Full Length Research Paper

From storyboard to story: Animation content development

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This research focused on a new method in the development of animation story content, which could shorten the creation process and arouse new ideas. Two phases of experiments were conducted to explore this reversed model. The first phase is a pretest of participants' creativity, which was a base for further examination the relationship between personal creativity and good story design. Torrance Tests of Creative Thinking (TTCT) was adopted and two divergent thinking tasks of TTCT - unusual uses task and picture construction task were executed. The second phase was an experiment by using a digital storyboarding system - Crazy Talk Animator to create a story without written script. The final storyboards were both self-evaluated and expert judged through questionnaire and interview to investigate whether this reversed model was practicable. The results showed that storyboarding as the method in creating animation content was workable. Personal creativity quotient did not have high correlation with story design performance. Participants regarded the storyboard driven method of content creation as helpful in visualizing and revising their creative ideas. Novices considered this method as easy while experts thought it as difficult for practice. In their design results, we found that a good story structure could still be created with storyboard driven method. Compared with the traditional process, the contributions of this model were more on the story climax, resolution, and plot. The findings of this study can assist in animation content training for novice designers.

Key words: Storyboard, story design, creativity, story structure, production pipeline.

INTRODUCTION

In film and animation production, scriptwriting is a crucial stage that determines the success of the movie. Since scriptwriting is the first step and all other works have to follow the storyline in order to create visual images, directors or investors are cautious about selecting a good story (Mou and Tu, 2013). However, story design is not an effortless work, which requires years of training, keen observation, and last but not least, talent. Even though a good story is created, a writer has to transform the story into a "script", which is a specific format of film production

that includes dialogue, action, timing, scene description, voice over, effects, etc. (Glebas, 2008). Table 1 is a sample of film script format. This professional format of scriptwriting is challenging for design students in animation and motion pictures field. Since creating a good story is fairly not easy, transforming the story into a script is another challenge for novice designers. With regard to current film and animation story source, it can be sorted into five categories. Table 2 shows the category and its representative works in film and

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Table 1. A simple of film scrpt format

Script Format Information	
INT: SULTAN'S PALACE-EVENING	**Setting is listed with time of day in capitals.**
A hand draws a picture of a mountaintop town. Scheherazade holds up the picture.	Description describes the action in lowercase.
SULTAN[VO]:	Character indented, all capitals.
"It's a mountaintop town."	Dialogue indented in a text block.
EXT.: MOUNTAINTOP TOWN – NIGHT	
EXT.: ALLEYWAY- NIGHT	
GOO, a self-centered but loveable monster, sits with a GIRL on a bench. Goo points out a star.	The first time a character is introduced, the name is all capitals.
GOO	
"Look, a shooting star."	Beat- Goo points.
The girl looks up.	
GIRL	
"Where?"	Beat- Girl looks.
Goo uses his other arm to reach behind and tap her on the shoulder.	
GIRL	
"Huh?"	Beat- Goo taps her.
The girl turns to look to see who is touching her.	Beat- She turns to look.
Goo leans in with lips puckered.	
The girl turns back right into Goo's kiss.	Beat- Goo puckers his lips.
She is surprised.	Beat – Girl turns into Goo's kiss, surprised.
GIRL	
"Mmmm."	
She closes her eyes and kisses Goo back.	Beat- She likes it.

INT., interior; EXT., exterior; VO, voiceover.

Table 2. Film and animation story source and representative works.

Story source	Representative works
Novel	Jaws, The Godfather, Brokeback Mountain, Life of Pi, Grave of the Fireflies
Comic	Keroro, Doraemon, Detective Conan, Death Note, Kindaichi Case Files
Real case	Central Station, Schindler's List, Eden Lake, The Passion of the Christ
Social observation	Food, Inc., Super Size Me, Earth, Religulous, March of the Penguins
Original creation	Polar Express, Shrek, Cars, Totoro, Spirited Away, Ice Age, Toy Story, Avatar

animation market. Here we can observe that the mainstream of story source is taking concepts from existing material, such as novel, comic and real case. Only few parts come from social observation and original creation, which require deliberately efforts to develop a story. For example, the script of film *Avatar* started from 1994 and not until 2007 the final script was set. *Shrek*, the first the episode released in 2001, had its rough script since 1991 and till 1995 the production could finally start. This could explain the fact that a good story is difficult to acquire.

If we present the category and its representative works in images (Figure 1), we can see that most animated film come from *comic* and *original* creation. Animation is a form of moving images (Hart, 1999; Williams, 2012), which each picture describes a situation of the scene and all of them being composed together become a story. Here we can realize that images/illustrations are the core and important process of animated film. Not only the written script is challenging, the transformation from conceptual written words to concrete images is another task especially in animation production. Here in Figure 2 we can be clearer about the relationship among story, script and image. Transformations between story/script

Figure 1. Representative images of film and animation.
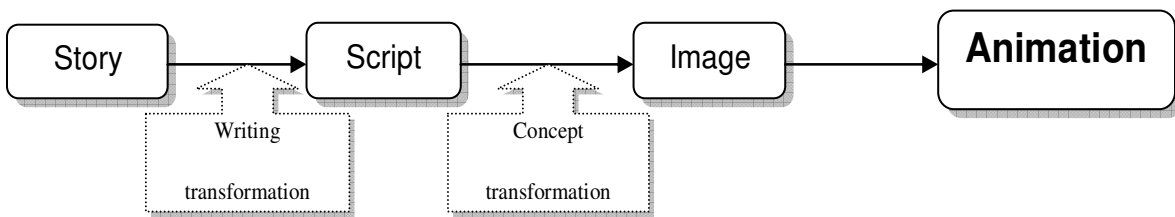

Figure 2. Animation is transformation from words to images.

and between script/image could become a barrier to production, since there is a gap which requires years of effort, experience, and even talent to accomplish the work. Therefore, how to solve this transformation problem and accelerate the production process has been a main issue in animation and film production.

Research question

Having the notion of story creation process and its difficulty in production, in this research, here we raise questions about the mechanism of story creation and probe the requirements of developing a good story. Following lists are the research questions of this study.

(1) Since original stories take time to develop, is there a new method to create stories that could accelerate the process?

(2) Animation is the combination of moving images. However, from story to script and from script to image, writing and concept transformation are critical to the final work. There are also gaps in these creation processes. Since image is the goal, without the written script, could a good story be created by images in the first place? That is, whether a reversed model, from image to story, is practicable to production.

