Zuul crurivastator: Ecology, taphonomy, and preservation of an ankylosaur fossil from the Late Cretaceous of Montana

Master's Research Project Proposal

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Abstract

In 2017, a new genus of ankylosaur was described, based on the discovery of the fossil *Zuul* crurivastator. To educate the general public about the significance of this fossil, a master's research project (MRP) animation will be created to describe the habitat, death, and preservation process of *Zuul*. There is a possibility of the animation being included in a natural history museum exhibit about *Zuul*. This proposal for the MRP animation will discuss the need for improved visualizations, such as animations, in a museum environment to explain the dynamic events of a specific dinosaur specimen's death and preservation and animations which emphasize that these events occurred on a very long timeline. A literature review and media audit on the efficacy of animation as an educational tool was conducted. From this survey, it was concluded that animations for a museum environment need to be short and simple enough for a general public visitor to understand. Furthermore, the efficacy of animations in a museum environment could be improved by using a factual story narrative, including basic interactive elements in the animation, and using standard visual storytelling motifs to decrease cognitive load.

Introduction

In 2014, a new ankylosaur genus from the Late Cretaceous was discovered in the Judith River Formation, Montana (Arbour et al. 2017). The new genus was described from a singular well-preserved fossil, the type species *Zuul crurivastator* (Arbour et al. 2017). The preservation and fossilization of this individual included a series of events specific to this individual specimen. For example, *Zuul's* carcass was deposited and overturned in a river channel following the "bloat and float" model proposed by Jordan Mallon (Mallon et al., 2018). The carcass sank and disarticulated in a unique way, and at least four sedimentary burying cycle events occurred to cover the carcass in its distinct position, as discovered (Evans, 2018).

To inform the general public about this newly discovered specimen's history, visuals and educational resources will be included with the *Zuul* fossil in a natural history museum exhibit.

There is the possibility of including an educational animation, created through this MRP, to help describe *Zuul's* death and the events leading to its fossilization. This animation will explore the specific geological nature of the preservation and how the body parts were positioned, along with the fossilization process, itself.

A Need for Improved Museum Exhibit Animations

Natural history museum exhibits can be busy, distracting environments, and museum patrons may have a limited amount of time and attention when visiting. Therefore, it is proposed that the development of more effective visualizations could increase their concentration and learning while decreasing their cognitive load. Science museums are an important part of informal science education (Wang, 2014). Improvements should be made to make the visitor's learning experience more effective and rewarding.

A Need for Dynamic Visualizations to Describe Dinosaur Fossilization

After analyzing available educational visualizations on fossilization, there appears to be a lack of educational material on dinosaur death and body preservation via fossilization. Effective animations depicting these events would assist in keeping the general public informed about current research and discoveries in the paleontological world, and their significance to understanding changes in our present environment. The currently available educational material does not effectively communicate that these dynamic events occurred millions of years ago and took place over a large period of time. As events which have taken place in, and during, what is referred to as 'deep time' are difficult to comprehend, there is a need for dynamic visualizations such as animations to effectively communicate this concept.

Background: Literature Review and Media Audit

To understand the issues related to the two visual communication problems previously described, a literature review and media audit was completed. I have divided this review into four sections:

1. Learning Science in Museum Spaces
2. Methods to Improve a Visitor's Attention and Learning
3. When Animations are an Appropriate Educational Tool
4. Current Visuals on the Animation Topic (Media Audit)

1. Learning Science in Museum Spaces

From experiments conducted in museum environments, it has been observed that many museum visitors have a short attention span. It has been demonstrated that the average museum patron spends on average only 30 seconds at an exhibit (Sauer, Neuroth, Chu, Ma, 2016). Visitors are prone to suffer from "museum fatigue", which means their attention and interest will decline as their visit progresses (Davey, 2005). Furthermore, visitors will lose interest if they encounter a topic which is too difficult for them to comprehend within a short time span (Sauer et al., 2016). Therefore, exhibit information must be communicated efficiently to decrease the length of time and the amount of energy needed for a visitor to learn. This means that any educational animation included as exhibit information should be short, have limited extraneous detail, and be overall simple enough for a museum visitor to understand.

