EXPLORING VISUALIZATION MODELS TO ELUCIDATE LEARNING CAPACITIES IN THE CONTEXT OF VISUAL HERMENEUTICS: A CASE STUDY OF ONLINE INSTRUCTIONAL ANIMATION

Terry Lucas [1]
Universiti Teknologi MARA
Universiti Malaysia Sarawak
[1] lterry@unimas.my
Ruslan Abdul Rahim [2]
Universiti Teknologi MARA
[2] ruslan@salam.uitm.edu.my

ABSTRACT
Online learning is becoming more prevalent throughout the years. At the same time, learners are using various technological devices to learn via the internet. One of the common ways of online learning is by watching videos from streaming sites such as YouTube. Some educational videos that are available online are presented in a form of instructional or expository animations. With the rise of instructional animations use for learning, it is essential to identify design characteristics of such animations. Hence, this paper focuses on the visual hermeneutic study of design characteristics of instructional and expository animations available on online streaming sites. Animation samples of the study are selected from established educational animation content creators on YouTube using several criterions. Aspects such as design characteristics and visual representations will be analysed and discussed in relation to the Cognitive Theory of Multimedia Learning principles and a characterisation system of expository animation. Based on these analyses, there are commons characteristics and uniquely different approaches to creating successful online instructional and expository animations. By being able to identify and aware of these characteristics, educators and animation designers can improve the quality of visual content and instructional design to cater to their teaching and learning needs.

Key Words
Instructional animation, Expository animation, Visual representations, Design characteristics, Cognitive Theory of Multimedia Learning, Visual hermeneutics

INTRODUCTION

The growth of online learning has provided a positive disruption on the way people learn. There are numerous new technologies that can facilitate learning more effectively and more efficiently. The ways the new generation of learners acquire knowledge are quite different as compared to the ways in the past. These contemporary learners are learning using accessible devices such as tablet PCs and smart phones. In addition, access to the internet is widely available and affordable to the masses. Governments in developed and developing countries are encouraging their citizens to be proactive in acquiring new knowledge as part of their lifelong learning agenda. For example, in Malaysia, there is a push for online learning as an integral component for higher education and lifelong learning in the Ministry of Higher Education's 10 Shifts (*Malaysia Education Blueprint 2015-2025 (Higher Education)*, 2015). Even in Massive Open Online Courses (MOOC) and blended learning teaching and learning methods, instructional and expository videos and animations are incorporated as common supplementary materials for courses in higher education. One of the possible reasons for this is because, according to Hoyek, Collet, Di Rienzo, De Almeida, and Guillot (2014), students perceived computer-based teaching as better than paper-based static material. In addition, it is also found that

the use online video on clinical skill for nurses showed encouraging student assessment results and satisfaction rating (Holland et al., 2013). The usage of online videos will increase as they are becoming more accessible. For example, a study reported that there was 71 percent of American users have watched online streaming videos (Moore, 2011). With the improving search and recommendation algorithm in YouTube, viewers are able to view a list of videos tailored to their current interests (Cramer, 2011). This search and recommendation technology would make finding relevant videos easier and faster for learners. Some educational videos available on online streaming sites such as YouTube come in a form of instructional or expository animations. These animations can be perceived appealing for learning by online learners. Some are creatively designed in various forms such as two-dimensional animation style, three-dimensional animation style and even a hybrid of both. In some cases, several animations are combined together with live-action videos. With a plethora of instructional and expository animations available in video steaming sites, these well-received instructional animations can be analysed to identify their common design characteristics. This paper focuses on the visual content analysis in identifying design characteristics and visual representations of relatively current online instructional animations on online streaming sites. For this study, the scope encompasses online instructional animations available to the public for free on YouTube. This paper will cover a brief literature review of studies focusing on using animation as an instructional medium and comparing two-dimensional style, three-dimensional style, and live-action visual representations. Next, the paper will describe selected samples and extraction method used for analysis. Finally, the paper will discuss findings from the analysis along with suggestions for future studies.

LITERATURE REVIEWS

Animation for Instructional Purposes

Animation can be appealing to a wider range of viewers and learners when it is designed appropriately. Likewise, presenting instructional and educational content via animation can be advantageous. With animation, information can be presented in aural and visual modalities. In addition, dynamic graphical information can be presented in sequence just as the user would see it on his or her computer screen at ease (van der Meij & van der Meij, 2014). Besides that, these videos can be incorporated as an illustration of conceptual knowledge and factual knowledge (Seidel, Blomberg, & Renkl, 2013). Potentially, students learning via instructional videos may experience significant increase in skills, test scores and grades (Kay, 2014). In addition, Hoyek et al. (2014) also supported the idea of learning via animation would be appealing to students and teachers. However, some researchers advised not to generalize that all animations are more effective than static images because the transient nature of animation and the amount of information to be processed may be overwhelming for learning (Ainsworth & Van Labeke, 2004; Hoyek et al., 2014; Tversky, Morrison, & Betrancourt, 2002). In addition, it is suggested that the illusion of comprehension may arise if learners were passive or not engaged in the activity of learning while viewing the animation (Hegarty, Kriz, & Cate, 2003; Hoyek et al., 2014; Lowe, 2003). Therefore, in order to have positive gains in learning by using animation, it is crucial that the design characteristics and visual representations are considered properly.

