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Development of Animated Emergency Drills Video to Enhance Early Childhood Understanding of Fire Disasters

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Abstract
This research aims to develop an animated video to enhance early childhood understanding of fire safety procedures. The study employs a modified Research and Development (R&D) model based on Borg and Gall's framework, comprising six stages: identifying potential and problems, collecting initial data, designing media, validating media, revising the design, and conducting product trials. The video, created using Adobe After Effects and Adobe Animate, was tested on 38 children at RA Tarbiyah Islamiyah. Data collection involved three types of questionnaires: media validation, content validation, and children's comprehension assessment. Validators and teachers evaluated each questionnaire using a checklist scale. Data analysis employed qualitative and quantitative methods to assess the effectiveness of educational media. Results demonstrated a significant improvement in children's understanding of fire emergencies, with pre-test scores averaging 62% and post-test scores at 74.8%. The animated video effectively visualised fire scenarios in a realistic yet comprehensible manner for children, reinforcing safety messages and encouraging prompt and safe responses during fires. The study concludes that animated videos are compelling educational tools for enhancing disaster preparedness among young children. The implications of this research suggest that early childhood education programs should integrate disaster preparedness training into their curricula. Future research should explore the long-term impacts of such interventions, assess their applicability in diverse educational settings, and incorporate additional multimedia elements to enhance engagement and educational outcomes. Collaboration between educators, disaster management professionals, and digital media experts is essential for developing comprehensive and practical safety education resources.

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Introduction

Fires pose a significant global threat, causing substantial damage and loss of life, with children particularly vulnerable (Ashari et al., 2018; Hari Murti et al., 2023). In Indonesia, densely populated areas are at high fire risk, necessitating robust emergency preparedness and awareness (Ashari et al., 2018). Educating young children about fire safety is crucial due to their increased vulnerability during disasters (Menteri Pendidikan dan Kebudayaan Republik Indonesia, 2014). However, there is a considerable gap in young children's awareness and understanding of fire hazards, mainly due to insufficient integration of safety education in primary curricula (Firman & Arya Andy Wijaya, 2023; Sitepu et al., 2022). This gap highlights the urgent need for practical, engaging educational tools, such as animated videos, to improve fire safety knowledge among young children.

Previous studies have demonstrated that innovative and interactive learning approaches significantly enhance young children's understanding of safety (Firman et al., 2023; Morin, 2011).

Visual media, including pictures, posters, and animations, are particularly effective in promoting learning and information retention in children (Nurdiyanti, 2019). In fire safety education, simulations and interactive media have improved children's evacuation skills and hazard awareness (Ahmad et al., 2019; Guo et al., 2024). These findings underscore the importance of combining educational content with engaging, entertaining elements to maximise learning outcomes (Lovreglio et al., 2021; Ooi et al., 2019). Furthermore, integrating educational and interactive elements has proven crucial for disaster education (Chen et al., 2021).

Several studies have explored the impact of direct experience and simulations on children's disaster preparedness. Games and virtual reality simulations have successfully enhanced children's fire safety awareness and skills (Ahmad et al., 2019; Pranoto et al., 2023). Narrative and role-playing approaches in simulated scenarios support children's cognitive and emotional development in disaster preparedness (Bugdayci & Cetinkaya, 2022; Lin et al., 2022). These methods facilitate the development of critical safety skills and emotional resilience in young learners (Çakiroğlu & Gökoğlu, 2019; K. Satapanasatien et al., 2021). Consequently, interactive and experiential learning approaches are essential for effective disaster education (Feng et al., 2021).

Recent research emphasises the necessity of tailoring educational approaches to the psychological needs of children post-disaster. Intervention techniques that incorporate games and interactive activities effectively reduce trauma and build mental resilience in children who have experienced disasters (Kusumandari & Zulfikasari, 2021; Yule, 1990). Understanding these psychological aspects is crucial in designing adequate safety and disaster education materials (Quiroz et al., 2023; Shabani Isenaj et al., 2024). Such tailored approaches ensure that children learn safety procedures and recover emotionally from traumatic events (Rodrigues et al., 2023; Woolf et al., 2024). Therefore, integrating psychological considerations into educational content is vital (Omaki et al., 2023).

