EDUTAINMENT APPROACH IN 2D ANIMATED FIRE SAFETY KIT FOR SCHOOL STUDENTS

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ABSTRACT

The safety of our communities from fire emergencies relies on firefighters, who have the crucial duty of raising public awareness about fire safety measures. This is particular among children, as they are most vulnerable and at risk from fires. However, traditional teaching methods often fall short in effectively conveying fire safety information to children. Hence, this study proposes the use of interactive 2D animation as a teaching tool, catering to the preferences of 10 to 14 years old school students. The main objective is to develop 2D animated series as an edutainment tool to educate school students about fire safety measures while providing an enjoyable and memorable learning experience. The animations focused on teaching emergency response and raising awareness of the hazards associated with fire. In developing the edutainment tool, Clip Studio Paint and DaVinci Resolve 18 is utilised to create a series of four short episodes of animations aimed at facilitating learning, comprehension, and addressing challenges with appropriate attention span. The four episodes including House Fire, Skyscraper Fire, Fire Extinguisher, and First Aid. The study used Rapid Application Development (RAD) method and the process involved defining a gap analysis and quick design (pre-production), prototype cycle (production) and testing (post-production). To ensure accessibility, the animations were made available online. The study involved collaborations from the Bandar Baru Bangi Fire and Rescue Station's firefighters and Libyan Damai School's teachers and students. Positive feedbacks through evaluation by 16 teachers and 35 school students highlighted the effectiveness of the 2D animated series for teaching fire safety measures. Teachers expressed their satisfaction and interest, giving an outstanding result for overall usability mean score of 4.43, while students expressed enjoyment and provided helpful suggestions for development, resulting in a very satisfactory overall usability mean score of 3.88. Thus, the animation series has potential to improve the awareness and understanding of fire safety measures among school students, and hopefully the risk of fire-related accidents and injuries among them can be reduced. For future development, the study suggests including a broader range of fire scenarios and preparing children for emergencies. This would require further research and collaboration with experts and other related stakeholders.

Keyword: Fire Safety, 2D Animation, Edutainment

I.   INTRODUCTION

Firefighters play a vital role in safeguarding communities from fire emergencies, and one of their pivotal responsibilities is to disseminate fire safety awareness, particularly among children who are most vulnerable to fire-related dangers. Leveraging technological advancements, firefighters have explored innovative ways to educate children about fire safety, with 2D animation emerging as an effective approach. 2D animation, employing two-dimensional images to simulate movement, has

been widely used in films, TV shows, and video games, making it well-suited for educating children. The introduction of vibrant and dynamic characters in 2D animations captures children's attention and enhances their information retention. This technique allows firefighters to create engaging teaching programs that illustrate correct fire extinguisher usage, safe evacuation from burning buildings, and fire prevention measures. These videos can be shared with schools, local institutions, and online platforms. The adaptability of 2D animation caters to diverse audiences, including those with varying languages and special needs (Emmanuel, 2021; Carvalho et al., 2022; Tremolada et al., 2019).

Teaching fire safety to children is crucial for instilling confidence in handling emergencies. While some schools neglect fire drill training due to misconceptions or other priorities, statistics reveal the importance of such education. In Malaysia alone, there were 336 fire-related fatalities in 2020, indicating the urgency of preparing children to face such situations (World Life Expectancy 2020). Short attention spans pose a challenge, with Tremolada et al. (2019) showing that age, familiarity, and complexity affect attention. Children's attention span increases by 2 to 3 minutes per year of age (Brain Balance, n.d.). To address this, Pang Yin Ling of UCSI Child Development Centre emphasized that engagement through fun learning and play is vital for effective education, exemplified by students successfully demonstrating escape routes (TheStar 2018). Given these challenges, animation emerges as a compelling alternative to traditional teaching methods, catering to short attention spans and enhancing engagement. Crafting short, engaging, educational animations can empower children with fire safety knowledge, ensuring preparedness in the event of a fire (Emmanuel, 2021; Carvalho et al., 2022; Tremolada et al., 2019; TheStar 2018).

A.   Problem Statement

The inadequate level of fire safety awareness among school students is a concerning issue faced by various countries. Empirical evidence from studies conducted in different regions underscores the urgency of improving fire safety education in schools. For instance, an enlightening study carried out in Tanzania by Emmanuel (2021) revealed that although secondary school heads, teachers, and students demonstrated a moderate level of knowledge concerning fire disaster preparedness, significant disparities in perceived knowledge were observed between secondary school teachers in public and private schools, as well as between teachers and students. Similarly, a recent Brazilian study by Carvalho et al. (2022) shed light on the critical gaps in safety awareness among both students and teachers. The study highlighted the unfortunate consequences of these knowledge gaps, such as injuries and fatalities during fire emergencies.

Malaysia, too, has witnessed a need for enhanced fire safety education among its school students. Subramaniam's survey (2004) identified six crucial elements for effective fire safety, with

belief in the importance of fire safety, the understanding of rapid reactions during fire incidents, and an appreciation for the significance of fire safety ranking as the top three elements. However, despite the importance of fire safety education, traditional teaching methods are often inadequate in reaching children with shorter attention spans and learning disabilities. Studies such as those conducted by Turker et al. (2019) and Božanić et al. (2021) have revealed significant deficits in arithmetic skills, sound-symbol associations, and short digit span forward tasks among children with attention deficit and learning disorders.

In this context, the utilization of animation has shown promise in enhancing learning experiences for children. Studies like Rosmiati (2019) have highlighted the effectiveness of animation in enhancing interest and comprehension across various subjects. This is further evidenced by studies such as Esthi Adhityarinis (2022) research on the improved interest and memorization of material achieved through interactive animations. Moreover, Zaini et al. (2020) work in using audio and animation for flood disaster education has demonstrated the potential for enhancing attention and learning in pre-schoolers. Unfortunately, current offerings of fire safety educational content, particularly animations, are lacking. An exploration of existing animation series related to fire safety using the official IMDB website revealed a dearth of recent and up-to-date offerings. Many fire safety productions, including animations, documentaries, and manuals, are outdated and largely forgotten, creating an urgency for contemporary and engaging content.

Furthermore, for firefighters, who are pivotal in delivering fire safety education, limitations arise due to their demanding schedules and the unpredictability of emergency situations. The ever-present need for rapid response to emergencies makes it challenging to allocate personnel to educational initiatives consistently. This challenge is exacerbated by the potential impact of work-related stress and exposure to traumatic situations, as shown in studies by Pennington et al. (2022). As such, creating accessible and captivating fire safety materials that can be disseminated widely without relying solely on the availability of firefighters becomes an imperative. Existing fire safety video games, while holding promise, exhibit certain limitations and flaws in their educational content and usability. Games like "Little Fire Station" and "Little Panda Fireman" have been criticized for repetitiveness, lack of educational value, and challenging controls. These games fail to provide comprehensive instruction in fire safety principles and overlook the importance of a local mascot that resonates with the target audience.