(3) Compared with the formal production process, in what aspects that this reversed model are superior or inferior to the traditional one? What novice designers and experts regard this new method of story creation?

This research will focus on these questions above and discuss the reversed model in terms of its feasibility, advantages and disadvantages, and examine from designers' perspective what this model could assist their story development.

Story design

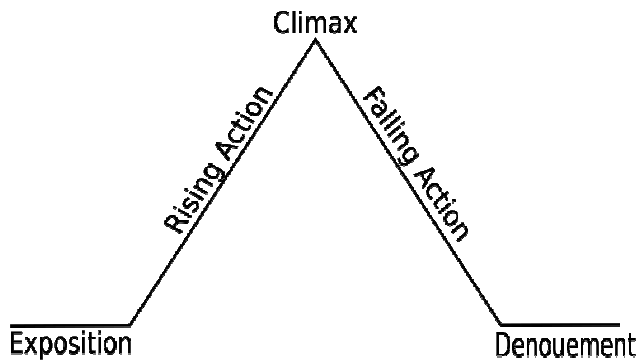A good story is the soul of film. Pixar and many other

Figure 3. Freytag's pyramid.

animation studios also regard story as the first and most important factor that determines the success of movies (Hsieh, 2009). Good animation performance and good design never save a bad story. Strong characters can make a weak story tolerable and a good story better, but characters develop *within* a story context (Beiman, 2012). This can explain the animation process in which story comes before character design. The concept of story has been used in various design researches. McDonnell et al. in their study of design expertise revealed that by constructing video stories, this method could support critical reflection about design experience (McDonnell et al., 2004). In their research, stories convey a rich and complex understanding of an event or situation. They are both a powerful and an accessible means of sharing knowledge and their value and pervasiveness in conveying knowledge is well-recognized. Tsai in their study of digital content service development also utilized the concept of storytelling in interdisciplinary collaboration of interaction design (Tsai et al., 2007).

Not only in design field, but also in education and psychology, story is used as a method for language acquisition (Skinner and Hagood, 2008; Southwood and Russell, 2004) and assessment feedback (Tharinger et al., 2008). By telling/creating a story about their experiences or emotions, people can involve more in the situation and feel comfortable to express their thoughts. Here we can see how the concept of story could enhance in design communication, learning, education, and psychology domain. 'Story' in itself has positive and incentive effect in many fields. Nevertheless, this utilization of story in these studies is to assist the research method. There are not strict rules, not necessary either, for story development in their design.

From the perspective of animation and film, however, story design is a serious, thoughtful but also playful process. It's the story that connects everything together and starts the production pipeline. Bearing this concept in mind, here we raise the questions; that is, what is a good story? What are the elements of a good story that should be included? To answer these questions we have to understand the story structure.

Aristotle (384 BC~322 BC), a famous Greek philosopher, scientist and poet, could be the first person to bring up the idea of plot structure (Arnold and Eddy, 2007). As he said: "A plot must have, a beginning, a middle, and an end, and the events of the plot must causally relate to one another as being either necessary or probable." Similar concept was also raised by contemporary German novelist and playwright, Gustav Freytag (1816~1895). Freytag considered plot as a narrative structure that divided a story into five parts, which is known as Freytag's pyramid (Figure 3). In script-writing for animation, film, TV and drama, a commonly referred structure is called "three-act structure", which is very practical and effective to attract the audiences' attention (Arnold and Eddy, 2007; Beiman, 2012; Mou and Tu, 2013; O'Neil, 2001; Sheppard, 2009; Tumminello, 2004). This '3-act' is very similar to Freytag's '5-part' in structure aspect. Figure 4 shows the three-act structure and explanations are followed.

Act 1 is the beginning of the story. In this exposition stage, the storyteller sets up the characters, location and conflict (situation) of the story. Several questions that need to be answered include: Who are the characters?

Where are they? When does the story take place (the future, past, or present)? Why are the characters there? etc. Act 1 is the stage that needs to provide the audiences necessary information to merge into the story.

Act 2 is the middle of the story which takes most of the time to present. In this confrontation stage, the main characters face many complications and obstacles in their strives for goal or solving a problem. The middle contains many twists and turns, and keeps rising the stakes to make the story interesting and tension building. Some obstacles may be resolved temporarily but more crises will come. Therefore, in Act 2, it is a process to confront the main characters with obstacles which become more and more difficult each time. As the story progresses, there is a rising and falling of tension, but an overall rising tension is built till the plot point 2, which is the climax. On this turning point, the main characters face the ultimate crisis and this point takes the story in a different direction.

Act 3 is the end of the story. In this resolution stage, the climax is reached and the problem is resolved. The main characters attain their goal as well. After the peak of climax, the story goes down to calm the audiences' mood. Subplots of the story are answered to satisfy audiences' curiosity. Act 3 is parallel to the falling action and denouement of Freytag's pyramid.

To better present the story structure visually, a curve diagram can illustrate the tension of the 3-acts accurately (Block, 2007). As shown in Figure 5, the X Axis is time and the Y Axis is tension. As time goes on, the tension increases till it reaches the climax, and from there the problems are solved and finally goes down to close the story.
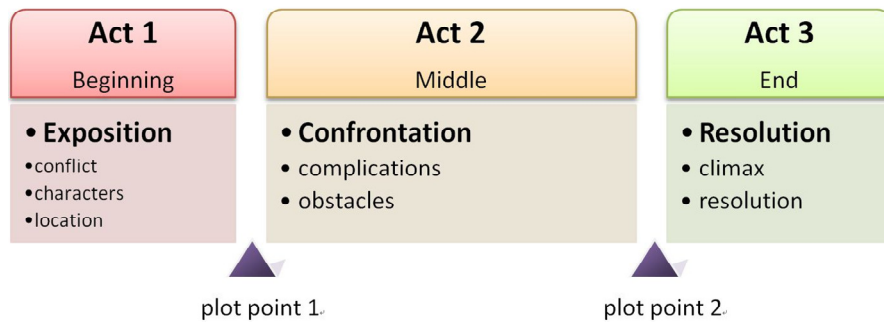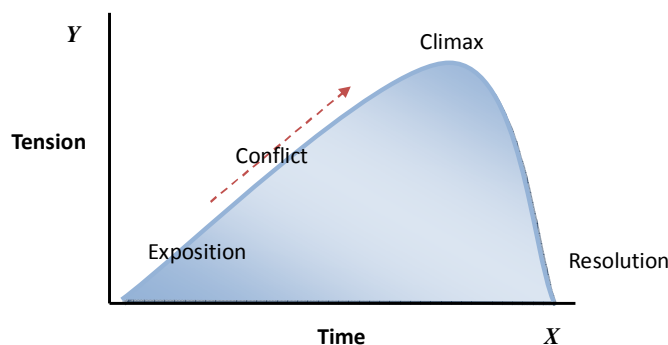
Figure 4. Three-act structure.