Comparing Visual Representations: 2D, 3D and Real Imagery

The question of whether to produce in two-dimensional animation style, three-dimensional animation style or live-action may come across in the animation designer's mind. There are several studies that have compared different types of visualizations such as two-dimensional representation, three-dimensional representation and real (actual) presentation. Some of these studies are taken from the fields of education (Croft, Rasiah, Cooper, & Nesbitt, 2014; Smith, McLaughlin, & Brown, 2012). Firstly, Smith et al. (2012) explored computer animation vignettes as a replacement for live-action video scenario of classroom behaviour situation used as an instructional resource in teacher education courses in classroom management strategies. This study aimed to determine if the

embedded behavioural information perceived in live-action video version of classroom management situations was the same as a three-dimensional animation version of the same content. Based on the study, the animation that was created to simulate the video vignettes was just as effective in communicating important elements within the designated context of study. However, the researchers were cautious at claiming that animation is more effective than video. Another recent example comes from a study by Croft et al. (2014). In this study, the researchers compared the use of animation and video for teaching communication skills to pharmacy students. Both animated and live-action videos were compared in a usability trial. Students from both the animation and video groups provided positive feedback on their training session. However, when given the chance to view both formats, both groups preferred the video presentation as opposed to the animation presentation. The researchers suggested that the design or style factor might have influenced the outcome. Thus, it is imperative to note that, as limitations of their study, the researchers were not confident that the animation produced managed to capture the key differentiating design factors that might be seen with a purposely made animation (Croft et al., 2014). All in all, when it comes to deciding which type of visual styles to use for the instructional or expository animation, there is yet a conclusive answer. Nevertheless, this allows for more opportunities to look into this matter even further. For instance, an explorative visual hermeneutics study on design characteristics and visual representations of well-received instructional or expository animations can be conducted.

OBJECTIVE

Based on a meta-analysis study, it was discovered that many studies on instructional animation tend to pay little attention to the design attributes of the animations used in their investigation (Ploetzner & Lowe, 2012). This is imperative because the design of instructional animation ought to support information processing (Brucker, Scheiter, & Gerjets, 2014). The main objective of this paper is to identify common and unique design characteristics and visual representations of instructional and expository animation on YouTube. By being mindful these characteristics, animation designers, educational animation content developers, and educators can be more cognizant in producing animation for learning more satisfying, productive, and meaningful. The scope of this study only covers instructional and expository type of animations available on YouTube. The benefit of referring these videos from YouTube is that they are freely accessible to the public. In this paper, two-dimensional animation style is defined as a form of computer generated animation that lacks the elements of depth of space and form. Meanwhile, three-dimensional animation style is defined as computer generated animation that contains the element of dimensions such as depth of space and form. It is important to note that this three-dimensional term used in this research indicates the depiction of objects in three-dimensional Cartesian space and does not indicate the use of stereo graphic techniques (Smith et al., 2012). Besides that, hybrid animation is defined as a possible combination of two-dimensional animation style, three-dimensional animation style, live-action or even other animation styles such as the stop motion.

METHODOLOGY

The selection process of instructional and expository animation samples for analysis was based on several criterions: (1) the selected samples were produced by established digital content creators in YouTube educational-themed channels; (2) these channels currently have considerably high number of YouTube subscribers; and (3) these YouTube channels have produced many educational videos in various forms of animations such as two-dimensional animation style, three-dimensional animation style or a combination of both and/or live-action video; (4) the selected animation has high viewership and 'likes' count; (5) the animation possesses Creative Commons license; and (6) the production of the animation was self-funded or externally supported by crowd funding or established television content publishers. In addition, the sample of educational animation that was selected to represent each channel was the most popular animation in its own channel, which was ranked by YouTube's sorting algorithm. These criterions were proposed in order to select samples that were of

satisfactory quality (the number of likes and viewership) from the viewers' point of view; were maintaining a consistent production standard; and were highly ranked based on YouTube ranking algorithm. Thus, below were ten selected educational animations (instructional or expository) from ten different YouTube digital content creators' channels for the analysis of this study (links to these samples can be obtained at the reference section of this paper):

1. Ted-Ed (Code: TED)

TED-Ed is an extension of TED Talk that publishes curated educational videos in a form of animation. As seen in the TED-Ed (TED-Ed, 2014) sample, the production teams of TED-Ed educational animations are usually a collaboration of educators and animators. Curious learners are exposed to a wide variety of educational animation in a myriad of entertaining animation styles.

Table 1: Details of TED-Ed animation sample (TED-Ed, 2014).

Channel:	TED-Ed
Total Subscribers:	1,911,648
Video Title:	How playing an instrument benefits your brain - Anita Collins
Publication Date:	July 22, 2014
Total Views:	4,177,400
Total Likes:	28,676
Total Dislikes:	309
Date Accessed:	January 15, 2016

2. BrainCraft (Code: BC)

Supported by PBS Digital Studios and hosted by Vanessa Hill, BrainCraft routinely produces unique and simple stop motion style educational animations. Cut-out animation is a common design style in many of its stop motion animations. A majority of topics explored by BrainCraft are about psychology and neuroscience. This channel also produces experimental stop motion videos combined with live-action videos by using the green screen technology. Occasionally, the show also invites some guest hosts to provide additional discourse and viewpoint on topics discussed.