In light of these gaps and challenges, this study aims to fill the void by leveraging the power of 2D animations to deliver effective fire safety education to school students. By incorporating animation principles and a relatable Malaysian mascot, the study aims to create engaging and

educational content that caters to different learning styles and enhances retention. Through this innovative approach, the study seeks to bridge the gap in fire safety education and equip children with the knowledge and skills necessary to stay safe in the event of a fire.

B.   Research Objectives And Questions

The questions that follow will be investigated in this study:

1.   What are the requirements and needs that are suitable in developing animation for catering the school children's preferences?

2.   How the implementation of 2D animation be useful to firefighters and teachers in effectively educating school students about fire safety emergency?

3.   Will the animation be captivating enough to grab the attention of school students so that they could be aware, understand and comprehend the safety measures during the event of a fire emergency?

The main aim of this study is to educate and spreading awareness to school students about fire safety procedures and emergency response techniques, create an entertaining and informative 2D animation. Firefighters and teachers can utilize the animation to increase awareness as well as readiness for potential fire hazards. The objectives of the research are as follows:

1.   To identify the requirements including related theory and animation principle that can improve the overall quality and effectiveness of the animation.

2.   To develop a short, comprehensive, 2D animated edutainment series that is always available, teaches children about fire safety measures, and integrates a Malaysian animal mascot to increase audience engagement and local connection.

3.   To evaluate the animation series based on users' (school students' and teachers) acceptance and satisfaction.

C.   Scope

The study encompasses the creation of a 2D animation video targeted at school students aged 10 to 14 years old, focusing on fire safety protocols and emergency response strategies. The animation

will cover topics such as identifying potential fire hazards, appropriate actions during a fire emergency, proper utilization of fire safety equipment, and the importance of having an evacuation plan. Leveraging a combination of visual and audio elements, the animation aims to both captivate and educate the audience. Collaboration with fire safety experts ensures the accuracy and effectiveness of the message conveyed. The final product will be shared through fire department social media platforms to maximize distribution.

The primary audience for this study is school students aged 10 to 14 years old. Animation offers the advantage of enhancing visual learning, which aids in comprehending complex concepts and systems. Animation's ability to simplify abstract ideas through visually engaging designs allows learners to interact with challenging content more effectively. By incorporating animated characters and captivating visuals, the study merges fire safety tips, guidelines, and exercises in an accessible and engaging manner. This approach is versatile and can be utilized not only in schools but also by parents or guardians at home, ensuring convenience and broader reach. Moreover, language barriers can be addressed by utilizing body language.

As elucidated by Johnston and Thomas (1995) in "The Illusion of Life," facial expressions alone may be insufficient to convey intricate emotions like resentment or envy in animation. Therefore, structuring the narrative to integrate character actions with emotions enhances the storytelling. Pardew (2008) underscores the role of body language in conveying emotions, noting that our daily interactions involve subconscious perception of emotions through gestures, stance, and facial expressions. Successful animation entails using the entire body, including the face, to effectively convey emotions, thus expanding on the potential of facial expressions alone (Pardew, 2008).

II.   LITERATURE REVIEW

The review of literature aims to explore the utilization of 2D animation as an educational tool, focusing on its application in fire safety education for school students. The prevalence of 2D animation in various industries, including education, underscores its potential to enhance students' motivation and comprehension of complex topics. Notably, 2D animation has been shown to improve mathematical proficiency and enthusiasm in students (Wulandari, 2022). Given the limitations of traditional teaching methods in engaging students effectively, the review highlights the potential of 2D animation to transform fire safety education into an engaging and educational experience.

The concept of "edutainment" emerges as a unique approach to teaching fire safety to students through 2D animation. Animated videos have been effective in capturing students' attention and

facilitating learning, particularly during online learning scenarios (Moonti & Gani, 2023). This approach proves beneficial for students with short attention spans, as it enhances working memory capacity and attentional control (Kane et al., 2001; Shimi et al., 2013). The use of restorative soundscapes and various animation techniques, including dramatic and musical elements, contributes to cognitive enhancement and engagement (Shu & Li, 2019; Othman et al., 2022). Utilizing this method with fire safety education through 2D animation ensures effective knowledge retention and adherence to safety procedures.

The review delves into the components of multimedia, including text, images, audio, animation, and video. These elements, when combined thoughtfully, enhance comprehension and engagement in educational materials. Multimedia's integration in technology, communication, entertainment, and education enhances learning outcomes and engagement (Moreno & Mayer, 2000). This approach can accommodate diverse learners and offer a stimulating and comprehensive educational environment. The review also discusses the principles of animation, highlighting four selected principles (anticipation, staging, follow through and overlapping actions, exaggeration) to be applied in the development of the fire safety 2D animation series kit. These principles contribute to creating engaging and dynamic animations that effectively convey fire safety concepts. Furthermore, the review introduces the capacity theory of attention, emphasizing the limited resources of attention and its gating function. The theory's insights are crucial when developing 2D animations, taking into account issues related to attention capacity, divided attention, and cognitive limitations.

In conclusion, the literature review underscores the research gap in utilizing animation for fire safety education. The potential of 2D animation remains largely untapped, offering an engaging and transformative educational experience for students. Empirical research is needed to gauge the effectiveness of animation in fire safety curriculum, with the potential to enhance safety awareness and prevent accidents in school environments.

III.   METHODOLOGY & DEVELOPMENT

A comprehensive overview of the development process for a 2D educational animation intended to teach schoolchildren about fire safety is provided in this section. Our system, which is based on the RAD methodology's fundamentals as shown in figure 3.1, encompasses the pre-production, production, and post-production phases.
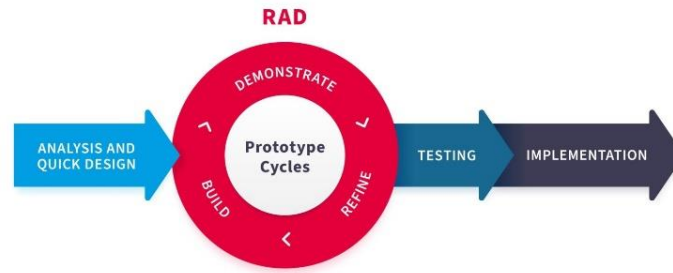
Figure 3.1   Methodology of Rapid application development (RAD)

