The development of motion comic storyboard based on digital literacy and elementary school mathematics ability in the new normal era during covid-19 pandemic

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Abstract. In this Covid-19 pandemic situation, educators are demanded to quickly adapt to a new approach one of which in terms of preparing online learning media that is in line with learning objectives and is digital-based. Motion comics are digital comics that are modified so that the character appears to move on each page; thus, they become more interesting than conventional comics. For this reason, this RnD research was conducted in order to create a representative motion comic. One of the stages in the development of a motion comic is the stage of creating a storyboard. This article will discuss in more depth the stages of making a motion comic storyboard with the learning topic about fractions by paying attention to the principles of excellent educational learning media as well as the characteristics of elementary school students. There are several stages of making a storyboard including conducting research, creating the story, writing scripts, writing the screenplay, drawing characters, creating a design environment, and making a storyboard. This research involved teachers, elementary school mathematicians, IT experts, and elementary school students. This storyboard is a reference in developing a motion comic prototype about fractions to improve the math skills of elementary school students.

1. Introduction

In this new normal era, there are big challenges facing educators in implementing the distance learning model, one of which is selecting learning media that will be used either in blended or completely online learning. Teachers are required to be able to adapt to this situation by harnessing technology. Moreover, most of the students in Indonesia are currently alpha generation. This generation has a high interest in technology [1]. Alpha generation's interest in technology is an important capital for adapting to today's distance learning.

Education model that matches the interests of the alpha generation is education that is based on digital technology. Digital technology can be integrated into learning media which is needed by students to understand the subject matter more easily. In the early stages, although the ability to think abstractly has started to be possessed since elementary school age, students need to know concrete concepts through the media [2].
The condition explained above encourages us as researchers to make learning media innovations in the form of a motion comic. One of the stages in creating a motion comic is the making of a storyboard. This stage is carried out after the creative process is complete. The script will be transformed into a storyboard that refers to the predetermined visual appearance and will explain the details of the scene, the details of each movement, and the camera movement. A storyboard artist has the role of translating each scene into the form of a storyboard panel consisting of images. This storyboard panel will provide instructions for the production operator. Activities carried out include layout making, blocking, camera movement techniques, and detailing elements used to build a scene or text that may be needed and will be drawn in one panel at a time [3].

The storyboard was developed to be used as a reference in the preparation and development of the motion comic. In addition, the development of motion comics can foster digital literacy and the ability to solve math problems in elementary schools. Therefore, the stages of storyboard development in making the motion comic are discussed in more depth as an effort to foster digital literacy and elementary school math skills.

2. Methods
This study uses a research and development (R&D) method with a model proposed by Borg and Gall. Research steps include research findings and information gathering, planning, initial product development, initial field testing, major product revisions, major field testing, improvement of operational results, operational field testing, improvement of final results, and dissemination and distribution [4]. Considering the needs and conditions in the field, the steps in developing the motion comic based on Borg and Gall's model aforementioned are adjusted into five steps, namely the initial study, planning (model design), model testing, model validation, and model finalization. One of the activities in the model design stage is making a storyboard.

The instruments used in the storyboard development stage were a questionnaire sheet for students' mathematical abilities, a questionnaire about students' reading literacy, and a questionnaire about digital literacy skills. This research was conducted at the Universitas Pendidikan Indonesia (UPI) Tasikmalaya campus laboratory elementary school or also known as SD Laboratorium Percontohan UPI Tasikmalaya. In the first year, the research will be carried out in the fourth grade. The study involved 25 elementary school students, teachers, university students, and elementary school mathematics and literature expert. This research involved various parties who participated in the design and development process. Those who have contributed to this research are experts in Mathematics, Indonesian Language and Literature, and ICT. This research also involved several homeroom teachers at the SD Laboratorium Percontohan UPI Tasikmalaya. The teachers played a role in the process of data collection, that is as observers exploring students' communication skills and their ability to solve math problems. The teachers also responded to the motion comics that were developed in extensive trials.

3. Findings and discussion

3.1. Findings

3.1.1. Motion comic storyboard. The process of making motion comics is similar to making non-digital comics. The stages of making a comic are determining the theme, determining the characters, developing the characters, making a plot, writing a script, making a storyboard/name, making panels, drawing, making word balloons, and making a cover [5]. A storyboard is a series of sketches (cartoon drawings) made in the shape of a long square depicting a sequence (storyline) of the elements for multimedia applications. The frame is a sketch of the design elements that will appear in the multimedia display. An example of a storyboard can be seen in Figure [6]. A motion comic storyboard contains a collection of sketches of images arranged sequentially and adjusted to the script. Story ideas in the script are conveyed easily through the illustrations on the storyboard. Besides, there are supporting information such as text messages, explanations of images, audio, and others. Another function is to provide an explanation of
the storyline based on the big picture, from the beginning of the story, the middle part, to the end of the story.