Table 2: Details of BrainCraft animation sample (BrainCraft, 2014).

Channel:	BrainCraft
Total Subscribers:	199,728
Video Title:	Amazing Effects of Sleep (And Lack of It)
Publication Date:	May 2, 2014
Total Views:	735,449
Total Likes:	3,153
Total Dislikes:	285
Date Accessed:	January 15, 2016

3. Kurz Gesagt – In a Nutshell (Code: KG)

Kurz Gesagt is an animation studio that designs and produces animations that explore the fields of education, science, and commerce. Founded by Philipp Dettmer and Stephan Rether in 2013, the studio produces distinctive and consistent style of animations that are minimalistic and cleverly utilized background music. Interestingly, their main character mascots are animated two-dimensional ducks.

Table 3: Details of Kurz Gesagt animation sample (Kurzgesagt – In a Nutshell, 2015).

Channel:	Kurz Gesagt – In a Nutshell
Total Subscribers:	1,721,967
Video Title:	The European Refugee Crisis and Syria Explained
Publication Date:	September 17, 2015
Total Views:	8,568,908
Total Likes:	117,088
Total Dislikes:	30,884
Date Accessed:	January 15, 2016

4. Extra Credits (Code: EC)

Extra Credits specializes in educating learners who are passionate to work in the gaming industry and who are gaming enthusiasts. Most animated videos produced by Extra Credits explore gaming related topics ranging from gamification, game character design to social issues in games. Similar to BrainCraft, their two-dimensional-style animated sequence of their characters are quite limited but still entertaining and informative.

Table 4: Details of Extra Credits animation sample (Extra Credits, 2015).

Channel:	Extra Credits
Total Subscribers:	637,763
Video Title:	Propaganda Games: Sesame Credit – The True Danger of Gamification
Publication Date:	December 16, 2015
Total Views:	922,053
Total Likes:	26,522
Total Dislikes:	611
Date Accessed:	January 15, 2016

5. CrashCourse (Code: CC)

CrashCourse produces a broad spectrum of topics ranging from Anatomy to World History. The organisation aims to provide educational videos (combining two-dimensional animation style and live-action video) to the public for free. To sustain itself, CrashCourse is currently partly supported through a crowd funding entity.

Table 5: Details of CrashCourse animation sample (CrashCourse, 2012).

Channel:	CrashCourse
Total Subscribers:	3,812,568
Video Title:	The Agricultural Revolution: CrashCourse World History #1
Publication Date:	January 26, 2012
Total Views:	4,624,912
Total Likes:	52,257
Total Dislikes:	845
Date Accessed:	January 15, 2016

6. Life Noggin (Code: LN)

Life Noggin publishes weekly educational animated shorts that cover the fields of science, pop culture, history, and arts. Life Noggin consistently produces new animated content on Mondays and Thursdays. The main character of the educational animation is called Blocko, a simple and plain white coloured two-dimensional character. This channel is a production of Discovery Digital Networks. The channel co-creator, Ian Dockie, along with Patrick Graziosi, wanted to create *"a series that would be the cleanest and simplest way to explain something, the short simple answer to the questions you've always wanted an answer to"* (Brouwer, 2014).

Table 6: Details of Life Noggin animation sample (Life Noggin, 2015).

Channel:	Life Noggin
Total Subscribers:	170,836
Video Title:	What If The Earth Were Twice As Big?
Publication Date:	November 9, 2015
Total Views:	365,605
Total Likes:	7,707
Total Dislikes:	205
Date Accessed:	January 15, 2016

7. Fig.1 by University of California (Code: F1)

In a partnership between University of California and TestTube, a channel called Fig.1 focuses on the latest research findings and shares them in a form of hybrid styled animation shorts. A combination of live-action recordings and interesting animations is used to present their topics, which ranges from health to history to environmental issues. On average, new videos are published monthly. This irregularity may be due to its particular focus on publishing studies from academics of University of California only.

Table 7: Details of Fig.1 sample (Fig. 1 by University of California, 2014).

Channel:	Fig.1 by University of California
Total Subscribers:	15,874
Video Title:	We Are Built To Be Kind
Publication Date:	December 2, 2014
Total Views:	184,437
Total Likes:	2,321
Total Dislikes:	35
Date Accessed:	January 15, 2016

8. The School of Life (Code: SL)

The School of Life produces animated non-scientific related content regarding human life. Although most topics are more not as scientific as other mentioned channels, the questions that are asked by The School of Life are, nonetheless, intriguing. The channel covers topics about the humanity side of life that are crucially relevant in the current societal context such as relationships, arts, literature, work-life balance, philosophy, economics and more. The channel incorporates a variety of animation styles in presenting its content ranging from stop motion animated Lego characters to cut-out animation styles to two-dimensional motion graphics. All in all, the channel aims to help their viewers to understand themselves and their interactions with the world they live in.