https://www.thirdrocktechkno.com/blog/what-is-rapid-application-development/

A.   Analysis And Quick Design (Pre-Production Stage)

Data collecting, research, and interviews are part of the initial phase's in-depth analysis, which serves as the basis for further quick design procedures including storyboarding, character design, and scripting. Our methodology is based on a conceptual model that facilitates the effective integration of animation as a teaching tool as shown in figure 3.2
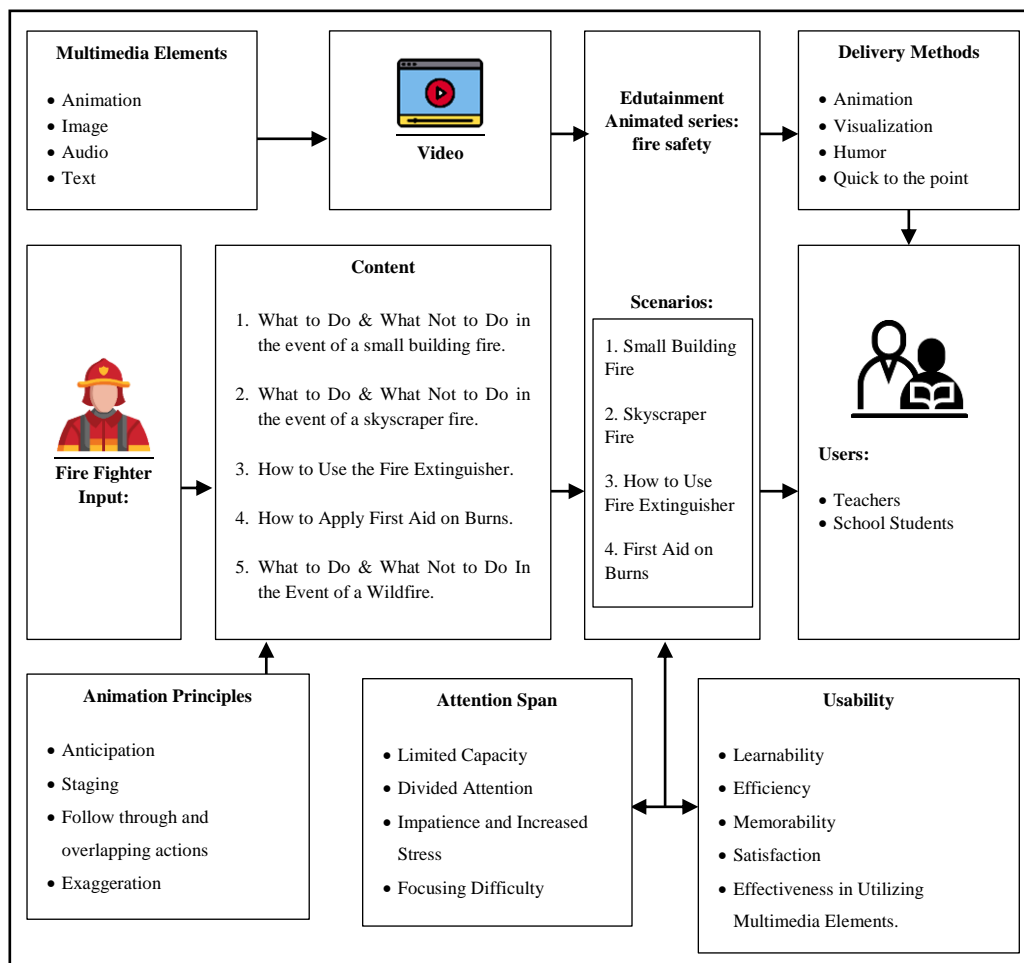
Figure 3.2   The Conceptual Model

In an interview, the representative of the Bandar Baru Bangi Fire and Rescue Station acknowledged to the effectiveness of the animation in imparting knowledge about fire safety, from which we drew our conclusions. An organized execution is ensured by a properly prepared development schedule that describes the activities and deadlines. Scripting, character design, and storyboarding are carefully constructed together throughout the quick design process to create an animation that works well. Our animation design, as shown in figure 3.3 represented by the mascot "Oscar the Tiger," takes cues from renowned figures and channels.
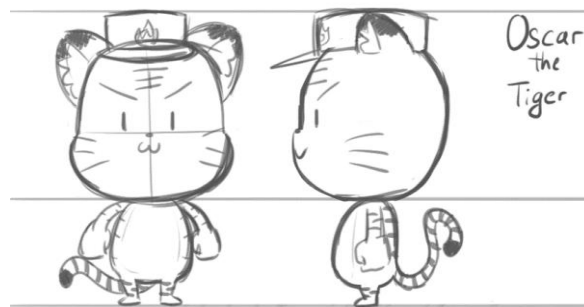
Figure 3.3   Oscar the Tiger Character Sheet

As shown in Figure 3.5 - Figure 3.8 Storyboards in great detail act as visual road maps that show how the animation's plot develops. We meticulously illustrate how animation can be used as a dynamic and interesting medium to teach schoolchildren essential fire safety concepts through careful research, design, and deployment.

Storyboard Episode: Small Building
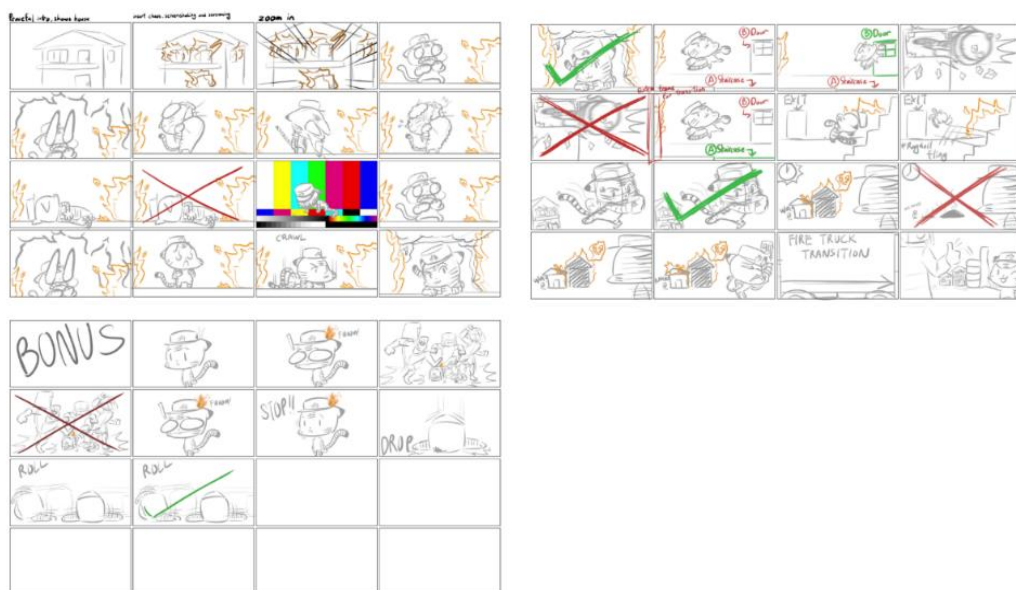
Figure 1.5   Episode 1 - Small Building Storyboard Sketch

