Best Practice for Animating APAs: An Analytical Approach to the Existing Structure of Animated Pedagogical Agents (APAs) and their Advancement in Multimedia Learning through the Lens of Character Animation's Twelve Principles.

(This dissertation has been approved for the MA in Digital Arts by the University; it has been awarded a Pass grade from the Faculty of Humanities. First submitted on 6th March 2018)

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Declaration

I declare that this Dissertation is my own unaided work. Proper accreditation has been given to all outside sources.

This report has not been submitted to another university or institution of higher learning. No part of this report has been published in any journals or social media.

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Abstract

A learner's cognition benefits from a well-embodied animated pedagogical agent that engenders a sense of social affinity with the learner within a virtual learning environment, such as e-learning. Herein, the theory of a balanced approach to animating pedagogical agents ties the principles of animation to those of multimedia design. This nascent theory informs the best practice for animating pedagogical agents (APAs). The grounded theory method raises it through an analysis of extant texts within the broad fields of animation and multimedia learning. Based on similar memos from the wide text base, focused codes are inductively derived. The focused codes then taper towards theoretical categories that group similar codes and ultimately inform the deductive reasoning behind the nascent theory of a balanced approach to animating pedagogical agents. Implications for future research, the design and animation of pedagogical agents are discussed.

Content

1. Introduction

People learn more deeply from words and pictures than from either alone. This statement is the basis of the multimedia principle. Across decades that statement has been taken apart and the pieces investigated to fully explore the ramifications of what is implied. Investigations have been conducted on: the types of people; their level of prior knowledge, theory based variations of learning itself, the intended depth; the level of cognition that has been approached through memory/ retention-tests and understanding/ transfer-tests, and lastly words and pictures; variations in spoken/ written words as well as static/ animated pictures.

Since each word in the statement of the multimedia principle has been treated as a variable, a wide research base exists concerning how people can benefit from the combination of words and pictures. Given the expanse of this field, this paper will narrow its focus on one aspect of multimedia principle's so-called pictures; the animated pedagogical agents (APAs). Prior research on APAs can be, tentatively, summarized as one response to the cognitive task of fostering generative learning. (Mayer; Lowe, Schnotz 32, Mayer 43)

Though advancements have been, and continue to be made across the field, including the APA sector; the current research stagnates at proven guidelines that address the APA's presence/ absence in an e-learning environment, their effectiveness when animated with human-like gestures and facial expressions, and the effects that follow (Mayer, 2014, 346). Richard Mayer provides a resonating voice in the field of multimedia learning. As a prolific academic researcher on the subject, he has written and published numerous texts on designing multimedia materials for the ultimate benefit of a learner's cognition. He called for advancing the research further into the effects of APAs human-like gestures and facial expressions, hypothesizing that it would enhance an affinity with the learner and it would help them through the learning process. (2011, 201)

A number of previous studies have addressed this problem, trying to investigate the execution of an APA. These studies range from the broader approach of assessing theory such as Mayer & DaPra's 2012 journal article *An Embodiment Effect in Computer-Based Learning with Animated Pedagogical Agents* to Amy Baylor's 2009 technology-centred article on *Designing Nonverbal Communication for Pedagogical Agents: When Less Is More*. However these studies,

among others, have inadvertently failed to address the animation of an APA through the lens of character animation itself.

This paper argues that if the discourse surrounding APA design and execution continues to overlook the, crucial, input from animation: its practice towards replicating motion; its twelve principles and its potential for audience involvement, then the required multimedia learning advancement towards human-like APA motion will fall short. Ultimately, this oversight will be detrimental to the learner. In response to the above problem, this paper analyses extant texts surrounding multimedia learning and animation through the qualitative method of grounded theory. This method sees a potential theory generated by building upwards from its foundation in extant texts/raw data, towards focused codes/memos, on to theoretical categories lastly developing the theory itself. This method combines both inductive and deductive reasoning (Charmaz 148); beginning as an inductive reasoning approach towards the raw data and takes a deductive reasoning turn towards the development of theoretical categories.

The purpose of this study is to understand the extent to which animation's principles and practices can help foster, as well as improve upon, generative learning through an APA's motion. This understanding would be brought out through the nascent theory that would bridge the two fields. Additionally, a creative piece will accompany this paper, acting as a sample APA animation whose production is informed by the nascent theory.

1.1.Method

This paper approaches the oversight of animation's contribution towards the APA's production through the grounded theory approach. A creative piece, which is informed by the theory generated, accompanies this paper and provides a practical demonstration of the theory's application.

The intent of grounded theory is to systematically build towards a theory from the initial wide base of raw data, with emphasis on comparative analysis of this data. Grounded theory, broadly speaking, involves extensive coding of raw data (in this case; extant texts) towards theoretical categories and the novel theory itself. This process is done non-linearly through steps such as initial coding, focused coding, memo writing and theoretical sampling.

The non-linear analysis began with the initial coding of raw data inductively elevated towards the final product of theoretical categories. Theoretical categories were then deductively organized to inform the nascent theory. The procedure was, to some extent, reflexive and periodically saw the return to raw data/earliest initial codes at various stages. The reflexivity was prompted by the necessity to support emergent ties between and within arguments/memos through extensive evidentiary citations.

The primary reflexive tactic utilized in this paper was the use of theoretical sampling. The tactic was used in the earliest stages of initial coding by bridging similar initial codes to create focused codes. Focused codes herein are titled in italics and listed under the broader grouping of animation and multimedia sections.

Saturated theoretical categories are the intent behind the reflexive theoretical sampling. The back and forth of theoretical sampling eventually gave saturated categories that no longer raised new claims/ properties/ processes.

1.2.Structure of the paper

The structure of the paper has borrowed heavily from the chosen grounded theory method. It's organized as follows: in the following second section, the focused/axial codes elevated from raw data are titled as subsections and memos discussed therein are written as arguments. The memos are broadly divided into two categories (1) memos surrounding the animation of an APA and (2) memos surrounding the APA's capacity within multimedia learning.

The first memo category structure is influenced by the animation pipeline structure of: preproduction – production – postproduction (see Figure 1.1). The second memo category structure is influenced by the cognitive demands of: extraneous – essential – generative processing (see Figure 1.2).

It is within these categories that the base arguments are posed towards understanding the input animation's principles and practice can have on an APA's process. The memos are further refined towards theoretical categories that, generally, group two or more similar memos.

In the third section; the theory is generated through deductively analysing the theoretical categories and the arguments within them. The process of theory generation will see a reflexive approach that could draw backwards as far as initial codes to support the potential theory.

Further supporting the potential theory are the theoretical review and literature framework. Both utilized to sensitize the nascent theory among related extant theories, as well as place this study within the broader scope of extant related texts. The fourth and final section concludes by presenting an overall view of the issues discussed in the paper.

This paper hypothesizes that animation's twelve principles, its practice and potential, has yet to be fully capitalized upon in the area of animated pedagogical agents' production. Given the call for advancement in APA's human-like animation, and its benefit towards the learning experience, the animator's perspective of APA creation is too important to be treated separately or as a secondary consideration.

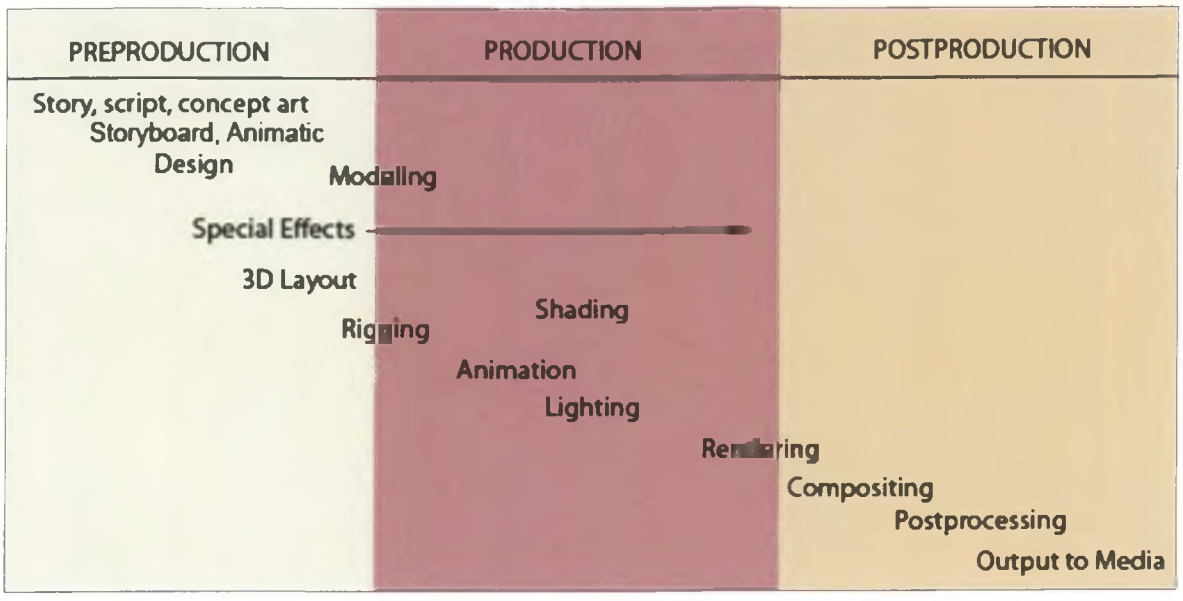

Figure 1.1 Ford, Mellisa. 3D Animation Pre-production. *Mel's Blog: Animation Pre-production and Modeling*, Wordpress, March 2016, www.melissafordsite.wordpress.com/2016/03/06/animation-pre-production-and-3d-modeling/ (Accessed 2nd November 2017)

Name	Description	Caused by	Learning processes	Example
Extraneous processing	Cognitive processing that is not related to the instructional goal	Poor instructional design	None	Focusing on irrelevant pictures
Essential processing	Cognitive processing to represent the essential presented material in working memory	Complexity of the material	Selecting	Memorizing the description of essential processing
Generative processing	Cognitive processing aimed at making sense of the material	Motivation to learn	Organizing and integrating	Explaining generative processing in one's own words

Figure 1.2 Mayer, Richard. "Three demands on cognitive capacity during multimedia learning". *Cognitive Theory of Multimedia Learning. The Cambridge Handbook of Multimedia Learning*, Cambridge University Press, 2014, 59.

1.3.Definition of terms

Animated Pedagogical Agents (APAs) are defined as embodied on-screen characters that communicates with learners by providing feedback, guidance, and encouragement (Mayer 365).

Character animations are herein categorized under orthodox animations. The term orthodox is raised by Paul Well's observation on the dichotomy of animated styles (Wells 36). The orthodox style of animation remains dominant in animation production.

Cognitive load theory is John Sweller's theoretical tie between human cognition and various multimedia instructional issues. Several empirical studies have been conducted on multimedia instruction for the benefit of human cognition based on Sweller's theory, which will be discussed at greater length under the section of theoretical categories. (Sweller 27)

Cognitive theory of multimedia learning is Richard Mayer's advancement from Sweller's theory and raises three broad multimedia design goals intended towards aiding cognition within a multimedia learning environment: reduce extraneous, manage essential and foster generative processes (see Figure 1.2).

2. Memos

2.1. Animation memos

2.1.1. Simplifying as an approach to APA pre-production

The procedure towards character animation often begins with a simple idea or concept. The simplicity of the idea allows it to be clearly communicated through the visual medium of animation. Thomas and Johnston co-author the 1991 book, *Disney Animation: The Illusion of Life*, with a background in animation production from one of the largest animation production companies (Walt Disney Studios), the authors provide insightful guides on how to produce the best animated product; their guides are still as useful as they were in the previous century. They advise a simple beginning to all their animations, "First, there must be a big, simple idea; the story you can tell in two sentences" (368). The term "big, simple idea" may seem paradoxical; however their intent was to portray a clear, expressive and simple idea (23). The core idea of a character's animation is best approached through a simplified manner for the benefit of clarity.

Following the clarified idea/concept phase is the story. An APA's 'story' is better termed as its role. The role an APA plays is integral to the action being conveyed, just as the character's story informs its action in a scene. A story in character animation relies on simplicity given, "We have found that the story for an animated film must be even more direct [than the live-action counterpart]" (Thomas, Johnston 369). The same direct approach is undertaken with the delineated APA roles, which include three broad categories ranked progressively in accordance with level of expertise; learner/companion, presenter/guide and lastly, expert/teacher/instructor/coach (Gulz, Haake, 2006, 323). The predetermined simplification of APA role adds clarity to the intended 'story' being conveyed. The ties between APA role and a simplified story will be discussed further in the section of balance as an overall approach to preproduction.

With a simplified/basic idea and corresponding role in place, the design phase begins. A basic design works best for an APA. The APA design ties to its overall intent to "provide elements of embodiment, visibility and personality". (Gulz, Haake, 2006, 323)

The basic design aids itself to visibility; the basis of this simplified design is the rounded shape - the simple rounded shape of a circle informs the base structure of several character designs from early to present designs, across media ranged from comics to animation. The rounded shape lends itself to fluidity in workflow and acts a discernable base from which several animators can work from. Supporting this is Preston Blair's approach to cartoon head, body and hands construction (2-18) outlined in his 1949 publication *Advanced Animation: Learn How to Draw Animated Cartoons*. The simple rounded shape holds the advantage towards initial design "as several people may work on the same drawing in a cartoon studio, the rounded form is used due to its simplicity—animation is thus easier" (5). Therefore the rounded shape begins the APA's approach towards the intended element of visibility.

The rounded shape simplifies the intended goal of personality in an APA through (to begin with) its physiology. The placement and emphasis of the rounded shape on the overall structure of a character's body defines its physiology, and thereby its personality. Citing previous social physiology studies, Gulz & Haake outline three major body types: ectomorph, mesomorph and endomorph. Each one carries its social stereotypes as, "muscular bodies [the mesomorph] are assigned positive traits, fat bodies [the endomorph] assigned negative traits and thin bodies [the ectomorph] are somewhere in between" (2006, 332). Those stereotypes are a means for society to imbue personality traits to the human figure. Similarly cartoon designs have personality traits assigned to them in accordance with their body type. Preston Blair outlines four key character designs, each with the rounded shape placed and emphasized differently; screwball, goofy, heavy-pugnacious and cute characters (13-16). See Figure 2.1.

However, Blair's designs can be viewed as contrary to the basic design better suited for the APA. Blair's tendency to incorporate extensive details into his character's base simple design is influenced by the role the character is meant to play. Given his background in animating comedic actions/gags, his animated characters often include ancillary props, such as the cigar between the ape's lips or the spiked club in Figure 2.1. Such ancillary props are included to emphasize the character's personality making it appear yet more pugnacious or 'thuggish'. The level of detailing best suited for an APA is discussed further in the following subsection.

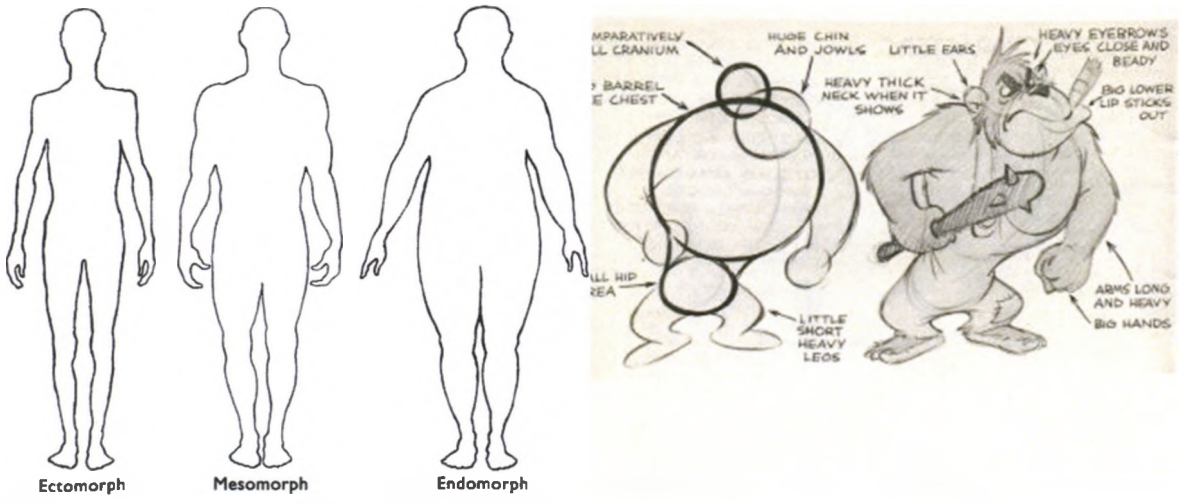

Figure 2.1 (Left) Gulz, Agenta and Haake, Magnus. "The three body stereotypes (somatotypes) defined by Sheldon et al. (1940)". *International Journal of Human-Computer Studies*, vol. 64, PsychInfo, 2006, 333. Compared with (Right) Blair. Preston. "Heavy-pugnacious character", *Advanced Animation*, Walter Foster Publishing, 1949, 15.

The rounded shape further simplifies the intended goal of personality in an APA through iconicity. Comic book scholar, Scott McCloud provides seminal insights on the character's design towards iconicity. While his 1993 book on *Understanding Comics: The Invisible Art* centres in (and around) the production of comics, a static medium, his input in design of character; and the design's influence on the audience perception is applicable, if not fundamental, to several arguments within this paper. He defined iconicity as "amplification through simplification" (30). In which icons "represent a person, place or idea" (27), though for this section focusing on pre-production of an APA, I will focus on the iconicity of a person.

Creating an iconized person (as exemplified through the face), according to McCloud involves the "stripping down of an image to its essential 'meaning'. An artist can amplify that meaning in a way that realistic art can't." (30). Pat Power's neurological analysis supports this amplification of simplified visuals by tying both Ramachandran's concept of isolation[1] and the minimalist art's ideal of 'less is more' towards iconicity. Power's expounds on the cognitive interrelationship between emotion, attention and memory, "Emotion drives attention, and stylized or expressive imagery can isolate and accentuate rhetorically, guiding and focusing

[1] Pat Power cites V.S. Ramachandran's argument on the bottleneck of visual attention from his 2004 book on human consciousness and cognition.

attention by amplifying the signal, and through metonymic and synesthesic connotation and resonance, can act as a multimodal neural hyperstimulus, capable of encapsulating an entity's essence in a blended aesthetic gestalt" (115). Synesthesia will be discussed further in the section on expression as an approach to APA pre-production.

The process of stripping down the face/head to its essential meaning (and thereby conceptualizing it) ties back to the basic rounded shape as McCloud emoted; "The fact that your mind is capable of taking a circle, two dots and a line and turning them into a face is nothing short of incredible!" (31) Beyond the base construction of the head and body physiology, the simplified rounded shape has the capacity to carry a character's personality through the character's face.