2. Methods to Improve a Visitor's Attention and Learning

One method to increase efficiency and effectiveness in educating a general public visitor is by presenting the information through the use of narrative storytelling. In certain studies, people were more engaged and attentive towards the educational context when narratives were used. (Frisch, Saunders, 2008). Other studies have shown that narratives are more efficient in communicating information, because it is in an easy to understand linear format which takes less time to comprehend when compared to descriptive text only (Dahlstrom, 2014). This is important when considering the need to communicate information clearly and simply to the general public in a limited amount of time. Thus, a storyline could be incorporated into an animation to help describe *Zuul's* history and fossilization process more efficiently.

Another technique used to enrich a visitor's learning experience is to include interactive elements within animations. Studies have shown that "interactivity reinforces the learning process" (O'Day, 2011). According to the "interactivity principle", an interactive environment helps the learners learn at their own pace and engage with the material (Yue, Kim, Ogawa, Stark, Kim,

2013). Incorporating interactive elements, such as a scrollbar and a play/pause option, may increase the audience's attention and, therefore, enhance their overall retention of information.

The information retention and attentiveness of a museum audience can be further increased by implementing certain methods to decrease cognitive load. Cognitive load in animations can be decreased by limiting animated elements to those most important to the message. Adding animated elements to simply make something eye-catching does not necessarily help with recall of the overall message being communicated and, typically, only serve to increase visual overload (Schwartz, 2005). Some studies have argued that static images alone are more effective learning tools because animations increase extraneous cognitive load (Mayer et al., 2005). A summary of these various research projects suggests that educational animations should limit the number of animated elements and characters, and static image slides could be incorporated into the video, itself, when appropriate. By following such guidelines, an animation can be a more effective learning tool.

3. When Animations are an Appropriate Educational Tool

While the efficacy of static images versus animation as learning tools is debated, other literature argues that educational animations are more helpful than static imagery when conveying information specifically in reference to dynamic events (O'Day, 2007). Additionally, animations have been argued to be effective when learning about events which have taken place over a large spatial or temporal time scale or are of a three-dimensional nature (Libarkin, Brick, 2002). Learning about dynamic events and learning about events over a large temporal time scale are both applicable to the animation of *Zuul*. *Zuul's* death and preservation events were dynamic processes that occurred over an extensive time period. This point is important to emphasize, since studies have shown that people, in this case students, have difficulty understanding the relative sizes of thousands and millions when geological time periods are concerned (Cheek, 2013). Animations may prove to be useful tools in helping students understand such time periods (Cheek, 2013). This means that creating an animation to help educate the public about *Zuul* may have a more productive outcome than just using static images.

It must be noted that through the literature review process, there seemed to be a lack of recent research on animations as educational tools in museum spaces. Much of the recent research on museum education tools seems to be more focused on interactive exhibits, such as virtual reality and

touch tables. This can be understood in light of the fact that these are newer technological advances which have attracted greater scrutiny. That being said, the findings and discussions from papers on interactive exhibits can also be applied to educational animations.

4. Current Visuals on the Animation Topic (Media Audit)

Along with reviewing the literature on how to create a more effective education animation about *Zuul*, currently available animations relating to the topic were analyzed. The analysis has been divided into two categories:

a) Dinosaur Documentaries
b) General Fossilization Animations

a) Dinosaur Documentaries

When analyzing dinosaur documentaries, such as "Truth about Killer Dinosaurs" by BBC, it was observed that story narratives were used more for entertainment than education. Some scholars have commented that entertainment and storytelling has become more of a focus than the scientific facts in documentaries discussing paleontology, where the entertaining anthropomorphized stories look like factual natural history studies to the audience (Campbell, 2009). One study mentioned that some students struggle with separating fictional and factual elements of the narratives (Prins et al., 2017). Story narratives can be a positive educational tool if the audience is aware of which elements are based on scientific evidence and which are based on hypothesis or speculation.

b) General Fossilization Animations

Educational fossilization animations available through the internet were analyzed. These included fossil animations by Osis Design and Pat Bradley. It was observed that there seems to be a lack of educational animations available depicting the history and the specific events leading to the preservation of a specific individual dinosaur or animal. The visuals that were found explain a very generalized fossilization occurrence that are not related to a specific, known fossil specimen. Additionally, they do not elaborate on how fossilization events are very cyclical in nature (i.e. how many repetitive sedimentary events it takes), nor do they emphasize the length of time a fossilization event takes and how long ago these events occurred. These shortcomings

will be focused on in the MRP animation of *Zuul*.