Storyboard Episode: Skyscraper
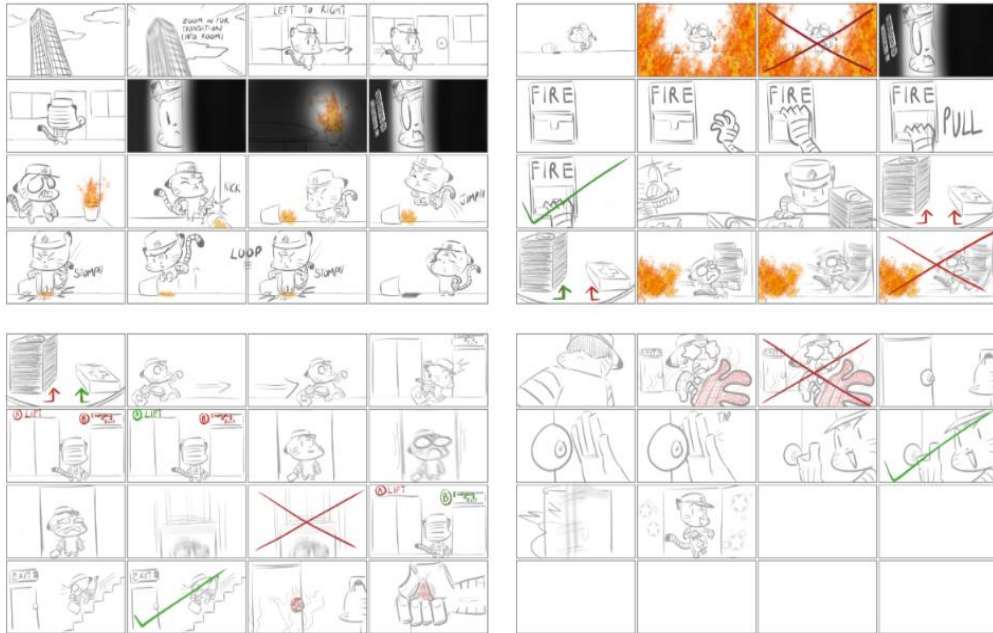
Figure 3.6   Episode 2 - Skyscraper Storyboard Sketch

Storyboard Episode: Fire Extinguisher
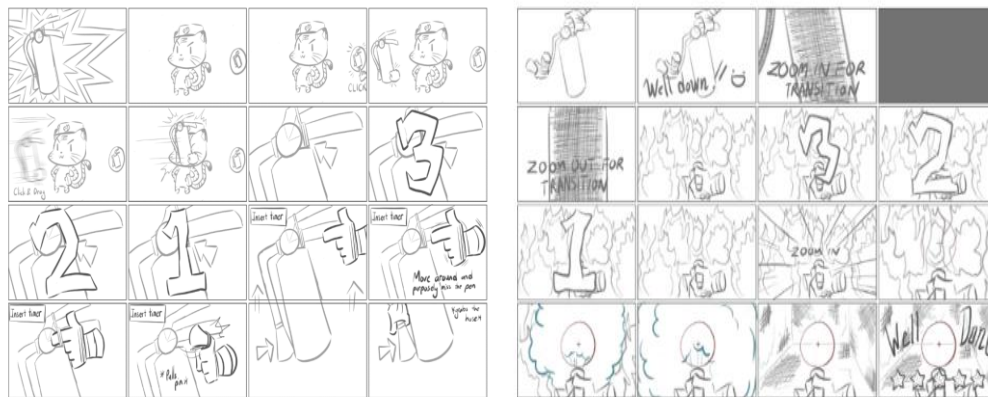
Figure 3.7   Episode 3 - Fire Extinguisher Storyboard Sketch

Storyboard Episode: Apply First Aid
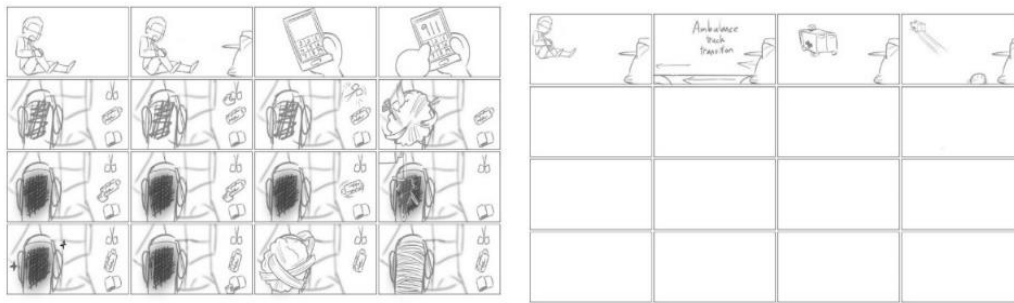
Figure 3.8   Episode 4 - Apply First Aid Storyboard Sketch

B.   Prototyping Cycle (Production Stage)

Every step of the "Prototyping Cycle (Production)" are crucial to the creation of the educational animation. To ensure compatibility and the best user experience, the first stage, "Refine," is devoted to finding the necessary hardware and software for animation production. As shown in Table 3.3 - Table 3.4

Table 3.3   Developer Requirement

Developer Required Software	Developer Required Hardware
DaVinci Resolve 18	• Processor: Intel(R) Core(TM) i5-5200U CPU @ 2.20GHz 2.19 GHz
Clip Studio Paint	• Memory: 4 GB RAM
	• Storage: 256 GB
OS: Windows 10	• GPU: NVIDIA GeForce 940M / Intel(R) HD Graphics 5500

Table 3.4   User Requirement

User Required Software	User Required Hardware
YouTube	• YouTube offers universal accessibility, enabling straightforward video streaming across all devices that has accesses to the internet.

The creation of the animation is done during the next phase, "Build," utilizing the appropriate tools and technologies. To turn the conceptual model into an actual animation that meets the objectives of the study, this consists of designing graphic components, animation sequences, and interactive elements as shown in Figure 3.9.
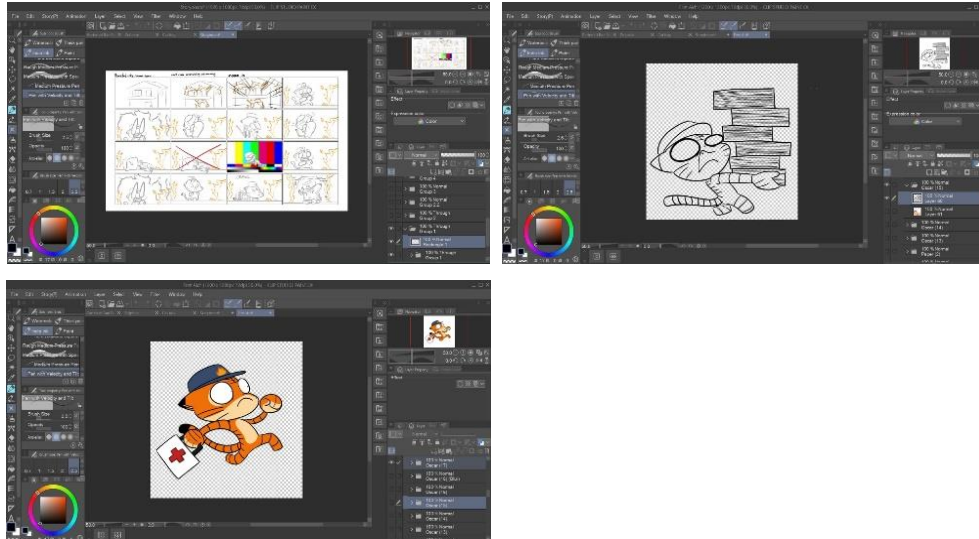

Figure 3.9   Designing Process

The animation is consistent with quality, usability, and educational standards thanks to continuous review cycles. Collaborating with fire department expert, the "Backgrounds" sub-phase creates visually appealing settings for fire scenario episodes as shown in figure 3.10 – 3.15 and Table 3.5.

