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# INTEGRATION OF TECHNOLOGIES INTO THE PRIMARY SCHOOL LEARNING PROCESS: BENEFITS AND CHALLENGES

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**ABSTRACT**

The need to integrate modern innovative tools into the formation of primary school students' competencies dictates the need to change approaches and tools for the educational process. The goal is to analyze the current challenges and advantages of using digital technologies in primary schools based on theoretical research and practical tools. Research methods. The paper considers innovative pedagogical tools that have been developed based on modern digital solutions, in particular online platforms and other interactive tools, as well as blended learning technologies for primary school age children. An experiment was conducted using pedagogical experimentation and virtual technologies. The results of the experiment were used in writing this study. In particular, emphasis was placed on the main advantages of innovative technologies that contribute to increasing the interest of young students, facilitate the learning process, and improve the quality of information assimilation. At the same time, interactive technologies allow for the most effective study of educational material in inclusive learning spaces. However, it is worth noting the possibility of information overload, decreased attention and concentration, increased risks of negative effects on children's health, and deterioration of social interaction. It has been proven that the use of visualization tools makes it possible to explain complex circumstances and abstract concepts to children, which improves the effectiveness of perception, engages the sensory and emotional spheres, and promotes critical thinking.

**Keywords:** *Interactive Technologies, Innovations, Natural Sciences, Future Teachers, Primary Education, Teaching Methodologies*

## 1. INTRODUCTION

The strategy for the development of education in Ukraine determines, to one degree or another, the basic requirements for the context of education, as well as for methodologies that can ensure the formation of individual competencies and skills, taking into account the critical thinking and creativity of the child. Modern technologies, in particular virtual environments, digital platforms, etc., not only form the basis for the formation of sustainable motivation to learn, but also contribute to the formation of new communication skills.

Scientists pay special attention to the dynamics of technological processes in the educational process, taking into account the need for primary schools in media education, mobile applications, interactive platforms, etc. In their works, many scientists have explored the potential of environments that can create realistic learning formats.

## 2. LITERATURE REVIEW

Many researchers are also attracted by the possibility of combining interactive learning technologies with a project-based approach to learning. It is the project methodology that allows a child to develop a much broader range of skills. Educational technologies in the context of creative communications allow for the comprehensive implementation of an approach to the learning process that involves various forms of dialogue. Sustainable professional competencies, digital skills, and a willingness to work with inclusion are the formats that primary school teachers need. Today, future teachers must not only strive for self-improvement, but also grow professionally by using technological solutions in their work. However, success depends not only on the methods of the educational process, but also on the involvement of all participants: children, parents, and teachers.

The purpose of this study is to examine the characteristics of the process of integrating innovative elements into the educational process of primary school, taking into account the advantages and challenges.

As part of the study, researchers focus on the digital skills of primary school teachers. For example, Gabarda Mendez et al. [1] believe that digital competence is the basis for effective integration.

Haleem et al. [2] draw attention to the role of online learning platforms in developing primary school education.

Criollo-C et al. [3] explored the potential of mobile learning as a means of developing creative thinking and communication.

According to Rasmitadila et al. [4], the formation of sustainable professional competence in teachers requires a willingness on the part of educators to continuously improve, as well as adequate material resources and methodological materials (teaching technologies, classrooms, equipment, programs, etc.).

Published works by other researchers suggest making maximum use of modern information systems and interactive platforms to improve children's motivation to learn and change models of a comprehensive approach to learning in primary school [5].

The results of scientific research by Demitriadou et al. [6] emphasize that immersive learning and gamification have great potential. They help children develop logical and critical thinking and problem-solving skills. This is achieved by creating a gaming environment that is understandable to primary school students.

Galan et al. [7] define primary school teacher training as requiring practical skills. According to the authors, it should be aimed at developing skills, using digital tools, and forming inclusive and intercultural competencies.

Spiteri and Chang Rundgren [8] researched practice-oriented teaching approaches. They proved that logical thinking, speech, and the ability to critically evaluate information are developed with the help of modern interactive technologies. It is emphasized that the digital educational environment influences cognitive processes, promotes the development of information and digital literacy, logical thinking, and the ability to self-reflect.

Despite a significant amount of research in this area, the issue of introducing innovative educational technologies in primary schools still requires deeper and updated analysis that takes into account the current challenges of education.