Figure 5. Visual story structure.

Storyboard

A good story is not ready for animation creation. It has to be transformed into a specific script format which includes all the detailed information needed for script-writing, such as dialogue, action, scene description, voice over, and effects (Glebas, 2008; Tumminello, 2004). Even though with a standard script, the transformation from written words to visual storyboards is a challenging task as well (Begleiter, 2010). Storyboards are illustrations displayed in sequence for the purpose of visualizing an animated or live-action film. A storyboard is essentially a large comic of the film produced beforehand to help the directors and cinematographers visualize the scenes.

Storyboarding is not just a translation of the script into a series of visual images though. It is more like a new rewrite of the story using the flow of images to show instead of words to tell. Movies use images, words, sounds, and music to show/tell their stories. A picture is worth 1001 words. Storyboarding is nothing less than the first pass at directing a film. Therefore, the storyboard artist is the one who will make sense of the initial interpretation in getting a film produced. The storyboard artist's contribution to the team is to help in visually evaluating and synthesizing the narrative flow of the

screenplay. His/her job is to give cohesion, interpretation, and illustration to the visual flux of imagery. Hence, a script is a verbal play for a story, while a storyboard is a plan for the visualization of that story (Arnold and Eddy, 2007). Storyboard is the inspirational heart, mind, and soul of a movie. Alfred Hitchcock (1899~1980), a famous director of suspense and psychological thriller film, also considered his films as storyboards come to life (Tumminello, 2004). He said: "I never look through the camera, you know. When in doubt I draw a rectangle then draw the shot out for the cameraman. The point is that you are, first of all, in a two-dimensional medium. Mustn't forget that. You have a rectangle to fill. Fill it. Compose it" (Begleiter, 2010). It is widely said that Hitchcock believed once storyboarding was completed, the movie was 95 percent done and the rest was execution (Glebas, 2008).

Storyboard is very similar to comics to some degree except it has more movement instructions. As defined early in this section, storyboard is essentially a large comic of the film. Eisner (1917~2005), an American comic writer and artist, regarded comics as "juxtaposed pictorial and other images in deliberate sequence, intended to convey information and/or to produce an aesthetic response in the viewer". Eisner (2008) descri-bed what he called "sequential art" as "the arrangement of pictures or images and words to narrate a story or dramatize an idea". Therefore, the concept of storyboard and comics is fundamentally equal. Today publishers and bookstores often use the term "graphic novels" or "graphic narratives" to mention all manner of comics. Comics, as an art form and as a narrative form, is a system in which a number of disparate elements work together to create a complex whole (Chute, 2006; Postema, 2010). The narrative features of comics are constructed in the same way as works of literature. We can say that comics and film employ very similar narrative strategies. That is, comics tell stories in the same way that films do, but in different visual media.

They are both typically a hybrid of the verbal and the

visual (Pratt, 2009).

Researches that make use of comics/storyboard concept for education and system development also show positive contributions of visuals. Herbst et al. (2011) in their study of university mathematics teaching developed a system called ThEMaT, which utilized cartoon characters and comics to assist teaching and classroom interaction. By using comics-based representations through information technology, they suggested that comics had opened an avenue for experimentation in the study of the rationality of teaching through story telling. They also allowed teachers to sketch a story that might be hard to come by in reality. Hence, as indicated from their research results, by presenting comics/storyboards like images to viewers, stories could be shaped out and thus communications begin. Nevertheless, whether a good structured story could be developed through storyboards still needs to be investigated in our study.

On the strength of understanding the features and advantages of storyboarding in animation, design, game, and education domains, we can have a clear idea of storyboard and its various applications, which are visually conductive in shaping out ideas and users' demands. With the development of technology, storyboard has been going digital as well. A new trend of digital storytelling (DST) is gradually changing the way people perceive stories and information. The following section shall discuss digital storytelling and its integration with images.

Digital storytelling

With the progression of technology, contemporary storytelling has utilized more media in presenting the story. New forms of media are creating a new way for people to record, express, and consume stories. The term "digital storytelling" (DST) is relatively new, which describes new practice of people who use digital tools to tell a story. Various definitions have been made for digital storytelling. Davis (2004) defines digital story as a form of short narrative, usually a personal narrative told in the first person, presented as a short movie for display on television or computer monitor or projected onto a screen. Davis's description of digital storytelling is fairly perspective limited, which only first person narrative could be counted. Frazel (2010) regards digital storytelling as a process that blends media to enrich and enhance the written or spoken world. This point of view is admissible since the process of creation is more meaningful than the end result for many educators and researchers. Ohler (2008) describes digital storytelling as the usage of technology to combine a number of media into a coherent narrative. He also extends the term and regards DST as "new media narrative". Digital is as new media format and storytelling is as narrative. This is a broad-reaching term that roughly refers to any digital

media production beyond print: video, image development, audio production and so forth. Another definition of DST made by the Digital Storytelling Association calls it "the modern expression of the ancient art of storytelling", a simple definition that emphasizes the continuity of the storytelling genre (Hayes and Matusov, 2005). To put it simple, we can think digital storytelling as the modern extension of the ancient art of storytelling which is now interwoven with digitized stills, moving images and sound. Therefore, digital storytelling is the art of storytelling with multimedia features, such as photography, animation, text, sound effects, voiceover, music, text and video. Nowadays, digital tools and software have made it easy and convenient for people of all ages to create a digital story.