The iconized design, lending itself to APA goals of personalization and embodiment, sees the ultimate benefit in audience identification. Iconized designs have a tendency to resonate with a generalized populous, as opposed to the counterpart realistic visuals of a person (such as a photo). Embodiment and personalization are dually achieved through McCloud's "phenomenon of non-visual self-awareness" (37). This phenomenon sees "a constant awareness of his or her own face, but this mind picture is not nearly so vivid; just a sketchy arrangement … a sense of shape … a sense of general placement" (36). This phenomenon is capitalized upon in conceptualized designs for the purposes of audience identification. Ultimately the iconized design allows the learner to "become" the APA, rather than to "just observe" it. (36)

Further benefits of a conceptualized design in an APA would include the learner paying more attention to the learning material, while still benefiting from the embodied presence achieved through simplification. An increase in detail, towards realism, in a design would have the consequence of the learner being "far too aware of the messenger to fully receive the message!" (McCloud 37)

2.1.2. Detailing as an approach to APA pre-production

While extensive detailing would deter the learner from the message/lesson activity, detailing is an inevitable part of the design process; as exemplified through the character's body.

Adding on to the earlier argument of body physiology built from rounded shapes; the rounded shape that informs the body type should be subject to more detail. For an APA, its face is best designed in an iconic style that aids embodiment and personalization. However, the APA's body can be detailed further; as McCloud pointed out, "non-visual self-awareness can, to a lesser degree, still apply to our whole bodies" (37). The lesser degree allows body design to appear more realistic than the face. The rising level of detail from the simplified/iconized design progresses towards the extent of realism. McCloud's ternary plot illustrates this progression from iconic/simplified towards realism for pictorial illustrations of a human face (Figure 2.2).

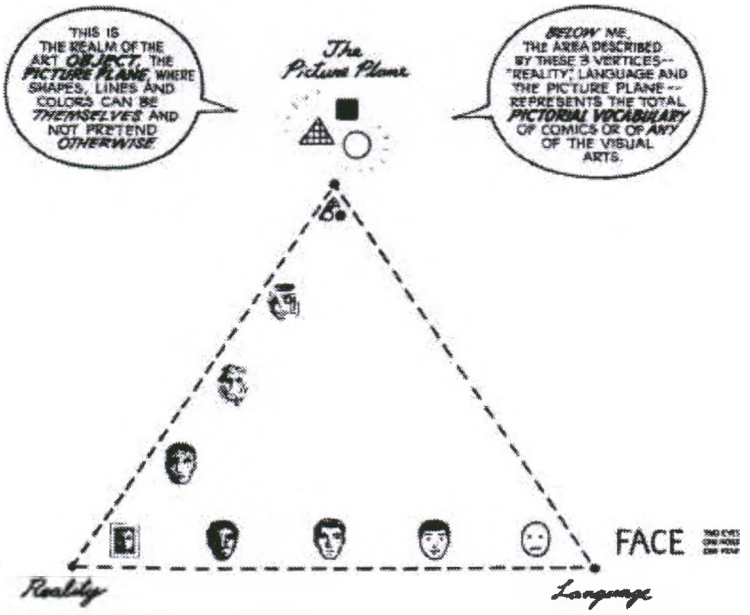

Figure 2.2 McCloud, Scott. "The Picture Plane". *Understanding Comics: The Invisible Art,* Kitchen Sink Press, HarperCollins, 1993, 51.

Supporting the addition of details to the base rounded shape is noted in the penultimate step under Preston Blair's progressive steps in cartoon design, "5. Details are now fitted in or hinged into their position" (1949, 8). The level of detailing prescribed by Blair veers closer towards realism than iconicity, as evidenced by his illustrated formulaic steps towards detailed character types (13-16).

Orthodox character animation has over the years maintained its early preference towards a realistic design. Realism in animation has been approached from various angles, and holds variegated definitions. McCloud tied realism to objectivity, specificity and complexity (46), while Disney maintains their approach to realism was not necessarily verisimilitude, rather a caricatured representation of reality, "When Walt asked for realism, he wanted a caricature of realism" (Thomas, Johnston 67). Gulz and Haake's 2006 article does not define realism directly, rather noting believability as a "central goal in the animated film domain" (331). Supporting the ties between realism and believability is Richard Williams' approach "to make the designs work, the movements have to be believable – which leads back to realism and real actions ..." (34). While Williams' approach to realism was founded on the production of movement in an animation, further support for believability in design is seen in David O'Reilly's paper *Basic Animation Aesthetics*. O'Reilly's paper critiqued the realistic visual tendencies in orthodox animation and posited a counter approach to believability through consistency of style (2). Pat Power's 2009 neurological approach to expressive animations sees his preference for the "somewhat less confusing term" of naturalism (108). Lastly Gulz and Haake's 2009 article propose the simplification of the term 'visually realistic' leads to mixed up distinctions within the field, "[the term] mixes up: ... fantasy or non-fantasy, human-like or non-human-like, detailed or non-detailed ... The tendency to speak of 'visual realism' in a simplified manner easily lead to unwanted over-generalizations" (40).

Detailing an APA's design towards the intended elements of embodiment, visibility and personality is an inevitable part of the design process. Notably a set/standardized level of realism for an APA (or an orthodox animated character) does not exist, as alluded to by the various definitions and approaches towards realism stated above. However, believability is a recurring thread in discussions surrounding the ambiguous realistic visuals. Therefore, detailing an APA's design should be done towards the extent of believability in order to achieve the three design elements; embodiment, visibility and personality.

Tying believability in design to the role an APA plays, is an easier task than tying the ambiguous term of 'realism' to the same. Borrowing from Gulz and Haake's 2006 assessment of APAs, The role played is reliant on its capacity to appear lifelike and capable of socio-emotive ability. This lifelike capacity directly influences the APA's embodiment and the task to promote

interest in the learning activity. Promoting the interest in the learning activity is approached through three broad role categories: "teacher/instructor/coach ... learning companion ... presenter/guide, and a combination of any of the above" (323). Regardless of the particular role, an APA's detailing towards believability will be influenced by the lifelike capacity displayed within its learning activity.

Low-level detailed APAs are best suited to the learner companion roles. Aside from the benefits of: audience identification towards and attention paid to the iconized design, the low-level of detail allows for easier, and more expressive animation which is crucial for a companion APA as, "a variety of emotional expressions for [companion] roles" is required (Gulz, Haake 51). The expressive requirements for APA animation are facilitated by the basic design through the rounded shape/circle base, as several animators will work the same design. Further expressive capacities of the design will be discussed extensively in the upcoming section on animation production.

A higher level of detail is required as the role the APA plays progresses towards instructor/coach or "expert"[2] (Gulz, Haake 51). The instructor APA role is represented as separate from the learner and has to be designed in an according manner. Increased level of detailing may deter the audience away from the message and towards the messenger, though this could be beneficial in the case of an instructor APA. An "older, serious looking, formally dressed" design is suited for the expert/instructor (51). Supporting the separation between audience and a designed character is McCloud's assessment of 'realistically' drawn characters. In which high level of details "objectifies them, emphasizing their otherness from the reader" (44). An instructor APA does not have to identify with the learner as much as the companion does, and therefore would benefit from the 'otherness' a high level of detail can provide.

After the APA character has been designed, the final step in the pre-production process involves designing a layout. One could argue that the layout or background design (providing a backdrop to the character's main action), being a design task in a learning environment tied to the APA, is subject to providing similar elements of embodiment, visibility and personality. However, "no one expects audiences to identify with brick walls or landscapes" (McCloud 42).

[2] Gulz and Haake cite Baylor, Kim 2005 structured breakdown of various pedagogical roles of an APA.

Therefore the layout should be designed towards photo-realism[3]. The combination of an iconic character (or a highly detailed character) with a photo-realistic background "allows readers to mask themselves in a character and safely enter a sensually stimulating world. One set of lines to see. Another set of lines to be" (43). This is known as McCloud's 'Masking Effect'. Neurological studies[4] support McCloud's analysis of iconic and photo-realistic designs; "whereas naturalistic live-action evokes brain responses that characterize recognition and mind-reading, expressive animated footage is more likely to activate areas associated with emotional reward" (Powers 115). With the intent of designing towards recognition, the sensually stimulating layout/background of an APA could be designed towards photo-realism regardless of the role an APA plays within the learning activity.

2.1.3. Expressing as an approach to APA preproduction

The line is innate to the APA's element of visibility. Aside from bounding simple/rounded shapes and providing detail through progressive additions of lines, the line holds expressive capacities. The line of action begins the approach towards expression in an APA's design. Preston Blair describes it as "an imaginary line extending thru [sic] the main action of the figure". According to Blair, "the first thing to draw when constructing a figure is the line of action – then build over that." (7) Accentuating the line of action: strengthens the design and adds a dramatic effect to it, thereby increasing the APA's visibility and personality. The line of action will be tied further to core animation principles of pose to pose and solid drawing in the section on animation production.

Notably the line of action, while influential, is deemed imaginary and therefore does not appear in the final design. Though, the visible lines that bound the shape of the APA add to its personality through line properties such as, direction, shape and character. Given the variety of lines used in several designs, a clear approach can be found in varying the lines along their expressive rendering (McCloud 125). Supporting the expressive capacity of lines from a neurological standpoint is Pat Powers' analysis, in which; the line holds "expressive energy …

[3] A descriptive term of realism seen in Pat Power's arguments, citing Lev Manovich.
[4] Pat Powers reverts to his own 2008 study's empirical evidence based on brain imaging analyses.

evoked by hand movement and vibration through a drawn line" evidenced by empirical studies on the brain's "mirror-neurons' capacity for active stimulation ... helps explain the nature of the expressive human warmth" (116). Through the line, an APA could therefore be personalized and capitalize upon the empathy tied to '*the human touch*'. For the purposes of an APA, a balance must be struck to capitalize on the expressive nature of the line, yet be subtle enough not to deter from the main learning activity. This balance will be reiterated in the section on balance as an approach to APA preproduction.

The line's capacity to represent ideas/concepts allows for expression within an APA. Conceptualizing through lines achieves embodiment in an APA, similar to the conceptualization of the iconic design discussed earlier. When conceptualized, the line carries the capacity to blur the boundary between ideas and reality, "the realm of concept – and the realm of the senses" (McCloud 39). Further, the blurred boundary allows for synaesthetics, which McCloud explained as unification of the [five] senses (123). He illustrates the comparison between drawings of a smoking pipe and an overturned garbage can. In both illustrations wavy lines emit from the pipe and the garbage; the pipe's wavy lines represent smoke – under the sensory and visible realm, while wavy lines of garbage represents its smell – under the conceptual and invisible realm (128). With this ability to cross between conceptual and sensory realms, the line becomes a symbol. Repeated or widespread use of a symbolic line sees it "enter the language [of comics and drawings] for good" (129). Figure 2.3 illustrates various symbolic lines that have entered the language of drawings for the purposes of representing ideas/concepts. This illustration, which also informs my creative practice, draws inspiration from comics and manga.

The symbolic lines purposed towards embodiment are often bound to the face/head of a character. This visual preference towards the face/head likely ties to the capacity of the iconized face for greater expression, in comparison to the less iconized body. Supporting the embodiment preference to the character's face is Thomas and Johnston's claim that the "change of expression" within the face holds the ability to display the thought process of a character (Thomas, Johnston, 125). To this end, Figure 2.3 displays a concise facial animation model sheet; an illustrated guide of a variety of emotive facial expressions a character (both iconized and detailed) would portray in an animation sequence (Blair 19).

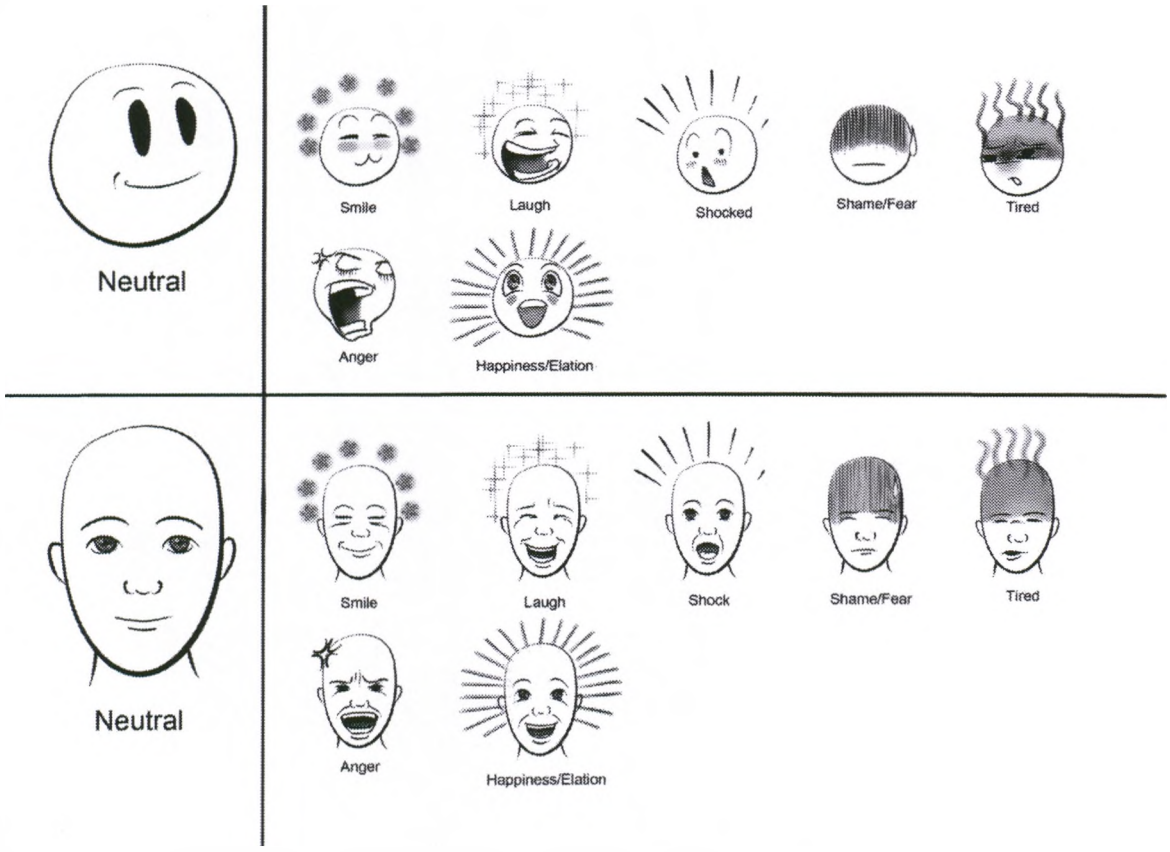

Figure 2.3 Munyao, Isabella. "Symbolic lines with emotive ties in APA designs; embodiment of an APA through lines." *Author's own production*, 2017.

Motion can be expressed through a still image for the purpose of dramatic effect. The attempts to replicating motion in still imagery have produced approaches such as: multiple images, streaking, blurring and subjective motion (McCloud 113). While still images in an animation have the potential to "go dead" in a matter of seconds on screen without any motion, an economic approach to motion can be found in the "limited animation" (Thomas, Johnston 513), which has the capacity for animation 'smears'[5], similar to McCloud's blurring approach. Limited animation will be addressed further in the APA animation production section.

Contrary to the prior argument of creating a layout design towards realism, I posit the alternative of an abstraction to the layout/background through expressive lines. The Masking

[5] Wikipedia source on definition of smear animation tied to blurring frames and a low shutter speed in photography.

Effect provides a set of lines to 'see' and others to 'be' (McCloud 43), though there could be a variation to provide both sets of lines (character and background) to 'be'. In which, the background is similarly iconized towards symbolism and both background and character capitalize on the identification with the audience. Ultimately, varied expressive lines can make the most of audience emotions. In Figure 2.4 below, McCloud illustrates various expressive lines and the corresponding (likely) emotions evoked in the audience. Placing the APA at the foreground of the expressive lines could amplify its expressive potential.

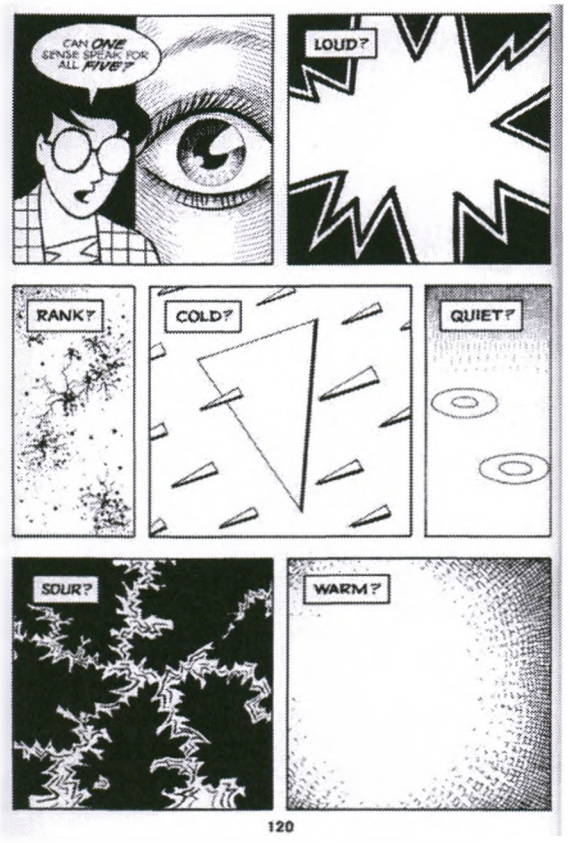

Figure 2.4: McCloud, Scott. "Expressive Lines". *Understanding Comics: The Invisible Art*, Kitchen Sink Press, HarperCollins, 1993, 120.

2.1.4. Expressing through colour in APA preproduction

Similar to the approach of detailing towards an APA's design, colour adds elements of embodiment, visibility and personality. Colour holds as much expressive capacity as the line, as

well as compliments the shape bound by the line. Colour emphasizes shapes "both animate and inanimate" (McCloud 188) and therefore can amplify: the iconized or detailed APA, the conceptualized background as well as the realistic background. Colour in an APA must be approached with caution; its power to emphasize a shape, character or even mood, can distract from the APA's intent to act as auxiliary support for the learning activity. An extreme use of colour is illustrated in Figure 2.5 (left) whereby the anger emotion is amplified; this emphasis through colour can be justified as overwhelming in the case of the APA, and therefore treated as an infraction in a multimedia learning environment.

Figure 2.5 (Left) Munyao, Isabella. "Colour emphasizing emotive capacity in a character: anger is illustrated & emphasized." *Author's own production*, 2017. Compared to (Right) Munyao, Isabella. "Colour emphasizing the "otherness", and separation, in background characters." *Author's own production*, 2017.