## 3. MATERIALS AND METHODS

The study was based on a detailed and consistent analysis of scientific articles, research papers, and global trends in the field of security, using industry statistics. A thematic approach was used to process the information, i.e., similar ideas and results were grouped together according to specific principles. Taking into account the actual conditions, the sample size was determined to be sufficient to ensure the scientific statistical validity of the research results. The research materials are available for verification through the program code, which allows for additional analysis if necessary. During their work, the authors followed the recommendations of the PRISMA 2020 standards.

The main sources were scientific publications from the leading databases Web of Science and Scopus, as well as official statistics. The analysis covers materials published between 2019 and 2025. Search engines, including Google Scholar, were used to find the necessary information. The materials obtained were analyzed with attention to the quality of the information.

An effective query included basic concepts, their synonyms and related terms, as well as authors' names and specialized terms. The main keywords were concepts related to methodology, initial education, and immersive and interactive technologies and innovations for training future

teachers. The final stage of the search for scientific sources was conducted in July 2025. Publications were selected based on temporal and spatial criteria and the level of reliability of the information. The quality of the sources was assessed in terms of relevance, objectivity, disclosure of the topic, and the authority of the researcher. Duplicate studies were identified and removed by comparing the titles of works, DOIs, and authors' names using special queries.

The analysis was based on a thematic research method, which involves careful processing of data and its coding to identify recurring ideas. This will allow us to highlight key themes and gain a deeper understanding of the content of the authors' research materials.

## 4. RESULTS

According to the modern educational concept, the main goal of primary school is the comprehensive development of the child. Therefore, teachers should be open to new ideas and think creatively, as well as use innovative approaches. Learning should be inclusive and combine different forms of presenting material, including digital tools, multimedia, and interactive elements [1].

At the same time, it is important to create a positive psychological atmosphere, helping students adapt to new learning formats. In the process of updating primary education, innovation is the result of searching for non-standard solutions to pedagogical problems. Interactive technologies play an important role, promoting active interaction between students and increasing the effectiveness of the learning process.

Pedagogical approaches with a positive impact include [2, 5, 9]:
- interactive technologies that can be applied in practice;
- a game-based form of presenting educational material to children;
- audiovisual aids that help to assimilate material through visual and non-verbal cues;
- mind maps and diagrams that develop critical thinking, speech, and communication skills;
- a personalized approach that increases student motivation and allows them to learn at their own pace;
- group work that promotes communication through the exchange of ideas, projects, dialogues, and joint tasks.

Bakhov et al [10] Gamification and storytelling are effective methods for teaching English in primary school. They involve individual, pair, and group work, activate and develop students' language skills, imagination, and creativity, and teach teamwork. Storytelling can be used in different ways, but for it to be successful, the teacher must choose the right story and develop and apply methods that will help students express their own thoughts. Digital storytelling is becoming increasingly popular thanks to tools such as My StoryMaker, which allows to create simple stories in the form of e-books.

For younger students, it is effective to use online platforms to create their own stories, such as My Storybook and ZooBurst, which allow to create 3D books.

Semenets-Orlova et al. [11] Such tools encourage children to read and promote speech development, as listening, retelling, and recording form basic language skills. Special attention should be paid to educational games for learning English and other foreign languages. They help to better consolidate and systematize knowledge and at the same time develop attention, memory, critical thinking, and speed of information processing. Games such as Anitemdescription, Chainstory, and Grabaminute have proven to be effective in teaching English. Game technologies can be used at any stage of the lesson: at the beginning to refresh knowledge, during the lesson to practice skills, and at the end to reduce tension. A more detailed description of modern teaching technologies in primary school is provided in Table 1.

The experience of European countries is considered indicative and representative for this study. Of particular importance is the dynamics of innovation implementation in the period 2021–2023, which demonstrates the active development of modern educational technologies.