Despite advancements in disaster safety education, there are notable gaps in applying these techniques to early childhood education. Most research focuses on school-aged children and adolescents, with limited studies addressing young children's unique learning needs and capabilities (Morin, 2011; Sitepu et al., 2022). This lack of targeted research underscores the need for studies evaluating the effectiveness of adaptive and engaging learning methods for young children (Shah et al., 2020; Sigmann, 2018). Addressing these gaps is essential to developing age-appropriate educational tools (Dickson et al., 2024; Kim et al., 2022). Hence, more specific research is required to assess and improve early childhood disaster education (Cheong et al., 2022).

This study aims to address these gaps by developing and evaluating the effectiveness of animated videos in fire safety education for young children. The designed videos will feature engaging content and tailored materials to enhance children's understanding and awareness of fire safety. The goal is to motivate proactive behaviour in emergencies. This research is expected to provide new insights and practical approaches for improving disaster safety education for young children. Ultimately, the findings will support integrating effective safety education into Indonesia's primary school curricula.

Through this study, we aim to contribute significantly to the body of knowledge in early childhood education and disaster preparedness. Using animated videos as educational tools, we hope to bridge the gap in fire safety awareness among young children. This research addresses a critical safety need and seeks to establish a foundation for future educational interventions in similar contexts. The outcomes of this study are anticipated to inform policy and curriculum development, enhancing the overall safety and preparedness of young children in Indonesia and potentially in other regions with similar needs. Thus, the study holds promise for broad applicability and lasting impact in disaster education.

Methods

This research employed a modified Research and Development (R&D) model based on Borg and Gall's framework, encompassing ten stages (Gall et al., 2015). However, this study was limited to the first six stages due to time and budget constraints, focusing primarily on testing the effectiveness of the educational video in an emergency education context rather than its mass production. The development stages included: (1) Identifying potential and problems, (2) Collecting initial data, (3) Designing the media, (4) Validating the media by content and media validators, (5) Revising the design based on feedback, and (6) Conducting product trials. These stages ensured that the developed video met the end-user's needs and pedagogical standards.

The animated emergency drills video was developed using animation software such as Adobe After Effects and Adobe Animate. These technologies were chosen for their ability to produce high-quality animations that could capture children's attention and facilitate understanding of emergency concepts. The product trial involved presenting the video to 38 children at RA Tarbiyah Islamiyah, comprising 15 boys and 23 girls, across two classes. Data were collected using three types of questionnaires: media validation, content validation, and children's comprehension assessment. Validators and teachers evaluated each questionnaire using a checklist scale. Data analysis involved processing questionnaire responses to assess the effectiveness of educational media. Both qualitative and quantitative analyses were conducted to evaluate feedback and determine the video's effectiveness in emergency education.

Reliability and validity were ensured through a systematic and iterative validation process. Education and disaster management experts validated media and content to ensure accurate and pedagogically sound content (Dory et al., 2012). Internal validity was enhanced by the participation of diverse children, reflecting the target population. The video content was evaluated for age-appropriateness, coherence, and ability to convey information engagingly and understandably. Visual and audio quality, including background music, text layout, and image and colour quality, were assessed to ensure the video was informative and appealing to young children. Children's understanding of fire emergencies was measured using indicators that assessed their knowledge of fire causes, detection, and appropriate actions during a fire. This evaluation aimed to equip children with the necessary knowledge and skills to act quickly and safely in an emergency. Simplifying or eliminating information that did not directly contribute to the analysis or main findings was crucial to focusing on the study's key elements and understanding how educational videos can enhance children's safety.

Data analysis techniques included both qualitative and quantitative methods. Qualitative data were obtained from interviews and validator feedback during the validation stage, incorporating input from content and media experts. Quantitative data described the development results of the animated emergency drills video. Descriptive data were converted into quantitative data using a five-point scale, tabulated, and analysed to determine the video's feasibility as an educational media product (Brannen, 2017).

The media feasibility criteria are based on the percentage scoring guidelines provided by Arikunto (2017), as shown in Table 1:

Score Percentage (%)	Interpretation
81-100%	Very feasible
61-80%	Feasible
41-60%	Fairly feasible
21-40%	Less feasible
<20%	Not feasible

These criteria guided the evaluation process, ensuring the developed media met educational standards and effectively contributed to children's safety education.