Since colour adds yet more detailing to the APA, inevitably, "we become more aware of the physical form of objects than in black and white" (189). Supporting this increased awareness are studies on learner preference on ethnic presentation/perceived race of pedagogical agents.[6] Gulz and Haake's article ties colour to the ethnic preference of learners, all towards the benefit of a "more attractive, more trustworthy and more persuasive" APA (326). Since Gulz and Haake do not explore the issue of race or ethnic preferences in visual representation further (and have

[6] Gulz and Haake cite a study conducted by Lee and Nass (1998) on facial look saw learner preference for animated agents with similar ethnicity

pointed out the lack of empirical studies on the topic), I posit the importance of reconnaissance of the learner/audience/end-user base in future APA productions and empirical studies, in order to tailor the APA's design and its perceived race to better identify with the learner.

2.1.5. Balancing the overall approach to APA preproduction

On the whole, a balance must be struck in the preproduction stage of APA design. This balance is influenced by, but not limited to, the role the APA plays in a learning activity. The initial idea/story, which is best approached in a simplified manner, will impact the variety of roles an APA can play. Therefore, a companion APA would be granted a simplified concept/story to act out, just as an instructor APA would.

APA design is balanced along the role; starting off as iconic/simple and detailed towards photo-realistic as the role advances. This advancement could be broached through both 'inter-balance' and an 'intra-balance'. The inter-balance takes into account the broader considerations of APA roles, while the intra-balance takes into account particular considerations of expressive lines and colours within the individual APA. An example of the intra-balance considerations would be the balance between an iconic design and photo-realistic background, McCloud's Masking Effect, or an iconic design and a symbolic background.

Balance as an approach is further tied to the APA's larger multimedia learning principles of embodiment and personalization through McCloud's seven combinations of words and pictures in comics. He illustrates a balance between words and pictures towards storytelling, "And indeed, words and pictures have great powers to tell stories when creators fully exploit them both" (152). Of the seven combinations, the "interdependent combination" suits the APA's function best. The symbiosis of words and pictures in which both, "go hand in hand to convey an idea that neither could alone" (155) provides a useful guideline for the pre-production tasks of scripting and designing the APA's actions. This symbiosis and balance of pictures and words will be explored further in the section of fostering generative learning under the category of multimedia learning.

It is important to reiterate the possible benefits of reconnaissance on the audience/learner base. Awareness of the end user would influence the APA design elements of embodiment, visibility and personality towards the end goal of maximizing on audience identification and involvement. Audience involvement will be discussed at length under the following section of APA animation production.

2.1.6. Simplifying as an approach to APA production

The APA preproduction design elements of embodiment, visibility and personality extend to its animated production. Specifically, the design element of embodiment has been subject to several empirical studies (Baylor, Kim 2012, Mayer 2005; 2008; 2011; 2014). Embodiment in an APA has been elevated to a principle of multimedia design targeted at enhancing cognition through fostering generative learning (Mayer 2011, 2012, 2014), and calls for the presence of: facial expressions, eye-gaze, hand gestures and human-like movement. Mayer has considered these four as social cues used by an onscreen agent[7] (241).

A simplified approach towards an embodied APA is supported by Disney's early production technique. Thomas and Johnston trace animation's early procedure to simple cartoons, a simplicity that maintained throughout the early years of 1920s to the mid-1940s. "The cartoon drawing had always been a very simple and direct graphic form ... When the cartoon was transferred to film these elements still applied, and nothing was drawn that was not part of the idea. Background, costume, character and expression were all designed for a succinct statement." (23) The background, costume and character have already been assessed for their embodiment capacity through simplification/iconicity in the previous section of pre-production. Herein facial expressions and gestures will be discussed in relation to their ties towards a simplified approach.

Facial expressions, however simple, should be varied in order to achieve human-like movement in an APA. According to empirical studies, facial expressions have been classified broadly under six categories of: happiness, sadness, surprise, fear, anger and disgust[8]. These expressions have been further isolated towards the facial areas of the "eyebrow, chin, cheeks, and other facial muscles [eyes and eyelids]" (Romero-Hall, Watson 362, Blair; 1994, 182). Blair, however, advises animators master the process of portraying a wide variety of facial expressions, "Studying your own grimaces in a mirror is a must, pick a character you know and go through the expressions with him" (1949; 19, 1994; 12), after which he illustrates various facial expressions that would later inform an animator's facial model sheet. Changing an APA's facial expressions adds both appeal and dynamic human-like movement by displaying the character's

[7] Mayer cites previous studies from Cassell, Lester and Rickel & Johnston to support his classification of social cues for an onscreen agent.
[8] Romero-Hall & Watson cite empirical investigations from Ekman & Friesen's 2003 book on facial expressions.

thinking (Thomas, Johnston 125). In order to achieve an embodied APA, a variety of facial expressions that display the character's thought process is necessary.

Human-like motion, including hand gestures, is best simplified for the benefit of the learner. Empirical studies support the learner's preference, and added cognitive benefit, of a gestural APA in a multimedia learning environment; as seen in post-test evaluation of learners' attitudes and transfer test scores from Baylor and Kim's 2008 study on non-verbal communication through deictic gestures and facial expressions (456). Deictic gestures, by their nature, are simplified to the extent of relaying the very information in the learning activity "where the learner must focus attention amongst competing distractions" (451). Mayer and DaPra's 2012 article expounds on the variegation of gestures, outlining four types: deictic, beat, iconic and metaphoric (249), their study focusing on deictic gestures saw learner's attitudinal preference for gestures that "prime a social stance in the learner that leads to deeper cognitive processing during learning and, therefore, more meaningful outcomes" (248).

Facial expressions and human-like motions, or social cues in an APA, are further tied towards the animation principles of staging, and appeal. Both principles call for clarity and simplification. The staging principle covers the three design and animation elements of: embodiment, visibility and personality. Thomas and Johnston define the intent of staging as, "the presentation of any idea so that it is completely and unmistakably clear. An action is staged so it is understood, a personality so it is recognizable, an expression so it can be seen, a mood so that it will affect the audience" (53). The benefits of clearly presented and unmistakable staging include: audience recognition with, and preference for, animations. These benefits extended to Disney's earlier works; which were then limited to mostly gags, "Walt's gags were intrinsically no better than any other studio's, but they were staged better, with more care taken to establish the situation... Animation began to come alive, and when audiences recognized familiar situations they began to identify with the characters' predicaments." (34). Further support for tailored staging in animated productions is evidenced in the 1967 film, *The Jungle Book* whereby the background was staged simply, yet very effectively embodied the jungle scene "the panther sitting on the tree limb with only the luminous mist of the tropical night behind him. In the foreground was a small cluster of leaves and a flower drawn very crisply... It took years of experience to know that this would be best, but, literally, only minutes to paint." (250). A

simplified approach towards staging of facial expressions and human-like motion of an APA would see similar benefits of audience/learner preference and recognition.

Additionally, the principle of appeal can be seen as a beneficial by-product of a simplified approach. According to Thomas and Johnston, the principle of appeal, "meant anything that a person likes to see, a quality of charm, pleasing design, simplicity, communication, and magnetism"; they narrow down from that broad definition by discounting any weak, complicated and hard to read drawings (68). Appeal, once approached through simplification, will add to audience preference. "Spectators enjoy watching something that is appealing to them, whether an expression, a character, a movement, or a whole situation...Only simple and direct attitudes make good drawings, and without good drawings we have little appeal" (69). By creating simple, clear, easily read drawings, appeal can be achieved in APA production, thereby benefiting from audience preference and enjoyment. Simplicity maintains a thread throughout APA social cues of human-like movement and facial expressions, concurrently the corresponding animation principles of staging.

Further support for simplification in embodied human-like movement is through the ubiquitous bouncing ball exercise, which is based on the rounded shape. The animated bouncing ball exercise is common in early animation practice (Blair, 1949, 1994; Thomas, Johnston, 1981 (50); Williams, 2002), in which animators are tasked with recreating the action of an, often, rubber ball bouncing on a flat surface. The bouncing ball tests a variety of animation principles: Blair's "spacing and timing along the path [of the ball's bounce]" (100), as well as Disney's illustration of the "moving circle [representing the ball]" creating an illusion of weight when principles of slow-in and slow-out and squash & stretch were applied (Thomas & Johnston, 51). The rounded shape that would inform an APA's design would then be subject to its corresponding principles for human-like movement and ultimately embodiment. These principles will be discussed further in the following arguments.

Future considerations for simplicity allow for personalization towards colour or emphatic light for the purpose of audience, or learner, involvement (Thomas, Johnston, 532). This amplifies the previous argument towards expressive use of colour in the preproduction phase.

2.1.7. Believability/realism as an approach to APA production

While all twelve animation principles are concerned with creating believable human-like movement (or caricatured realism) eight principles concerned with; the character's distribution of weight, its flexibility, and lastly its timing will be isolated herein. For the purposes of analyzing embodiment towards – weight, flexibility and timing – in an APA, the eight principles of: squash and stretch, anticipation, straight ahead and pose to pose, follow through and overlapping action, ease in and ease out/slow in – slow out, arcs, timing and solid drawing will be assessed.

Believable social cues of facial expressions and human-like movement are heavily reliant on the squash and stretch principle. Squash and stretch informs the motion of most organic shapes, therefore human characters' anatomy. Believable facial expressions involving the eyebrows, cheeks, chin and other muscles must be squashed and stretched, relative to one another, in order to create believable expressions that the audience would recognize and resonate with. The audience similarly relies on the principle to discern the weight and elasticity in a character's motion. Thomas and Johnston discount only "the most rigid shapes, such as chairs and dishes and pans" as exempt from the squash and stretch principle (47). When animating an APA towards believable facial expressions, the interplay of facial muscles was outlined as, "The face, whether chewing, smiling, talking, or just showing a change in expression, is alive with changing shapes in cheeks, the lips, the eyes – The movement from one drawing to the next became the very essence of animation. A smile was no longer a simple line spread across a face, it now defined the lips and their relation to the cheeks" (48). The audience benefits from a more believable action through the illusion of weight as, "The proper use of squash and stretch will strengthen an action, it is essential in creating a feeling of weight in characters" (Blair, 1994, 157). However, the principle must balance between the elasticity of the character's shape and its given volume, in order to avoid distended drawings. Thomas and Johnston advise the animation exercise of the half-filled flour sack, ensuring that "[a shape] will never change volume" (49).

The principle of anticipation must be applied to an APA's social cues, largely for the benefit of the audience. Anticipation ensures the audience is prepared for the succeeding action, thereby allowing them to appreciate the action fully. This appreciation stemmed from the added

naturalism and believability of a character's motion. The principle elevated Disney animations from their earlier gag-based productions to believable productions that resonated with the audience. Thomas and Johnston expound on the audience benefits through the anticipation principle, "They must be prepared for the next movement and expect it before it actually occurs … This anticipation can be as small as a change of expression or as big as the broadest physical action … The anticipatory moves may not show why he is doing something, but there is no question about what he is doing – or what he is going to do next; expecting that, the audience can now enjoy the way it is done" (52). Audience recognition of an anticipated action is based on the fact that, "Few movements occur in real life without some kind of anticipation. It seems to be the natural way for creatures to move" (53).Without the preparatory principle of anticipation, the outcome is a (rather limited) surprise gag, "which only works when the audience is expecting one thing to happen, and suddenly, without warning, something entirely different happens … no action can be anything but a series of meaningless surprises without anticipation" (52). Ultimately, the greatest benefit from the anticipation principle is seen in the audience/ learner enjoyment.

The dual principles of straight ahead action and pose to pose are approaches within animation production, both geared towards believable motion. Animation's goal of caricatured realism can be approached through either a straight forward procedure involving drawing frames consecutively depicting the action, or through initial planned key pose drawings that are later filled in with inbetween drawings. Straight ahead approach has been designated to motions that are spontaneous or "actions that involve rhythms in character movements … they are impossible to pose plan, and may be discovered as you animate straight ahead" (Blair 1994, 134). Whereas pose to pose fits "well-defined actions (such as a walk or run) by first drawing a path of action [an arc] using perspective, then the in-between drawings are planes with spacing charts … The in-betweens can radically change an action – either improving or stunting it" (139).

According to Thomas and Johnston, straight ahead action approach has considerably less planning and preparation in comparison to pose to pose, "Straight ahead … the animator knows the story point of the scene and the business that is to be included, but he has little plan of how it will all be done … Pose to pose, the animator plans his action, figures out which drawings will be needed … relating them to each other in size and action, and gives the scene to his assistant to

draw the inbetweens" (56). The pose to pose approach proves beneficial to the audience as it adds an extra dimension of texture through its planned approach "if the overall pattern contains accents and surprises, contrasts of smooth-flowing actions with short, jerky moves, and unexpected timing, the whole thing becomes a delight to watch. Obviously, this is impossible to attain with Straight Ahead Action." (58) The APA's embodiment would be achieved through either approach, if successfully carried out in conjunction with the other principles, but the pose to pose approach holds the added benefit of audience preference.

Hosting all three animation elements of personality, visibility and embodiment is the combined principle of follow through and overlapping action. Follow through and overlap support the embodiment of a character's human-like motion by taking into consideration how a believable action stops. The personality and visibility of a character is additionally influenced by the implementation of this principle. Animators found over several years of practice that a character's motion would never come to a simultaneous stop. Rather, a believable action ceased in a cumulative manner. Blair suggests its application as, "In a strict sense, any object that "gives" in animation has a certain amount of follow-thru action" (1949; 34, 1994; 156). Blair cements his suggested application of the follow-thru principle by illustrating the dancing hippo; drawing its dance in various stages and highlighting the combined overlap of follow through and squash and stretch principles (158).

Thomas and Johnston further the applications of this principle by dividing its influence to five categories: appendages on a character, the character's body itself, their loose flesh, the manner an action is completed and lastly the moving hold. Firstly, believable human-like movement in appendages requires their timing to follow the path of the main body, "This is easy to see in real life. The movement of each [appendage] must be timed carefully so it will have the correct feeling of weight, and it must continue to follow through in the pattern of action in a believable way, no matter how broadly it [the action] is cartooned" (59). Secondly, the human body itself contracts and expands at varied rates, "As one part arrives at the stopping point, others may still be in movement; an arm or hand may continue its action even after the body is in its pose" (59). Loose flesh on a character, such as body fat and facial cheeks will believably "drag" behind more bony/skeletal parts of the anatomy resulting in a "looseness and a solidity to the figure that is vital to the feeling of life" (60). The personality element of an APA is conveyed

through the follow through category focused on the manner in which an action is completed as the "punch line … often tells us more about the person than the drawings of the movement itself" (61). Lastly, the moving hold category aids visibility in an APA by extending the duration of the end pose. The final drawing in an action is held to, "allow the audience time to absorb the attitude"

The ease in and ease out principle (formerly slow in and slow out) lends itself to the pose to pose approach as the inbetweens are structured and timed closer to the extreme/key poses. While pose to pose aids embodiment through believable human-like motion, ease in and ease out aids visibility of this believable motion. Thomas and Johnston expound on the ease in and out procedure; "By putting the inbetweens close to each extreme and only one fleeting drawing halfway between, the animator achieved a very spirited result", notably, they caution "Too much of this gave a mechanical feel to the action, robbing the scene of the very life that was being sought" (62). Considerate use of this principle would see an APA's key poses amplified towards a more visible result.

The principle of arcs further refutes rigid motion in order to attain believable social cues in a character/APA. The path of action of an organic character would follow the arc, as illustrated throughout the ubiquitous exercise of the bouncing ball as well as illustrations of a run cycle or jump cycle (Blair 1994, 140); thereby the path of any APA would be under the arc's motion. Arcs provided a naturalistic path as "most living creatures will follow a circular path" (Thomas Johnston, 62). Similar to the line of action discussed earlier, arcs were preparatory lines used to inform the character's human-like motion, "Arcs were sketched in, as the key actions were planned, to guide the eventual drawings along this curved path" (63).

The elements of embodiment and personality weigh in considerably on the principle of timing. Timing accounts for the duration in which any action is displayed in a scene. Given the breadth of this principle it has considerable overlap with other principles concerned with believable human-like motion of: squash and stretch, anticipation, follow through and overlap, ease in and ease out, and pose to pose. Blair ties timing to squash and stretch through his assessment of weight-recoil effects. By illustrating the variation between a heavy weight (an elephant), light weight (a deer), and the bouncing ball he states, "The timing of a character action

has a great deal to do with weight – or lack of it" (1994; 155). Additionally, the personality assigned to an APA, dependent on the role it plays, will influence the time it takes to convey any given action, "the personalities that were developing were defined more by their movements than their appearance, and the varying speed of those movements determined whether the character was lethargic, excited, nervous, relaxed. Neither acting nor attitude could be portrayed without paying very close attention to Timing" (Thomas Johnston, 64).

The solid drawing principle largely aids the element of visibility in an APA. This principle cements design elements of visibility and personality, conveying both through key poses and character design. Thomas and Johnston state their intent of this principle through a shape they termed "plastic". This saw a "search for an 'animatable' shape, one that had volume but was still flexible, possessed strength without rigidity, and gave us opportunities for the movement that put over our ideas." (67) By creating the 'plastic' shape to begin with, animators can capitalize on the visibility it affords and, thereby, the personality and embodiment the same shape holds.

Future productions of APAs should adhere towards believable, embodied, motions expressed herein. An accompanying creative practice piece discussed in this paper's final section showcases the influence animation principles have on the APA's production.

2.1.8. Expressing as an approach to APA production

A change of expression in any animated character has been considered as the primary means to display its thinking (see the sub-section of simplifying as an approach to APA production). A combination of embodiment's: facial expressions, eye-gaze, hand gestures and human-like movement, contribute towards the variety of changes in a character's expressions. Blair noted the progression of cartoon characters' thought process based on their "gestures, mannerisms, attitudes of picture, and outbursts … speaks emotions and reveals character. As the art develops, the comic characters begin to 'think' and assume predictable character – most of it hilarious." (150) Illustrated in Figure 2.6 is Mayer's use of static thought bubbles as an alternative means to display an on-screen agent's thought process; given in his example the agent was static rather than animated, "The learner can see into the expert's thinking process. The on-

screen bubble displays her [the expert pedagogical agent] thoughts as she frames her answers" (2011, 358). Regardless of the means of display, the insight a learner has on the APA's thinking is a necessary requirement to achieve its embodiment.

