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# Animation Teaching Materials about Female Mathematicians—With Émilie du Châtelet as an Example

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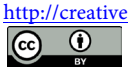




## Abstract

Helping people to understand how women can perform their due capability in mathematics, which is a fundamental knowledge discipline, is a crucial part of science education. However, animation teaching materials that introduce female mathematicians remain insufficient. This study used five software packages to produce an animation of Émilie du Châtelet, a French female mathematician, in order to attract students' attention to the life stories of female mathematicians and to raise their recognition of the social contributions made by female mathematicians. It is anticipated that the learners can understand the exemplary role of the animated figure, develop the concept that mathematics and even science are gender-neutral, and cultivate gender consciousness. In this way, the learners are encouraged to explore science, develop interests in mathematics, and make scientific contributions to help advance the culture and civilization of human beings.

## Keywords

Female Mathematician, Émilie du Châtelet, Real Stories, Animation Teaching Materials

## 1. Introduction

Mathematics education is deemed as an important part of basic education, and the level of mastery of it has considerate impacts on other subjects. In addition, it can affect the learning and perception of other professional areas as well as the ability to use tools and technology (Hung, Angelalo, & Shieh, 2011). In history, numerous females were unable to give full play to their strengths due to gender discrimination. Yang (1993) argued that conservatism and inequity deeply af-

fected people's choice in entering higher education from secondary education. As a result, males tended to study engineering and natural science while females were expected to follow tradition to be students of the arts, which led to male dominance in science and technology in the early times and the bias that females were not good at science (Chen, Tsai, & Li, 2016). However, the fact is that females are able to perform as well as males when studying in environments with gender equality (Hyde & Mertz, 2009; Chen & Hsieh, 2015). Lee & Shan (2002) stated that mathematics plays a major role in human living, existence, and scientific and cultural development. Moreover, countries have attached more importance to the relation between math and nature in their curriculum requirement of the 21st century as a result of growing recognition for the value of math.

Banks (1993) and Liu (2013) asserted that multi-cultural education should respect cultural differences, promote equal access in education, and show positive attitudes toward diverse ethnic groups and cultural communities. By doing so, students could learn relevant knowledge, skills, and attitude to accommodate themselves in today's dynamic world. Attention should also be directed to the combination of knowledge and practice to challenge the traditional idea that knowledge is value-free. This study anticipates that students could recognize the great contribution made by females and boost their interest in learning mathematics by introducing the real stories of a female mathematician.

## 2. Motivation

Mathematics is the key to the world of science, a scientific language, a medium of thinking, a methodology, the art of reasoning, and a rational spirit. However, girls tend to deliver poor performance in this basic subject, which indicates the importance of enabling girls to perform their due capability as a crucial part of science education (Suen, 2011). Textual introduction or pictures are generally used to tell stories of historical figures while adopting animation, where the audience's acceptance to the story could be improved, and animation has become more popular and convenient compared to the relatively unattractive words and pictures. Just like a thick literature book and an animated film, a film is easier to appreciate, because it carries no weight and integrates words and pictures into an image to stimulate people's sense and memory, making the historic story of mathematicians more interesting and attractive.

Scant studies can be found in the literature regarding animation teaching materials about female mathematicians. Thus, this study selected females as the study subject with the hope of changing their impression that males tend to be more capable of mathematics and the negative impact brought by gender difference. Female models or examples were introduced to aid students in overcoming stereotypes, and genuine stories of female mathematicians were integrated into animation to teach students. Different from the traditional static teaching method of using words and pictures, vibrant animation was adopted to promote students' understanding of female mathematicians, broaden their horizons on

careers, and stimulate their interests in mathematics and science learning.

## 3. Purpose

Not all mathematicians are males, and females could become excellent mathematicians as well. For instance, Émilie du Châtelet was a great mathematician who had profound impacts on society by her social contribution, indicating that females are extraordinary equipped with thinking ability in logic as well. The aim of this study was to increase the audience's knowledge of female mathematicians by introducing animation of female mathematicians that are not monotonous. In this manner, the audience was encouraged to picture the prospects of female mathematicians and devote more interest and vigor to learning math and science as well as attaining self-fulfillment.

