of Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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