The advantages of digital storytelling are apparent. Technology offers a broad base of expressive capabilities for its users. It enhances the experiences for both the author and audience and allows for greater interactivity. Digital storytelling allows people to construct narrative and expository texts through combining multiple media including images, voice, music, video, transitions, titles, and movement (Skinner and Hagood, 2008). It offers opportunities to compose/design with handy digital tools, an oftentimes less laborious process than with a pencil. Digital media allows production to be edited on the spot; thus, the users could conveniently shape and edit their works as they explored their imaginations with the digital media at their disposal (Tan, 2012). Because digital storytelling affords production-on-the-go practice, it is more meaningful for people to think in terms of sounds, images, words and gestures when working directly with the media. Bran (2010) in her study of DST also agreed that digital storytelling covers all the elements of traditional stories, including setting, plot, conflict, theme, character and point of view. As Bran claimed, the strong point of digital storytelling is the fact that users with little or no technical background should be able to create digital stories easily. DST takes its users through the writing/storytelling process in an engaging way. With the technical aspects out of the way, the emphasis will shift to the content. This point of view is also supported by Ohler (2005) who suggested that focus should first be given to the story and later to the digital medium.

According to Ohler (2005), the use of digital storytelling is to enhance skills in critical thinking, expository writing, and media literacy. His approaches to digital storytelling are story mapping and practicing oral storytelling before bringing in digital elements. This usage of digital media is quite conventional because he still went through standard process of designing story before going digital. Nevertheless, his contention that digital storytelling provides an immersed environment for creation and learning opportunities is approved by other studies (Barrett, 2005; Bran, 2010; Lambert, 2012). To sum up the advantages and value of digital storytelling, the following lists are brief and essential.

(1) Digital tools allow people to construct narratives easily.
(2) Digital storytelling covers all the elements of traditional stories.
(3) Digital storytelling provides an immersed atmosphere of engagement and learning.
(4) Story content development is the key to good digital storytelling.

Creativity

Every design needs creativity. Story design in animation is the first and most important stage which creativity in storyline will add pleasure and surprise to the audiences. With the development of short and feature length animation films, overall and detailed planning of the plot requires not only good structured story, but also a story that tells characters' moods and actions cleverly with humor and sympathy. This is what creativity reveals in a story. Therefore, creativity is a non-neglectable element that has to be designed through story. Designers' personal creativity thus is at least partly related to the performance of work. We will examine this factor in this study as well. Here we have to look into what creativity is and how to measure this characteristic.

J. P. Guilford, a United States psychologist, performed important work in the field of creativity. In his psychological model called the "Structure of the Intellect", Guilford used a factor analytic technique to separate creative thinking skills from others'. As part of this model, he identified two distinct forms of thinking: divergent thinking and convergent thinking. By drawing a distinction between these two thinking, he claimed that creativity was generation of ideas that were novel and appropriate to the field (Guilford, 1967). Divergent thinking is that associated with creative thoughts, or the ability to access memory to derive unique, multiple, and numerous answers to open-ended questions; Whereas convergent thinking involves aiming for a single, correct solution to a problem. Therefore, divergent thinking is sometimes used as a synonym for creativity. In animation design field, the pre-production stage involves story design, storyboard design and character and layout design, and etc. Various design possibilities are raised and evaluated to decide the final selection. It is clear that through this divergent thinking of different designs, designers' creativity is displayed in the artwork. Based on the divergent thinking concept of creativity, Guildford operationally defined creativity through four major factors, which were put into practice to assess individual creativity. These four factors are:

(1) Originality: statistical uncommonness of the total responses
(2) Fluency: quantity of appropriate responses
(3) Flexibility: variety of categories of appropriate responses
(4) Elaboration: amount of detail in the responses

Above four factors are used and assessed in the creativity test developed by Guildford, which is called Guilford's Alternative Uses Task (Guilford, 1967). The task is designed to represent an expected factor of divergent thinking. Guilford's pioneering work led other researchers into the field of identifying and measuring creative thinking. From the 1960s until today, a proliferation of creativity tests to measure creativity or identify creative individuals have sprung up. Among these tests of creativity, one of the most eminent tests is Torrance's Tests of Creative Thinking (Torrance, 1984) (TTCT).

Torrance's Tests of Creative Thinking (Torrance, 1966), originally had the same four scales as Guilford, had revised four times and attained the fame as the most popular creativity test that psychometrically measure divergent thinking and other problem-solving skills. The original purposes of the tests were for understanding strengths of students, research and experimentation, and general use for instructional planning. The reliability and validity of the TTCT has made Torrance nationally and internationally known, and in the psychological literature he is routinely called the "father of creativity research." More than 50 languages of TTCT have been conducted in the world. Therefore, in our study of creativity factor in the story design, TTCT is used for analysis of the novice designers. Torrance's Tests of Creative Thinking has two parts as following:

(1) TTCT - Verbal: There are five activities including: ask-and-guess, product improvement, unusual uses, unusual questions, and just suppose. The stimulus for each task includes a picture to which people respond in writing (Torrance, 1966, 1974).
(2) TTCT - Figural: There are three activities including: picture construction, picture completion, and repeated figures of lines or circles.

Each task has limited time to complete and drawing skills or abilities are not important in the tasks (Chase, 1985).

The final score is called a creativity quotient, or CQ. The score reflects the ability to come up with innovative, original, and novel thoughts, ideas, and images. These traits of creativity in fact are what story and animation designers need. Accordingly, by employing the TTCT - Verbal and Figural tasks, we can find out the relationship between personal creativity and story creativity.

Besides the reliability and validity of TTCT, positive features of the test also include the wealth of information available, the short time needed for administration, and the ease of execution. Moreover, it is more researched and analyzed than any other creativity instrument (Almeida et al., 2008; Clapham, 2004; Frasier, 1988; Kaufman and Sternberg, 2007; Kim et al., 2006;

Rudowicz et al., 1995; Runco et al., 2010). Instead of using the test to measure an individual's ability, Torrance treated it as a tool for enhancing and nurturing creativity. He recommended the creation of a game-like, thinking, or problem-solving atmosphere, avoiding the threatening situation associated with testing. His intent was to set the tone so that examinees would enjoy the activities created (Kim, 2006). Thus the score of CQ is only a reference for understanding personal creativity, not a interpretation of a person's ability (Hébert et al., 2002). As Kim, an apprentice of Torrance, described in her study of TTCT the goals of the tests (Kim, 2006):

(1) To *understand* the human mind and its functioning and development.
(2) To discover the effective bases for *individualizing* instruction.
(3) To *provide clues* for remedial and psychotherapeutic programs.
(4) To *evaluate* the effects of educational programs, materials, curricula, and teaching procedures.