Episode 1 - Small Building Background
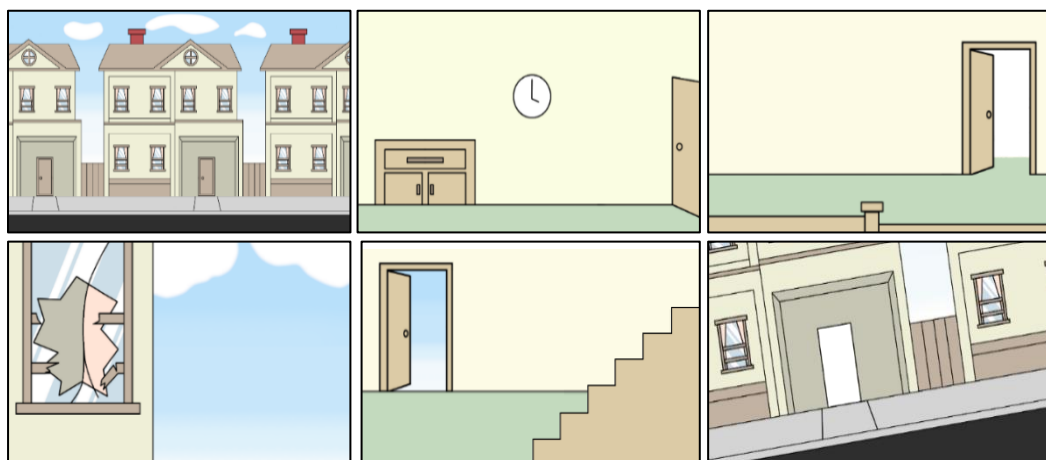
Figure 3.10   Episode 1 - Small Building Background

Episode 2 - Skyscraper Background
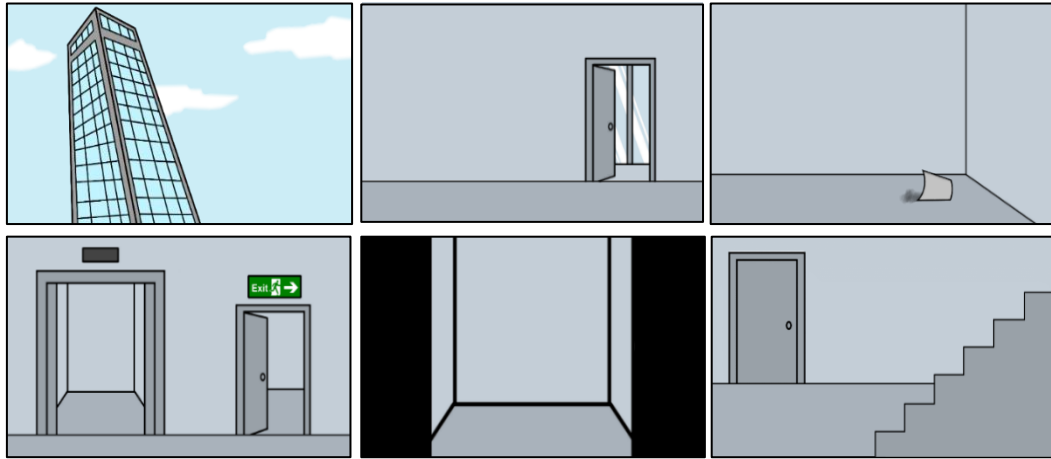
Figure 3.11   Episode 2 - Skyscraper Background
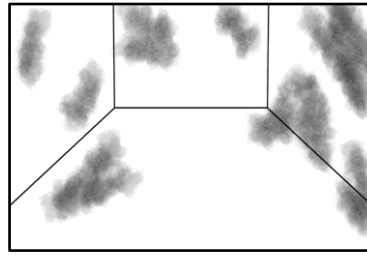
Episode 3 - Fire Extinguisher Background

Figure 3.12   Episode 3 - Fire Extinguisher Background

Episode 4 - First Aid on Burns Background
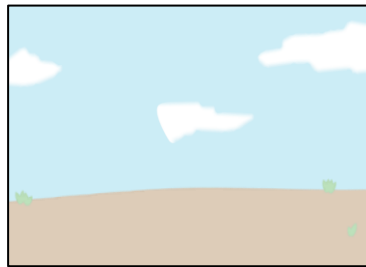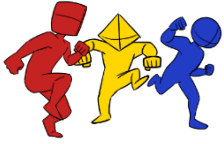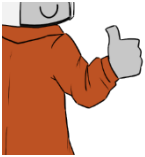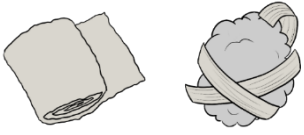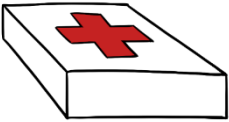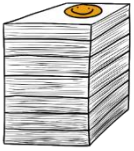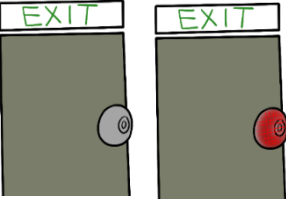

Figure 3.13   Episode 4: Apply First Aid Background

The "Characters & Objects" section describes the many people and things that appear in the animation, each of whom has a specific role. As shown in table 3.5

Table 3.5   Characters & Objects

Characters

Oscar the Fire Safety Tiger

Edie Bomba Sarawak Mascot

School Students

Pedestrian

Fire Fighter

Burn Victim

Objects

Phone

Water Bottle

Bandage & Wrap Cloud

Scissors & Cutting Cloud

Fire Extinguisher

Ambulance

Fire Alarm

First Aid Kit

Paper Stack

Stars

Doors

To increase the impact of the animation, "Sound / Voice / Dialogue Recording" comprises recording dialogue and character sounds. As shown in Error**! Not a valid bookmark self-reference.** 3.14