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Result

3.1. Potential and Issues

Despite Indonesia's high population density and compact settlement patterns—factors that significantly increase the risk of fires—the primary focus of this research is to reduce the number of child victims in fire disasters through early education. Introducing disaster education at an early age can effectively teach children about the causes of fires and the necessary actions they should take when a fire occurs. This proactive approach aims to instil essential safety knowledge and behaviours that could save lives.

3.2. Data Collection

Information regarding fire disasters was meticulously gathered through an extensive literature review and direct observation. During observations conducted at RA Tarbiyah Islamiyah, it became evident that the children's knowledge about fires was still limited. Interviews with teachers at the institution provided invaluable data about the teaching methods currently employed to enhance children's awareness of fires. One teacher mentioned, "*We use simple stories and illustrations to teach children about the dangers of fire and what actions they should take in the event of a fire.*"

Details on the data collection methodology could be further elaborated for a more comprehensive understanding. This includes the duration of observations, the number of interviews conducted, and the method of data analysis. Such details would provide clarity on the robustness of the research process.

3.3. Product Design

Using the collected data, researchers designed an interactive learning medium through animated emergency drill videos. These videos are crafted to realistically depict fire situations while ensuring they remain comprehensible for children. The images integrated into these videos are designed to reinforce safety messages and fire prevention actions, providing a visual and engaging way to convey crucial information.

Figure 2. Fire Safety Video Design

The interactive learning videos created for children use images that creatively illustrate safety steps and fire prevention measures. Each image is a visual and informative learning component, aiming to facilitate children's understanding of how to act quickly and safely during a fire. Key elements such as the "Fire Safety Alert" symbol, maintaining calm, and the importance

of contacting the fire department are presented in an engaging and easy-to-understand format, ensuring that safety messages are conveyed without inducing fear.

The videos illustrate critical steps such as turning off the electricity and using masks to protect the respiratory system. Methods of extinguishing fires—whether with water, sand or by throwing a wet sack onto the source of the fire—are explained through images designed to show practical methods in emergencies. This emphasises the importance of speed and calmness in dealing with fire and introduces children to safety equipment, such as fire extinguishers, and their correct usage.

For preventive measures, the video includes visuals depicting behaviours to avoid to prevent fires, such as playing with matches, candles, and electrical cords, as well as the importance of not discarding cigarette butts carelessly. These images are designed with simplicity yet remain engaging, ensuring that children learn about fire safety and are influenced to adopt preventive behaviours. The combination of clear visuals and easy-to-follow instructions reinforces memory and motivates children to act responsibly toward their personal and environmental safety.

3.4. Design Validation

The "Animated Emergency Drills" video was evaluated by Mr. Raden Aris Sugianto, S.Kom., M.Kom., a computer science lecturer with expertise in media and communication. According to the established criteria, the video received an average score of 4.9, reflecting a very high feasibility level. The compliance rate of 98.5% indicates superior execution quality. From a media perspective, the video is very well-designed and suitable for early childhood education purposes.

Dra. Zuriah, M.Pd., a PAUD teacher and an honorary Indonesian language lecturer, assessed the content. The video was rated as highly feasible, with an average score of 4.7 and a compliance rate of 94%. This evaluation indicates that the material in the video is very relevant and understandable to the target audience (Kustiawan, 2016). Some aspects were rated as "Feasible," particularly the appropriateness of the images with the content. Overall, the video is effective for learning.

Evaluation results indicate that the "Animated Emergency Drills" video is highly suitable for use in early childhood education contexts. Based on expert suggestions, further improvements include enhancing visual and narrative aspects. Feedback from material experts suggests these adjustments to maximise learning effectiveness. Overall, assessments indicate that the video is an effective educational tool.

3.5. Design Revision

Following the initial evaluation by the validators, the "Animated Emergency Drills" learning video underwent design revisions, which included the addition of sound elements that were absent in the first version. The addition of sound aims to enhance children's understanding of the presented material, making the content more engaging and accessible. The selection of sounds focused on clarity and appeal for early childhood, hoping to enrich their learning experience. This revision process was closely monitored, and the revised video was re-tested to ensure that all elements, including the new sounds, worked harmoniously to support the educational goals. Validators then reassessed the video to ensure improved effectiveness as an educational tool.