Research Objectives

The overall goal of the MRP animation of *Zuul* is to create an animation specifically suited for a museum environment that effectively teaches a general public audience about the life, death, and fossilization process of a recently discovered fossil, *Zuul crurivastator*. The specific objectives of this goal are as follows:

1. To improve learning in a busy, distracting museum environment, narrative (storyline) elements, basic interactive elements, short animation clips, summary slides, and other techniques will be used. These will help increase the motivation to learn and decrease the cognitive load of the general public viewer. By decreasing cognitive load on the audience, hopefully there will be a decrease of museum fatigue.

2. To create an animation that effectively communicates a specific dinosaur specimen's dynamic life and death events that occurred a long time ago and over a long period of time, the best visual techniques to approach this will be explored.

Methods

Target Audience

The target audience for this animation is the general public visiting or interested in natural history museums. The final animation may or may not be included in the exhibit about the *Zuul crurivastator* fossil that would travel to various natural history museums. However, if the animation is not included in the exhibit, then it may possibly be presented on the Royal Ontario Museum website in a section about *Zuul crurivastator*, to advertise and promote the exhibit as well as educate the public.

Materials and Measures

The animation, itself, would roughly total three minutes in length. There is the possibility of sectioning it into shorter clips with each clip ending with a brief summary slide. There is also the

possibility of incorporating basic interactive elements within the animation, such as a timeline scroll bar, a play/pause tab and possibly even interactive elements in the summary slides. If adding such interactive elements for the MRP, itself, is not possible due to time constraints, mock interactive elements may be displayed in the final presentation to show how they could be incorporated in the future.

Procedure

Storyboarding and Script

A script will be written and evaluated by my committee, Dave Mazierski and David Evans. After approval, a storyboard will be created and evaluated by my committee. Scenes and information that will be considered include:

- *Zuul* in its natural environment and interacting with other Late Cretaceous taxa.
- *Zuul's* death and decomposition, including the disarticulation pattern of its carcass.
- *Zuul's* fossilization process through time and the related geologic occurrences.

Through the creation of the script and storyboard, challenges and solutions will be focused on and considered. These will include:

- Challenge: How to make a scientifically accurate, yet engaging story narrative animation
- Solution: The animation will limit the use of fictional narrative elements and will clarify which parts of the story are just hypotheses of what occurred. Both verbal and visual narrative elements will help guide the audience and focus them on the most important elements.

- Challenge: How to effectively visually describe dynamic events occurring on a large timeline involving thousands and millions of years
- Solution: The animation will possibly include a timeline bar to allow the audience to visually appreciate, through spatial cues, the length of time between events. This timeline bar may become an interactive scroll bar to allow the audience to jump back and forth through the timeline of events described in the animation.

- Challenge: How to effectively decrease the cognitive load and mental fatigue of the audience
- Solution: The animation will include static image slides when animated characters are not important so as to decrease the cognitive load for the audience. Also, the animation may be broken up into shorter animation clips with summary slides after each to help summarize and break down information, especially the scientific language used.

Modelling, Animation and Possible Interactive Elements

The development of 3D models and other assets will begin after committee approval of the script and storyboard. Z-brush, Maya and After Effects will be used to model and create the animation. It is not yet known what the animation's 3D to 2D ratio will be. However, a simpler style (2D animation) will be used when possible to decrease cognitive load. When a three-dimensional nature is important to understand volume and spatial relationships, 3D modelling will be used.

Anticipated Significance

A museum visitor faces the challenge of learning in a distracting and busy environment. A museum visitor also has a limited amount of time and attention. The animation of *Zuul* for the MRP will hopefully improve the learning experience of museum visitors. Through the literature research process, it was noted that the current research focus is on how interactive media, such as virtual reality, can improve a museum visitors' learning. There appears to be less focus on how educational narrative animations can be improved or be beneficial when in a museum environment or any public space. This project hopefully can help in this area. Furthermore, this animation of *Zuul* is anticipated to be an improvement on how to visually present dynamic events, such as fossilization, through the medium of animation.

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