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*Table 1: Technological solutions*

| Technology | Solution | Characteristics |
|---|---|---|
| Online platforms | Kahoot | Conducting quizzes, creating tests and educational games. Available in free and paid versions, it can be used for various lessons. |
| | Flippity | A set of digital tools for creating interactive exercises and tasks using Google Sheets. |
| | Matific | Interactive exercises developed by experts for students in grades 0-6. |
| | HUMAN | An electronic document management system for teachers helps them create and save their own lessons. |
| | Google Classroom | Google Drive services. |
| | MOODLE | Platform for learning and testing |
| Learning through games | "An item description" | Descriptions of words or phrases depicted on interactive cards to improve vocabulary. |
| | ALPA Kids | For developing speech, math skills, motor skills, curiosity, and creativity. |
| | "Chainstory" | Creating chain stories. |
| | "Grab a minute" | The child has 1 minute to explain the word written on the card. |
| Mobile applications | Kahoot! App | An educational platform for creating texts. Available in a mobile app or via a browser. |
| Interactive learning technologies | Liveworksheets | Converts printed sheets (pdf, jpg, doc) into interactive exercises |
| | LearningApps | Helps create games |
| Audiovisualization | Nearpod | Designed for creating "live" lessons. |
| | Padlet | A multimedia resource for posting photos, files, links to web pages, and notes for shared access |
| Mind maps and diagrams | Draw.io | A multifunctional service for block diagrams, tables, and simple infographics. |
| | Canva | A platform for designers with templates for creating mind maps, photos, and videos. |

As shown in Figure 1, based on monitoring data from the UNESCO Global Report for 2021–2023, EU countries are seeing steady growth and use of modern digital technologies in primary education. During this period, the share of mobile technologies, applications, digital platforms, personalized learning, and gamification has increased significantly. As a result, as of 2023, the most widespread technologies are digital platforms, mobile applications, and gamification tools.

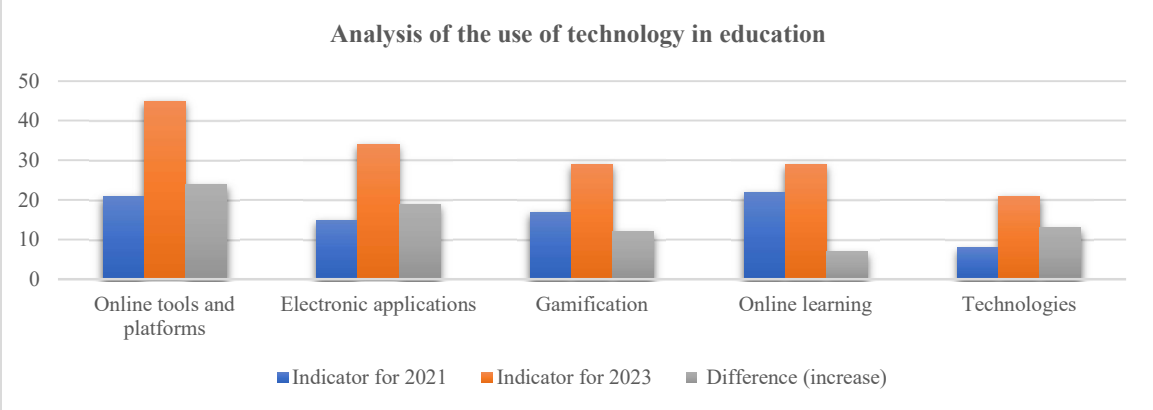


*Figure 1: Level of innovation implementation in primary schools (EU countries, 2021–2023) %*
Source: UNESCO [12]

Empirical research, the data of which is systematized and visualized in Figure 2, allows us to assert the high level of intensity of interactive and digital technologies that have been implemented in the social and educational practices of European Union countries during 2020–2024. Based on the results of statistical analysis, strategic vectors of technological transformation have been identified and a hierarchical structure of tools has been established according to the criteria and degree of their implementation.

Supriani et al. [13], they form the most relevant modern requirements for flexibility and interactivity in education. Stable positive integration dynamics are observed thanks to visualization tools. Their use contributes to the cognitive optimization of information perception. During the analyzed period, distance education technologies are being transformed in accordance with forced adaptive measures into a systemic element of the educational infrastructure, while ensuring sustainable development and inclusion.