Table 8: Details of The School of Life animation sample (The School of Life, 2014).

Channel:	The School of Life
Total Subscribers:	656,999
Video Title:	Why Some Countries Are Poor and Others Rich
Publication Date:	November 24, 2014
Total Views:	982,535
Total Likes:	Undisclosed
Total Dislikes:	Undisclosed
Date Accessed:	January 15, 2016

9. WatchWellCast (Code: WC)

Seemed to be inactive, WatchWellCast or WellCast explored issues of physical, mental and emotional paths to wellness in a form of educational animation. The animations were done in simple and sufficient sketches that can be drawn quickly. This method allowed them to produce more regular and consistent publications weekly. Not only that, the channel provided expository animation on selected topics, it also provided some exercises, similar to journaling, for viewers to apply the information that have been provided to them. The show's narrator, Caitlin, provided an amicable big sister-like tone while guiding viewers in the exercises. She always greeted the viewers as "WellCasters".

Table 9: Details of WatchWellCast animation sample (Watchwellcast, 2013).

Channel:	WatchWellCast
Total Subscribers:	548,038
Video Title:	All About Boys Puberty
Publication Date:	April 11, 2013
Total Views:	3,313,032
Total Likes:	10,983
Total Dislikes:	1,317
Date Accessed:	January 15, 2016

10. 8-Bit Philosophy (Code: 8B)

Under the umbrella of the Wisecrack's channel, 8-bit Philosophy focuses its animation content on the philosophical and humanistic questions. Some of these thought provoking examples are 'What is Real?', 'What Is a Woman?', 'Is Capitalism Bad for You?', 'Does Rationality Give Life Meaning?', and others.

Table 10: Details of 8-Bit Philosophy animation sample (Wisecrack, 2014).

Channel:	Wisecrack (8-Bit Philosophy)
Total Subscribers:	717,028
Video Title:	What is Real? (Plato's Allegory of the Cave)
Publication Date:	April 27, 2014
Total Views:	939,582
Total Likes:	16,950
Total Dislikes:	370
Date Accessed:	January 15, 2016

Moreover, it delivers its content in a form of retro-gaming style from the 1980s and 1990s. In addition, 8-Bit Philosophy also portrays some well-known video game characters such as Mario, Link,

Megaman, and more. Though, these characters are usually incorporated as minor roles and even as props in the animation. Nevertheless, they are able to pique viewers' interests while they are watching the animations. Even the narration simulates the tone of an aristocratic or learned speaker.

Extraction Method

These selected instructional and expository animations were analysed in reference to Cognitive Theory of Multimedia Learning (Mayer, 2009) and a characterisation system of expository animation (Ploetzner & Lowe, 2012). Because the goal of instructional animation is for the learning, it is reasonable to use established related learning theory to analyse the common characteristics of well-received instructional animations. This section will describe briefly about the principles and the characterisation system used for the visual content analysis of this study.

Cognitive Theory of Multimedia Learning

Cognitive Theory of Multimedia Learning (CTML) is an evidence-based multimedia learning principles in which Mayer (2009) based his theory on three assumptions: (1) learners have auditory and visual channels that are independent of each other; (2) these channels have limited capacity; and (3) the process of actively selecting, organizing, and integrating incoming auditory and visual information can garner meaningful learning. Using multimedia for learning can benefit learners with low-prior knowledge of a topic to be learned. Also, it can be suitable to be used to teach complex materials in a faster pace to learners. The theory is comprised of three main categories. They are: (1) managing essential processing (pre-training principles, segmenting and modality principle); (2) minimizing extraneous processing (coherence principle, redundancy principle, signalling principle, temporal contiguity principle, and spatial contiguity principle); and (3) facilitating generative processing (multimedia principle, personalization principle, voice principle and image principle) (Mayer, 2009). Below are the definitions of CTML principles:

1. Coherence Principle: People learn better when extraneous words, pictures, and sounds are excluded rather than included.
2. Signalling Principle: People learn better when cues that highlight the organization of the essential material are added.
3. Redundancy Principle: People learn better from graphics and narration than from graphics, narration, and on-screen text.
4. Spatial Contiguity Principle: People learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.
5. Temporal Contiguity Principle: People learn better when corresponding words and pictures are presented simultaneously rather than successively.
6. Modality Principle: People can comprehend better from animation with narration than from animation with on-screen text.
7. Multimedia Principle: People learn better from words and pictures than from word alone.
8. Personalization Principles: People learn better from multimedia lessons when words are in conversational style rather formal style.
9. Voice Principle: People learn better when the narration in multimedia lessons is spoken in a friendly human voice rather than a machine voice.
10. Image Principle: People do not necessarily learn better from a multimedia lesson when the speaker's image is added to the screen.

For this study, CTML is used as one of the possible tools to for video analysis as it is based on cognitive load empirical studies. It is advisable to use appropriate educational design based on research of optimal cognitive loads when investigating video-based study (Arguel & Jamet, 2009). Apart from referring to the CTML, this study also incorporated the systematic characterisation system of expository animation to explore design characteristics and visual representations of instructional animation samples further.