The goals of TTCT actually correspond with the sub-goal of our study, in which we intend to find out the design cognition of novice designers and how to contribute the results to education. Torrance's test and its contributions to the field of psychological research cannot be understated. The tests started since 1950s and 1960s, and are continued by colleagues and students till today. Longitudinal studies may be the most useful kind of investigation for the study of creativity and its fulfillment. From the results of the 50-year follow-up of the longitudinal study, researchers found that TTCT scores were moderately correlated with personal achievement, not with public achievement (Runco et al., 2010). This finding implies that divergent thinking plays a role in certain kinds of creative expression and achievement, and does so throughout the lifespan. Therefore, if creative teaching and learning methods can be conducted in education, such as a reversed model, storyboard-driven method of story design, creativity inspiration and cultivation can become a usual practice for designers' lifelong advancement. Thus, in this study we will find out to what extent novice designers regard this storyboard driven task as supportive to their story design creativity.

MATERIALS AND METHODS

Pretest of creativity

Torrance Tests of Creative Thinking is used in our study. The TTCT can be administered as an individual or group test from the kindergarten level to the graduate level and beyond. It requires 10 min of working time to do each activity. Thus speed is important, and artistic quality is not required to receive credit (Chase, 1985). Here we used the Chinese version of TTCT, which is modified and translated by Wu (1998). There are two parts of TTCT: Verbal form

and Figural form. The verbal task in our study is *unusual uses* task. In this task, the participants were asked to think of as many answers as possible the most unusual, interesting uses of the given object: chopsticks. The target of chopsticks is a usual and ordinary object in Asian countries. This type of object is suitable for creativity test because participants have to break through the "mental block" to achieve creativity. A piece of paper with blank form was provided to the each participant. Participants were asked to write down the unusual uses of chopsticks in each blank. There was a supervisor in the session to introduce and count time the task. As Torrance suggested, creativity tests should be administered in a game-like testing context (Torrance, 1984). Thus a warm-up activity was included in this session to arouse the incubation processes and increase motivation. The total test time of verbal form was 10 min.

In the figural task of TTCT, we used the picture construction task. Participants were given a Chinese word "人". This word was treated as a form or shape, not a word in the task. They were asked to think of a picture in which the given shape was an integral part. White sheets with 42 "人" shape were provided to the participants for them to draw the picture. When they finished the drawing, they also had to write down the name of the work in blank area. As mentioned before, the task is to examine creativity. Thus in picture construction task, artistic drawing quality is not considered for score. The test time was 10 min as verbal task and warm-up activity was also conducted.

These two parts of TTCT forms are oriented to measure four principal cognitive processes of creativity, which include fluency, flexibility, originality, and elaboration. These four scales also correspond to divergent thinking factors that Guilford proposed in Structure of the Intellect Model (Guilford, 1959). The answers from verbal form were evaluated based on fluency, flexibility, originality and answers from figural form were evaluated on all of the four scales. The scoring standard followed the Chinese version of TTCT Norms-Technical Manual to get a "creativity quotient" (CQ). Two judges were trained for six hours on how to use the manual for scoring. After judging several sample tests and checking for accuracy, the judges started scoring work. Torrance believed there were general mental abilities that are involved in, and predict, creative achievements. Therefore, the scales in TTCT are regarded as indicators of creative potential that increase the likelihood of creative behavior (Runco et al., 2010).

Design task

Here the design problem that we raise to the participants is story design with storyboarding method. Without a specific animation script for storyboard design, participants had to create a new story by directly design with the digital storyboard system. The storyboard system will be introduced in the next section. Participants were provided with basic story design elements and requirements. They had to finish the task within limited time. Figure 6 shows the visual elements provided for the participants. The elements/requirements provided as following:

(1) Story genre: comedy
(2) Characters: a cartoon boy and girl character, a puppy
(3) Background: outdoor scenery with meadow, fence and small river
(4) Storyboard: 10 to 15 panels of storyboard for a complete story
Before participants started the task, a training session on how to use this system was conducted. They were taught the basic techniques for digital storyboarding, such as how to add dialogue box, camera movement, character poses, facial expressions, effects, scene description, storyboard panel saving, etc. Besides the basic elements provided, other props or effects were allowed for use at the participants' demand. However, the provided characters
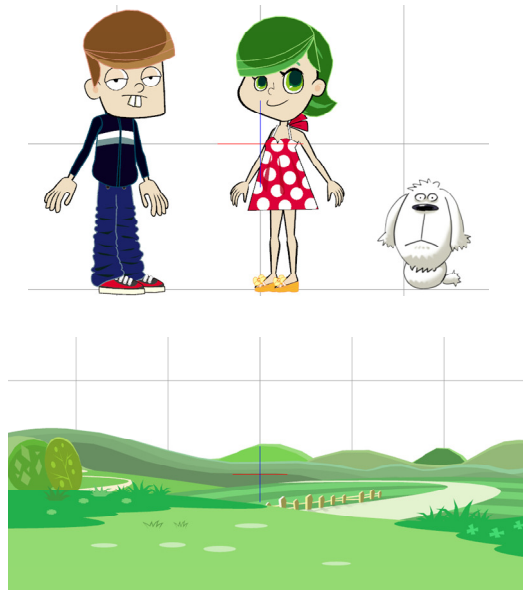
Figure 6. Elements of storyboard design task.

and background could not be changed, nor could new characters being added.

A sample of finished project with 15 panels was shown to the participants. So they would have clear understanding of what the end results should look like. Participants were required to finish the design task within 30 min. This task was conducted individually and followed by an interview and evaluation when they finished the experiment.

Storyboarding system

The system that we used is called *CrazyTalk Animator* developed by Reallusion company. It is a user-friendly system and easy to manipulate. We used the Chinese version of the system to avoid language barrier and decrease unfamiliarity with the software. The goal is to create storyboards with CrazyTalk Animator. The main functions of this system are described as following points.

Figure 7 shows the basic interface and menu of the system. The top column contains main functions for creation, including the project, actor, animation, effects and output setting. By clicking each menu, users can easily switch to their desired function. Basic tools are just above the picture frame. Tools include move, rotate, scale, home, etc. With the tools users can change property of the elements, such as character's position, prop's and effect's sizes and rotation. The top column on the right is content manager. It displays the various choices that users can use from the main menu. For example, when we click animation in the main menu, content manager will show all the animation poses available for use. By clicking the preferred poses, the animation will apply to the character. Figure 8 shows a sample of this application. The bottom column on the right is scene manager. All the elements used in the project are listed here. Users can delete, hide or show the elements here. Timeline control is at the bottom of the interface. Animation movements or effects can be reviewed in timeline. Users can play, pause, forward, backward, or stop the animation.