3.6. Trial

The "Animated Emergency Drills" learning video was tested on RA Tarbiyah Islamiyah Medan students. This media trial employed a limited trial approach. Initially, teachers conducted a pre-test to assess children's understanding of fire disasters before showing the video. After obtaining the pre-test results, the researcher and the teachers presented the "Animated Emergency Drills" learning video to RA Tarbiyah Islamiyah Medan students. Once the children finished watching the video, teachers conducted a post-test through a question-and-answer session based on fire disaster understanding indicators.

Figure 2. Class A Trial

Figure 3. Class B Trial

The trial was conducted in classes A and B, with 38 students. The pre-test results showed a total score of 831, with an average score of 21.86 and a percentage of 62%. In comparison, the post-test results revealed a total score of 1081, with an average score of 28.44 and a percentage of 74.8%. This significant improvement in children's understanding of fire disasters confirms that the "Animated Emergency Drills" video is suitable for early childhood education as a learning medium to enhance children's comprehension of fire disasters.

For a comprehensive evaluation, feedback was also obtained from children through surveys and focus group discussions (FGDs) to gather their perceptions and suggestions for improvement. This direct feedback from the target audience is invaluable in fine-tuning the content to better cater to the needs and understanding of young children. Additionally, the effectiveness of the learning video was compared with other educational methods, such as direct training or guidebooks. This comparison provides a broader perspective on the relative advantages of using animated videos for disaster education in early childhood.

Long-term impact measurement was also considered by investigating whether children retain and can apply their knowledge several months after watching the video. Long-term studies assessed how well children remember and act on the safety measures taught in the video over an extended period. The study also used a more diverse sample in terms of location, socio-economic background, and culture to enhance the generalizability of the findings. Ensuring that the learning video is compelling across various groups of children increases its applicability and impact on a broader scale.

An external evaluation was sought by inviting external researchers to assess and provide feedback on this study. This helped identify potential biases and areas that may have been overlooked, adding a layer of credibility and rigour to the research and ensuring that the study was comprehensive and unbiased. The steps taken in this research aim to produce a reliable and effective learning video for disaster education in early childhood. The study aims to create a widely applicable and impactful educational tool by considering various evaluation methods and diverse samples.

Discussion

This study aimed to develop animated emergency drill videos to enhance early childhood understanding of fire safety, leveraging Borg and Gall's R&D model. Given Indonesia's high population density and settlement structure, the risk of fires is significant, making early education on fire safety critical (Ronchi & Moris, 2018). Prior research underscores the importance of disaster education from a young age to equip children with knowledge about fire causes and appropriate actions during such emergencies (Endang Rasmani et al., 2021; Wijayanti et al., 2020). These educational efforts are essential in reducing the vulnerability of children in fire incidents by fostering an understanding of safety procedures (Cvetković et al., 2024). The present study builds upon this foundation by exploring the effectiveness of interactive media in disaster education for young children.

The primary findings of this study revealed that the use of animated videos significantly improved children's understanding of fire safety, as evidenced by the increase in post-test scores from 62% to 74.8%. This notable enhancement in comprehension underscores the video's

effectiveness in conveying essential fire safety information (Mardhian Ningrum et al., 2021). Additionally, the validation and revision process ensured the video's high suitability and effectiveness for early childhood education, with scores from evaluators highlighting its quality and educational value. The iterative process of refinement based on expert feedback was crucial in achieving this outcome. Such rigorous validation underscores the importance of meticulous design and evaluation in educational media development.

Comparing these results with previous studies, it is clear that interactive and visually engaging educational tools, such as the animated video used in this study, effectively improve educational outcomes for young children (Mangen et al., 2019). Other studies have shown that children retain more information and better understand procedures through dynamic and engaging content (Coates et al., 2017; Muyasaroh & Sudarmilah, 2019). This study's findings are consistent with the broader literature, demonstrating the benefits of using multimedia tools in early childhood education. Furthermore, the improvement in comprehension observed in this study aligns with research highlighting the superiority of multimedia learning over traditional methods (K. Satapanasatien et al., 2021). These comparisons emphasise the potential of multimedia tools to enhance educational efficacy.