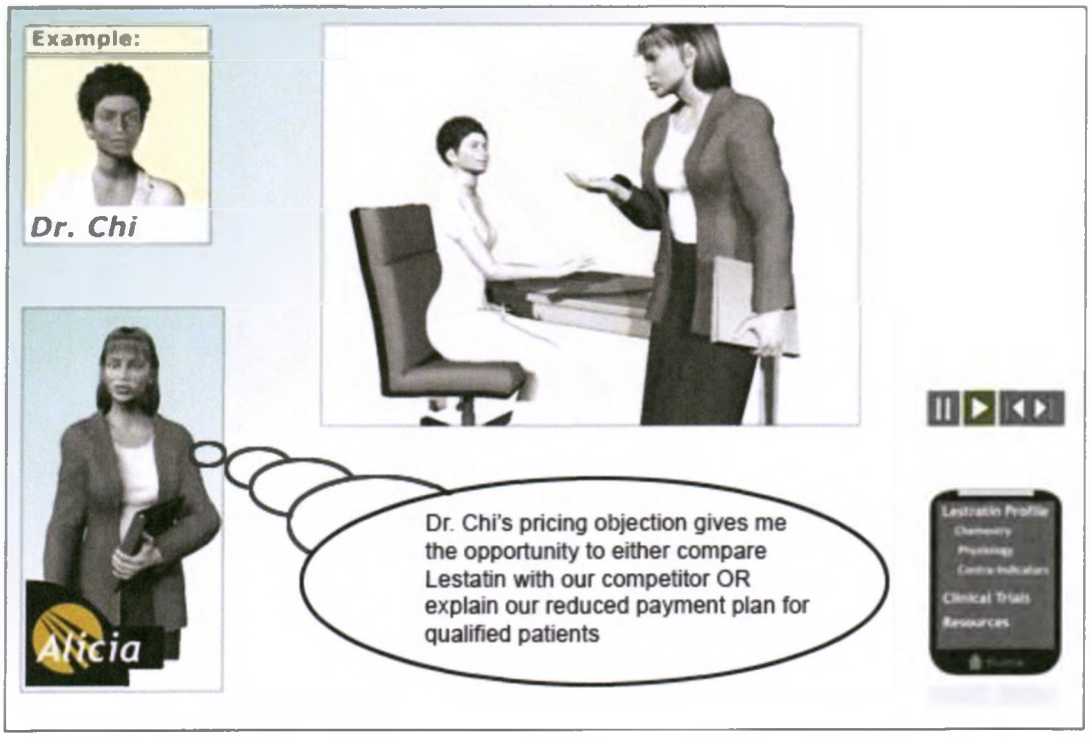

Figure 2.6 Mayer, Richard. "The Thought Bubble Makes Thinking Explicit". *E-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning*, 3rd Ed., Pfieffer Publishing, 2011, 358.

This change of expression can be fortified through the principle of secondary action. The secondary action principle interfaces with the follow through and overlap principle through the latter's category involving; a manner in which an action is completed, thereby adding "extra business" (Thomas Johnston, 64). Secondary action holds the capacity to amplify or emphasize through its support of the main action. Blair mistakenly lumps this principle with the intent of follow through stating, "Delayed secondary actions are effective in putting life into poses and holds, a chain of parts can arrive late at different timed and in different timings to take the curse off any held drawing" (144). However, secondary action, as Thomas and Johnston caution, "is always kept subordinate to the primary action. If it conflicts or becomes more interesting or

dominating in any way, it is either the wrong choice or is staged improperly." (64) For the purposes of embodying an APA, the secondary action principle must always play a subordinate part to the primary action the APA is conveying.

The exaggeration principle is rooted in the caricature of Disney's aim towards caricatured-realism. Exaggeration often saw animators mistakenly creating distorted drawings. Rather, exaggeration calls for an emphasis on embodiment through believable motion or human expressions. Blair advises animators use "exaggerated foreshortening", a cinematography technique that forces perspective in order to emphasize an action (221). Thomas and Johnston point out, "One artist analyzed it correctly when he said 'I don't think he [Walt] meant realism. I think he meant something that was more convincing, that made a bigger contact with people, and he just said 'realism' because 'real' things do". Walt Disney believed "if a character was to be sad, make him sadder; bright, make him brighter; worried, more worried; wild, make him wilder" (65). Caution must be taken with the use of this principle (similar to colour in pre-production), as exaggeration of embodiment in gestures and facial expressions in an APA could easily distract from the learning activity.

Lack of consideration towards the extent of exaggeration in embodied APAs will distract the learner, and thereby detract from the entire learning activity. Exaggeration of colour (see Figure 2.5 (left)) or embodiment elements of facial expressions and human-like movement will draw too much attention towards the APA rather than have it play a supplementary role to the learning activity. Romero-Hall et al. 2014 empirical study assessing the effects of an APA using physiological measures resulted in the learners expressing negative emotions of sadness and fear, largely due to their APA's overt display of a narrow range of expressions, "negative emotions such as sadness, fear, disgust, and/or anger. This ultimately led to their dislike of their APA. This disproportion in the emotions presented could have prevented the participants from experiencing and expressing positive emotions" (378). While I maintain that an APA must have a variety of facial expressions and emotive range, the exaggeration of expressions should be approached mindfully. Rather than overtly expressing negative emotions such as anger, I reiterate the alternative of compositing expressive lines denoting anger in the APA's background while complimenting a subtle facial expression in the APA. This could temper the expression without losing its emotion.

Further tempering the expressions an APA displays, is the influence of its role in the learning activity. The role of an APA has already been tied to its personality (through its design) and the action it undertakes in a learning activity (equivocal to the story). To reiterate, the companion APA would call for more expressive animation in comparison to the counterpart expert/coach APA role.

The expressions of an APA are the heart of its pathos potential. Disney animators eventually developed a tempered approach towards expressions in order to achieve pathos. Their formulaic approach towards pathos insists on the character earnestly displaying emotions both broad and subtle. This earnest display is best approached simply for maximum impact in the audience. Thomas and Johnston dissect the earnest approach taken towards achieving pathos through the dwarfs' characters from the 1937 film *Snow White and the Seven Dwarfs*. At the time animators had grown accustomed to expressing emotions through a change in expressions however, the scene called for a subtle grief in the character. By limiting their dwarf character's motion down to a held drawing, they prolonged the visibility of their grief, and ultimately this resonated with the audience, "These decisions proved right for the sequence, especially the decision to keep the dwarfs in nearly "held" positions. Their subdued attitudes contributed more to the working of the sequence than we realized at the time … The audience cried for the first time during an animated cartoon" (478). The simplicity of maintaining an expressive held drawing had maximum pay-off in achieving pathos with the audience.

2.1.9. Audience involvement as the goal of production

This section will assess the choice of animation as a medium for pedagogical agents in a multimedia learning environment. Audience involvement is the intent of several media forms, including animation and multimedia learning. Most media are tailored with the end user/ audience in mind, animation, however, has the distinct advantage of conveying ideas to a broad audience base. "Conveying a certain feeling is the essence of communication in any art form. The response of the viewer is an emotional one, because art speaks to the heart. This gives animation an almost magical ability to reach inside any audience and communicate with all peoples everywhere, regardless of language barriers." (15)

Thomas and Johnston's comparative analysis between animation and live-action sees their delegation of live-action as a useful source of reference material for the more vital medium of animation. This further supports the animation medium through it capacity for simplicity and clarity given, "The first live-action films we had shot were for reference only ... Soon we were shooting film for specific scenes or special actions, so that the animator would not have to spend too much time searching for relevant material ... then he strengthens those [actions] until they become the dominant action, with everything else either eliminated or subordinated. What appeared on the screen is a simple, strong, direct statement that has clarity and vitality. The spirit and life have been gained by adapting the human form to an artist's own designs, the shapes and forms that he uses in reaching an audience" (323). While live-action plays an important role in the believability of an action, it is often used as reference material towards a clearer, simpler and modified action in animation.

The goal of a pedagogical agent (animated or otherwise) is to develop an affinity with the learner, through the creation of an embodied aid within the learning activity; all with the intent to foster generative learning and enhanced cognition (Mayer 2001; 2011 92; 2014 346). This goal would be best achieved through animations' developed procedures such as the pathos formula and twelve principles aimed at "making the audience feel the emotions of the characters, rather than appreciate them intellectually. We want our viewers not merely to enjoy the situation with a murmured, "Isn't he cu-ute? [sic]" but really to feel something of what the character is feeling ... And that is audience involvement." (Thomas Johnston, 22)

Thomas and Johnston surmise the entirety of the animation procedure below:

> The general appearance of the character can be almost any design that fits the story and the overall style of its presentation, but the specifics of how he is drawn depend entirely on what business he has to do, what attitudes he must show, and what expressions he will have. The voice will suggest many facets of his personality, but the needs of the story and his place in it are major considerations. Once you know what you want him to do, you will know how to construct him so that he can do those things best. His job as an animated character is to communicate story ideas in the most entertaining way, and just being alive is not enough. (222)

The passage above cements several earlier arguments concerning APA roles, design and embodiment through human-like movement. Therefore, the animation medium holds its prevalence in embodying pedagogical agents for the common benefit of audience/learner involvement.

2.1.10. Balance as an approach to APA production

The preproduction section on balance as an approach raised considerations of 'inter-balance' and an 'intra-balance'. The two are raised once more under this section of animation production; as the interrelated twelve principles coexist on a balance of both.

The inter-balance between principles begins with an intra-balance of the principles of straight ahead action or pose to pose. One approach could be chosen over the other, or a combination of both to capitalize on the spontaneity straight ahead offers with the structure and, eventual, audience preference provided by the pose to pose technique. The intra-balance within the approach chosen will influence the manner in which an action is staged in order to convey the chosen action clearly.

The clarity in an action, when staged properly, must follow a believable path of motion, this path is often an arc. The arc not only predetermines the path of action, but additionally informs the key drawings of a solidly drawn character through its line of action. The plastic/ 'animatable' shape sought after in solid drawing is easily malleable for a bulk of principles including: squash and stretch, anticipation, follow through and overlapping action.

The plasticity of the shape is subject to the timing allotted to it in any given action within a scene. The timing, and motion, of the action is further made visible through the ease in and ease out of drawings surrounding the key/ extreme drawing. In tandem with the visibility of key drawings, is the additional extra business through secondary action that adds an element of personalization to the character. The personalized character can then be caricatured further through the principle of exaggeration. Wholly, this would result in an appealing end product that is certain to engage, resonate with and elicit pathos in the audience/learner.

2.1.11. Consistency in style as an approach to APA postproduction

The postproduction phase involves processes including, but not limited to, rendering, compositing and output of the final product (Figure 1.1). Even within the final stage of the animation pipeline there exists an expressive capacity, mostly within the rendering and compositing processes.

Expressive rendering has been subject to Power's analysis through neuroesthetic studies, in which he found expressively rendered visuals lends to emotional engagement (123). Power posits the expressive style of visual rendering as counter to the naturalist norm prevalent in mainstream 3D visuals; the expressive style involves "creating more expressive narrative output from 3D animation environments" whereas the common naturalistic render norms are closer to pictorial verisimilitude (108). The benefit of the expressive style is seen through its "potential for powerful impact, enabling more active and creative interaction by audiences in making their own aesthetic and imaginative connections[9]" (114). His critique of naturalistic render norms highlights its shortcomings; "3D CG is usually indexically dehumanized through absence of such qualities [such as] expressive strokes, fingertips, gouges, or any indexical artifacts of embodied gesture involved in its construction." (117)

While an expressive render style would amplify embodiment of the APA's visuals, I maintain that a consistency in style will determine the final render and composition of an APA's postproduction. The style chosen in the preproduction phase must carry throughout the entire pipeline, "In 3D believability is simply how coherent they [elements] are; how all the elements tie together under a set of rules which govern them consistently" (O'Reilly, 1). Once the elements of: design (character and setting), sound, dialogue, movement are decided upon in the preproduction phase, they must maintain consistency throughout the production in order to attain believability.

[9] Power cites Julie Taymor's 1998 analysis of an artist's approach to reality through transformation.

2.2.Multimedia Memos

As previously mentioned in the introduction, the multimedia principle's stance on combining words and pictures, for the benefit of the learner, has an extensive research base. This extensive research has seen over a dozen, empirically proven, design guidelines; one of which is the embodiment principle, which has informed the focus of this study.

However, the embodiment principle does not hold sole influence over APA design, production and implementation within an e-learning/multimedia environment. Rather, the APA's existence, function and success within an e-learning environment is subject to the guidelines of several other proven principles of multimedia learning; all in an effort to aid the learner's cognition.

The chart illustrated in Figure 2.7 shows the relationship between: the base multimedia principle, the type of instruction, the processes/intended goals within the multimedia principle, all tied to the role of an APA. Further, the role of an APA's influence on: its design, the APA's script in preproduction, the signaling and pre-training principles are charted as well.

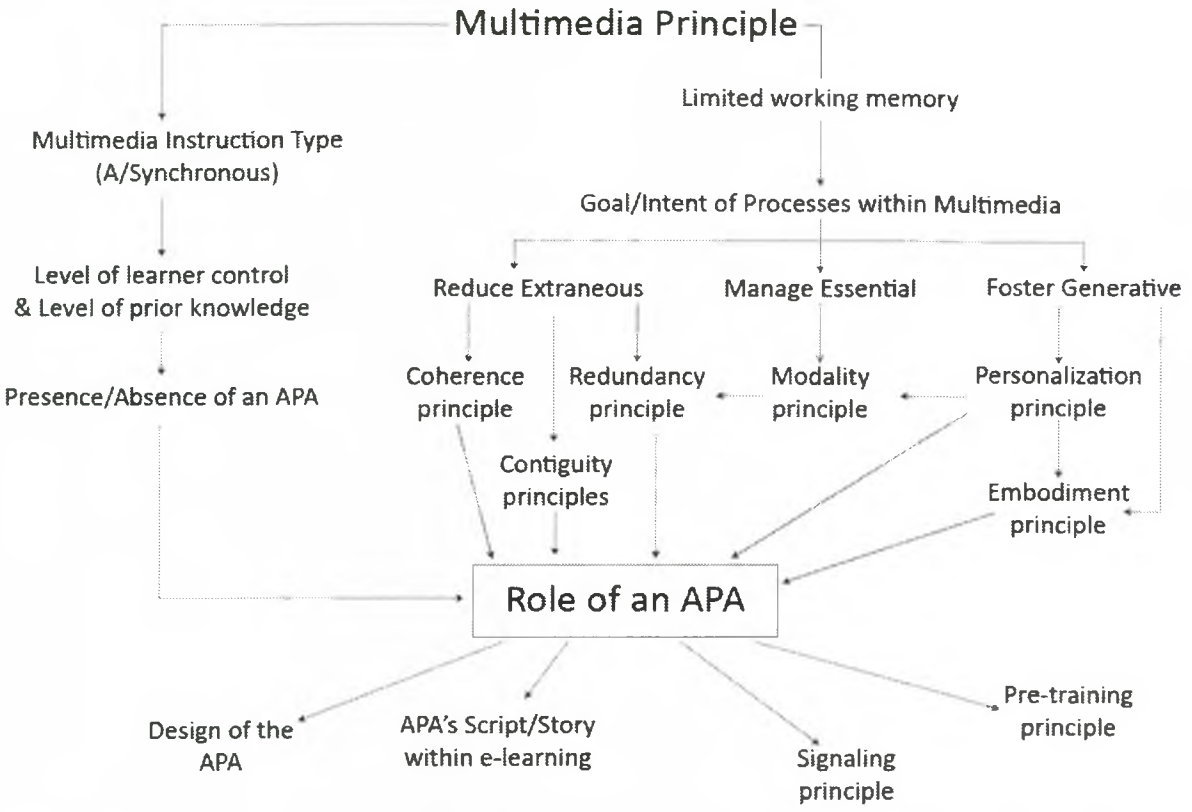

Figure 2.7 Chart centralizing the role of an APA within the broader field of multimedia learning and design

Subsequent arguments within this section will highlight separate sections of the chart above in Figure 2.7. The separated sections will be illustrated in accordance with both Creswell and Charmaz's guides on illustration for research. Creswell's visual model of representing the relationship between quantitative variables, both independent and dependent, sees the "position [of] the dependent variables on the right and the independent variables on the left" (88). Charmaz supports the use of diagrammatical charts within the grounded theory method through cluster mapping. Cluster maps are illustrated during pre-memo writing in order to speed up the writing process and easily visualize connections between codes (86). Therefore, the illustrated flowcharts in this section will borrow from both the chosen grounded theory method of this study as well as certain aspects of Creswell's quantitative illustrations. A blend between qualitative and quantitative illustrations results in a display of the dependency between the role an APA plays and the surrounding multimedia principles.

2.2.1. Form of instruction influencing the role and existence of an APA

The chosen form of instruction influences learning more than the mode of delivery; whether the delivery is computer-based or a more traditional print-based approach. Consequently, the role an APA plays (inside an e-learning environment), with the intent to aid learning, will be influenced by the chosen instruction form. Delivery through e-learning, and its multimedia capabilities, is often viewed superior to more traditional delivery methods such as print or 'chalk-and-talk' – use of blackboards and accompanied with aural presentations. While computers have distinct advantages over traditional methods, the advantages are often situational. Mayer's 2011 edition of *e-Learning and the Science of Instruction* expounds that while, "Computers represent one of the most flexible media options … Overwhelming evidence has shown that learning in an online environment can be as effective as that in traditional classrooms. Second, students' learning in the online environment is affected by the quality of online instruction." (13) The situational advantage accorded to e-learning highlighted therein is the quality of instruction. Additionally, the other advantage held is through e-learning's flexibility in conducting distance learning courses[10]. Given the similarity between modes of delivery (with the quality of instruction being constant), considerations must be made towards not just the role of an APA, but also to its broader existence in a learning environment.

Mayer outlined two forms of multimedia instruction; one designed for self-study – asynchronous and synchronous instructor-led learning (7). Both forms of instruction are subject to the proven principles of multimedia design within the parent multimedia principle. The forms of instruction then influence the role and existence of an APA within an e-learning environment. Figure 2.7 illustrates the relationship between the multimedia principle, instruction forms, and the APA's role/existence, valance signs (-/+) have been included to indicate negative/positive ties.

[10] Mayer cites Bernard et al. 2004 study comparing electronic distance education and traditional classroom instruction.

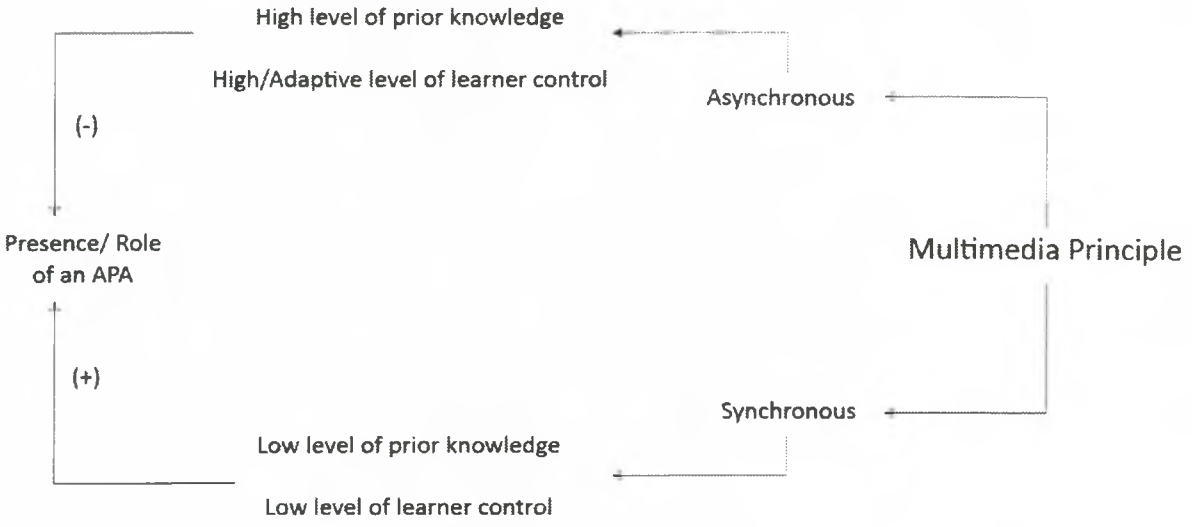

Figure 2.8 Ties between the multimedia principle, instruction forms and the APA's role/existence

Both forms of instruction share the intent of tailoring a learner-centred approach to learning with technology. Both asynchronous and synchronous forms take into account the learners' needs and capabilities then tailor the multimedia lesson to fit. Mayer surmises, "The focus is on how people learn and technology is adapted to the learner in order to assist the learning process ... it has shown to be more effective in promoting productive learning" (32). Three main considerations are raised in an effort towards the learner-centred approach, "the instructional goal of your training, the prior knowledge of your learners and the environment in which you will develop and deploy your training" (23). Studies noted prior knowledge as particularly influential, "While various individual differences such as learning styles have received the attention of the training community, research has shown that the learner's prior knowledge of the course content exerts the most influence on learning" (24). While several differences exist between the two forms of instruction, their similarities include the learner-centred approach, and the crucial awareness of the learner's level of prior knowledge.

