Chapter 5
A Proposed Protocol of Multimedia Optimized Production for STEAM E–Learning

Jenny Z. Xu
University of California – Irvine, USA

Nicholas Graham
University of California – Irvine, USA

Scott E. Gaines
University of California – Irvine, USA

Bradley S. Hughes
University of California – Irvine, USA

ABSTRACT

There are many nuances to utilizing multimedia successfully as a pedagogical tool. With pressure for educational institutions to adopt e-learning tools such as online animations, it is important that a protocol be made to optimize the process and ensure students walk away with important content knowledge. Effective STEAM multimedia requires attractive aesthetics to engage viewers, research-based pedagogy to effectively educate viewers, and an efficient workflow that lowers costs. Focusing on the Science, Technology, Engineering, Arts, and Mathematic (STEAM) fields, this paper reviews literature on the effectiveness of animations for the classroom and online environments, and examines why some projects work while others do not. While addressing the problems that arise when using on-demand animation, we propose a unique protocol that practitioners and researchers can utilize in the production of their own educational animation.

INTRODUCTION

Teaching in science, technology, engineering, arts and math (STEAM, an extension of STEM), within both the online and offline environments, has become more crucial than ever as the United States and European governments push for more STEM graduates in the wake of a recent downturn in worldwide research and design shares, from 37 to 30 percent and 26 percent to 22 percent respectively, a result of massive growth in Asian countries (NSF, 2014). With a changing economic landscape, these disciplin-
ary fields are shifting to higher priorities, and as such new pedagogical tools are increasingly seen as necessary to more effectively train new students in the STEAM fields. Multimedia has become a desirable means to reach modern students, as it is more effective than more traditional teaching practices and can efficiently be utilized outside of the classroom as on-demand learning (both supplemental and independent to coursework). Within multimedia, animation proves to be a fairly effective strategy in visualizing topics for STEAM learning, as it is more effective through imagining concrete subject matter and procedural learning (Höffler & Leutner, 2007).

However, utilizing animation for educational purposes is deceptively difficult. Once regarded as a panacea for reaching a diverse audience in education, it has become apparent that creating effective animation is not as simple as putting together a series of moving pictures and presenting it as-is. Not only does an animation need to be visually appealing to retain audience attention, it must also follow scientifically-backed pedagogical design while also staying under (a usually sparse) budget. The need for effective online animations is growing, from in-class supplementary reading to distance education (online coursework). For instance, the United States has seen a growth in the percentage of undergraduate students taking online courses, up to 26.5% taking at least one course and 11.34% taking only online courses in 2015 (NCES, 2015). With social media increasingly spreading scientific information utilizing these tools, there is a potential explosion of multimedia viewership approaching.

With such widespread use, understanding the optimization of animations for educational purposes and accurately identifying whether animation is the appropriate technique for those purposes is becoming more important. For instance, use of animation in social sciences and applied professions is less effective for students (Xu & Jaggars, 2014), but for more physical models and procedural content that requires some mental visualization, these tools are highly effective (Höffler & Leutner, 2007). Combined with a higher cost than traditional forms of education, it is essential that practitioners and researchers utilize animations only when they are appropriate, while employing best practices in maximizing design effectiveness when developing these tools.

While both online and offline approaches to STEAM education can be efficacious, there are significant advantages and drawbacks to utilizing a visual media to demonstrate scientific processes, especially for self-driven education. Acknowledging that animations are not always the best approach, we propose a protocol for determining utilization for developing multimedia for STEAM education. First, this chapter reviews the evidence that multimedia, in particular animation and other visualization tools, can improve student performance both in the classroom and online. Second, we discuss the nuances that play a significant role in when and for whom animation is appropriate. We conclude this chapter with description and explanation of our proposed protocol and how this addresses some of the problems associated with animation.

**ANIMATION AS A TOOL TO BUILD KNOWLEDGE IN STEAM**

**The Application of Media Online**

Advancements in web-based technologies have changed how youths approach their social and professional lives. However, while youth quickly adopt and adapt to new technology, research generally lags behind in fully understanding the impact this has on education. Educators utilizing web-based lecture