3.14
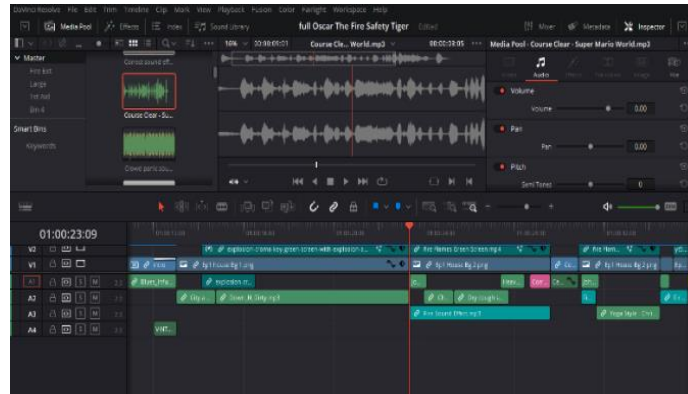
Error! Not a valid bookmark self-reference. 3.14 Sound Recording and Editing

The "Animating" step advances into the execution of actual animation, as shown in Figure 3.15
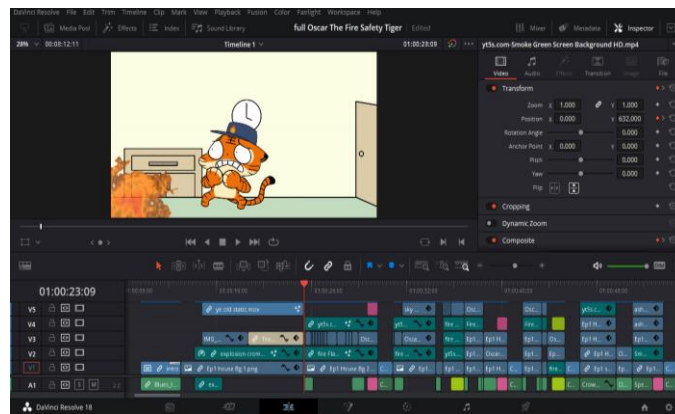
Figure 3.15   Animation Process

Which is followed by the "Demonstrate" phase. In this instance, the completed animation is shown to students and teachers for evaluation in order to collect feedback on how to improve its overall quality, interactivity, and educational value. An entertaining and potent educational tool is ensured by this comprehensive approach to animation development.

C.   Testing and Implementation (Post-Production Stage)

In this stage, extensive testing ensures the 2D animation's excellent operation, error-free performance, and exceptional user experience. There are two crucial sections in this stage: "Developer Testing" and "User Testing." The "Developer Testing" phase, which includes features like software usability, key frame animations, audio-visual synchronization, and scene transitions, focuses on accuracy and error elimination. To make sure that colors, textures, and visual effects are accurately recreated, the rendering process is carefully reviewed. A strong basis for a flawless and captivating

animation is created by thoroughly examining rig movement, character alignment, and background consistency.

Important information is gathered during the "User Testing" stage through surveys distributed to both teachers and students. The feedback measures the effectiveness and reception of the animation. The assessments of teachers are used to evaluate the animation's educational value, conceptual simplicity, and potential for integration into the classroom. The responses received from the students reveal their levels of understanding, interest, and enjoyment, providing insightful input for improvement. On the basis of the analysis of the input, the users' issues are addressed, taken into account, and enhanced. This continuous approach ensures consistency with the requirements and expectations of the target audience, producing an enjoyable and interesting learning experience.

The animation undergoes adjustments during the "Implementation" stage in response to student and teacher feedback. The effect of the animation is substantially improved by helpful suggestions. To improve the effectiveness of the animation in teaching viewers about fire safety, precise changes are made after carefully going over the data and identifying patterns. A final editing process improves the animation's audio, video, and textual elements while adding additional sound effects to increase impact. The animation is generated in its final format and rendered in accordance with distribution requirements following the editing process. The finished video is then released and made accessible on websites such as YouTube in order to effectively reach the target audience.

The 2D fire safety animation's "User Interface" was carefully created to provide important knowledge about fire safety precautions in emergency situations. The interface uses clear animations and graphics to explain the best course of action for a variety of situations, including evacuations, utilizing fire extinguishers, giving first aid, and putting out fires. This method equips users with the knowledge they need to act responsibly in the event of a fire, and the animation's opening and closing scenes draw in viewers and invite participation.

In the first episode, the mascot makes decisions that result in both success and failure as it learns about fire safety. In episode 2, the mascot makes good decisions while navigating a scenario involving a skyscraper fire. In Episode 3, the P.A.S technique is highlighted, demonstrating a successful extinguishing technique. The mascot aids a burn victim in Episode 4, emphasizing the importance of quick actions to minimize harm.

The full methodology utilized to produce the instructive 2D fire safety animation is summarized in the research's conclusion. The importance of each stage—pre-production, production, and post-production—in creating an effective tool for education is highlighted. The animation is in

line with instructional objectives and target audience expectations thanks to interviews with firefighting experts, surveys of teachers and students, and continuous revisions.

IV.   RESULTS & DISCUSSION

D.   *Evaluation Set-up*

A school visit was carried out at the Libyan School Damai as part of this research survey. The aims is to evaluate the efficacy of utilising animation as a tool for instructing fire safety to school students. During the visit, 35 school students, 2 students are 10 years old (6%), 8 students are 11 years old (23%), 5 students are 12 years old (14%), 10 students are 13 years old (28%), 10 students are 14 years old (29%). and 16 teachers were shown the fire safety animation series. Then they were given a questionnaire consisting 25 questions to fill up in order to obtain their opinions and feedback. The questionnaire objectives are to investigate elements learnability, efficiency, memorability, satisfaction, etc., of an animated fire safety educational tool, as well as to gather data on the attitudes and perceptions of school students and teachers towards fire safety. To achieve this, a questionnaire has been developed using a Likert scale ranging from 1-5: strongly disagree to strongly agree as shown in Table 4.1 and a few Yes and No questions and open questions. Table 4.1 show the Likert scale used, while the open question regarding what they've learned from the animation and suggestions on how to improve it. The questionnaires used are adapted from Mohd Razali et al. (2021) and Monk (2011) were used for the descriptive evaluation of the interaction design.

Table 4.1   Evaluation Likert Scale

Value	Scale
5	Strongly Agree
4	Agree
3	Neutral
2	Disagree
1	Strongly Disagree

E.   *Evaluation Responses*

The questionnaire is administered to the school students and teachers in order to assess their agreement with various statements related to fire safety. The data gathered from this study will contribute to the understanding of the efficacy of educational tools in promoting fire safety awareness among school students, as well as provide insight into the attitudes and perceptions of this population towards fire safety.