## 4. Literature Review

### 4.1. How Mathematics Impacts Stereotype

In the United States and Taiwan, females remain in a disadvantaged position in science, technology, engineering, and mathematics (STEM), as noted in Hu and Chen (2010). Most females do not have outstanding performance in STEM fields, but this does not mean that they are logically inferior to males. Instead, it is a result of stereotype (Chao & Shu, 2010). Furthermore, females are inclined not to recognize their success is driven by ability and interest when facing gender stereotypes in subjects (Chen & Suen, 2006). However, studies believed their failure is caused by incompetence and thus enhanced the idea of gender stereotype (Burkley & Blanton, 2007; Huang, 2007; Wang, Chan, Soffa, & Nachman, 2017; Hu & Ortagus, 2019).

Studies also found that females were affected by gender stereotype threats when doing aptitude tests of mathematics and space or spatial tests (Gonzales, Blanton, & Williams, 2002). Tsai, Wang, and Wu (2007) argued that the development of science has failed to embrace gender equality ever since Western scientific exploration in the 17th century, because the emphasis fell on rationality, objectivity, independence, and abstract thinking, and these were masculine characteristics that society expected males to possess. Such an idea indicated that feminine sensitivity was unwelcome in scientific development, and scientific characteristics and images were bound with males, masculinity, or macho. Wang (2012) supported this idea by claiming that science is a manly field, science is fit for males, males are more scientific, and scientific brains imply excellence. All of these concepts not only affirmed the masculinity of science and the male value in science, but also suppressed female's desire to study science and technology due to gender identity pressure. As a result, men dominated science and technology. It might be more correct to say science was inspired by men rather than humans, because not only did men outnumber women in science, but also in the leadership of high-tech fields, which is an indicator of gendered science and technology. To conclude, a review of the literature suggests that gender stereotypes have

affected female's learning and development in math, which could cause their mathematical performance deficiency and even stop them from devoting themselves to math.

Marx and Roman (2002) found that while learning math, females tend to have better math test results when there is a female mathematician example, suggesting that the very example could remind females of the possibility to overcome stereotypes, perform well in math, and improve math performance. McIntyre, Paulson, and Lord (2003) asked an experimental group to name female figures with achievements in architecture, law, medical study, and invention, while the control group read passages about enterprises that thrived in these four sectors. The experimental group outperformed the control group on the math test, indicating that female figures with no relation to math could also benefit from female's performance in math (Suen, 2012). Furthermore, Hung, Angelalo and Shieh (2011) pointed out that the more experienced female students are in the study, lesson, or training related to gender and knowledge of the social construction and history of gender role, the more they are likely to have gender equity awareness, and the less likely that they would be affected by gender stereotype and its threats. More importantly, they could recognize their math ability, which could in turn promote their understanding of multiculturalism and critical thinking, observe any hidden bias in society, and take action against discrimination and prejudice (Yu, 2013; Academy for Educational Research, 2019; Heikkilä, Isaksson, & Stranne, 2020).

This present study suggests that the ingrained gender stereotype in traditional culture could be reduced when more female examples are introduced in school lessons and teaching materials, along with experiences of female scientists being animated as stories with vigorous, lovely, and smart characters. By animating the real stories of female mathematicians and bringing them to class, female students could realize that they are not the inferior gender. It will also help to reduce gender stereotype threats, encourage students to practice, and generate practical effects on gender education.

### 4.2. Attraction of Virtual Characters Based on Real Stories

Callcott and Lee (1994) asserted that a wider audience could be attracted when adopting cartoon figures as spokespersons (Callcott & Phillips, 1996). In addition, virtual characters are more eye-catching (Fang, 2008). For products or brands advertised by virtual characters, their reputation and image could be enhanced. On the Internet, females generate more consumer confidence like males and cartoons when compared with virtual characters and humans (Luo, McGoldrick, Beatty, & Keeling, 2006).

Some students adopt the educational method of textual description, while some may find it monotonous, yet students nowadays are more likely to enjoy animation or visual picture in education. Hung, Wu, and Hsieh (2003) rendered math as necessary knowledge in ordinary life, and students' math capability

could affect many other aspects in their adulthood. Employing artificial virtual technology could improve students' engagement in teaching and promote their learning motivation and effectiveness, whereas using computing animation to produce virtual characters and unique stories is more likely to stimulate students' curiosity and interest (Siao & Liu, 2019). In this context, one learns that previous studies proved an animation-based teaching method is beneficial to school teaching, student's confidence, and learning motivation.