Systematic Characterisation of Expository Animation

The number of studies focusing on animation to foster learning is increasing in popularity. In a meta-analysis study, Ploetzner and Lowe (2012) proposed a systematic characterisation of expository animations that can be used as a tool in conducting animation research for educational purposes. Their scope of analysis was on animation for instructional purposes. The researchers defined expository animation as "*an explicit explanation of entities, structures, and processes involved in the subject matter to be learned*" (Ploetzner & Lowe, 2012, p. 782). From the study, they analysed and characterized attributes of expository animations into four dimensions: (1) presentation, (2) user control, (3) scaffolding, and (4) configuration. They stated that the 'user control', 'scaffolding' and 'configuration' dimensions are geared towards external supplements to animations. In relation to this study, the authors focused on the presentation dimension as the attribute is comprised of inherent characteristics of the animations and how it presents the subject matter to the learner. Below is a list of selected sub-dimensions that comprises of the presentation dimension:-

1. Representations employed.
    a. Visual representation: iconic, analytic pictures, formal notations**,** and written text.
    b. Auditory representation: sound (non-verbal information), speech (verbalization of an animated subject), and narration (verbalization to describe or explain the animated subject).
2. Abstraction: Animations can utilize iconic presentations (realistic pictures and schematic pictures) or abstract representations (analytic pictures and formal notations).
3. Explanatory focus: Animation explains the behaviour, structure or function of the subject matter.
4. Viewer perspective: Animation may offer single or multiple perspectives.
5. Duration: The length of time of a complete animation.

The following section of this paper will discuss the analysis done based on CTML and the systematic characterisations of expository animation. The analysis is presented in three different tables which include the previously mentioned methods with the addition of the visualization type comparison.

RESULTS & DISCUSSION

The aim of the study is to analyse design characteristics of popular instructional and expository animations found on online video streaming sites such as YouTube. By incorporating the CTML and characterisation system of expository animation as the basis of analysis, several common design characteristics and visualization techniques were found. By referring to Table 11, nine out of ten samples analysed used two-dimensional style animation as their form of visualization. Based on this, many had opted for two-dimensional style option as educational content. None of the animation had incorporated three-dimensional animation style. Only animation samples from CrashCourse, Fig.1 and The School of Life portrayed more than two visualization types (two-dimensional animation and live-action video). These samples presented speakers (real human) who were experts in their field to present their information. Besides that, the BrainCraft sample visualized itself in stop motion style using cut-out animation. These findings also raised up a question on the suitability of visual representation of animated characters within in the instructional and expository animation. Perhaps that creating two-dimensional animation style is less resource-intensive to produce. Also, perhaps that the content does not necessitate three-dimensional presentation styles. Moreover, the perceptual effects of the animated character render styles may or may not appeal to the viewers. In previous perceptual studies, characters rendered in cartoon or stylized renders are considered highly appealing (McDonnell, Breidt, & Bülthoff, 2012; McDonnell, 2012). In addition, McDonnell (2012) stated that viewers might more likely to be more forgiving if there were motion artefacts in character motion rendered in cartoon style as compared to highly realistic appearance. Thus, animation designers could 'get away with' limited animation.

Table 11: Visualization Types.

		TED	CC	KG	BC	EC	LN	F1	SL	WC	8B
Visualization Types	2D Animation	●	●	●		●	●	●	●	●	●
	3D Animation										
	Live-Action		●					●	●		
	Stop Motion				●						

Table 12: Cognitive Theory of Multimedia Learning Content Analysis.

		TED	CC	KG	BC	EC	LN	F1	SL	WC	8B
Cognitive Theory of Multimedia Learning	Coherence	●	●	●	●	●	●	●	●	●	●
	Signalling	●	●	●	●	●	●	●	●	●	●
	Redundancy	●	●	●	●	●	●	●	●	●	●
	Spatial Contiguity	●	●	●	●	●	●	●	●	●	●
	Temporal Contiguity	●	●	●	●	●	●	●	●	●	●
	Modality	●	●	●	●	●	●	●	●	●	●
	Multimedia	●	●	●	●	●	●	●	●	●	●
	Personalization	●	●	●	●	●	●	●	●	●	●
	Voice	●	●	●	●		●	●	●	●	●
	Image		●			●		●			

From the analysis in Table 12, it is evident that all the samples adhered to the principles in the Cognitive Theory of Multimedia Learning. Exceptions were on the Voice and Image principles. The Extra Credits sample employed a digitally modified voice for its main character. Despite using a digitally modified voice, the tone of the speaker in the animation was still amiable. Only the CrashCourse, Extra Credits, and the Fig. 1 samples incorporated photographic images in their videos.

Table 13: Characteristics of Expository Animation Content Analysis.