Teachers are ideal individuals to evaluate educational resources since they are knowledgeable about the wants and needs of their students as learners. Thus, it was essential to include school teachers in participate in this survey to get an expert opinion on the educational aspect of the fire safety animation, They were able to offer insightful input on the animation's learnability, effectiveness, memorability, satisfaction, multimedia elements, and general suitability for school students because to their knowledge in curriculum alignment and comprehension of effective teaching techniques. Hence the survey could verify that the animation satisfies the educational requirements and expectations of the teaching community by incorporating teachers in the review process, thereby boosting its usefulness as an important instructional resource.

The evaluation is successfully completed, and the outcomes are collected and analysed. The results, findings and conclusions is discussed in this section. The discussion is based on the mean score interpretation by Vipinosa (2015) as shown in Table 4.2

Table 4.2   Mean Score Interpretation

Mean Score	Interpretation
4.21 – 5.00	Outstanding
3.41 – 4.20	Very Satisfactory
2.61 – 3.40	Satisfactory
1.81 – 2.60	Fair
1.00 – 1.80	Unsatisfactory

F.   Teachers Feedback and Suggestions
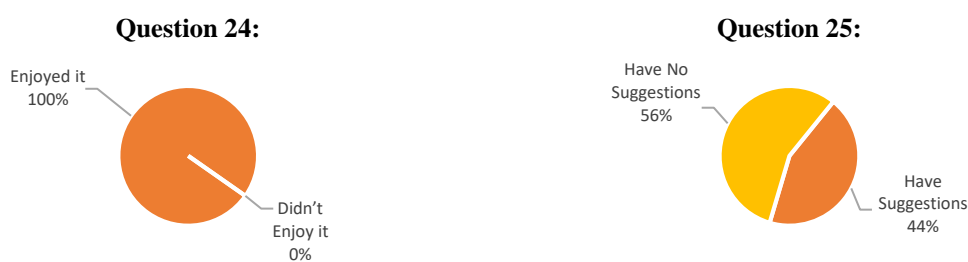
Figure 4.8   Teachers Feedback and Suggestion Result Charts

According to the results shown in Figure 4.8, the teachers' response to the cartoon were overwhelmingly favorable. All 16 teachers (100%) who responded to question 24 stated they had enjoyed the cartoon. For Question 25, nine teachers said they were happy with the cartoon and had no suggestions to improvement. However, two teachers proposed improving the animation's interactivity and engagement to encourage student participation more, and

two more suggested adding extra fire safety information. Additionally, two teachers suggested that the animation be slowed down and should give clearer explanations, and 1 teacher especially emphasized the necessity for a slower pace. These recommendations show how much the teachers value the cartoon's usefulness while also offering insightful suggestions for future improvements that could further improve the students' educational experience.

G.   Overall Teachers Evaluation

The overall average score for the teacher usability evaluation, which is displayed in Table 4.9**Error! Reference source not found.**, reveals a very positive evaluation of the animations' numerous usability aspects.

Table 4.9   Teachers Overall Usability Evaluation Average Result

Usability	Means Score	Interpretation
Learnability	4.60	Outstanding
Efficiency	4.17	Very Satisfactory
Memorability	4.39	Outstanding
Satisfaction	4.56	Outstanding
Multimedia Elements	4.27	Outstanding
General Questions	4.60	Outstanding
Overall Evaluation	4.43	Outstanding

Learnability: When each of the usability aspects were evaluated, the learnability component had a mean score of 4.60 and was interpreted as outstanding, demonstrating that the animations proved very successful in increasing the learning process. The animations were generally effective at educating about fire safety, as seen by the efficiency mean score of 4.17, which was classified as very satisfactory.

Efficiency: The animations proved effective at educating about fire safety, receiving a mean score of 4.17, which is interpreted to be very satisfactory. The teachers agreed that the animations effectively conveyed the required information in a timely manner, ensuring that students understood the main concepts without unnecessary confusion or delays.

Memorability: The animations have remarkable memorability, scoring a mean of 4.39 and being interpreted as outstanding. This indicates that the content was impactful and leaves a lasting

impression. The teachers were pleased how easily it was to remember the information on fire safety that was presented in the animations, which can increase their student's readiness and awareness of future emergencies.

Satisfaction: Teachers' satisfaction with the animations was outstanding as seen by their mean score of 4.56, which is interpreted as outstanding. Teachers found the animations to be interesting, educational, and fun, which led to successful learning outcomes, indicating that their students would enjoy and learn from the animations.

Multimedia Elements: The use of multimedia elements in the animations received positive evaluations, with a mean score of 4.27 being interpreted as outstanding. The teachers were pleased with the carefully chosen font type and size, eye-catching graphics and images, pleasing colour schemes, suitable background layout, interesting sound effects, and audio. These components can improve students' understanding, involvement, and overall enjoyment of the animations.

General Questions: The teachers give the general questions a mean score of 4.60, which is interpreted to be outstanding. This demonstrates their general positive evaluation of the animations. The teachers thought the animations were interesting, beneficial, and informative for their students. They recognised the usefulness of the animations in teaching students about fire safety and valued the way that educational information and entertainment element were combined.

The teachers' combined overall average mean score of 4.43, interpreted as outstanding, in light of the comprehensive evaluation across all six usability aspects, highlights the usefulness of the animations in promoting student learning and participation in fire safety instruction. The animations showed excellent memorability, efficiency, learnability, and satisfaction while effectively integrating multimedia elements to produce a fun and educational experience. The usability of the animations was highly praised by the teachers, who acknowledged their beneficial effects on the learning and awareness of fire safety.