This study therefore used software to produce stories of a mathematician with the goal of stimulating brain memory through the virtual effect of animation and dynamic activities. The goal is to spur sense and memory through these attractions, which could then stir students' curiosity on the life and studies of mathematicians. Unlike the logical development of male mathematicians, female mathematicians gradually developed their studies and accomplishments in the new era, and their contributions to society are no less than that of their male peers. Many examples of female mathematicians fall into this group and can be found throughout history and even in current times (Torres-Carrión et al., 2018; Cardoso et al., 2019).

## 5. Production

This research will explore whether the process of making mathematician story animations can help female students motivate to learn mathematics. The author of this study will select a female student from National Chiayi University in Taiwan as the research object and observe his reaction, using the observation log for recording.

This study collected stories of Émilie du Châtelet (Mitford, 1999; Zinsser, 2006; Bodanis, 2006) during the research period and worked out the basic outline of the story, which is also called Act. Theoretically, each Act contains one Scene and many events of Émilie du Châtelet, and each event is made of several action shots of the virtual Émilie du Châtelet character based on the story need. Different sections were also designed to evoke different vibes and emotions.

The software employed to produce the animation and their functions are shown in Table 1, including Evertoon, Viva Video, Inshot, Instagram GIF, and Pinterest.

**Table 1.** Name and function of software.

| Software | Function |
|---|---|
| **Evertoon** | Animate 3D cartoon characters to tell stories, conduct interaction, dance, hug, etc. |
| **Viva Video** | Work on background music, scene-switching, editing, and subtitles. |
| **Inshot** | Add music and special effects into the movie, blur the background and framework, and integrate them into the movie. |
| **Instagram GIF** | Produce dynamic maps to compress the movie. |
| **Pinterest** | Search for background photos. |

The 3D character and the action, background, and sounds were animated in Evertoon. Viva Video was adopted to work on the background music, scene-switching, editing, and subtitles. Inshot was for the integration of the movie, while Instagram GIF was for compressing dynamic short movies. Pinterest was for finding background photos.

Émilie du Châtelet was an extraordinary female mathematician in France and around the world. The major content of this animation is presented as follows (Mitford, 1999; Zinsser, 2006; Bodanis, 2006):

Born in a noble family when the French Enlightenment emerged, Émilie du Châtelet was originally named Gabrielle Émilie Le Tonnelier de Breteuil. She was born in Paris on December 17, 1706. She spent most of her childhood with her brother (**Figure 1(a)**), which enabled her to learn mathematical knowledge from his tutors (**Figure 1(b)**). By that time, females were expected to marry at an early age instead of learning knowledge. As a result, Émilie married Marquis du Châtelet-Lomont who was 10 years older than her when she was only 19 due to a family arrangement. However, Émilie du Châtelet was smart, intelligent, and eager to learn more knowledge.

Unlike other noble ladies at that time, Émilie du Châtelet was free from parenting and housework. She received a good education, because she successfully persuaded her father who was a teacher himself to support her to further her study. As a passionate learner, Émilie du Châtelet made impressive accomplishments in science and mathematics, and it became her life's work later (**Figure 2(a)**).

Émilie du Châtelet translated, commented, and annotated Newtown's theories into French. Back then, France was a powerful country in Europe. Émilie du Châtelet was the French translator of Newton's Mathematical Principles of Natural Philosophy (**Figure 2(b)**), on which she gave comments and annotations. This act helped to popularize Newton's theories in Europe and indirectly aided Newton to held a place in Europe at that time. She also made contributions to physics by finding that kinetic energy was directly proportional to the square of velocity, and it helped advance the development of science (**Figure 3(a)** and **Figure 3(b)**).