Due to a higher level of prior knowledge in asynchronous instructions, they are less likely to include an APA in their environment, illustrated by the negative valence sign in Figure 2.8. Self-study/asynchronous instructions are given to learners with high-level prior knowledge; the same high-level learner is less likely to require the presence of an APA, and the subsequent social presence provided by the APA. The influential high-level of prior knowledge informs an

important boundary condition within several multimedia design principles, embodiment among them. Mayer's excerpt on research based principles from Lowe and Schnotz's 2008 book *Learning with Animation: Research Implications for Design* states, "Concerning boundary conditions, the effects may be strongest for learners with low rather than high working memory capacity … Additionally, the embodiment principle may not apply when there are negative social cues such as machine voice." (39) The boundary condition of machine voice will be assessed further in the section concerning fostering generative learning, though it must be noted that the high-level prior knowledge outweighs the machine voice condition.

Notably, learner control should be granted to both low and high-level prior knowledge learners in their corresponding synchronous and asynchronous instruction types. Learner control includes, but not limited to, "navigational features such as menus, site maps, and links that allow learners to select the topics and instructional elements they prefer" (Mayer 2011, 309). Mayer emphatically supports the inclusion of learner control stating, "Learners like learner control! To the extent that student appeal is a major goal of your instructional project, learner control is a definite satisfier" (315). Thereby, with the intent of generating an appealing end product of multimedia learning, certain amounts of learner control must be granted.

To counter the absence of an APA, high-level prior knowledge learners are afforded a greater level of control within the asynchronous multimedia learning environment. Asynchronous instruction types are more likely to include one of, or all three types, of instructional/learner control: "content sequencing [in which] learners can control the order of the lessons, topics and screens, pacing – learners can control the time spent on each page, and access to learning support – learners can control instructional components such as examples or practice exercises" (312). While all learners appreciate control of, and within, the instruction, the control afforded to the must be balanced for the benefit of their learning. This raises a couple of principles geared towards learner control: adaptive control, and giving experienced learners more control. Adaptive control (alias personalized instruction/user modeling) balances between program control and learner control by dynamically adjusting the lesson's difficulty and level of support based on the program's evaluation of learner responses (324). Therefore, the multimedia program intuitively adjusts the amount of control the learner has depending on the feedback it receives from the learner's progress through its learning activities. Mayer gives a simple example

of a learner progressing successfully through six exercise questions and is then branched off to a more difficult lesson topic (323). Reinforcing the argument of granting high-level prior knowledge learners more control is the second control principle; giving experienced learners more control (319).

Drawing back to Mayer's learner control example of a learner successfully, and consecutively, completing six questions and automatically routed to a more difficult learning activity; there is less use for an APA intended towards guiding, aiding or instructing such a learner. That high-level prior knowledge learner is more likely to benefit from controlling the amount of time spent in an instructional module (pacing), freedom of choice on what topics to learn (content sequencing) as well as accessing help at their own discretion (learning and navigational support).

Conversely, low-level prior knowledge learners (learning from the synchronous instructional format) are a target audience for the majority of multimedia learning and design guidelines, among them the embodiment principle: an embodied APA's concurrent presence, and its role within a multimedia instruction. This has been indicated by the positive valence sign in Figure 2.8. Reiterating the definition of synchronous instruction forms as those with instructor-led learning, the APA could be embodied towards the role of an instructor. Similarly, the synchronous instruction could host the various roles of an APA as: an instructor/teacher, learning companion, presenter/guide or all of the above three roles. Mayer concurs stating, "The multimedia principle works best for novices ... There is evidence that our recommendation to use words and graphics is particularly important for learners who have low knowledge of the domain (whom we can call novices) rather than learners who have high knowledge of the domain (whom we can call experts)" (83). Given an understanding of the target audience as those with low prior knowledge, it is advisable to limit the amount of control granted to the learner and instead provide an instructional aide through an embodied APA.

The role an APA plays is influenced by one of the three main considerations towards a learner-centred approach previously mentioned: the instructional goal of your training. The categories of instructional goals within a multimedia instruction have been broadly outlined as either to perform or inform. Programs designed towards informing have been defined as,

"lessons that communicate information", while those deigned towards performing are, "lessons that build procedural skills (to promote near transfer) [or] lessons that build strategic skills (to promote far transfer)" (Mayer 20). Each of the multimedia instructional goals offers a prescribed level of interactivity, and each level of interactivity corresponds with a theoretically proven view of learning. The instructional goal to inform offers a low level of interactivity that conforms to the information acquisition view of learning; whereby the instructor dispenses information. The instructional goal to perform towards building procedural skills offers a medium level of interactivity that conforms to the response strengthening view of learning; whereby the instructor acts as a dispenser of rewards and punishments. Lastly, the instructional goal to perform towards building strategic skills offers a high level of interactivity that conforms to the knowledge construction view of learning; whereby the instructor acts as a cognitive guide. (Mayer 22, 34) The role an APA plays should comply with the pre-existing theoretically-based view of learning tied to the chosen multimedia instructional goal; such that an instructor APA is better suited towards inform goals of dispensing information. Conversely a learning companion APA is better suited towards the multimedia instructional goal of performing tasks that build strategic skills; therein the highly interactive APA acts as a cognitive guide conforming to the knowledge construction view of learning.

The ties between an APA's role and the broader instructional goals within multimedia learning are tabulated in Table 2.1 below.

Multimedia Instructional Goal	Level of Interactivity	Theoretical View	APA Role
Inform	Low	Information acquisition	Instructor/Teacher/Coach
Perform (near-transfer)	Medium	Response strengthening	Instructor/Teacher/Coach/Guide
Perform (far-transfer)	High	Knowledge construction	Learning companion/Presenter

Table 2.1 Instructional goals of multimedia learning and the corresponding role of an APA

The previous section of this paper, concerned with animation memos, cements the role of an APA within animation design and production. This subsection, focused on the form of multimedia instruction, has found the role an APA plays to be influenced by the larger educational and instructional goals. As Clark and Choi concur, "... it seems important to focus an agent on learning goals and provide both the simplest, least distracting and most conceptually relevant support for the achievement of learning objectives" (319).

It is important to caution multimedia designers on the pre-existing pitfall to overlooking the main consideration of a learner's level of prior knowledge. By doing so, this would result in expertise reversal effect in which, "design principles that are effective for novice learners may not be effective or even hinder learning for more knowledgeable learners" (Kalyuga 576).

2.2.2. Limitations of working memory influencing multimedia's design

The previous subsection saw the APA's role tied to two broad multimedia instruction forms of either asynchronous or synchronous. This subsection will tie the former to:

- Working memory as a central consideration of instructional delivery modes, both traditional and multimedia. See Figure 2.9.
- Multimedia's design goals of: reducing extraneous processing, managing essential processing and fostering generative learning.

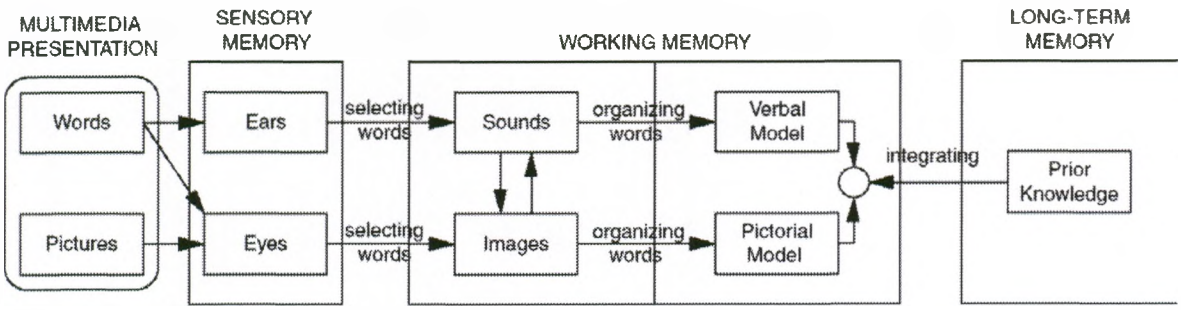

Figure 2.9 Mayer, Richard. "Cognitive model of multimedia learning". *Cognitive Theory of Multimedia Learning, The Cambridge Handbook of Multimedia Learning*, Cambridge University Press, 2014, 52.

Working memory is a central consideration of learning, regardless of whether the delivery mode is traditional or through e-learning. So much so, Mayer includes working memory under one of the three assumptions for his cognitive theory of multimedia learning; limited capacity (2014, 47), while Sweller's cognitive load theory addresses working memory through: information a learner holds and what they simultaneously process (2014, 37). These two theories will be addressed further under the theoretical review. The learner's working memory holds the retention capacity with which to acquire information or to perform tasks. However, this capacity to retain is limited and several proven guidelines of multimedia design have been tailored, primarily, to cater to the limitations of working memory. Mayer surmises the influence of working memory considerations in his 2011 book,

> Therefore, instructional methods that overload working memory make learning more difficult. The burden imposed on working memory in the form of information that must be processed is referred to as *cognitive load.* Methods that reduce cognitive load foster learning by freeing working memory capacity for learning. In the past ten years we've learned a lot about ways to reduce cognitive load in instructional materials. Many of the guidelines we present from Chapter 5 through 11 are effective because they reduce or manage load. For example, the coherence principle described in Chapter 8 states that better learning results when e-lessons minimize irrelevant or complex visuals, omit background music and environmental sounds, and use succinct text. In other words, less is more. This is because a minimalist approach that avoids overloading working memory allows greater capacity to be devoted to rehearsal processes leading to learning. (41)

Mayer additionally cautions that failing to consider the learners' limited working memory capacity would result in "the limited capacity becoming filled, processing becomes inefficient. Learning slows and frustration grows" (41). Conversely, the learner benefits from the above considerations towards working memory, "The psychological advantage of integrating text and graphics results from a reduced need to search for which parts of a graphic correspond to which words, thereby allowing the user to devote limited cognitive resources to understanding the materials" (92).

With an understanding of the limitations of the learner's working memory, the multimedia lesson is then designed with three design intentions/goals: to reduce extraneous processing; to manage essential processing; and to foster generative processing. To rephrase what has been cited above from Mayer's excerpt – reducing cognitive load sees a cumulative effort of the reduction and management of the learning material that ultimately fosters better learning. The three multimedia design goals will be tied to the role an APA plays within the e-learning environment. These ties will be bridged by select design principles within each of the three design goals, see Figure 2.10 below.

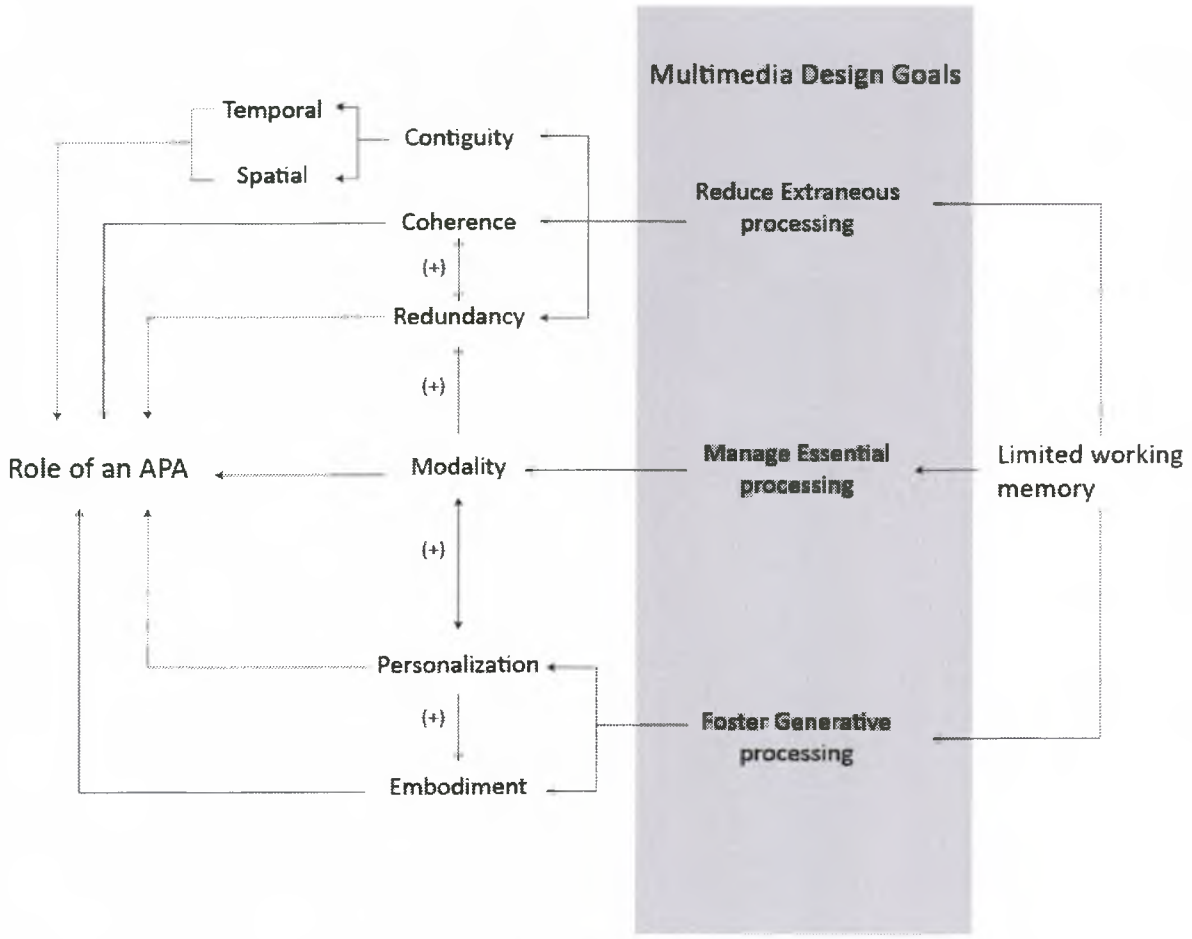

Figure 2.10 Ties between the multimedia principle, design goals, their subsequent design principles and the APA's role.

2.2.3. Reducing extraneous processing for the benefit of the APA

Prior studies on the APA have considered it as a separate visual entity from other on-screen visuals, assessing it with the sole intent towards fostering generative learning through enhancing embodied social cues. However, the subsequent arguments will posit an advancement by considering the APA as standard visual (albeit a series of static visuals as animations, and film, are based on), and assess it in accordance with multimedia design principles concerned with reducing extraneous processing and managing essential processing for the benefit of fostering the learner's cognition. Supporting this stance is the description of the APA used in this study as, "an on-screen character that communicates with learners by providing feedback, guidance, and encouragement" (Mayer 365). By treating the APA as similar to any other on-screen visual and thereby assessing its gestalt in a multimedia environment, the advancement towards a better informed design would emerge.

Extraneous processes are those that involve the learner dedicating already limited working memory towards extraneous material that, inevitably, deters from the essential material within a multimedia learning task. Mayer and Fiorella concur with this definition stating, "Extraneous overload occurs when extraneous cognitive processing (required to process extraneous material or to overcome confusing layout in a multimedia message) exceeds the learner's cognitive capacity [whereby] extraneous material refers to words and pictures that are not relevant to achieving the instructional objective" (280).

Among the principles raised towards reducing extraneous processing, the principles of spatial and temporal contiguity will be addressed first along with their ties to the role an APA plays. Following that are discussions on the coherence and redundancy principles.

Temporal contiguity guides multimedia designers towards synchronizing audio narrations with their corresponding dynamic visuals. The APA would adhere to this principle and present any accompanying audio narration simultaneously rather than successively. Regardless of the role an APA plays, any accompanying narration would have to be synchronized with the character's animation. Mayer and Fiorella put forward the temporal contiguity principle as a solution towards a particular extraneous overload scenario, "For example, an animation is presented before or after a corresponding narration ... [the solution is to] Present corresponding

narration and animation at the same time to minimize the need to hold representations in working memory." (2014, 282) Supporting the simultaneous presentation of animation and narration is Blair's illustrations on dialogue for character animations. He proposes the animator conduct a self-study to best recreate an animated character's dialogue; this self-study would undoubtedly have simultaneous visuals and audio. "Study yourself in a mirror as you speak the words you are animating – pronounce the words very distinctly and the correct positions [of the mouth shape] will be apparent" (36). In order for the APA to achieve believable human-like motion, in the case of dialogue, and additionally reduce extraneous overload, its animation must be synchronized with its audio narration.

The spatial continuity principle advises the placement of visuals closer to corresponding text rather than further apart. Mayer's rationalized that, "it reduces the effort required to scan back and forth between the text and the graphic" (283). Therefore the APA must be placed close to its corresponding text in order to alleviate the extraneous load on the learner. Additionally, the animation principle of staging, which calls for simplicity and clarity while presenting an idea, would further support the designed placement of an APA closer to its corresponding text. However, Mayer proposed an alternative segmented means of approaching spatial continuity which allowed the learner an amount of control within the e-learning environment, "A better solution is to present the text for reading and instruct the learner to press a play button to view the animation after reading. The text remains on the screen for review as desired while the learner watches the animation." (101). While the segmented alternative may seem contrary to the spatial continuity principle, the intent above was to afford more control to the learner. The segmented animation (while controlled at the learner's discretion) must still be placed close to its corresponding text.