		TED	CC	KG	BC	EC	LN	F1	SL	WC	8B
Visual Representation	Iconic	●	●	●	●	●	●	●	●	●	●
	Analytic Pictures					●	●		●		
	Formal Notations			●					●		
	Written Text	●	●	●	●	●	●	●	●	●	●
Auditory Representation	Sound	●	●	●	●		●	●	●		●
	Speech		●			●		●			
	Narration	●	●	●	●	●	●	●	●	●	●
Abstraction	Iconic	●	●	●	●	●		●	●	●	
	Abstract	●	●	●	●		●	●	●	●	●
Explanatory Focus	Behaviour	●	●	●	●	●	●	●	●	●	●
	Structure	●	●	●		●	●	●	●		
	Function	●	●	●	●	●	●	●	●	●	
Viewer Perspective	Single	●		●	●	●	●				●
	Multiple		●					●	●	●	
Time	Duration	4:44	11:11	6:16	3:58	7:38	2:44	4:36	8:47	5:00	2:48

By referring to Table 13, all samples utilized iconic visual representations to present their content. On the other hand, Life Noggin, The School of Life and Extra Credits samples also exhibited analytic pictures to present their information. Besides that, only the Kurz Gesagt and The School of Life samples contained formal notations in their visuals. In addition, a majority of the samples use written text as part of their visual presentations in their animation. These texts were either visualized in short or long sentences. Some texts were presented in familiar standard fonts and some are visually stylized. Unlike other samples that mainly used narration to communicate the information, CrashCourse, Fig. 1, and Extra Credits also used speech as their auditory representation. In addition, BrainCraft employed male and female voices to narrate its animation. This was due to the incorporation of a digital character or a real actor in the video. The use of sound as auditory representation was evident in most samples except for Extra Credits, Life Noggin and WatchWellCast. Almost all samples presented their information in iconic and abstract representation of the subject

matter. Almost all samples provided behavioural, structural (except BrainCraft, WatchWellCast and 8-Bit Philosophy samples) and functional (except for 8-Bit Philosophy sample) information of the subject matter in their content. While many samples only utilized a single user perspective throughout their animations, CrashCourse, Fig. 1, The School of Life and WatchWellCast samples applied multiple camera angles in visualizing its content. In regard to the animation length, most animation durations varied in the approximate range of 2 to 11 minutes. To reiterate, these samples used in the content analyses were selected and rated as the most popular video in their respective YouTube channel. Thus, these samples can be considered more successfully made (based on viewers point of view) as they have received high total number of likes and views, making these animations being the most popular animation in their respective channels. These findings showed that the instructional and expository animations under study have demonstrated good applications of the CTML principles. The application of CTML principles in designing of the instructional animation can prove to be useful. It is recommended to appropriately incorporate these principles when designing an instructional animation as they may be able to make the transfer of information more effective. Similarly, instructional animation designers have the liberty to decide how to portray the content of their animation. Options to consider are the type of visual representations, auditory representation, abstraction of information, explanation styles, and the camera angle or perspectives used to present the content. The duration of the instructional information can vary based on the amount of the content needed to be presented. For instructional animation purposes, most animations analysed are not more than 12 minutes long. Many of these samples were presented in two-dimensional animation styles. There could be several reasons to the popular use of the style. It could be that it is cheaper to produce. Having less animated details could also means fewer resources needed to produce the animations. As seen in the BrainCraft and Extra Credits samples, the animation details were quite limited. Nevertheless, they were still effective in explaining the information since they are the most popular videos of within their own channels. Despite that the two-dimensional visual representation style is more prevalent among all the samples studied, it is essential to take into consideration on the perceptual effect of the visual representation may have on viewers. For instance, how a character is rendered can affect how that character's personality is perceived (Zibrek & McDonnell, 2014). It is so because render styles used in representing a character may have an effect on viewing patterns and subjective opinions of the characters (Carter, Mahler, & Hodgins, 2013). Previously, McDonnell et al. (2012) conducted a study investigating the effect of typical render styles used in computer graphics productions on the perception of animated virtual humans. Explicit and implicit psychophysical experiments were conducted to measure perception over several types of render styles. They found out that the digital characters presented in highly realistic and highly abstract styles were deemed attractive in either still or moving actions. Conversely, they also found that digital cartoon characters were considered highly appealing and more pleasant than more realistic looking digital characters. Also, cartoon characters were rated as friendlier than its more realistic counterpart. Thus, they suggested that the use of cartoon style characters may be more suitable for several virtual interactions. Nevertheless, they also cautioned that not all cartoon characters are considered appealing. They posited that it might have been due to the lack of familiarity of the rendering style (McDonnell et al., 2012). Hence, as an example in the past, due to the presumably Uncanny Valley effect, video game developers chose stylized rendering over realistic render of character in order to avoid negative reactions for their target audiences (Thompson, 2004). However, as a whole, studying the characteristics of the whole animation just by using CTML and the characterisation system tables can seem partially cover the whole story. Aside from the visual analysis, the authors also observed some distinctive characteristics and pattern of instructional design from the analysed samples. Other characteristics not proposed by Ploetzner and Lowe (2012)'s characterisation system such as the application of background music, the integration of humour, pacing, and artful use of editing with visual effects were noted during the analyses. Another external factor such as the promotion of such animations also aid in increasing the total number of likes and views for the particular videos. Nevertheless, YouTube does aid in promoting good quality

videos based on the number of likes given by the viewers. Therefore, high quality videos in terms of content will likely have higher chance to be promoted or recommended by YouTube to potential viewers based on its own search and recommendation algorithm.

