Comparing the Effectiveness and Engagement of Comics to 3D Animation in Teaching Advances in Nanomedicine

Angela W. Gao¹, Evelyn T. Maizels, MD, PhD, MS¹, Kevin M. Brennan, MS, CMI¹, C. Shad Thaxton, MD, PhD², Kaylin McMahon, PhD², and Christine D. Young, MA, CMI, FAMI¹

¹Department of Biomedical and Health Information Sciences, University of Illinois at Chicago, Chicago, IL, ²Department of Urology, Northwestern University, Feinberg School of Medicine, Chicago, IL

Abstract

Translating new discoveries into viable therapies is dependent upon communication between scientists and medical professionals, especially in the emerging field of nanomedicine. Understanding of mechanisms on the cellular and molecular scale is commonly facilitated using 3D animation. However, this project sought to validate the knowledge transfer of complex biomedical information in nanomedicine using an alternative medium, the comic book. This medium has been effective for science communication but remains largely untested in medical education.

In order to explore the differences in knowledge gain, engagement, and preference between comics and 3D animations, a comic book about a synthetic high-density lipoprotein gold nanoparticle's apoptotic effects on lymphoma cells was created and compared to a 3D animation with identical content. Thirty-five individuals consisting of medical students, physicians, graduate students, and research scientists in the biomedical sciences were randomly shown the comic or the animation following a pretest. A posttest and preferences survey was conducted afterward. Results indicated that both the comic and animation were similarly effective at increasing knowledge about the HDLAuNP mechanism of action and had a similar level of engagement.

Background

HDL AuNP as a Potential Therapy for Lymphoma

Communication of biomedical research discoveries to healthcare professionals is crucial to the acceptance and implementation of new technologies and therapies for disease, especially in the fast-paced, emerging field of nanomedicine. One such discovery is a synthetic HDL gold nanoparticle (HDL AuNP) which is being investigated in the treatment of diffuse large B-cell lymphoma (DLBCL) (Rink et. al 2017). The HDL AuNP mimics native HDL and binds a receptor expressed on malignant B cells, scavenger receptor class B type I (SR-BI). This event blocks cholesterol transport to the B cell necessary for metabolism, leading to apoptosis. It has been experimentally shown to differentially affect malignant B cells without damaging healthy B cells, as the malignant B cells overexpress SR-BI (McMahon et. al 2017). Visually communicating advances in nanomedicine to medical professionals offers opportunities to advance understanding in translating research findings into clinical practice.

Animation and Learning Science

3D animations are a commonly used and accepted format for medical education and have been shown to be effective for communication of complex science information (Höffler & Leutner, 2007). Research in learning theory has identified that animation is an advantageous medium because it implements multimedia learning (Mayer, 2003) and key instructional design principles, such as the cognitive load theory (Sweller, Ayres, & Kalyuga, 2011). However, a major drawback of 3D animation is its high production cost and lengthy creation process, which limits its use in medical education.

Comic Books as an Educational Tool

An alternative medium which also follows the same learning theory and instructional design principles is the comic book. Comic books are also similar to animations in that they are viewed in a temporally-based manner. This makes them excellent for showing information step-wise information, such as drug mechanism of action (Jee & Anggoro, 2012). Unlike animations, comics have a relatively low production cost.

Comics have been successfully used in education for everything from increasing student interest and motivation in biology to explaining healthcare reform (Hosler & Boomer, 2011). Most research on comics and education has been performed in the K-12 setting and it has only cautiously begun to enter traditionally academic arenas such as medical education. Comic-like study tools for medical students, such as SketchyMedical (www.sketchymedical.com) and Picmonic (www.picmonic.com) have been widely used and commercially successful, and indicate a possible role for comics in medical education. This research project seeks to examine the value of a comic book format for medical student understanding of innovation in nanomedicine to determine if it may be a viable medium for education of medical students and physicians.