The coherence principle exerts an amount of influence on the surrounding multimedia design principles, as illustrated by the positive valence signs between: it; redundancy; modality; personalization; and embodiment principles (see Figure 2.10). This principle guides designers against the inclusion of extraneous materials that will distract and deter from the essential material within a multimedia learning environment. Part of the principle's influence can be traced back to the capacity of both visuals (static and dynamic) and text (written or audio narration) being extraneous materials, by being either irrelevant or excessive. Fiorella outlines an

extraneous overload scenario in which "one or both channels [audio and visual] are overloaded by essential processing and extraneous processing (attributed to extraneous material). For example, a multimedia lesson contains extraneous words and/or pictures." The solution towards this scenario would be through application of the coherence principle; "Eliminate extraneous material to reduce processing of extraneous material. For example, exclude interesting but irrelevant statements or graphics." (282) To better define extraneous graphics, Mayer's 2011 book highlights five graphical representations that have been organised in accordance with their level of extraneous material, "we recommend that you:

- minimize graphics that decorate the page without enhancing the message of the lesson (*decorative graphics*) or simply represent a single object, such as a photo with a [corresponding] caption (*representational graphics*),
- and that you incorporate graphics that help the learner understand by either depicting changes in an object over time (*transformational graphics*) or by illustrating invisible relationships through animation (*interpretive graphics*)
- or incorporate graphics that help the learner organize the material by depicting the relations among elements (*organizational graphics*)" (Mayer, 2011 72).

The APA would be suitably categorized under either interpretive or transformational graphics. The role that the APA plays would be influenced by its categorization as either transformational or interpretive, given that each graphic type has a predetermined approach to aiding cognition. Mayer exemplifies a learning content type[11] in which the process task involves the description of how something works, and posits the useful graphic types therein as either transformational, interpretive or organizational (75).

Failing to comply with the coherence principle (particularly with extraneous visuals) would certainly result in an increase in the learner's extraneous overload thereby, "the information learners extract tends to be perceptually salient rather than what is task relevant" (Lowe 72). Further, decorative visuals in and around and APA's design are "unlikely to improve learning" (Mayer 159). This supports earlier arguments on a simplified approach to the APA's

[11] Mayer adapts five content types in learning derived from Clark's 2008 analysis, ties them to varied levels of extraneous graphics.

design, which supported simplified/ionised/ less detailed visuals. It is more likely that decorative visuals, and other extraneous types, will "interfere through:

- Distraction – by guiding the learner's limited attention away from the relevant material and toward the irrelevant material.
- Disruption – by preventing the learner from building appropriate links among pieces of relevant material because pieces of irrelevant material are in the way.
- Seduction – by priming inappropriate existing knowledge (suggested by the added pictures), which is then used to organize the incoming content" (161).

To counter these pitfalls, Mayer proposes using simpler visuals, "especially when understanding of a process or principles is the goal [which would use either transformational/ interpretive graphic types]. By "simple" we mean visuals with fewer details presented at one time" (164). Once APA designers comply with the coherence principle they would invariably adhere to the simplified/iconized approach discussed under this paper's section of APA preproduction.

Given the breadth of this principle, adhering to it will improve the graphical design of the APA for the benefit of the learner's limited working memory. And would positively affect surrounding principles concerned with audio and text such as redundancy, modality and personalization. These ties towards audio and text will be discussed further in the following arguments.

The redundancy principle guides designers against use of both text and corresponding audio within the same learning activity. The positive valence sign between coherence and redundancy principles in Figure 2.10 is accompanied by a two-headed arrow, which, according to Creswell's quantitative diagrammatic guidelines, indicates "unanalysed relationships between variables" (89). Aside from both principles being concerned with reducing extraneous processing, explicit ties between the principles have yet to be made. To which, I posit the symbiosis between the coherence principle that would guide the reduction of extraneous material; which the redundancy principle has classified as the presence of all three types of materials: graphics, narration and on-screen text. "Redundancy occurs when the same information is presented concurrently in multiple forms or is unnecessarily elaborated" (Kalyuga 247). Mayer adds on his preferred combination of "graphics and narration rather than all three"

(279). Designers adhering to the redundancy principle would invariably eliminate extraneous material in line with the coherence principle. Similarly designers adhering to the coherence principle will eliminate extra material such as identical text for a narration, or visuals that portray the same information as the accompanying text.

2.2.4. Managing essential processing for the benefit of the APA

The previous section defined extraneous processing as a deterrent from essential material. Essential material will be treated as opposite to extraneous, and rather than eliminating (as with extraneous material), essential material must be managed in order to aid the learner's cognition. This management is tied to the broader considerations of pre-existing limited working memory, similar to the previous discussion on extraneous processing. Pilegard defines essential overload through complex materials as, "occurring when the amount of essential cognitive processing, required to understand the multimedia instructional message, exceeds the learner's cognitive capacity" (316). Mayer poses a management solution towards the complex, yet essential, material through "Essential processing [which] involves selecting relevant information from the presentation and organizing it as presented" (59).

The modality principle provides a useful, empirically based, response to the designer's decision between presenting the APA's words as either audio/narration or text in an e-learning environment. Certainly both cannot be used within the same presentation, as that would breach the redundancy principle. This tasks the designer with making an informed choice between accompanying their APA with a narration (which must be temporally contiguous) or combining the APA with text (which must be spatially contiguous).

Modality guides designers towards using audio narration over on-screen text for the benefit of managing a learner's essential processes. Mayer surmises the extensive empirical research on this principle, "[It] has the most research support of any of the principles described in this book … when it's feasible to use audio, there is considerable evidence that presenting words in audio rather than on-screen text can result in significant learning gains" (115) Among the empirical studies supporting the principle is Low and Sweller's assessment, "The modality

effect results in superior learning using spoken (and therefore auditory) information rather than written (and therefore visual) information." (227)

In order to manage the learner's essential processing in a multimedia environment, designers should present an APA's words through audio narration rather than on-screen text. The role of an APA is thereby influenced by this design consideration; whether the APA was an expert/coach or a companion, their words should be audible rather than written.

Notably, the type and quality of the audio narration has a considerable effect on the outcome, as illustrated by the two-headed arrow tying modality to personalization principle (Figure 2.10). This will be expounded upon in the following subsection concerned with fostering generative learning.

2.2.5. Fostering generative processing for the benefit of the APA

Generative processing motivates the learner towards making sense of the instructional material. Given the limitations of working memory, the reduction of extraneous material and management of those essential will result in enhanced cognition. However the learner would require a level of incentive to integrate the essential material from working memory towards long-term memory as well as incorporating any extant information from long-term memory into the current essential material. Mayer defines generative processing as "cognitive processing aimed at making sense of the material and is caused by the learner's motivation to learn. For example, when the material is presented by a likeable instructor, the learner may exert more effort to understand what the instructor is presenting. Generative processing involves reorganizing the incoming information and integrating it with relevant prior knowledge." (60) That degree of incentive is necessary for integrating long-term memory with working memory (see Figure 2.9). Incentive is addressed by a couple of principles highlighted here focused on building social cues within a multimedia learning environment.

The personalization principle guides designers towards use of conversational style, polite wording and additional human voice in audio narration. The use of friendly/conversational speech combined with polite wording all presented in a human voice, primes social cues in the

learner that encourage their efforts to make sense of the material being spoken. The challenge here is to generate a sense of affinity with the inanimate computer by mimicking a conversational partner. Mayer states the psychological purpose behind these efforts as "to induce the learner to engage with the computer as a social conversational partner" (2011, 180). This social response sees "an increase in active cognitive processing by the learner – as the learner works harder to select, organize and integrate incoming information – which in turn leads to a learning outcome that provides better support for problem-solving transfer performance." (Mayer, 2014 346)

This principle (as well the embodiment principle) has been tied towards the theoretical perspective Mayer raised in his 2012 article on embodiment; the social agency theory. The 2012 study has been previously cited in this paper, and informed a bulk of arguments concerned with animation production in the previous section on animation memos. While the animation memos section addresses social cues through the lens of animation's twelve principles, the social cues within the audio narration of an APA's speech also influence its capacity to prime a social affinity with the learner. Unfortunately, an in-depth analytical look at the APA's narrative delivery through the personalization principle is outside of the scope of this paper. Rather, the personalization principle will be utilized to better inform the boundary conditions surrounding the embodiment of an APA.

Multimedia designers must bear in mind the ties between personalization and other audio-based principles. Reverting to the ties illustrated between redundancy, modality and personalization (Figure 2.10); the use of audio narration will void the addition of similar on-screen text. And while empirically proven to be preferred, the audio narration must be presented in a conversational rather than formal style. Additionally the audio narration must be spoken in a human voice, rather than a machine voice.

The personalization principle exerts an amount of influence over the embodiment principle, and its subsequent guidelines on APA construction (note the positive valence sign between principles under Figure 2.10). Regardless of the role an APA plays, its accompanying audio narration must adhere to the personalization principle. Mayer stated important boundary conditions that may deter from the effectiveness of a well-embodied APA, "Possible boundary

conditions are that the embodiment principle may not apply when there are negative social cues such as machine voice or foreign-accented voice." (2014, 345; 364; Mayer 2012, 248) The APA (and its role) has been found susceptible to a number of negative social cues concerned with low embodiment: lack of human-like motion and gestures, lack of facial expressions, lack of eye-gaze, all of which have been discussed prior under animation memos. An addition to the list of boundary conditions is the APA's susceptibility to negative audio-based social cues, which will inevitably influence its production.

The embodiment principle has been discussed at length in previous sections. Therefore this argument will concisely summarize its: definition and theoretical basis, extant presentations of an embodied agent, and the influence the embodiment principle exerts on the roles of an APA.

Mayer defines the embodiment principle as "people learning more deeply when on-screen agents display human-like gesturing, movement, eye-contact and facial expressions rather than not" (346). This deeper learning is based on Mayer's social agency theory and the subsequent, easily identifiable and relatable, social cues the APA intends to embody. By replicating a social environment through on-screen agents with human-like motions and a corresponding human voice, the multimedia lesson "increases the learner's motivational commitment to active cognitive processing" (346).

The APA's presentation, once embodied, can be displayed in a number of ways: "visually as cartoon-like characters, as a talking head video, or as virtual reality avatars; they can be represented verbally through human recorded voice, or printed text. Agents can be representations of real people using video and human voice or artificial characters using animation" (Mayer 2016, 192). Notably, Mayer's analysis of empirical studies[12] conducted on the presentation of an APA and learner preference saw, "Overall, the groups did not differ much in their test performance, suggesting that a real character did not work any better than a cartoon character" (Mayer 2016, 195). Given the various presentational options available for an APA, and no overt learner preference for a particular presentational format, the use of animation as a production method should remain an option rather than becoming the norm. Regardless of the

[12] Mayer's 2016 edition of e-Learning Guidelines advances empirical studies investigating the visual appearance of pedagogical agents

chosen representation, the design guidelines of an embodied APA towards human-like motion, for the benefit of motivating a learner's cognition, remain.

Summarily, the role a pedagogical agent plays must be guided by both the personalization and embodiment principles, and (if animated) it must adhere to the animation principles expounded upon in this paper.

2.2.6. Balancing multimedia instruction and design goals for the benefit of the APA

A balance must be struck from the earliest considerations of multimedia learning. The balance struck would begin with the instructional form; either synchronous or asynchronous, towards an intra-balance within multimedia design goals of reducing extraneous, managing essential and fostering generative processes.

Initial considerations towards striking a balance between multimedia instruction goals and design goals involve the designer's awareness of the learner's level of prior knowledge. A learner's level of prior knowledge, high or low, will exert a great amount of influence on the production of an APA. The high-level prior knowledge learners will be better suited towards an asynchronous form of multimedia instruction, in which they are afforded a greater amount of adaptive control. With a greater level of adaptive control afforded to them, high-level prior knowledge learners are less likely to require the assistance of an APA. On the contrary, the low-level prior knowledge learner will require a greater amount of assistance through an e-learning activity, therefore would benefit from a balanced combination of multiple multimedia design principles aimed at enhancing cognition.

The intra-balance within multimedia design goals revolve around the presentation of audio materials. To reiterate, audio-based principles are outside of the scope of this study and have been assessed briefly in connection to their influence on the dynamic visual; the APA. Audio materials that accompany the APA must be, foremost, synchronized with the mouth shapes of the APA as instructed by animation dialogue procedure. Animating audio narration towards a believable dialogue is in line with the temporal contiguity principle. The designer's choice to prioritize audio narration over on-screen text will adhere to the three principles of

redundancy, contiguity and modality. As a word of caution, the accompanying audio narration must be presented in a polite, conversational/friendly manner and narrated with a human voice in order to incite a sense of social affinity with the learner.

2.2.7. Reducing extraneous and managing essential processing through the APA

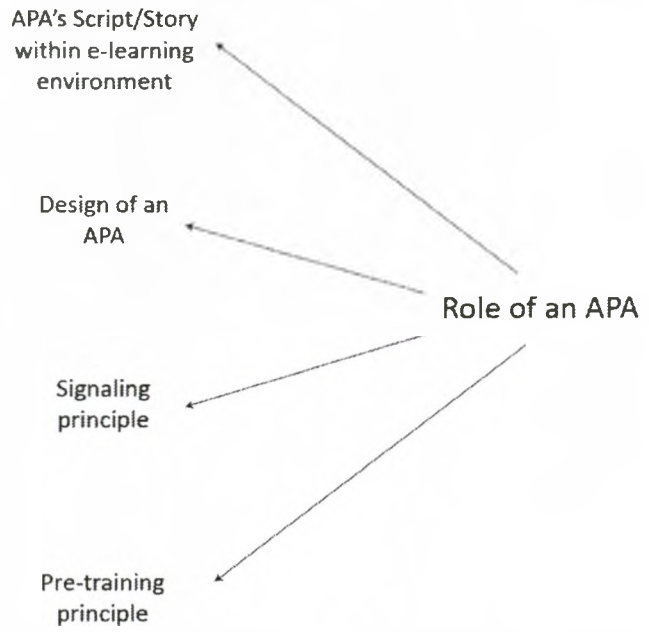

Figure 2.11 Ties between the role of an APA, its "script", design, the signaling and pre-training principles.

Briefly summarizing the earlier section on animation memos, the role of an APA was tied to both preproduction procedures of: the simplified 'story' or script equivalent, and the character's expressive design. The APA's script will be influenced by the role it plays within a multimedia learning environment, such that a companion APA must be scripted differently from an expert APA. Secondly, the level of detail added on to an APA's design was proportionately tied to the advancement of its role; an expert APA will be designed (and detailed) towards a less expressive and more 'realistic' visual, as opposed to a learning companion APA which would best be presented through an expressive and iconic design with far fewer details.

Maintaining the categories of APA roles listed in the animation memos section, the APA can be an expert/coach, a presenter/guide or a learning companion. Given that each role has a corresponding script to follow, the actions the APA conducts within a multimedia environment (with the intent of managing essential or reducing extraneous processing) will be influenced by its chosen role. Through its actions, the APA exerts its influence within the multimedia design field. Its role would dictate its actions towards reducing extraneous processing, through the signaling principle, or managing essential processing, through the pre-training principle.

The signaling principle guides designers towards incorporating cues; both visual and text that "guide learners' attention to the relevant elements of the material or highlight the organization of the material" (van Gog 263). This principle is concerned with reducing extraneous processing for low-prior knowledge learners by isolating and highlighting task-relevant information. Van Gog describes the extraneous overload scenario targeted through signaling as "novices may rely more on the characteristics of the stimulus material. That is, they are likely to pay much attention to perceptually salient features, even though these may not always be the most relevant to the task at hand. Processing information that is not relevant to learning induces cognitive load that is ineffective for learning or may even hamper learning." (264)

The role an APA plays will influence it probability to signal or cue task-relevant information for the learner's benefit. A companion APA is more likely to signal towards essential information within the multimedia lesson as opposed to the expert APA, which would be better suited for a higher-level prior knowledge learner.

Low-level prior knowledge learners would have the added benefit of signaling through the (companion) APA. The signaling APA would offer both the incentive to make sense of the material while simultaneously highlighting the essential aspects of the same. Van Gog concurs, "signaling not only may prevent extraneous load by preventing processing of less relevant information, but may simultaneously foster germane load [generative processing], by facilitating the organization or integration of essential material." (264)

The pre-training principle guides designers towards introducing the names and characteristics of a multimedia task's main concepts beforehand in order to manage essential

processing. Pilegard and Mayer state the rationale behind pre-training as "it equips learners with prior knowledge that they can use to process the subsequent narrated animation with less cognitive effort ... thus reducing the amount of essential processing that is required." (318)

The expert APA is best suited towards the action of pre-training as they are designed to present a knowledgeable instructor within a complex learning task. Both low and high-level prior knowledge learners would benefit from a pre-training APA. And, if executed successfully, the pre-training will result in an increased level of prior knowledge. The increased level of prior knowledge would see an overall enhancement of learners' cognition.

2.3.Theoretical categories

This section will see several focused/axial codes, and the memos discussed within them, refined further towards theoretical categories. Generally, these theoretical categories will group two or more similar focused/axial codes.

In order of appearance, focused/axial codes within this paper are listed below:

- Simplifying as an approach to APA pre-production
- Detailing as an approach to APA pre-production
- Expressing as an approach to APA preproduction
- Expressing through colour in APA preproduction
- Balancing the overall approach to APA preproduction
- Simplifying as an approach to APA production
- Believability/realism as an approach to APA production
- Expressing as an approach to APA production
- Audience involvement as the goal of production
- Balance as an approach to APA production
- Consistency in style as an approach to APA postproduction
- Form of instruction influencing the role and existence of an APA
- Limitations of working memory influencing multimedia's design
- Reducing extraneous processing for the benefit of the APA
- Managing essential processing for the benefit of the APA
- Fostering generative processing for the benefit of the APA
- Balancing multimedia instruction and design goals for the benefit of the APA
- Reducing extraneous and managing essential processing through the APA

Some focused codes are explicitly grouped given their names. Evidently similar focused codes include: simplifying as an approach; expressing as an approach; balance as an approach to APA preproduction and production, multimedia instruction and multimedia design goals. These are easily elevated towards theoretical categories.

Other focused codes are explicitly tied given the pre-existing hierarchy. At the top of this hierarchy is the limitation of working memory influencing multimedia's design. Subsequent focused codes branching out from this are: reducing extraneous processing, managing essential processing and fostering generative processing all for the benefit of the APA. This hierarchical tie between focused codes has been illustrated in Figure 2.10. This hierarchy-based combination of focused codes raises the theoretical category of – prescribing multimedia goal-oriented design of an APA, considering the limitations of working memory.

Other similarities between focused codes are less explicit. Implicit, yet strong, ties can be made between focused codes. The first implicit tie is between detailing as an approach to preproduction and believability/realism as an approach to production. Under the memos/arguments raised within the detailing approach, the term realistic was substituted as defining term, rather using believability. Believability was then connected to Disney's definition of caricatured realism. Therefore, both focused codes concerning believability and detailing raise the theoretical category of – an APA's believability is achieved through caricatured realism.