*H.	School Students Feedback and Suggestions*

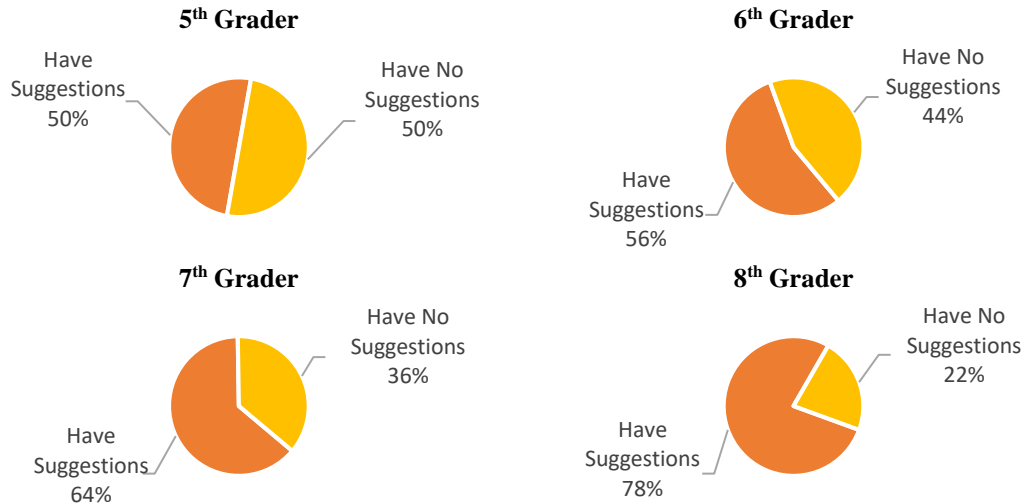**Question 24:**
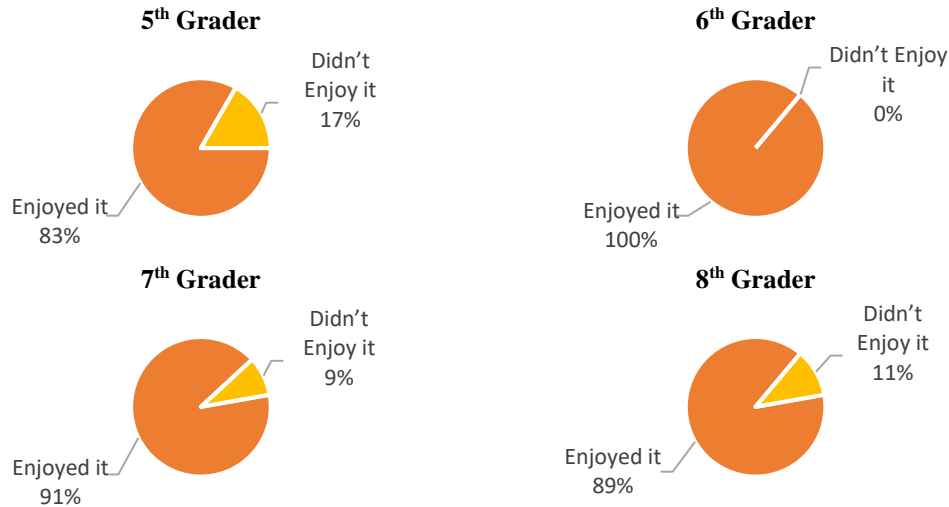
Question 25:

Figure 4.17	School Students Overall Usability Evaluation Average Result

Responses to Question 24, which are shown in Figure 4.17 shed light on the reasons why students in various grade levels liked or disliked the animation. When questioned why they liked the cartoon, 83% of the students across all grade levels gave a positive response. Due to the cartoon's captivating and entertaining qualities, which grabbed their attention and made learning enjoyable, many students considered it to be delightful. They like the cartoon's instructive and entertaining elements, demonstrating that it successfully handled educational and entertainment quality. Their enjoyment was influenced by the appealing aesthetics, captivating narrative, and comprehensible material.

The reasons given by the students who didn't like the cartoon, on the other hand, 17% of students answered in Question 25, some students identified specific areas where we could have

done better, which may have contributed to their lack of enjoyment. The need for clearer audio, a slower pace, additional explanations, and a change from an animal to a human mascot were among the suggestions. These students might have thought that these features decreased their enjoyment of the cartoon overall.

It's crucial to point out that across all grade levels, the proportion of students who did not enjoy the animation was very low, indicating that the students did enjoy it. The criticism from those who didn't like it offers insightful information about areas where we could try to address issues and further improve its appeal and enjoyment for all students.

We have the opportunity to gain a thorough grasp of the components that contribute to student satisfaction and places where improvements can be made by taking into account both the positive feedback from students who liked the cartoon and the constructive suggestion for enhancement from those who didn't. This adaptive method enables ongoing improvement and ensures that subsequent revisions of the animation will improve it to suit the interests and preferences of the students.

I.   Overall School Students Evaluation Score

Results from school students' usability evaluations as shown in Table 4.22 offer insightful information about how they interacted with the animation from several usability perspectives.

Table 4.22   School Students Overall Usability Evaluation Average Result

Usability	Means Score	Interpretation
Learnability	4.10	Very Satisfactory
Efficiency	3.89	Very Satisfactory
Memorability	3.90	Very Satisfactory
Satisfaction	3.72	Very Satisfactory
Multimedia Elements	3.76	Very Satisfactory
General Questions	3.88	Very Satisfactory
Overall Evaluation	3.88	Very Satisfactory

Learnability: A very satisfactory level is indicated by the students' 4.10 average mean in this category. It implies that the cartoon's simplicity enabled students to understand the principles and lessons it was intended to teach. This successful outcome indicates the cartoon's effectiveness as a learning tool for school students.

Efficiency: The students gave the cartoon an overall efficiency mean of 3.89, which is interpreted to be very satisfactory. This shows that the information was delivered promptly, enabling students to learn well without feeling pressured or overwhelmed. The cartoon's effectiveness as a teaching tool was certainly enhanced by its pacing and structure.

Memorability: The students' average memorability mean of 3.90 interprets a very satisfactory level. This shows that the student's capacity to remember and retain the material delivered was a result of the cartoon's lasting influence on them. The cartoon's captivating style and effective material delivery are certainly what made it memorable to the students.

Satisfaction: The students gave the animation an overall mean of 3.72, which is interpreted as very satisfactory. This shows that they enjoyed watching the cartoon and thought it was an enjoyable learning opportunity. They provided with plenty of positive reviews since it combined entertaining element with instructive material.

Multimedia Elements: The students gave this category an overall average mean of 3.76, which interpreted a very satisfactory level of usability. It shows that the students were pleased with the way the cartoon's many multimedia elements including font size, images, audio, and special effects were used. These elements undoubtedly increased their interest and aided in efficient text comprehension.

General Questions: The students' responses to the general questions about the cartoon were positive, with an average mean of 3.88, which has been interpreted as very satisfactory. This shows that students were happy with the cartoon's usefulness as instruction and overall enjoyment, among other things. The affirmative responses serve to further demonstrate the cartoon's usefulness and impact among school students.

The results of this detailed usability evaluation demonstrate that school students generally viewed the animated cartoon positively. The cartoon's simplicity, effectiveness, memorability, satisfaction, and multimedia elements were appreciated by students. Their positive responses to general questions underscore their overall enjoyment with the cartoon. The results show that the animation effectively meets the usability requirements of school students, offering an enjoyable and productive learning experience.

V.   CONCLUSION

This study focused on creating an educational 2D animation for fire safety. Creating an accessible edutainment series, identifying animation principles, and integrating a mascot were among the research's objectives. Research into principles like anticipation, staging, and exaggeration was done for the first objective, which defined the requirements for animation to keep students' attention. The second objective involved conducting research, making a plan, and producing a comprehensive 2D animation that was made available on YouTube. The third objective used questionnaires to evaluate student's awareness.

According to the research, the increasing interest involved using animation techniques and a Malaysian tiger mascot. A conceptual model, a 2D animation production kit, the importance of the mascot, and cooperation with stakeholders were among the contributions. Interest and comprehension were highlights, although it was recommended that the pace, graphics, and audio be improved. In order to improve fire safety education, future work will involve improving animations, using the latest technologies including AR and VR, addressing new hazards, and continuous assessment.

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