Participants

64 college students joined in this experiment. They were design

students from multimedia, animation and motion pictures production. The backgrounds of the participants matched our research goal. That is, to examine whether a storyboard driven method for story design is practicable for novice designers. Novice designers from related domains are the future talents in the industry. This research can further contribute to the education and incubation of their training of story creation.

Although gender issue in previous studies showed no differences in creativity (Kaufman and Sternberg, 2007), to make the experimental design has fair judgment, the gender component of participants were 32 male and 32 female. Based on related visual and storyboarding studies, the number of participants in this research were appropriate for in-depth analysis of creative design outcomes (McDonnell et al., 2004; Moreno-Ger et al., 2007; Tan, 2012; Tang and Gero, 2002). Participants who joined this study were volunteers. This is good since people will be most creative when they feel motivated primarily by the interest, enjoyment, satisfaction, and challenge of the work itself - and not by external pressures (Amabile, 1988; Yuan and Zhou, 2008). Motivation is a critical factor to design outcome. Therefore, task results from volunteer participants could be more representative and reveal the effectiveness of our designed model.

Evaluation

The evaluation of the story design was conducted by both the participants and experts. After they finished the task, which was done individually, participants were invited to fill out a questionnaire on self-assessment of the story. A five-point Likert scale on the story plot, dialogue, opening, climax, resolution, character's experience in the story, timing, entertainment, and the supporting role (puppy) arrangement were evaluated. The scale format was from 1 (strongly unsatisfying) to 5 (strongly satisfying) with the judged item. In the questionnaire we also collect participants' views on the difficulty of the above aspects when they engaged in the storyboard approach to story creation. The scale was also from 1 (very easy) to 5 (very difficult). After the questionnaire was done, the second part was in-depth interview with the participants. In this part, we wanted to further understand novice designers' thinking regarding the new method of story creation compared with the traditional method and how they viewed the creativity of their stories. The comparison of two methods can verify whether storyboard driven way of animation content development is suitable for novice designers, and whether this way is practicable in real production.

The evaluation was also conducted by experts in story design field. Three experts with more than 20 years of animation and comic story design experiences were invited to assess the works. They used the same scale to judge participants' works. Their scores for each participant were averaged to acquire the mean value. After they finished the scoring, focus group interview with the experts was followed. We wanted to further understand how they regarded the creativity and structure of the story design from the experiment. This could examine whether a reversed model of story creation, that is, storyboard driven method is workable and intuitive for creation. The scores from both participants' self-assessment and experts' assessment were compared to see the differences on satisfying design (Mou and Ho, 2008; Simon, 1996). The comparisons can give feedback to design education and training in the future.

RESULTS AND DISCUSSION

Personal creativity and story design

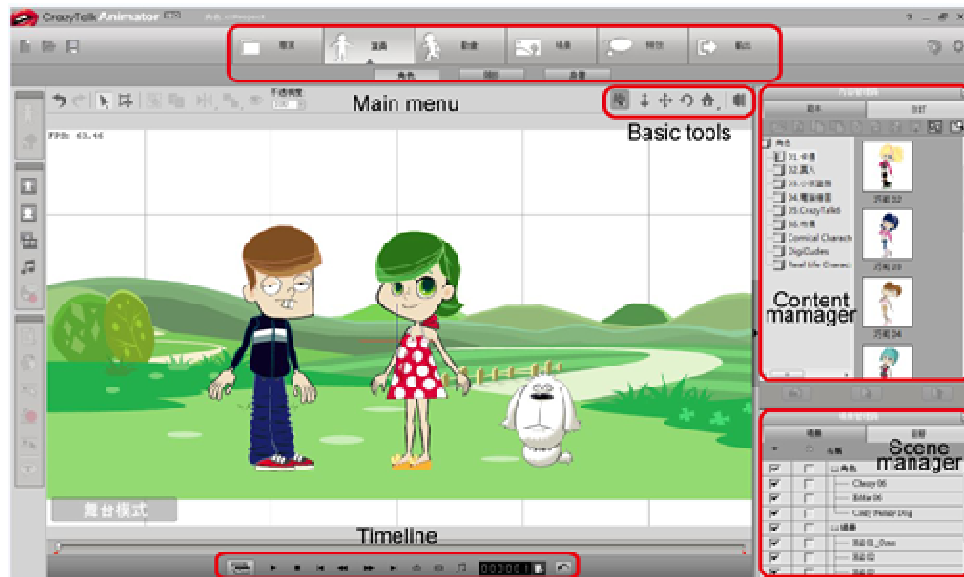Although the CQ score are 85.31 and 80.47 for male and

Figure 7. Basic interface and menu of CrazyTalk Animator.

Figure 8. Animation poses applied to the characters.

female participants respectively, there is no significant difference between them (p = 0.7>0.05). One reason for this phenomenon could because they are from related design background: multimedia, animation, and film production. Creative thinking is an ability that could be trained and progressed gradually. The participants' ages are between 19 to 21 years old, which are sophomore and junior year in college. Two years of training could have some influences on their creativity development. This would also probably explain why there is no significant difference of CQ in the participants.

The examination on participants' CQ and their story design evaluation shows low correlation (R = 0.37, R^2 = 0.137). Strictly speaking, the overall CQ score could only explain 13.7% of the design performance. This means that participants' CQ could not be an indicator or reference for their story design performance. Though the TTCT is a popular test and has empirical reliability and validity for over 50 years, in this study personal creativity seems to have less impact on their story design. Recent research on creativity proposed that creative test could be best thought of as a measure of *creative potential*. Creative achievement depends on additional factors that are not measured by creativity tests, such as mental health, technical skills and even opportunity (Cropley, 2010). If we take this point of view on creative achievement, then it is reasonable to reveal low correlation between CQ and story design performance.

To further inspect their creativity and story design performance, the CQ score of the participants ranged from the highest 148 to the lowest 45, with the average of 82.93. Story design evaluations from the top 10% of high

CQ participants had average of 31 and the rear-end 10% of low CQ participants had average of 25. The CQ score indeed reflected certain difference of participants' story design performance. High CQ participants could have better story design while low CQ participants performed lower in story design. One interesting point to know is that although high CQ participants performed better, some still had low story design evaluations, which were only around 22 points. Likewise, some low CQ participants still had high story design scores, which were 30 points. This phenomenon can explain why in the regression analysis shows low correlation of the two variables: CQ and story design performance.