Materials & Methods

Animation Production

3D animation production occurred in 3 stages: script & storyboard, animatic, and animation. Storyboards were sketched out in Adobe Photoshop. An animatic, made for testing out camera motions and adjusting comoposition, was created with primitives in Autodesk 3ds Max. Narration was recoded and edited with Adobe Audition. The final models were rigged, animated, rendered out of 3ds Max with the Redshift render engine, composited in Adobe After Effects, and encoded in Adobe Media Encoder. This animation was created in collaboration with UIC biomedical visualization graduate student, Stephanie O'Neil.

The 3D models created for this animation with close attention to current experimental research, especially that of scavenger receptor type B-I (SR-BI), as the true 3D structure has yet to be fully elucidated by x-ray crystallography. This model was built using Uniprot sequence data and a combination of homology modeling with SWISS-MODEL and in silico prediction using PEP-FOLD3.

Comic Production

The final comic was also intended to teach the effect an mechanism of HDL AuNP on diffuse large B cell lymphoma, but the style and tone were quite different from that of the 3D animation.

It was first roughly sketched out on paper. An edited version was resketched digitally, inked, and colored in both Adobe Photoshop and Celsys Clip Studio Paint. Final pages were laid out in Adobe InDesign for print.

Study Design

Results

Mean Pretest and Posttest Scores

	Pretest	Posttest	Difference
Comic Group (n = 17)	7.47 (57.5%)	8.47 (65.2%)	1.00 (7.7%)*
Animation Group (n = 18)	7.56 (58.1%)	9.00 (69.2%)	1.44 (11.1%)*

Scored out of 13 points total. * indicates significance via Wilcoxon signed rank test.

Response to Stimulus

	Clarity	Information Appropriateness	Engagement
Comic Group (n = 17)	5 (4.88)	5 (4.59)	5 (4.71)
Animation Group (n = 18)	4 (4.11)	5 (5.61)	5 (4.56)

Rated on a 5-point Likert scale. Median response shown, with mean in parentheses.

Learning Preference

	Preferred animation	Preferred comic	Both
Comic Group (n = 17)	6	4	7
Animation Group (n = 18)	7	3	8

Conclusion

The comic was just as effective as the animation in its ability to teach a learner the mechanism of action of the HDL gold nanoparticle. Both the comic and animation were rated highly in clarity, information appropriateness, and engagement. The comic was well received and many participants indicated an interest in learning other topics through the medium, further suggesting that the comic book may be a viable medium for complex biomedical communication to a professional scientific or medical audience.

Bibliography

1. Rink J, Yang S, Osman C, et al. Rational Targeting of Cellular Cholesterol in Diffuse Large B-Cell Lymphoma (DLBCL) Enabled by Functional Lipoprotein Nanoparticles: A Therapeutic Strategy Dependent on Cell of Origin. Mol Pharm. 2017;14(11):4042-4051. doi:10.1021/acs.molpharmaceut.7b00710.
2. McMahon KM, Scielzo C, Angeloni NL, et al. Synthetic high-density lipoproteins as targeted monotherapy for chronic lymphocytic leukemia. Oncotarget. 2017;8(7):11219-11227. doi:10.18632/oncotarget.14494.
3. Höffler TN, Leutner D. Instructional animation versus static pictures: A meta-analysis. Learn Instr. 2007;17(6):722-738. doi:http://dx.doi.org/10.1016/j.learninstruc.2007.09.013.
4. Mayer RE. The promise of multimedia learning: using the same instructional design methods across different media. Learn Instr. 2003;13(2):125-139. doi:http://dx.doi.org/10.1016/S0959-4752(02)00016-6.
5. Sweller J, Ayres P, Kalyuga S. Cognitive Load Theory. (Spector MJ, Lajoie SP, eds.). New York, NY: Springer Science+Business; 2011. doi:10.1007/978-1-4419-8126-4.
6. Jee BD, Anggoro FK. Comic Cognition: Exploring the Potential Cognitive Impacts of Science Comics. J Cogn Educ Psychol. 2012;11(2):196-208. doi:10.1891/1945-8959.11.2.196.
7. Hosler J, Boomer KB. Are comic books an effective way to engage nonmajors in learning and appreciating science? CBE Life Sci Educ. 2011;10(3):309-317. doi:10.1187/cbe.10-07-0090.