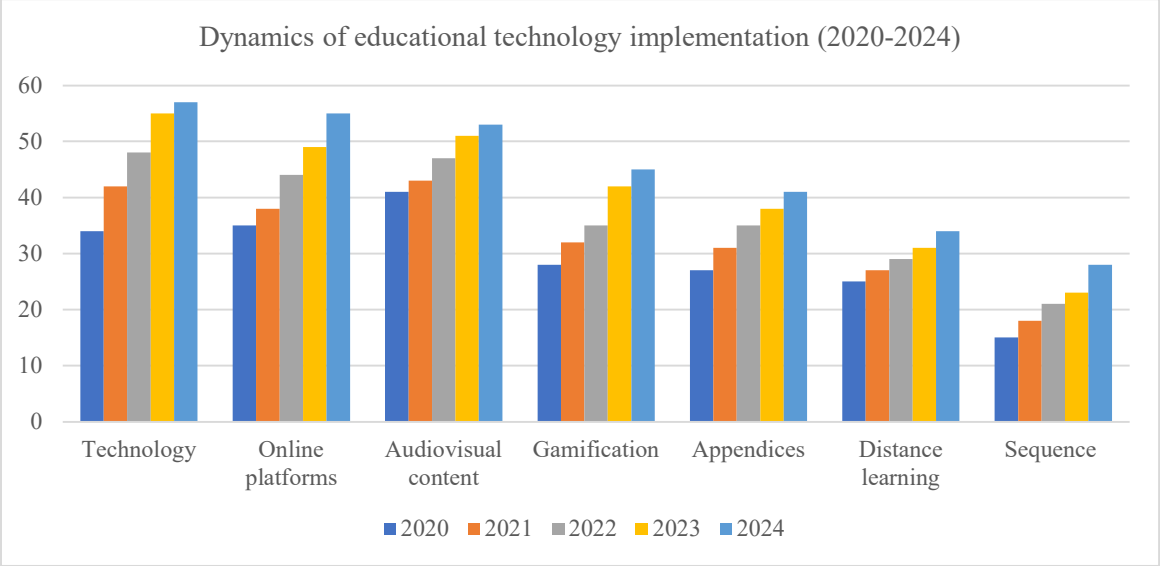


*Figure 2: Educational innovations in primary education in EU countries, 2020–2024, %*
Source: Eurostat [14]

Observations confirm the hypothesis of a transition from the partial use of digital tools to the formation of comprehensive digital learning ecosystems within the European educational space. This format requires further development of methodological principles for assessing the quality and effectiveness of various interactive formats.

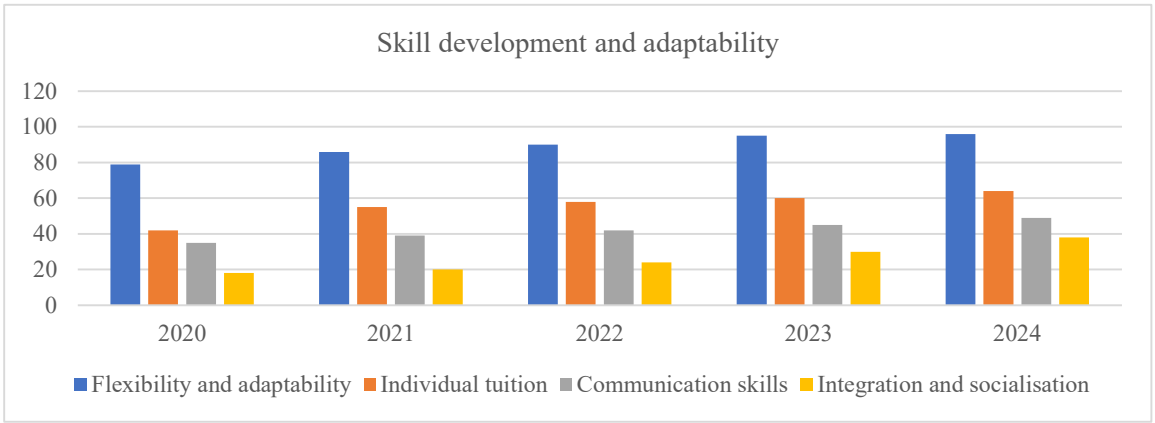


*Figure 3: Effectiveness in primary schools in EU countries where interactive technologies were used (2020–2024), %*

The results of the graphical analysis indicate a steady positive trend in learning adaptability indicators for the period from 2020 to 2024. The study reflects a trend that allows us to assert the fundamental nature of the conditions and the possibility of practically implementing an individual educational trajectory for participants in the educational process, even in conditions of inclusiveness, and personalizing the educational process in accordance with the cognitive needs of students.