In the TTCT we examined verbal and figural creativity of participants. The *post-hoc* analysis shows that participants with higher Figural elaboration scores performed better in story design with storyboard. Figural elaboration is an expression of detail in the picture construction design. Participants who showed more design details in TTCT figural task also revealed this trait in their storyboard design task. The fullness of storyboards can make the story much clearer and understandable. Characteristics of storyboard details include accrescence of facial expression, appropriate action pose, and dialogue or scene description. These details could make the story not only clear but also construct a better visual storyline which is helpful to story structure. A sample of elaboration on TTCT figural design and storyboard design design is shown in Figure 9.

Storyline and ending are part of the story structure. Some participants were not satisfied with their work lying in the structure arrangement. Likewise, participants who were satisfied also mentioned that they liked the plot they planned for the characters. In the interviews, we found out that the rareness or surprise of the plot made the story design more interesting and better. Stories that followed ordinary events or predictable reactions usually received lower scores and not satisfied by many of their creators. Results from the interviews and analysis of the data actually respond to one of the creativity factors: originality. The uncommonness of their story design could make the story more pleasurable and appealingly.

Cognition on storyboard driven method of animation content

After the storyboard task, an evaluation on the difficulty of the new model of story design was conducted by the participants as well as experts. The result shows that there is significant difference between novice designers and experts ($p = 0<0.05$). Novice designers regard the storyboard driven method of animation content design easier than experts. In the focus group interview with experts, some implications could explain the reason why experts thought the new method have certain degree of difficulty. They mentioned that they had years of experiences and training on transforming the script texts to images. Storyboarding from scriptwriting information has become an integrated ability for them. Experts knew how to present the story with the best image design. A well planned story is important for them to start the production. Thus, creating story from storyboard without a written script is regarded as a new challenge for experts. This point from experts can explain why they think the storyboard driven method as more difficult than novices. Analyzing from the participants' side, since they are less experienced in storyboard or story design, plus from the data analysis we also found out novices were more satisfied with their works, it is interpretable that novice designers considered the new method as easier than experts.

Interviews with the participants regarding the new method of story design also showed some design thinking of novices. Forty-four of the participants had positive attitudes towards storyboard driven method of animation content creation. Their responses can be synthesized into following points.

(a) It is helpful to construct images directly and frame the appropriate shot.
(b) It is easier to think about the storyline and examine the storyboard for the whole story structure.
(c) It is a supportive method to concretize our mental images and to know the difference between imagination and realization.
(d) It is a good way to express creativity and imagination.

From the above points we can see that in overall participants thought the new method as helpful in story creation. The storyboard is a visual format of story. Thus from creating the storyboard directly, they could develop the story simultaneously. The storyboard panel is ready for participants to design with different frame heights, such as full shot, medium shot or close up.
 "Different frame shots are helpful to describe the story more accurately. It can help me to set an appropriate shot and save time by design storyboard directly", as one novice designer said.

Regarding the story structure, in the interviews many participants also believed that it was easier for them to see the storyline arrangement as a whole. They could view whether each storyboard panel told a good plot or circumstance. "Compared with the traditional method, the length and timing of the story is easier to control by storyboard driven method", one said. They mentioned that by design with storyboard, they could know what they wanted for the storyline development clearly, avoided unnecessary shots, and kept important and meaningful panels for the story. Thus, although not all of the participants performed well in the task, from novice designers' point of view, the storyboard driven method is helpful for developing animation story content.

Storyboard as a visual expression of ideas can also

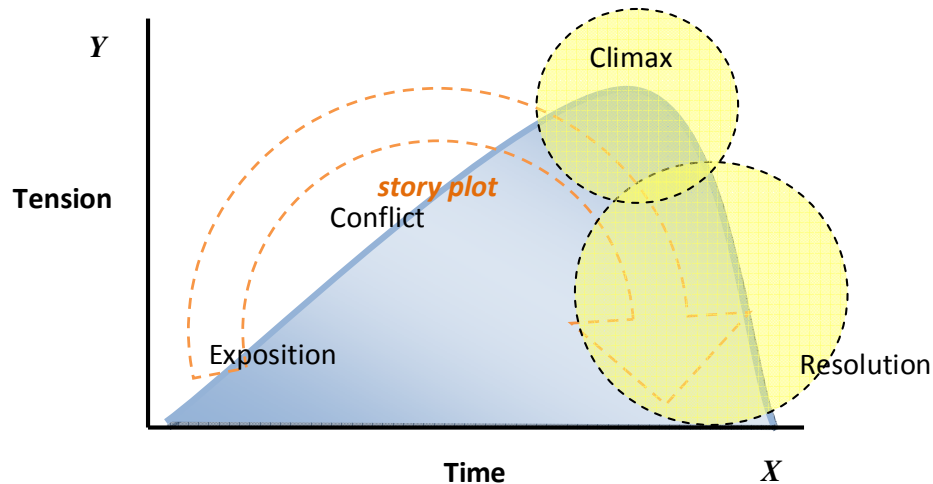**Figure 9.** Elaboration on TTCT figural design and storyboard design.

Figure 10. Positive support of storyboard driven method to animation content design.

help novice designers to show their creativity and imagination. From the interviews, many participants mentioned that it was fun to create storyboards which were intuitive to design and work with the digital tool. Since drawing skill was no longer a barrier to creation, they were able to make use of the digital storyboard tool to frame the shot and pose the characters' action. They could easily change the shot at their own choice to set the desired storyboard. Therefore, from novice designers' point of view, storyboard driven method of animation content is a good way to express their imagination and creativity.

Even though most of the participants thought this method as helpful for story design, there are still some of them who addressed disadvantages of the storyboard driven method. The main drawbacks they reported include lack of detailed plot transition, plot fluency, rough dialogue, and less imagination. Regarding plot transition and plot fluency, the limit of 10 to 15 storyboard panels could be the main reason for the response. It is indeed a complex interactions or emotions in the task. Thus, many of the short stories presented in poses with simple dialogues to show the situations. This kind of presentation is actually suitable for short animation content. A good animation can be shown with appropriate acting poses without any words (Arnold and Eddy, 2007; Williams, 2012). Characters' poses and facial expressions can tell the story already. Dialogue is used as an addition for describing the shot more clearly. As the old proverb says, "A picture is worth a thousand words." If the storyboard image can tell the story, then the writing of dialogues is less important.