Limitations and Future Studies

For this explorative study, the content analysis of samples was based solely on the authors' interpretation and analysis. Future work can include additional researchers' interpretation and analysis to cross check on the consistency of the analysis. In addition, more instructional and expository animation samples from various established digital content creators that are available to the public can also be analysed. As for this study, samples are selected based on several criteria which are the number of views and likes given by the YouTube users, and the YouTube's current algorithm that ranks the most popular videos in each of the respective educational video channels. Future studies can improve this sample selection method by testing the effectiveness of each video in imparting the information to learners. Besides that, further study can also be done by conducting an experimental study to evaluate the effectiveness of the animation in imparting information in a form of recall and retention test. As the analysis and review of the animations were focusing on instructional and expository animation, the findings may not be applicable to animations that focus on learning via storytelling. Thus, future studies can also touch on the utilization of animated storytelling for learning as this approach requires a more subtle transfer of information. Additionally, the characterisation system of expository animation proposed by Ploetzner and Lowe (2012) can be enhanced to capture more characteristics of successful instructional animation in video format. Another domain of instructional animations that are not included in this study is on procedural learning. It involves the use of instructional animations for psychomotor learning that has may have potential not only in demonstrative video but also in virtual reality (Lucas & Abdul Rahim, 2015). Thus, a study on design characteristics of instructional animation for psychomotor learning can also be look into. Furthermore, other factors such as target audience's preferences in various animation styles may need further investigation when creating educational animation in order to gain and maintain their attention and interest. This can also include a study on the learning strategies used by learners when learning with instructional animations.

CONCLUSION

Creating animation for educational purpose is not solely a creative process. Instructional animation design is not meant for decorative purposes only; it is designed to foster learning too. A well-thought design consideration from multiple aspects is needed to make the animation suitable for learning. By determining these characteristics of instructional animation, one can improve quality of content and instruction of the animation to be used for teaching and learning aid. In return, meaningful learning can be achieved with the facilitation of effective instructional animation. Instructional animation can also play a role in experiential learning. For instance, instructional animation can be a substitute for delivering content that is not easily available to live-action video. For example, by using an animated simulation, learners can visualize or create a mental model of the information based on the animation. By understanding these design characteristics and visual representations, educators and instructional animation content designers can creatively design visual elements in animation for learning more efficiently and effectively. These findings can also guide educators who are interested to create their own simple animations to be used in their lessons. Online video content creators may find these design characteristics and visual representations useful when designing their video for public viewing. Besides that, education-domain researchers and animation content developers in can use these findings to study applications of animation as an educational medium further.

REFERENCES

Ainsworth, S., & Van Labeke, N. (2004). Multiple forms of dynamic representation. *Learning and Instruction*, *14*(3), 241–255. doi:10.1016/j.learninstruc.2004.06.002

Arguel, A., & Jamet, E. (2009). Using video and static pictures to improve learning of procedural contents. *Computers in Human Behavior*, *25*(2), 354–359. doi:10.1016/j.chb.2008.12.014

BrainCraft. (2014). Amazing effects of sleep (and lack of it) [Video file]. *YouTube*. Retrieved June 30, 2016, from https://www.youtube.com/watch?v=ZPpvS9wDOcA

Brouwer, B. (2014). Discovery, TestTube launch animated educational series "Life Noggin." *Tubefiller*. Retrieved August 13, 2015, from http://www.tubefilter.com/2014/08/27/discovery-testtube-life-noggin/

Brucker, B., Scheiter, K., & Gerjets, P. (2014). Learning with dynamic and static visualizations: Realistic details only benefit learners with high visuospatial abilities. *Computers in Human Behavior*, *36*(2014), 330–339. doi:10.1016/j.chb.2014.03.077

Carter, E. J., Mahler, M., & Hodgins, J. K. (2013). Unpleasantness of animated characters corresponds to increased viewer attention to faces. In *Proceedings of the ACM Symposium on Applied Perception* (pp. 35–40). doi:10.1145/2492494.2502059

Cramer, T. (2011). The makeup chair. *EContent*. Retrieved from http://www.econtentmag.com/Articles/Column/T.0/The-Makeup-Chair-Strategic-Video-at-Work-79114.htm

CrashCourse. (2012). The agricultural revolution: CrashCourse World History #1 [Video file]. *YouTube*. Retrieved June 30, 2016, from https://www.youtube.com/watch?v=Yocja_N5s1I

Croft, H., Rasiah, R., Cooper, J., & Nesbitt, K. (2014). Comparing animation with video for teaching communication skills. In *Proceedings of the 2014 Conference on Interactive Entertainment - IE2014* (pp. 1–10). New York, New York, USA: ACM Press. doi:10.1145/2677758.2677777

Extra Credits. (2015). Propaganda games: Sesame Credit - The true danger of gamification [Video file]. *YouTube*. Retrieved June 30, 2016, from https://www.youtube.com/watch?v=lHcTKWiZ8sI

Fig. 1 by University of California. (2014). We are built to be kind [Video file]. *YouTube*. Retrieved June 30, 2016, from https://www.youtube.com/watch?v=SsWs6bf7tvI

Hegarty, M., Kriz, S., & Cate, C. (2003). The roles of mental animations and external animations in understanding mechanical systems. *Cognition and Instruction*, *21*(4), 325–360. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-1042268287&partnerID=tZOtx3y1