The second implicit tie is between focused codes of audience involvement as the goal of production and balancing multimedia instruction/ design goals for the benefit of the APA. The memo-arguments within each focused code sees considerations made for and towards the end user. Animation's focus towards audience involvement sees the entire production pipeline geared towards presenting the most engaging, enjoyable and appealing product. While multimedia's consideration towards the audience (in this case, the learner) revolves mainly around the learner's limited working memory and awareness of their level of prior knowledge. Therefore both focused codes raise the theoretical category of – necessary awareness of the learners.

The final implicit tie is between reducing extraneous and managing essential processing through the APA and the focused code of consistency in style as an approach to APA postproduction. The chosen style determined during the preproduction/design phase of an APA's creation must extend towards its production and postproduction. Additionally, the APA's consistent design would reflect its role and therefore influence the probability of conducting actions geared to either managing essential or reducing extraneous processes for the learner.

Summarily the theoretical categories are tabulated below:

Theoretical Category	*Grouped Focused Codes*
Simplifying as an approach to APA	• Simplifying in APA preproduction • Simplifying in APA production
Expressing as an approach to APA	• Expressing in APA preproduction • Expressing through colour • Expressing in APA production
Believability as an approach to APA	• Detailing in APA preproduction • Believability/realism in APA production
Balance as an approach to APA	• Balancing the overall approach to APA preproduction • Balance as an approach to APA production • Balancing multimedia instruction and design goals for the benefit of the APA
Prescribing multimedia goal-oriented design of an APA, considering the limitations of working memory	• Limitations of working memory influencing multimedia's design • Reducing extraneous processing for the benefit of the APA • Managing essential processing for the benefit of the APA • Fostering generative processing for the benefit of the APA
Necessary awareness of the learners	• Audience involvement as the goal of production • Form of instruction influencing the role and existence of an APA
Consistency in style as an approach to APA	• Consistency in style as an approach to APA postproduction • Reducing extraneous and managing

	essential processing through the APA

Table 2.2 Tabulated focused codes grouped under broader theoretical categories.

3. Generated theory

3.1. The Balanced Approach to Animating Pedagogical Agents

This interdisciplinary study has combined the fields of animation and multimedia and was conducted using the grounded theory method, thereby producing the nascent theory of a balanced approach to animating pedagogical agents.

This nascent theory intends to advise future multimedia designers on the best practice for animating pedagogical agents within multimedia/ e-learning environments for the ultimate benefit of the learner's cognition.

The balanced approach to animating pedagogical agents is initiated and informed by an awareness of the learner. Two key aspects that a designer must be aware of prior to creating an APA include: the learner's level of prior knowledge and the intended goal of the multimedia/e-learning instruction (either to inform or perform).

With this awareness, the designer considers the next phase; an inter-balance between animation principles and multimedia design principles. This inter-balance is informed by the APA's proven intent towards embodiment through generating a social presence. A social presence ultimately alleviates the strain on limited working memory by motivating the learner, thus fostering cognition. A symbiosis emerges between the animation principles that caricature reality for the benefit of audience involvement, and the multimedia principles that seek a recreation of reality within a virtual e-learning environment for the benefit of a learner's cognition.

Considerations of this symbiosis will lead the designer towards an intra-balance within both production pipelines. The animation production pipeline (preproduction – production - postproduction) finds considerable interaction with the multimedia design pipeline/processes (reduce extraneous – manage essential – foster generative).

Central to the interaction between the two, is the role an APA plays. It is at this point that the designer must decide the role the APA intends to play within the e-learning environment. Each role has (previously implicit) specifications towards: its story/script (including both audio-

narration and believable actions), the simplicity and consistency of its design/visual appearance, and its expressive capacity/range. Therefore, designers should consider the APA's role as a crucial element of their APA productions.

Equipped with the prerequisite awareness of the learner, knowledge of both animation and multimedia principles, and a clear role for the APA to play out; the designer can begin the production of a well animated pedagogical agent.

3.2.Theoretical review

This section will place the nascent theory of a Balanced Approach to Animating Pedagogical Agents within the broader scope of extant theories concerned with animation as well as those surrounding multimedia design and instruction.

Initializing the theoretical framework is Geary's evolutionary principle-based distinction between biologically primary and secondary knowledge[13]. Both biological primary and secondary knowledge are characteristics of the larger intricate relations between working memory and long-term memory (Sweller 27). Geary's distinction, rooted in well-established evolutionary principles, outlines biologically primary knowledge as "knowledge that we have specifically evolved to acquire over many generations. Because we have specifically evolved to acquire them, very complex primary skills can be acquired rapidly, easily, without mental effort and frequently unconsciously" and biologically secondary knowledge as "knowledge we have not evolved to acquire but that we need for cultural reasons. Schools and other educational institutions were invented to assist us to acquire biologically secondary knowledge".Sweller examples listening and speaking as biologically primary, while reading and writing are biologically secondary knowledge (28).

Geary's cognitive architecture then informs Sweller's cognitive load theory. Sweller's theory is defined as "concerned primarily with the acquisition of biologically secondary knowledge. The manner in which we process information associated with this acquisition is determined by cognitive architecture [of working and long-term memory]" (29). The theory further posits three categories of cognitive load which have been empirically tested and continually developed. The three categories are intrinsic, extraneous and germane load "all categories are concerned with the acquisition, storage and use of biologically secondary information" (37).

Mayer's cognitive theory of multimedia learning has advanced from Sweller's theory, tailoring it towards a multimedia learning environment. Mayer's theory outlines the three, now familiar, instructional goals ensuring "multimedia instructional messages designed to guide appropriate cognitive processing during learning without overloading the learner's cognitive system" (43). While Mayer's theory situates the issue of cognitive load within a multimedia

[13] Sweller cites Geary's 2007, 2008 and 2012 studies within the field of evolutionary educational psychology

space, some broader aspects of cognitive load theory are maintained, such as central considerations for working memory, and Sweller's extraneous load category. The other two cognitive load categories of intrinsic and germane load, were rephrased as essential processing and generative processing respectively; "essential processing is analogous to intrinsic cognitive load in cognitive load theory … generative processing is analogous to germane cognitive load, in cognitive load theory, as described by Sweller" (60).

The cognitive theory of multimedia learning raises the important consideration of the limitations of working memory. Mayer and DaPra address these limitations further, through the lens of embodiment, in the proceeding social agency theory of learning. The social agency theory is "suggests social cues that motivate the learner to engage in the cognitive processes of organizing and integrating, which are focal elements in the cognitive theory of multimedia learning" (240). The social cues within the theory call for a personalized human voice presented in a friendly, polite manner, and embodied human-like gestures, motion, and eye-gaze. All are presented through an animated pedagogical agent towards the intent of building a social presence and the resultant affinity with the learner.

The nascent balanced approach theory is best viewed as an extension from Mayer and DaPra's social agency theory. Balanced approach intends to better inform the design and production of APAs towards generating a social presence thereby motivating the learner. These hierarchical ties are illustrated in Figure 3.1 below.

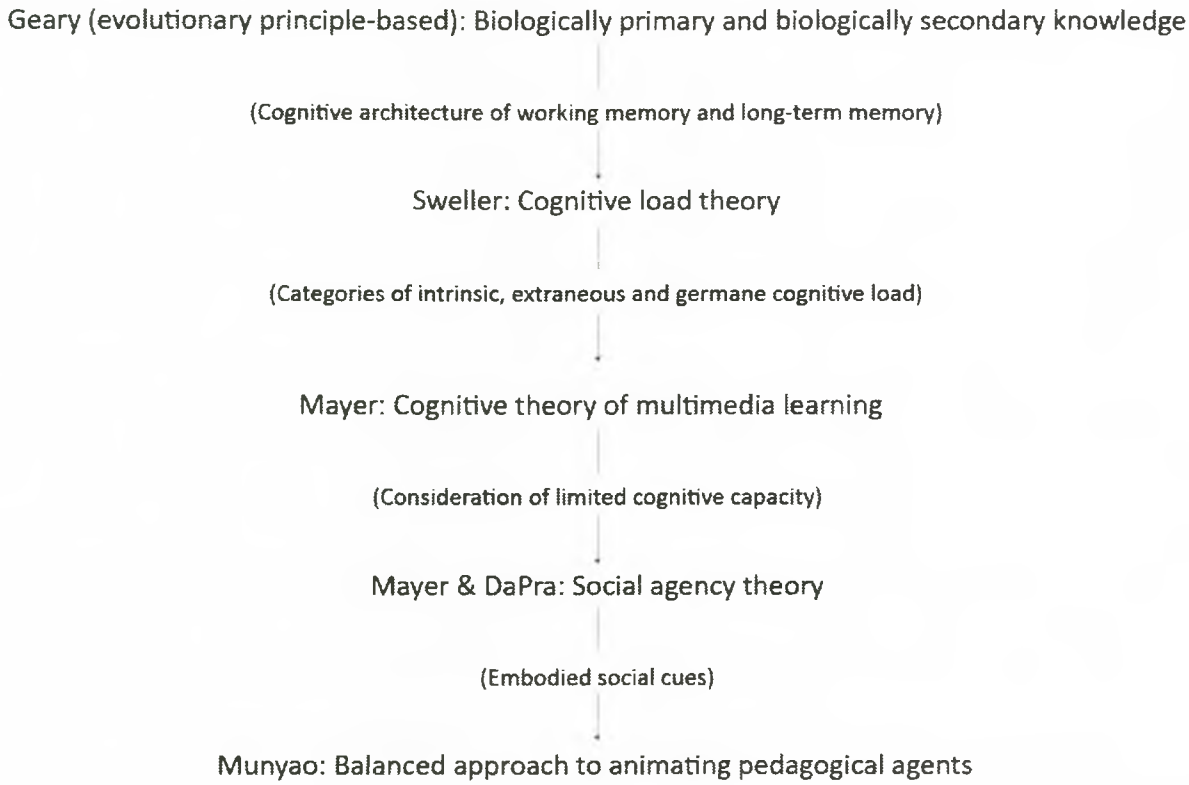

Figure 3.1 Placing the nascent balanced approach theory among extant theories surrounding multimedia, learning and cognition.

Kim and Baylor's 2006 article addressed the, then, lacking theoretical frameworks in studies surrounding pedagogical agents. They posit well-established theories sourced from seminal psychologists such as Bandura, Vygotsky and Piaget. The social considerations towards learning recurrent through the above mentioned theories were tied towards a pedagogical agent's competency, appearance, interaction type, its feedback, and affect (590).

More recently, the social agency theory has been linked to several other theories within various fields such as computer science, psycholinguistics, communication, cognitive science and educational psychology (Mayer DaPra 2012, 240).

3.3.Literature review

This section will situate this study amongst the literature sources cited. Several literature sources provided data for this textual analysis, which was then coded and inductively organized towards theoretical categories that informed the balanced approach to animating APAs.

To better sensitize this study amongst its sources, the latter will be grouped broadly under categories of: those in and around design; those in and around embodiment and animation and lastly those in overlapping areas. Sources will then be summarized with regards to the problem(s) addressed within the particular study/text (Figure 3.2).

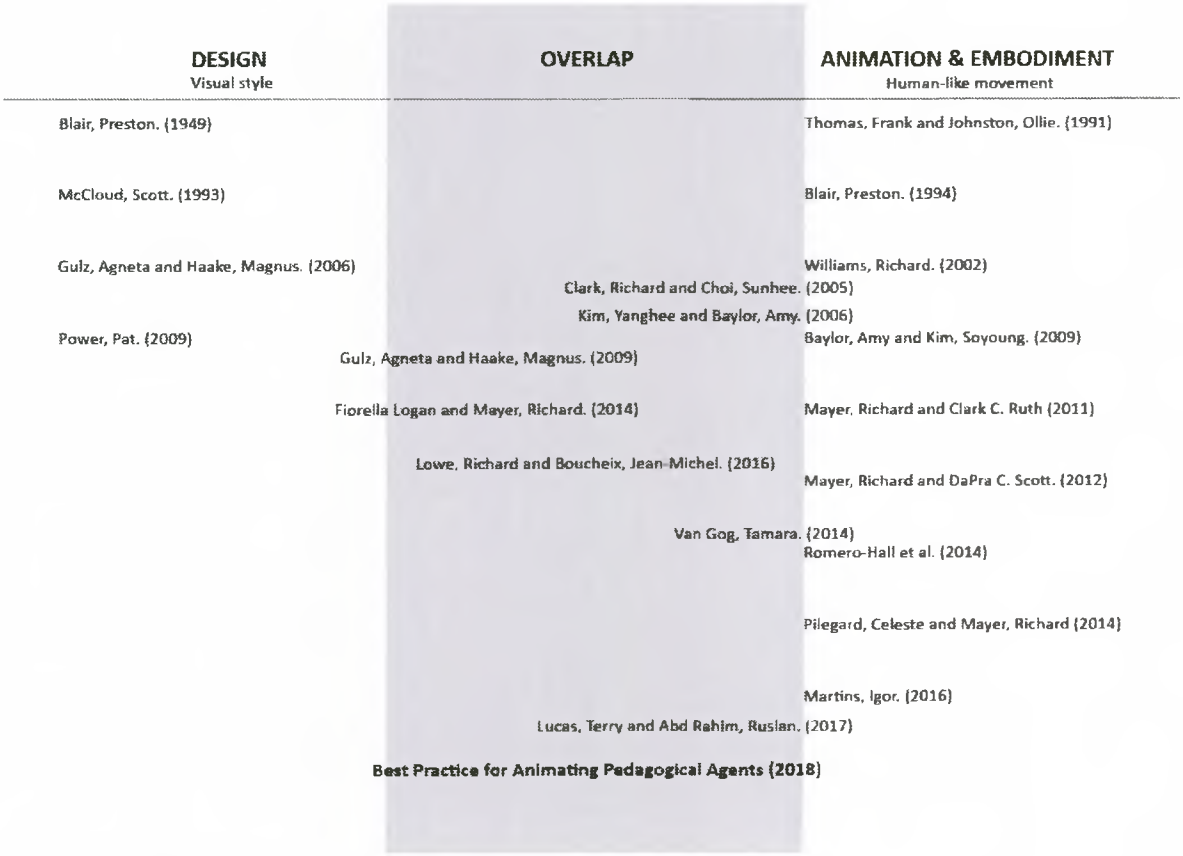

Figure 3.2 Situating this study amongst literature sources cited

The design category begins with the earliest publication cited, Preston Blair's 1949 publication *Advanced Animation*, which served as a "how-to" guide on creating animated

characters. While this publication has been surpassed by more recent writings on the subject, it remains a firm basis for the foundation of cartoon design. Scott McCloud's 1993 book *Understanding Comics: The Invisible Art* takes an illustrative approach to explaining comics. Similar to Blair's publication, McCloud uses a diagrammatic approach to interrogate the history, content, style, execution and theory surrounding comics. Overall, the book offered an in-depth study on the art form of character design and a design's planning towards audience involvement.

Gulz and Haake's 2006 journal article *Design of Animated Pedagogical Agents – A Look at their Look* addressed an overlooked area within APA design and function - their visual rendering. Guided by the aim of creating an APA that informs, motivates and engages the learner, the authors assessed the visual rendering in terms of its supposed benefit towards the learner's perception and reception of the APA. Pat Power's 2009 article *Animated Expressions: Expressive Style in 3D Computer Graphic Narrative Animation* provided insight into the neuroesthetics and psychology behind expressive visual render styles.

A number of texts overlapped between areas of design and animation, though some veered more towards concerns surrounding visual style and design, while others towards embodiment/animation. Gulz and Haake's 2009 journal article, *A Look at the Roles of Look & Roles in Embodied Pedagogical Agents – A User Preference Perspective* is among the overlapping tests that skews towards design. The authors investigated the relationship between APA design, in terms of their visual style, their pedagogical role and learner preference. The study found a learner preference for a stylized agent that aided their lesson activity. Fiorella and Mayer's chapter on *Principles for Reducing Extraneous Processing in Multimedia Learning: Coherence, Signaling, Redundancy, Spatial Contiguity and Temporal Contiguity Principles* expounded on crucial multimedia design principles tailored towards reducing the learner's extraneous processing by, largely, omitting extraneous materials. The omission of extraneous materials alleviates the already limited working memory and frees up the learner's mental capacity to process essential materials. The study broadened the APA's design by tying its considerations towards less extraneous materials.

Lowe and Boucheix's 2016 journal article *Principled Animation Design Improves Comprehension of Complex Dynamics* attempted to tackle the difficulties learners face in

comprehending animated processes/ dynamics within a multimedia learning environment. To solve the problem, they posed their "composition approach" (72) to designing animations based on complex mechanical dynamics. Their study has been situated centrally under the overlap column as it considers both design and animation. Albeit their animation was not character based, rather it featured a dynamic display of a mechanical sequence.

Veering towards the category of embodiment/ animation is Clark and Choi's 2005 journal article *Five Design Principles for Experiments on the Effects of Animated Pedagogical Agents* addresses the problem of varied outcomes prevalent in the quantitative research on APAs. They put forth a solution by designing the methodological approaches that are best suited to interrogate the effectiveness of APAs in experimental studies. Clark and Choi's article would inform future empirical studies' methodological approaches. Kim and Baylor's 2006 article *A Social-Cognitive Framework for Pedagogical Agents as Learning Companions* addresses the gap between extant social-learning theoretical frameworks and pedagogical agents. Being a theoretical study, the article is best placed closer to the embodiment/animation category with the intent of informing future empirical studies theoretical perspectives.

Van Gog's chapter on The Signaling (or Cueing) Principle in Multimedia Learning isolated the signaling design principle aimed at reducing extraneous processing. Van Gog's chapter mainly supports Fiorella and Mayer's assessment of the same principle. The study proved useful in informing the actions an APA takes dependent on its preconceived role. Lucas and Rahim's 2017 article *The Similarities and Nuances of Explicit Design Characteristics of Well-Received Online Instructional Animations* took an exploratory analysis approach towards the design and visual representations behind successful online educational videos. Gauging by their findings on successful online educational videos based advertently/inadvertently on multimedia design principles, further designs of APAs with the principles in mind would lead to successful multimedia products.

Lastly, the category of embodiment/animation grouped texts concerned with human-like motion. Chief among them is Thomas & Johnston's 1981 book *Disney Animation: The Illusion of Life* which is widely considered as a primary literature source within the field of animation. The high regard for the book has withheld through several years. The book's dissection of the

success of animated works dating back to the early 20th century, its guidelines on how to replicate a successful animation through the twelve principles of animation, and the innate motivation to engage the audience and engender empathetic reactions from them all cumulate towards its fame. Preston Blair's 1994 book *Animating Cartoon Characters* advances from his 1949, more concise, publication. However, most of the content within Blair's book is subsumed by Thomas & Johnston. Richard Williams' 2002 edition of *The Animator's Survival Kit* is considered an invaluable character animation reference. Just as Blair, Johnston and Thomas have done prior, Williams took an illustrative approach to explaining the animation process. The book serves as a useful tutorial for animation productions and informed several implicit production considerations within this paper's accompanying practical project.

