Impact of Visual Scientific Data on Comprehension and Perception of Educational Animations for Biomedical Researchers

Isabel Romero Calvo[1], Leah A. Lebowicz[1], Christine D. Young[1], Kevin M. Brennan[1]

[1]*Department of Biomedical and Health Informatino Sciences, University of Illinois at Chicago, Chicago, IL*

Abstract

Due to the rapid evolution of biomedical research, it is crucial to effectively communicate new technological advances in topics such as organoid models in cancer therapeutics to help improve health outcomes. Visual communication, including animation, has been shown to improve cognition and understanding of complex biological processes. However, there is contradictory information about the amount of detail that should be used for effective communication when utilizing animation. Although it is known that the inclusion of detailed references increases the scientific community's perceived credibility of the visualization, the effect of including visual scientific data is unknown. This research examines the impact of including visual scientific data in an educational animation by analyzing biomedical researchers' perception of credibility and learning outcomes with respect to cancer organoid research.

Introduction

The use of visual representations for communicating complex scientific topics is clearly beneficial[1]. In fact, the integration of auditory and visual components increases learning and reinforces long-term memory[2], and it is well established that animation is an efficient teaching method [3,4,5]. However, there is contradictory information regarding the optimal amount of detail to use in an educational animation. Some research has shown that an excessive amount of detail in an animation can be a distraction for the viewer and decrease retention[6], whereas several investigations show that detailed information promotes information retention [7,8,9,10,11]. Interestingly, the addition of detailed references increases the perception of credibility of animations for the research community[12]. These studies suggest that the type of detail used is critical to improving educational animations. This research focused on improving animations for an audience of scientists by asking if the use of *visual scientific data* in animations improves communication/ learning and perception of the information. To define *visual scientific data*, we can first define *data* "as any product of research activities, which is collected, stored and disseminated in order to be used as evidence of knowledge claims" (The Data Journalism Handbook, pg. 19, Kirk, 2016). Additionally, *visual scientific data* can be thought of as scientific data that is represented by color and/or images.

The animation that forms the core of this project focuses on the rapidly developing field of cancer organoid research. Organoids, an artificial *in vitro* 3D culture of cells that resemble the morphology and histopathology of an organ [13], have evolved exponentially during the past 10 years [14, 15, 16, 17]. They maintain the patient-specific genetic and histopathological fidelity of the primary tumor and are therefore an optimal model to understand the etiology of tumor biology and design treatments for cancer patients. The goal of the project was to test two versions of the animation, with or without the incorporation of *visual scientific data*, in order to optimize learning and perception from educational animation for biomedical researchers.

Results

The participants that watched the animation with data were significantly faster (~8 min) than the participants that watched the animation without data (~11 min), (**Figure 1**).

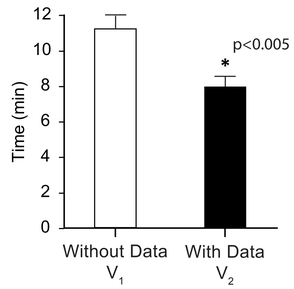

Figure 1: Graphical representation of the time (in minutes) each group spent taking the entire survey.*p<0.005, n=15-13.

There is a gain of knowledge in both versions of the animation. Specifically, thre is a gain of knowledge in V_2 is 21% higher than in V_1, (**Figure 2**).

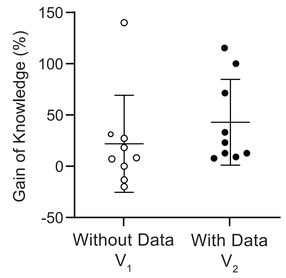

Figure 2: Graphical representation of the gain of knowledge (in percentage) of V_1 and V_2, n=15-13.

The inclusion of *visual scientific data* in an educational animation for biomedical researchers improves information credibility, visual appeal, and scientific relevance (**Table 1**).

Credibility	The majority of the participants agreed that the information presented is scientifically accurate. **90% of all the participants strongly agree** that having scientific data **increases the animation credibility.**
Visual Appeal	Almost **70%** of the total participants agree or strongly agree that the inclusion of scientific data within the animation **makes it more visually appealing**.
Scientific Relevance	Over **85%** of the total participants agree or strongly agree that having scientific data within the animation **increases its scientific relevance**.

Table 1: Summary of the credibility, visual appeal and scientific relevance related questions collected after the animation intervention. Results are expressed in percentage, n=15-13.

Conclusions

The inclusion of *visual scientific data* in an educational animation for biomedical researchers:

- Benefits information retention and processing time of information
- Improves opinion regarding credibility, visual appeal and scientific relevance

Materials & Methods

In order to determine the effect of the inclusion of *visual scientific data* in a scientific animation, two versions of an animation were developed, with and without the inclusion of *visual scientific data*, Version 1 (V_1) and Version 2 (V_2), **Figure 3**.

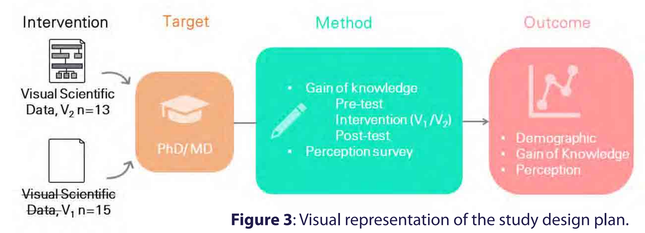

Figure 3: Visual representation of the study design plan.

The animations were randomly assigned, watched and reviewed by 28 voluntary and anonymous participants with graduate degrees in the medical field (MDs and PhDs) from the United States. Questionnaires were utilized to test comprehension of the educational information contained in the animations. Information retention was tested by detailed scientific questions before (pre-test) and after (post-test) watching the animation. Statistical testing was performed using the Student´s T-test (for normal distributed data) and Wilcoxon signed-rank test (for non-normal distributed data). After the intervention, participants were also asked to rate the animation's perception: credibility, visual appeal, and scientific relevance on a 5-point Likert scale.

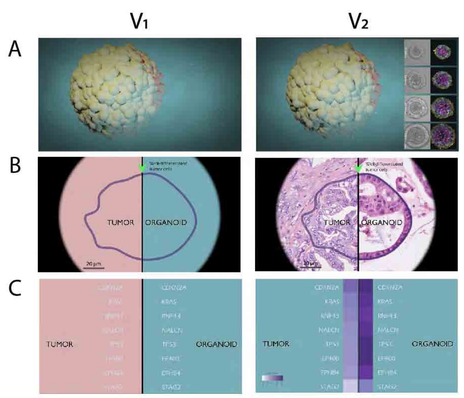

Figure 4: Single-frames from the two versions of the final animation (V_1 and V_2) showing the three types of *visual scientific data* inclusion. **Figure 4A** and **4B** show two types of microscopy staining, fluorescence and eosin & hematoxylin staining (minutes 00:52 and 01:02)[17]. **Figure 4C** includes DNA sequencing data[15] (minute 01:15).

Research & Storyboard

Animation

Survey & Data Analysis

Scan QR code to watch the complete animation with the inclusion of *visual scientific data* (V_2).

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