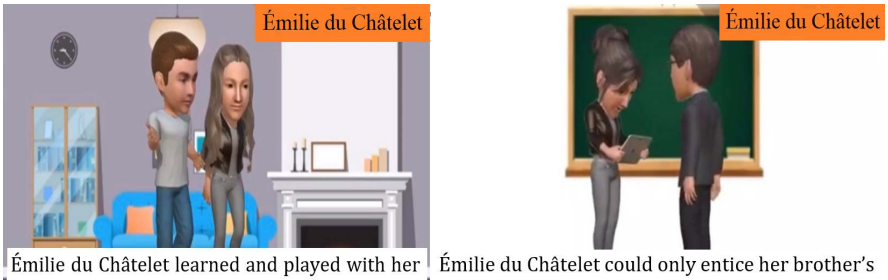
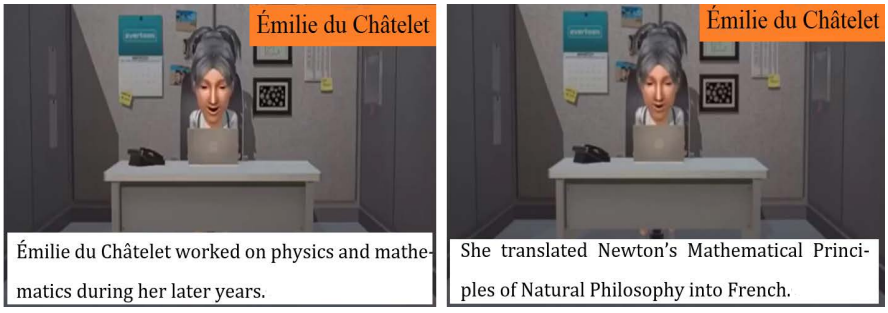
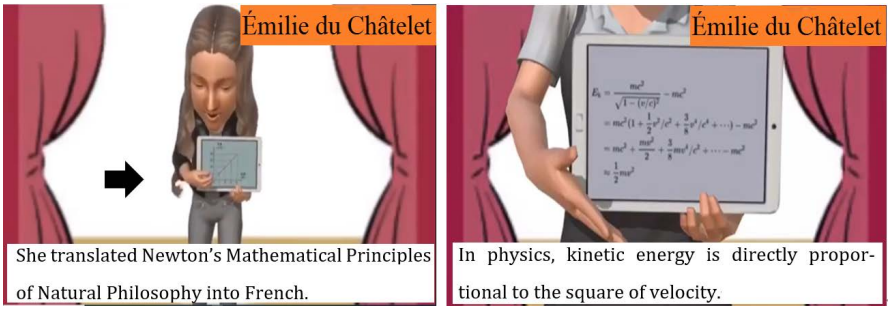



**Figure 1.** (a) Émilie du Châtelet usually stayed with her brother. (b) Émilie du Châtelet learned mathematical knowledge from her brother's tutor.




(a) (b)

**Figure 2.** (a) and (b) Émilie du Châtelet worked on physics and mathematics in her later years.




(a) (b)

**Figure 3.** (a) Émilie du Châtelet translated Newton's *Mathematical Principles of Natural Philosophy* into French. (b) She discovered that kinetic energy is directly proportional to the square of velocity in physics.

As one of the few female scientists in the 18th century, Émilie du Châtelet was chosen as a member of the Academy of Sciences of the Institute of Bologna.

She passed away under the age of 43, which was not only a loss to the European scientific community, but to mankind. In 2019, France issued commemorative stamps to honor Émilie du Châtelet.

## 6. Conclusion

### 6.1. Research Conclusion

According to the observation of the author of this study, animation teaching materials could improve the effectiveness of integrating technology into education and for sharing digital animation resources, thus saving educational costs and enhancing students' learning. Adopting animation teaching material in classrooms as an auxiliary means of learning could arouse students' passion for learning and make them become active learners to achieve better learning efficiency. This could assist teachers to teach smoothly and students to learn independently and ultimately achieve progress that benefit teachers, students, and parents. If male students could learn to respect contributions made by females around them since childhood instead of being trapped by stereotypes that may undermine females, then it could introduce more possibilities to break male ste-

reotypes and limitations of females.

### 6.2. Research Limitations and Suggestions for Future Studies

The five applied software packages failed to recreate the historical background that Émilie du Châtelet lived in and some objects and scenes in the animation could only be replaced by available tools in the software. In addition, the clothing, historical objects, and historical scenes were restricted by the available images of the five software packages. The story of Émilie du Châtelet in the animation was based on her real stories that were collected from the literature. In the future, it is recommended to develop the animation by employing software with more historical objects and virtual scenes.

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## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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