Holland, A., Smith, F., McCrossan, G., Adamson, E., Watt, S., & Penny, K. (2013). Online video in clinical skills education of oral medication administration for undergraduate student nurses: A mixed methods, prospective cohort study. *Nurse Education Today*, *33*(6), 663–670. doi:10.1016/j.nedt.2012.01.006

Hoyek, N., Collet, C., Rienzo, F. Di, Almeida, M. De, & Guillot, A. (2014). Effectiveness of three-dimensional digital animation in teaching human anatomy in an authentic classroom context. *Anatomical Sciences Education*, *1*(1982), 1–8. doi:10.1002/ase.1446

Kay, R. H. (2014). Developing a framework for creating effective instructional video podcasts. *International Journal of Emerging Technologies in Learning*, *9*(1), 22. doi:10.3991/ijet.v9i1.3335

Kurzgesagt – In a Nutshell. (2015). The European refugee crisis and Syria explained [Video file]. *YouTube*. Retrieved June 30, 2016, from https://www.youtube.com/watch?v=RvOnXh3NN9w

Life Noggin. (2015). What if the earth were twice as big? [Video file]. *YouTube*. Retrieved June 30, 2016, from https://www.youtube.com/watch?v=1bVfzBD-40E

Lowe, R. K. (2003). Animation and learning: Selective processing of information in dynamic graphics. *Learning and Instruction*, *13*(2), 157–176. doi:10.1016/S0959-4752(02)00018-X

Lucas, T., & Abdul Rahim, R. (2015). Designing instructional animation for psychomotor learning - A conceptual framework. In *Proceedings of the 7th International Conference on Computer Supported Education* (pp. 313–318). Lisbon: SCITEPRESS. doi:10.5220/0005477303130318

Malaysia Education Blueprint 2015-2025 (Higher Education). (2015). Putrajaya. Retrieved from http://www.moe.gov.my/cms/upload_files/files/3_ Malaysia Education Blueprint 2015-2025 (Higher Education).pdf

Mayer, R. (2009). *Multimedia Learning* (2nd ed.). New York, NY: Cambridge University Press.

McDonnell, R. (2012). Appealing virtual humans. In *Motion in games SE - 10* (Vol. 7660, pp. 102–111). doi:10.1007/978-3-642-34710-8_10

McDonnell, R., Breidt, M., & Bülthoff, H. H. (2012). Render me real? Investigating the effect of render style on the perception of animated virtual humans. *ACM Transactions on Graphics*, *31*(4), 1–11. doi:10.1145/2185520.2185587

Moore, K. (2011). 71% of online adults now use video-sharing sites. *PewResearch*. Retrieved from http://www.pewinternet.org/2011/07/26/71-of-online-adults-now-use-video-sharing-sites/

Ploetzner, R., & Lowe, R. (2012). A systematic characterisation of expository animations. *Computers in Human Behavior*, *28*(3), 781–794. doi:10.1016/j.chb.2011.12.001

Seidel, T., Blomberg, G., & Renkl, A. (2013). Instructional strategies for using video in teacher education. *Teaching and Teacher Education*, *34*, 56–65. doi:10.1016/j.tate.2013.03.004

Smith, D., McLaughlin, T., & Brown, I. (2012). 3-D computer animation vs. live-action video: Differences in viewers' response to instructional vignettes. *Contemporary Issues in Technology and Teacher Education*, *12*, 41–54.

TED-Ed. (2014). How playing an instrument benefits your brain - Anita Collins [Video file]. *YouTube*. Retrieved June 30, 2016, from https://www.youtube.com/watch?v=R0JKCYZ8hng

The School of Life. (2014). Why some countries are poor and others rich [Video file]. *YouTube*. Retrieved June 30, 2016, from https://www.youtube.com/watch?v=9-4V3HR696k

Thompson, C. (2004). The undead zone: Why realistic graphics make human look creepy. *Slate*. Retrieved March 8, 2015, from http://www.slate.com/articles/technology/gaming/2004/06/the_undead_zone.html

Tversky, B., Morrison, J., & Bétrancourt, M. (2002). Animation: Can it facilitate? *International Journal of Human-Computer Studies*, *57*, 247–262. doi:10.1006/ijhc.1017

van der Meij, H., & van der Meij, J. (2014). A comparison of paper-based and video tutorials for software learning. *Computers and Education*, *78*, 150–159. doi:10.1016/j.compedu.2014.06.003

Watchwellcast. (2013). All about boys puberty [Video file]. *YouTube*. Retrieved June 30, 2016, from https://www.youtube.com/watch?v=Yvw7QGytgNQ

Wisecrack. (2014). What is real? (Plato's allegory of the cave) - 8-Bit Philosophy [Video file]. *YouTube*. Retrieved June 30, 2016, from https://www.youtube.com/watch?v=lVDaSgyi3xE

Zibrek, K., & McDonnell, R. (2014). Does render style affect perception of personality in virtual humans? In *SAP '14 Proceedings of the ACM Symposium on Applied Perception* (pp. 111–115). ACM. doi:10.1145/2628257.2628270