The last disadvantage that some participants raised is less imagination. This point is quite the contrary to the supportive side. Novice designers who thought the storyboard driven method as helpful enjoyed the way to express their creative ideas. As already discussed

limitation for designers to complete a structured short story with certain amount of storyboard panels. Some emotional responses or complex actions could not be revealed within limited number of panels. The purpose of the task is to find out whether the new method is practicable for story content development. Design task constraints of short story and limited number of storyboard panels are necessary for control of experimental results. Detailed story information could be an additive to story entertainment, but what is more important is whether a good structured story is created with the new method. The formation of animation content has been a critical issue in production pipeline. Thus, although limitation on storyboard panels may lose some details, the overall storyline development is what we intend to examine.

With regard to dialogue design, some participants mentioned that only simple dialogues could be expressed in the storyboard. There was not enough time to design previously, by direct designing the images, they could explore and manipulate with the storyboard system to get their desired frame. The other side who regarded it as less imaginative, actually also acquired lower scores in the task. This could imply two possible reasons. First, they are not proficient in image design. Some of them have high CQ while their storyboard scores are still low. This does not mean they were less creative, since there was low correlation between creativity and story design performance. Instead, we can say participants who thought this method as limitation to imagination could have better performance in traditional method of story design. Language and scriptwriting as a conceptual presentation of creative ideas are suitable for people familiar with its manipulation. Whether high CQ participants with low storyboard design scores will perform better in traditional scriptwriting method needs to be further

investigated. The second reason for this interview response could lie in emotional resistance to their design outcomes, which they thought it as bad. Thus, by saying this method having the limitation on their imagination, this way could release their expectation, as well as others' expectation, for the story design.

Story structure and key factors of good story

To see whether the storyboard driven method of animation content design can construct a good structured story, we checked the evaluations from experts regarding the story elements. Participants' self-assessment results are also compared to see their cognitive differences on story design. The top 3 evaluations from experts are resolution, climax, and story plot. As for novices, the top 3 self-evaluations are resolution, climax, and entertainment. It is worthy to know that the top 3 scored elements from experts are *story structure* related. This implies that the new method of story design can actually work. Although not all of the stories received good scores from experts, the overall evaluations that experts regarded as good enough were about story structure; in other words, resolution, climax, and story plot. This is a good phenomenon to know that novices have the same first two elements of good story as experts judged. They were able to see the whole and judge what a good story should contain.

In animation and film story design, "three-act structure" (Arnold and Eddy, 2007; Sheppard, 2009; Tumminello, 2004) is the standard format for most productions. As we have already mentioned, with the reversed model of story content development, we also follow the same story structure rule for judgment. The results show that from both experts' and novices' point of view, the storyboard driven method of content development can achieve some good structure story design. Figure 10 shows the scope that the new method of story development could positively be supported in story design. From the storyboard design experiment, we find out the new method can help in the overall story plot, the design of climax and resolution. Regarding the exposition and conflict, there seems to be less contribution to story development.

Conclusions

The goal of this study is to find out whether a storyboard driven method of animation content development could work for production. The results showed that in personal creativity, there was no significant difference between male and female participants. Reasons for this phenolmenon could lie in participants from related design background and with almost equal years of training. The examination on participants' CQ and their story design

performance showed low correlation. Although TTCT is a popular test and has empirical reliability and validity for over 50 years, it could be best regarded as a measure of creative potential (Cropley, 2010) but not creative performance.

Though there seems to be low correlation between creativity and story design performance, there are still some interesting facts in the results. The CQ score ranged from 148 to 45, with the average of 82.93. The top 10% of high CQ participants had average scores of 31 in story design; while the rear-end 10% of low CQ participants had average of 25 in story design. The CQ score indeed reflected certain difference of participants' story design performance. One interesting point is that although high CQ participants performed better, some still had low story design evaluations, which were only around 22 points. Likewise, some low CQ participants had high story design scores, which were 30 points. This phenomenon can explain why in the regression analysis showed low correlation between CQ and story design performance.

The data of what novices and experts thought about the practice of this method was collected by questionnaire and interviews. The result showed that there was significant difference (p = 0<0.05). Novices regarded the method as easier than experts did. Experts mentioned that storyboarding from written scripts was an integrated ability for them since they had years of experiences. A well planned story was important for them. Thus, creating story from storyboard without a written script was regarded as a new challenge for experts. Novices, on the other hand, were satisfied with their works and less experienced in story design or storyboarding. These facts could explain why they thought the method as easy.

From interviews with participants regarding the method, 44 of them had positive attitudes towards storyboard driven method of animation content creation. Their responses can be synthesized into four points. First, this method is helpful to construct images directly and frame the appropriate shot. Second, it is easier to think about the storyline and examine the storyboard for the whole story structure. Third, it is a supportive method to concretize our mental images and to know the difference between imagination and realization. Fourth, it is a good way to express creativity and imagination. From these interview responses, we can confirm that with storyboard driven method, novice designers were able to construct and visualize images in their minds and see the whole story structure. Compared with the traditional method, the storyboard driven method is not only time saving in animation process, but also more productive in creating story and storyboard simultaneously.

Even though most people thought the method as helpful, some drawbacks proposed by participants included: lack of detailed plot transition, plot fluency, rough dialogue, and less imagination. With the limit of 10 to 15 storyboard panels, it was indeed some emotional

responses or complex actions could not be revealed. Thus, plot transition and fluency could not be fully revealed in the task. However, our research purpose is to find out whether the new method is practicable for story content development. So although the design constraints may lose some details, the overall storyline development and experimental control are more important. With regard to dialogue design, a good animation story can be shown with appropriate acting poses and facial expressions. Therefore, if the storyboard image can tell the story, then the writing of dialogues is less important as novices thought. Regarding the imagination issue, there were positive and negative opinions. Most novices enjoyed to explore storyboarding to get their desired frame; while some regarded the method as less imaginative. This could imply that they may not be proficient in image design. However, it does not mean that they were less creative, since there was low correlation between creativity and story design performance. Therefore, we could only imply this method as effective for designers with better image manipulation and proficiency. Participants who were not good at image creation may still train with the traditional method.

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