3.1.2. **Motion comic animation using after effects.** A comic is a series of images that tell a story, which is used as a medium of entertainment for the readers. The comic is a cartoon that expresses a character and exhibits a story in a tight sequence, is connected to an image, and is designed to provide entertainment for the readers [7]. Thus, comics have some components including images that illustrate characters and places of events, material or stories, and language as a means of communicating material or stories to readers. Cartoons can provide motivation and attract students' attention and foster interest in learning. In accordance with technological developments, comics are also presented more practically in digital form and are more attractive with motion and sound effects which are known as motion comics [8].

Motion comics are a combination of traditional comic grids with animated elements, including animated transitions, panning and zooming, and with soundtracks. In other words, a motion comic is a comic that is presented in digital form and is given interesting sound effects and graphics. The meaning of the comic itself is a series of images that tells a story, which is used as a medium of entertainment for the readers [9].

Making motion comics is similar to making non-digital comics which include several stages, namely, determining the theme, determining the characters, making a plot, writing a script, making a storyboard, making panels, drawing images, making word balloons and going through the digitization process which consists of pre-production, production and postproduction. Meanwhile, the stages in the development of motion comics as learning media are the stage of designing comic material, a lot of thoughts dedicated to having 21st Century skills that are seamlessly inserted through the context in the motion comics, the implementation stage, teachers have many opportunities to expose students and develop their 21st-century skills, and the stage of developing interest and motivation towards learning mathematics and acquiring 21st-century skills and the response of students to the children stories comic to determine whether the comic is very good and suitable to be used for learning [10].

3.1.3. **Stages of the motion comic pre-production.** Several applications can be used for making the motion comic video animations including MediBang Paint, Clip Studio Paint and PaintTool SAI. The production process is shown in a flow chart as follows. This discussion will be limited to the pre-production stage only.

![Motion comic production flowchart](image)

**Figure 1.** Motion comic production flowchart [3].

Based on Figure 1, the process of developing motion comics includes three stages, namely, pre-production, production and post-production. At the pre-production stage there is a storyboard creation
activity. The story will be made according to the predetermined mathematical content, settings, plot and characters. From this story, a script will be created that describes in more detail about the story. The script will be described in the form of story panels, image panels, and sound panels aimed at facilitating the production process, grouping scenes, and sounds so that everything can be well organized and can be done gradually and regularly.

3.2. Discussion

3.2.1. The motion comic storyboard. The storyboard created is a series of 47 sketched images made in a rectangular shape depicting a sequence of storylines and the elements for multimedia applications. The story chosen is daily activities in the elementary school environment. In the storyline, there are two main characters who are assisted by several other characters that describe the process of learning mathematics about fractions. Inside the storyboard are illustration images depicting the text beside it. The text that is written is not too long and uses everyday language that is standard and easy to understand. Each part represents a motion comic scene that will be designed.

The example of the storyboard that has been created is as shown below:

![Figure 2. Pieces of motion comic storyboard.](image)

Figure 2 about the storyboard, the scene starts from the beginning to the end of the story. In each scene, there is a prologue to describe the situation or setting contained in the motion comic. In addition, there are scenes that contain mathematical content that is suitable for learning as shown below.

![Figure 3. Mathematical content in the storyboard.](image)

Based on Figure 3, storyboards help illustrators get a representation that is closer to the real image in developing motion comics. The storyboard is a reference for making sheet-by-sheet motion comic illustrations. In transforming the storyboard into the motion comic, the illustrator used an application. In the motion comic creation process, there can be adjustments between what is created on the storyboard and the motion comics created in the application. However, the adjustments still paid attention to important points in the storyboard.
### 3.2.2. Creating an animated motion comic using after effects

Motion comic animated video is made by using several software or applications. Based on their function, applications are classified into drawing applications, animation applications, and project export applications. Drawing applications used were MediBang Paint, Clip Studio Paint and PaintTool SAI. While the animation application used is the After Effects. Video Exporting application used Media Encoder. The process of making an animated video involving these applications is briefly explained in the following section.

- **Preparing visual asset (comic images)**
  Visual assets are prepared in an editable image document format. The format used is ".psd". This format was chosen because it can be opened in various drawing applications. Applications that are used to create and edit images are Madibang paint, MediBang Paint, Clip Studio Paint and PaintTool SAI. The three applications are used collaboratively. Each application has its own features and ease of use.

- **Exporting Image Parts**
  Images are exported in part according to animation needs. If in one scene there are clouds moving behind the building, then we export the cloud and the building separately.

- **Creating an Animation Project**
  The process of creating animated motion comic is done by using the After Effects application, it is a professional software for Motion Graphic Design needs. The first step is to create an animation project. The first project creation requires its user to determine the video size, duration, number of frames per second (FPS) at the beginning. The video size that made in this project is Full HD 1920x1080, 30 Fps, and the video duration is 15 minutes.