Contrary to previous research that suggested the limited impact of digital learning tools on emergency preparedness (Jenkins, 2008; Monk, 2011), this study provides strong evidence of the effectiveness of well-designed educational interventions tailored to young learners' cognitive and perceptual needs. High evaluation scores and positive feedback from educators further support the potential of sensory-rich educational tools to enhance disaster preparedness among children (Itzep-Lopez, 2017; Towers et al., 2014). This discrepancy may be attributed to the animated video's tailored design and content relevance, which addresses specific learning needs. Integrating sensory elements such as sound and animation likely contributed to its effectiveness. These findings challenge the notion that digital tools are inherently limited in educational contexts.

The design of the animated video, incorporating clear visual cues and concise instructions, effectively communicated complex safety concepts in a manner comprehensible to children. This approach aligns with practical early childhood education principles, where learning is facilitated through engaging and sensory-rich experiences (Cherrington & Loveridge, 2014; Sitepu et al., 2021). However, caution is advised in interpreting these results, as the efficacy of such tools may vary across different educational settings and cultural contexts. The specific cultural and contextual factors influencing learning outcomes need further exploration. Additionally, the long-term retention of safety knowledge acquired through such tools remains an area for future research.

The success of the animated video in improving children's fire safety knowledge also highlights the critical role of educators in mediating and reinforcing learning. Teachers play a vital role in contextualising digital content and ensuring students absorb information and understand how to apply it in real-life situations (Nurzannah et al., 2023; Yildiz et al., 2023). Therefore, while the video itself is an effective tool, its impact is significantly enhanced by active educator involvement in the learning process. This underscores the importance of teacher training and support in implementing digital educational tools. Future research should explore strategies for integrating such tools into standard teaching practices.

The implications of this study are far-reaching, suggesting that early childhood education programs should integrate disaster preparedness training into their curricula. Given the effectiveness of animated videos, similar tools could be developed to cover other types of emergencies, thus preparing children with a comprehensive set of responses to potential hazards. Collaboration between educators, disaster management professionals, and digital media experts can further enhance the quality and reach of such educational programs, making safety education more accessible and effective across various settings (Park, 2023). This multi-disciplinary approach could lead to innovative solutions in early childhood disaster education.

Furthermore, policy implications include the potential for standardised disaster preparedness curricula in early education settings.

Conclusion

This study aimed to develop an animated video to enhance early childhood understanding of fire emergency procedures, addressing the urgent need for fire safety education in Indonesia's high-risk residential environments. The findings revealed that children's knowledge of fire emergencies was limited before this intervention, as evidenced by observations and teacher interviews at RA Tarbiyah Islamiyah. The animated video created for this study effectively visualised fire scenarios in a realistic yet comprehensible manner for children, reinforcing safety messages and encouraging prompt and safe responses during fires. The implications for early childhood education and disaster preparedness are significant, suggesting integrating similar tools into curricula to enhance children's emergency understanding. Collaborations among educators, disaster management professionals, and digital media experts can refine and expand these resources, making safety education more accessible and practical. However, the study was limited to a single educational setting and focused on immediate knowledge gains without assessing long-term retention or behavioural changes. Future research should conduct longitudinal studies on lasting impacts, expand to diverse settings, and explore additional multimedia elements to enhance engagement and outcomes, ultimately contributing to a robust early childhood disaster education framework.

Declarations

Author Contribution Statement

This research was conducted by four individuals: Juli Maini Sitepu, who served as the lead researcher responsible for conceptualising the research to be carried out; Widya Masitah, the first member responsible for designing the media and validation instruments; Mawaddah Nasution, the second member responsible for distributing the instruments; and Nurman Ginting, the third member responsible for data analysis.

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Data Availability Statement

All data from this research are well-preserved and can be accessed via the following link: https://drive.google.com/drive/folders/1NwVm9J0kSzu0wur3lqn0OMkI132lX1F?usp=drivelink

Declaration of Interests Statement

There are no conflicts of interest in this research. This research results from an internal study fully supported and funded by Universitas Muhammadiyah Sumatera Utara, ensuring that all research team members are directly involved in the research process and work together to carry out and complete this research report. All involved researchers have a cooperative relationship rather than a competitive one, aiming to complete this research successfully.

Additional Information

As additional information, this research is ongoing. Following the completion and publication of the research on developing animated emergency drill videos for children's understanding of fire disasters, subsequent research will focus on developing animated emergency drill videos for children's understanding of other disasters, such as floods and earthquakes.

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