The effectiveness of innovative methods was tested at Lutsk Lyceum No. 21. Second-grade students participated in the experiment and were divided into control and experimental groups. The total number was 24 children, 12 students in each group, aged 7–8 years.

In order to establish a basis for comparison, at the initial stage of the experiment, a diagnosis of the initial level of skill formation in primary school students was carried out. The test results are presented in Figure 4.

Yang [15], to understand the effectiveness of immersive learning, an educational experiment was conducted aimed at developing students' skills in preventing and localizing forest fires. The study was based on the use of the advanced virtual reality system FLAIM Trainer (developed by FLAIM Systems, Australia), which integrates highly realistic firefighting scenarios. The research was based on a comparative analysis of the results of two groups: experimental and control. The use of VR technologies allows achieving maximum presence and realism in extreme situations. The educational process is implemented using traditional methods based on reproductive teaching methods without the use of virtual reality tools.

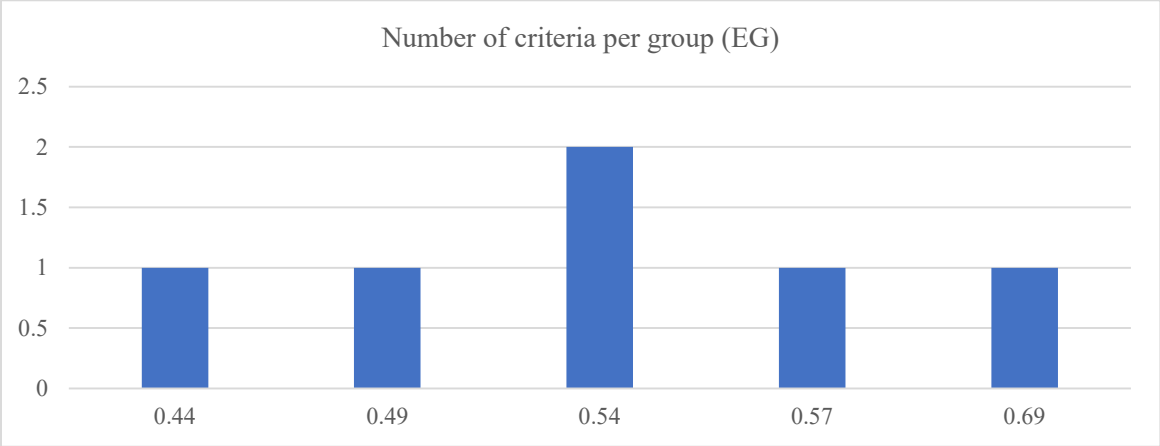


*Figure 4: Students' initial skills*

The data obtained during the experimental study will allow determining the level of feasibility of introducing multimodal virtual learning environments into primary school practice. The main mechanism of influence of such technologies is based on the intensity and emotions experienced by the participant in the educational process. This is, in fact, human experience, which acts as a catalyst for cognitive visualization processes. The use of modern technological products in the learning process is changing with positive dynamics of development, in particular: the level of critical thinking and the ability to find solutions in non-standard situations are increasing; the child's cognitive interest and involvement in the educational process are growing; the overall intensification of material assimilation is changing thanks to visualisation and interactivity. At the same time, there are many challenges, including: the high cost of licensed software, a shortage of hardware in educational institutions, and the risk of developing excessive dependence on devices and somatic disorders.

Smolinska et al. [16], global digitalization is becoming particularly relevant, given the need to understand the role of the teacher. The effectiveness of innovation implementation is reflected in the level of digital competence of the teacher, which involves not only technical mastery of tools, but also the ability to integrate digital tools into the learning process and specific lessons. Helping students become aware of their own educational strategies is important for forming a holistic view of the world and adequate self-esteem. The place and role of the teacher is transforming from a transmitter of knowledge to a facilitator of digital development,

where a balance between technology and people is maintained. And this is a decisive condition for the sustainability of the educational model.