- **Creating Animations**
  With the project open, a solid composition was created to make the video background. The color used was white. This color was used to make the video look papery. Then, the assets that were ready to be used in After Effects were put into. It was done by blocking all visual assets that were still in File Explorer, dragging them to After Effects, dropping them on the project panel in the Footage section. After that, the visual assets were put one by one or more than one at a time into the source name panel by dragging them. Then, the size and position of each asset were adjusted. Some of the ways used to create animation are by changing the size, position, rotation, and transparency of visual assets. In addition, there were visual assets grouped according to the scene. This was done to avoid errors in the animation process. There will be many screens that appear if they are not grouped. For every scene that had been animated, sound assets were added. These sound assets were adjusted according to the appearance of each scene. Example, for outdoor visuals, a school building with moving clouds and trees, wind sound effect was used. In addition, sound assets from several sources were also used. One of the most used sources is YouTube as it provides a free sound library in the form of music and visual effects.

- **Adding word balloons**
  The video made is a motion comic. This video does not facilitate dialogue messages in audio form but in text form. The dialogue text for each character will appear on the video. It is similar to the word balloon in comics, that is black text on a white background that is round or square and has a tail that indicates which character is speaking. The word balloons are directly created in the After Effects by using the features called shape and text.

- **Exporting the Video**
  The animated video that has been created was then exported using a separate application (not using the built-in program in After Effects). The reason for not using the built-in After Effects feature to export videos was to reduce video size. A video that is exported by using the built-in After Effects feature is usually very large. One minute of Full HD video can be more than one gigabyte in size. This is because After Effects does not yet support the H.264 (MPEG-4) code format. The solution is to use Media Encoder. Media Encoder is an application for exporting various video projects into various formats. Moreover, the Media Encoder has been integrated
into After Effects. Thus, in After Effects menu, there is an option to export video using the Media Encoder.

3.2.3. Motion comic pre-production artwork. Pre-production that was carried out is the process of preparing images and comic materials that are needed before they are animated. This stage is a follow-up to a previously designed storyboard. In drawing images and comic materials, several graphic design applications/software were used. The applications were MediBang Paint, Clip Studio Paint, PaintTool SAI, and Adobe Photoshop. The artwork carried out includes:

- Making an initial sketch based on the storyboard
  The process of visualizing the story that is transformed into the sketch paid attention to the proportions and camera angles of the images that are easy to understand in each sketch. In addition, the collaboration in making sketches is adjusted to the atmosphere, character expression, appropriate setting, mathematical content, and moral messages to be conveyed in each character scene. The process is done repeatedly to create easily understood images.

- Inking process on the sketch
  This inking process is a process where the sketch that has been made is thickened to make it look smooth and beautiful. Therefore, the initial sketch is the reference used in this inking process. While the previous process emphasizes the ease of understanding of the image in each sketch, this process emphasizes the proportion and thickness of the inking lines used.

- Coloring and shading process
  In this coloring process, the sketch underwent coloring process so that it becomes contrast and attractive. This color selection was also based on the color aesthetics and ethics of colors in the real world. Furthermore, to make the images look more alive, the shading process was carried out. The making of the bright side and the shadow was adapted to the scene in each sketch.

- The use of screen tone
  There are several scenes that use screen tones. This screen tone is the addition of an image in the form of a pattern in certain parts so that there is a color combination that does not overlap each other.

- The separation of image parts
  Images that had gone through the previous stages were then separated into several parts/layers. This was done in accordance with the motion scene in each sketch. For example: in the classroom scene, the teacher was explaining the lesson, the pictures were separated into classroom image, table images, student images, and teacher images. This image separation aimed to make the animation process easier and faster.

- Saving the comic artwork
  The finished and separated images were then saved as “.csp” and “.psd” files. The ”.csp” file in the Clip Studio Paint application was separated layers including inking sketches, coloring, shading and screen tones. Meanwhile, the “.psd” file in the Photoshop application was a separated image layer for each part that would be animated later.

4. Conclusion
The motion comic storyboard created consists of a series of 47 sketched images arranged sequentially and adjusted to the script. The story ideas in the script are originated from daily activities in the elementary school environment. The focus of the story is the learning process about fractions in elementary schools. In the story, there are two main characters and are assisted by several other characters. In addition, there is supporting information such as text messages, explanations, images, audio, and others. The storyboard is part of pre-production aiming to make the planning process of the motion comic development can be done carefully. Careful planning aims to make the motion comic becomes appropriate alternative learning medium. Thus, the quality of pre-production, especially storyboard creation, will significantly determine the quality of the production of this motion comic. The storyboard holds the key to explaining the storyline and plot and is the main reference for executing a
scene. The visual mood is also very important to provide an initial picture of the final result which can be seen and then designed into sequential images. It is the storyboard that will transform the animation design into a real moving image through the pre-production artwork process and the final result polishing by using After Effects.

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