## 5. DISCUSSION

The challenges of introducing innovative technologies into primary school activities require the expansion of methodologies, tools, and adaptation to digitalization. The positive effects of digital transformation allow us to identify the following basic vectors: improvement of cognitive motivation, implementation of the principles of individualization, flexibility, and adaptability of the teaching process in accordance with the needs of students. Khaitov et al. [17] and Washbrooke [18] confirm the high validity of using a mixed model. The authors emphasize the priority of experience in using sensors and reflection as mechanisms for deep knowledge acquisition.

In the context of inclusion and differentiation of learning, special attention should be paid to the works of Bernaki et al. [19] and Sumardi et al. [20]. It has been proven that online platforms and gamified environments are key elements of an inclusive space that can provide multimodal content delivery (visual and audio channels), which contributes to memory development.

Traditional teaching methods and modern digital tools can significantly improve the effectiveness of the educational environment. According to Leoste [21] and other researchers, primary school teachers should have advanced digital skills. At the same time, the results of this study show that the ability to analyze, evaluate students' achievements, and maintain their motivation is no less important. The effectiveness of specific digital tools – such as mixed reality, gamification, and online platforms – is confirmed by the works of Bernaki et al. [19] and Sumardi et al. [20]. They prove the importance of using online resources for inclusive learning. This will allow the creation of interactive tasks, taking into account the needs of various forms of inclusion. Modern technologies have a positive effect on human cognitive processes and memory.

Rofii and Syarifah [22] point out that the learning process requires a comprehensive approach and a focus on the development of logical thinking, speech abilities, thinking, and cognitive activity. Hockridge [23], in turn, justifies the importance of developing computer literacy through games, in particular My Storybook and ZooBurst. These tools increase interest and help apply theoretical knowledge in practice. The researcher also emphasizes that gamification promotes the development of critical and creative thinking, teamwork, and effective communication.

Timotheou et al. [24] note that children need practical support when using innovative technologies. This approach helps to better consolidate and systematize the material. Interactive methods and gaming technologies have a positive effect on development, attention, and memory.

Among the variety of innovative technologies, teachers should choose those that best suit the age characteristics of younger students. This is confirmed by researches by Velverde-Berrocoso et al. [25], Hanif [26], Pavlou [27]. The highest educational effect can be achieved through simulation and role-playing games. At the same time, there are a number of unresolved issues. These include the insufficient development of inclusive practices and the limited practical implementation of digital technologies. This necessitates the expansion of pedagogical approaches. The limitations of the study include the vaguely defined boundaries of the topic, the limited number of sources used, and the insufficient analysis of individual materials.

## 6. CONCLUSIONS

The modern model of education involves integrating digital resources and technologies into traditional forms and methods of teaching. This allows students to acquire knowledge at different levels. The results of the experiment conducted in this work suggest that the use of a virtual environment offers significant advantages. Gamification and storytelling methods have proven particularly effective, acting as catalysts in the process of individual learning and activities in pairs or groups. A characteristic feature of these technologies is that they compensate for the risks of digital isolation and develop children's social skills in an educational environment. A key factor in the successful extrapolation of digital tools into primary education is the teacher's willingness to design a high-tech environment and introduce innovations into their work. Pedagogical skill reflects the quality of results. Further research should be aimed at developing practical models of digitalization in primary education and ensuring a high level of adaptability in the learning process.

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**APPENDIX A**

Questionnaire for collecting expert assessments of the level of development of primary school students' competencies

*Questionnaire. Please answer the questions using a scale from 1 to 10, where 1 means not important/not a threat and 10 means very important/a threat.*

*1. To what extent do humans contribute to the occurrence of forest fires?*

*2. Is it dangerous to smoke or throw unextinguished matches or cigarette butts in the forest?*

*3. How important is the influence of weather on the spread of fire?*

*4. Is it important to call for help immediately after a fire threat arises?*

*5. How high is the risk of using pyrotechnics and fireworks?*

*6. Is it important to extinguish small fires yourself?*

*7. How serious is the threat of using aerosols near open flames?*

*8. How important is it to cover your respiratory organs with a damp cloth?*

*9. How important is it to immediately leave the scene of a fire and call for help?*

*10. How important is it to monitor the scene after extinguishing a fire?*

*11. Assess the level of risk associated with playing with fire.*

*12. How important is it to call 101 and report the exact location of the fire?*