Baylor & Kim's 2008 journal article on *Designing Nonverbal Communication for Pedagogical Agents: When Less Is More* saw an experiment based investigation on the effects of an APA's deictic gestures. Results supported their hypothesis that APA's gestures and facial expressions influenced their perception and student learning. Mayer and DaPra's 2012 journal article *An Embodiment Effect in Computer-Based Learning with Animated Pedagogical Agents* conducted an experiment on the learner's preference for social cues within an APA. Their study found high scores in transfer tests from participants exposed to APAs with a high level of embodiment coupled with a human-like voice; which supported their hypothesis as well as their social agency theory raised in the study. Romero-Hall et al 2014 journal article on *Using Physiological Measures to Assess the Effects of Animated Pedagogical Agents in Multimedia Instruction* addressed the effect that emotive versus non-emotive APAs has on a learner's perception. Detrimentally, their study utilized an over-expressive/over-emotive APA that displayed negative facial expressions that ultimately prove distracting. As a result, the participants in their study failed to perform in transfer tests. Romero-Hall's study acts as a caution against ignoring a balanced approach, particularly in the APA's facial expressions.

Martins' 2016 journal article *Pedagogical Agent Gestures to Improve Learner Comprehension of Abstract Concepts in Hints* centralizes on an APA's ability to 'hint' and the validity thereof to aid a learners' performance. This study informed my ties between APA's actions and their roles within a multimedia learning environment. Mayer and Clark's 3rd edition of *E-learning and the Science of Instruction: Proven guidelines for Consumers and Designers of*

Multimedia Learning published in 2011 is a comprehensive manual for creating, designing and displaying multimedia content in an e-learning environment. While a number of multimedia design principles were sourced from this text, the embodiment and personalization design principles (those concerned with social cues) were paid particular focus.

Lastly, augmenting Mayer and Clark's 2011 book, is Mayer's chapter on *Principles Based on Social Cues in Multimedia Learning: Personalization, Voice, Image and Embodiment Principles,* which I consider to be a confluence of his previous findings based on social cues and his well-documented fostering generative learning principles. While this chapter did not explicitly raise new information on the embodiment principle, its theoretical basis was advanced. The updated theoretical basis informed the review discussed in the previous section.

4. Conclusion

This interdisciplinary study sought to advance from the existing discourse on multimedia learning's embodied animated pedagogical agent (APA) through the lens of animation's well-established practice and production principles. It has been established that an APA's goal of embodiment is reliant on the social cues of human-like motion and gestures, eye-gaze and facial expressions. Given the symbiosis found herein between multimedia and animation principles, it is advisable that future APA designers consider animation's twelve principles and its guidelines on character design throughout their production, in order to achieve the embodied result that the learner requires from an APA.

Additionally, findings display other multimedia's principles exerting influence through voice-based social cues. The voice-based social cues advise use of a human voice presented in a friendly, politely worded conversational style (Mayer 179). Future designers must consider this audio-visual correlation in the event their APA is accompanied by an audio narration.

Overall, an awareness of the learner informs whether or not the APA exists within the multimedia learning environment. A learner's high level of prior knowledge may see no need for the auxiliary aid given by the APA, whereas learners with a lower level of prior knowledge may exert preferences towards the APA's design (and its role) with regards to its appearance; such as the APA's perceived age/gender/ethnicity. As a word of caution, while future APA designers may be equipped with the requisite knowledge of (and requisite skill in executing) the balance between animation and multimedia principles; without an awareness of the end user/learner, designers would ultimately fall short of full social affinity between the APA and the learner.

The balanced approached to animating pedagogical agents theory covers several queries raised within the area of embodying pedagogical agents towards the ultimate intent of fostering generative learning by engendering a social affinity with the learner.

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Appendix

PRACTICE ASPECT DOCUMENTATION

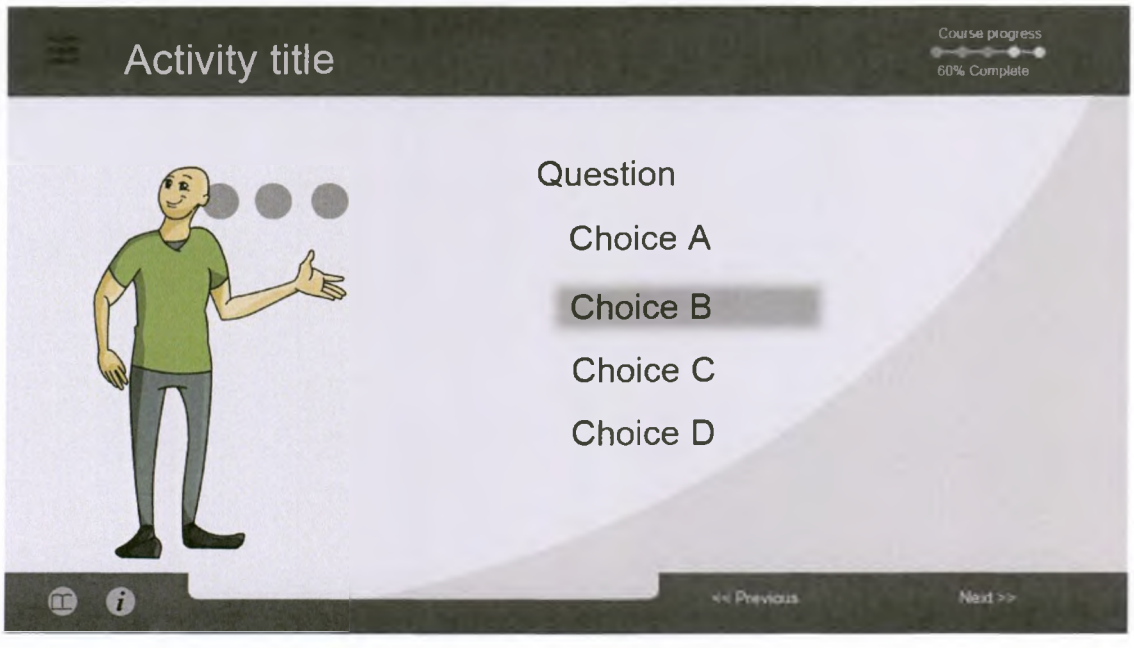
Isabella Munyao

PROJECT DESCRIPTION

The piece tries to depict the best practice for animating an Animated Pedagogical Agent (APA). The animated character takes on the role of a companion; that of a character intent on aiding learning through developing a social affinity with the learner.

The APA character performs the action of hinting. The action falls under the role of a companion APA; as a companion can best be suited to help the learner along by providing timely hints. The character's action of hinting, and the piece a whole, is cyclic (can be played seamlessly in a loop) and lasts 9 seconds.

The animated piece can viewed below through an interactive PDF attachment below or be accessed via the Vimeo website; "Best Practice for Animating APAs." *Vimeo*, uploaded by Bella Munyao, 8 June 2018, https://vimeo.com/274103758



Best Practice for Animating APAs

CONCEPT DEVELOPMENT – PROCESS

Conceptualizing the APA began with an assumption of the level of prior-knowledge of the learner; I assumed the learner as having a low-level of prior knowledge. This assumption skewed towards the preferred audience of a principled-designed multimedia message, which has been proven to be a novice learner (Mayer, 2011). In accordance with the balanced approach theory, future productions should attempt to gain a clearer understanding of the end user/learner and better tailor the APA towards them. With the intended audience in mind, the APA's role was decided as that of a companion. The companion was best suited to engender a feeling of camaraderie with the learner. I decided the companion APA was best suited for a clear/simple action inspired by a similarly clear/simple idea. In this case, it is the action of hinting at the correct answer in a template e-learning environment.

The concept of the piece centres on building a social affinity with the learner, an important addition to an e-learning environment, as it fosters generative learning and, wholly, cognition. While all APAs, regardless of the role the play in a multimedia environment, have to appear friendly/socially capable and had to be animated in a believable/human-like manner, the companion APA is tasked with identifying with the learner more than its counterparts. Therefore, the companion APA produced was aimed at the task of identification as well as customary elements of embodiment.

Several considerations were taken into account and enacted for the aim of replicating a friendly persona and human-like motion in the APA. Particularly, balance had to be considered through almost every step of the process; initially a balance had to be struck in the design. Production saw a balance between the subtlety of an action such as hinting and clarity of the same. And an overall balancing act of portraying an APA that would not distract from the template learning activity, thereby the APA would not defy the coherence multimedia design principle.

TECHNICAL DEVELOPMENT

Pre-production

The APA design began with the rounded shape. The rounded shape informed, most visibly, the head, hands and feet and the body. The body's physique is designed towards the mesomorph body type, which lent itself well to the chosen male gender of the APA. The mesomorph physique offers a balance between Blair's pugnacious character (top heavy) and his screwball character (bottom heavy). This balance attempts to capitalize on the screwball's antics, which have been the "funniest on the screen" (13), and the pugnacious character's overt physical presence through the enlarged hands; which were designed to aid clarity in the hinting. (See Figure 4.1)

The benefits of using the rounded shape saw an ease in production. Using the example of the APA's head, which changed perspective as the APA hinted, the rounded shape eased the transition between key poses. Similarly the rounded base of the hands, later solidly drawn, aided the squash and stretch of the same. This will expounded upon later in the production section.

With the rounded shape basis established, the APA preproduction continued towards detailing an iconic design. The level of iconicity, gauged through McCloud's ternary plot, skewed towards the cartoon rather than 'realistic'. The APA's iconic face was designed towards the overall intent of audience identification. The design choices of the face: bald, no facial hair, no nose, single line representing the mouth, all skews towards simplicity and the intended aim of audience identification. The APA's costume/clothing consisting of a t-shirt and trousers was similarly tailored with simplicity and audience identification in mind. The generic costume would likely identify with a larger audience base as opposed to a specified costume.

As previously mentioned the size of the hands was exaggerated slightly for the benefit of clarity towards the action of hinting. Unlike the rest of the body, the hands were detailed slightly towards 'realism'; including five fingers as opposed to the common cartoons' four fingers. This choice was influenced by the embodiment intent of creating a believable human-like motion. Given that the hands were central to the action of hinting, the design of five fingers was thought better suited to aid the believability of hinting.

Benefiting from an iconic design, the APA resonates and can identify with a larger audience base. Additionally, the consistency/coherency in the iconic design aids believability as per David O'Reilly's recommendation of visual representation (3).

Designing a layout specifically suited for the APA was omitted. The APA's action neither required an established setting, nor would a setting aid the learning activity. Therefore the APA's background sees only a template learning environment. The environment is 'muted' (displayed in grey scale), in order to draw focus on the APA. It includes a multiple choice question and highlighting of the various answers available.

The choice to omit a layout was intuitive; however the benefits of the same include a minimized display that is less likely to draw too much attention away from the learning activity to the APA. This thereby minimizes the level of extraneous processing in the learner.

Expression in the APA's design was approached through decisions based on the line. The top row of images in Figure 2.3 informed the range of expressions available to my APA through expressive lines. Bearing in mind the facial model sheet made does not necessarily dictate the expressions used in the production; rather the APA's capacity to express emotions. In this practice piece the APA's: imaginary line of action, line art, the continuity and coherency of the same, and the ellipses, were all composited dictated by the APA's action of hinting. The initial line of action was curved for the APA's key poses; both neutral and hinting (see Figure 4.2). The curved line of action "[strengthened] the dramatic effect" (Blair 6) more so dramatizing the hinting pose.

The APA's line art was created with a combination of Adobe Animate line tools: the brush and line tools. The line tool offers a more consistent line in terms of width and texture while the brush tool provides an, often, expressive line that displays the human touch (see Figure 4.3). It was decided that the line tool is best suited to outline the APA's body, creating coherent visuals based on consistency of line weight and appearance. The more expressive brush tool was used to emphasize the character's facial expressions.

Lastly, the expression of the primary hinting action was amplified through the use of ellipses. Grammatically, ellipses are indicative of an omission, their use in grammar has seen considerable overlap in visual media such as comics and manga given that, "If enough artists begin using the symbol, it will enter the [symbol-based] language for good – as many have through the years" (McCloud 129). The ellipses in this piece compliment the subtlety of hinting

by balancing between emphasizing the action, yet not overtly supplying the answer for the learning activity.

The APA's design benefited from a balance struck in its expressive capacity. The capability of the expressive line was tempered largely for the benefit of coherent line art. Additionally, the complimentary ellipses were balanced between maximizing on the hint while maintaining its innate subtlety.

The expressive capacity of the APA was tempered further through use of medium-saturation, low-contrast colours. Addition of shadow and highlight colours expressed the character's solid drawing further, though balanced as to not produce an overexposed/underexposed image as indicated in Figure 4.4.

The perceived race of the APA was a challenge, given my unawareness of the end users' preference. As previously stated under the section on expressive colour in preproduction, the APA's perceived race has an effect on the user's preference (Gulz Haake 326); as learners are more likely to prefer an APA that looks like them. However, I posit that the choice of APA's perceived race rests on the preference of the learner, and while it remains beneficial to design the APA towards the fullest extent of identifying with the learner/audience, the aspect of perceived race in the design remains a preference and not a determinant. Thereby, that preference has a limited bearing/influence on the learners' capacity to learn from an APA, given that the APA (regardless of perceived race) adheres to the proven guidelines of multimedia learning as well as is designed and animated with a balanced approach in mind.

With these colour-based considerations, the APA's coloured with a slightly tanned base skin tone.

Production

Production began by choosing the pose to pose approach over its counterpart straight ahead action. A combination of both was considered, given the brevity of the action, incorporating straight ahead approach did appear initially suitable. However, the pose to pose choice eventually led the production as its provision of solidly drawn key poses and structured

breakdown poses enhanced the workflow. Further, the spontaneity and vibrancy offered by straight ahead action seemed overt for an action as subdued as hinting. This vibrancy would likely deter from this specific learning activity and breach the coherence principle.

Production benefited from the pose to pose approach as it structural nature provided easy guides through key poses that informed the proceeding inbetween/tweening process. Additionally, the added benefit of audience appreciation for pose to pose approach was aimed towards and capitalized upon in the production.

The production was staged in the cinematographic full-length shot. This was staged in order to show the entirety of the APA's motion. A medium-length shot was earlier considered in the production, as majority of the APA's action was focused on his upper body. Given the likelihood of segments the action being cut out of frame (such as the hand swinging upwards/downwards), I opted to include the character's entire frame to avoid that possibility.

By staging a full-length shot, the learner gets to see the APA's body embodied fully. This aids the aim of believable human-like motion in an embodied APA and would, overall, foster generative learning.

Reiterating the design choices taken the preproduction phase, the solid drawing principle was approached with a "plastic" character in mind. The intent was for a plastic character that balanced between malleable yet solid, and adhered to a human-like appearance influenced by the companion role chosen for the APA. The plasticity in the APA's design carried on to its key poses which invariably inform the inbetweens, resulting in a solidly drawn animated sequence.

The solid drawing principle overlapped with a number of other principles in this production: squash and stretch, anticipation, follow through and overlap, and secondary action. Firstly, the principle of squash and stretch was aided by the solidly drawn character not just through its design basis of rounded shapes; which lend themselves well to organic deformations, but also through its solidly drawn key poses of anticipation and hinting.

Given the minimalism of the hint, the pose was drawn in a squashed manner to comply with this subdued nature. Therefore the prior pose anticipating the primary action (hinting) must

be stretched. Both poses, as well as other key poses in the sequence, were solidly drawn towards plasticity, visibility and clarity.

Secondly, the principle of anticipation as expounded above overlapped with principles of squash and stretch as well as solid drawing. Once the action of hinting was suitably drawn, anticipated and carried out, the ending of the hint had to be considered. These eventually led to the follow through and overlap principle. Overall, the approach to the follow through principle and the manner in which the hint ended had to be subtle, yet display the companion personality of the APA. This balance towards a finality that was both clear and did not overpower the hint itself was approached through facial expressions. The APA finalized the hint by (facially) expressing collaboration with a slight smile, a change from the smirk he had on while he hinted. This change of facial expression within the hint added life to the APA.

Adding yet more life to the APA, through change of expressions, saw the use of a particular follow through category; the moving hold. The APA's hinting forms a fraction of its time on screen, the rest sees the character 'idle' on screen. The idle state is essential as the APA could not motion throughout the activity, an act that would certainly distract and detract from the learning activity. The convergent moving hold and idle pose ensure the APA does not 'go dead' in the scene and coincidentally breach multimedia principles of image and coherence. In order to create the moving hold, the APA was animated along a breathing cycle: inhale – rest – exhale – rest – inhale, as illustrated in Figure 4.5. The character changes expressions from its idle state to the hint and back to idling.

Lastly, the overlap between principles of solid drawing and secondary action involved considerations of the facial expressions. The changes of expressions between idle to hinting action and between the hinting to its follow through give additional information and extra business to the entire animated sequence.

The arc principle and its organic paths were included in the entire animated sequence; from the broader arm path as the APA hints, to the smaller arcs as he breathes during the idle pose. To capitalize on the arc path, I repurposed it to inform the spacing of inbetween drawings, this would then inform the timing, ease in and ease out, and lag/follow through principles, Figure 4.5. The idea to use the arc in this manner was drawn from William's observation of an old

Disney technique (47) in which Grim Natwick indicated all the different 'spacings' on his drawing (47). This technique led to timing charts and eventually the exposure sheets/X-sheets in use presently.

The timing involved in the idle pose was considerably less demanding than that of the hinting. The idle was a structured cycle based on a moving hold with the primary purpose of ensuring the character does not go dead on scene. The spacing of the inbetweens for the idle cycle was influenced by the ease in and ease out principle to achieve a relaxed slow action.

The more demanding task in timing was surrounding the hinting. The action had to be balanced on screen long enough to be visible, yet in accordance with the subtlety of the hint, ensure it does not give away the answer entirely. I chose to time the hint in line with the duration of the highlighted answer. An intra-balance was struck within the hint to give majority of the time towards the action itself rather than the previous anticipatory action or the proceeding follow through concluding action. Further, with the intent of a believable human-like motion, more time was allotted to the concluding follow through action in comparison to the preceding anticipation action. This was in line with the ease in/ "cushion in" approach (Williams 51) that provides a smoother ending.

By repurposing the arc path to include timing and spacing of key poses and inbetweens, the production benefited greatly. The principle of ease in and ease out, including the subsequent believability in the APA's motion was achieved far quicker through the combination of arcs and timing.

A balance was struck within the principle of exaggeration. The capacity for caricature was weighed between the minimalist action and the previously decided iconic design. With those preexisting choices, there was limited room for exaggerated animation. However, the ellipses used to compliment the hinting can be deemed a form of exaggeration or emphasis on the action.

Cumulatively, the choices and approaches taken for this APA's production (in all three production areas of design, execution and composition) have produced an appealing animated sequence that intends to create a sense of affinity with the learner and aid their cognition through fostering generative learning.

Postproduction

There were no postproduction considerations to be made for this production. All assets were created during the preproduction phase in Adobe Photoshop and imported to Adobe Animate for production. Use of the Adobe Animate program allows for ease of integration to webpages through Adobe Animate's HTML (Hypertext Markup Language) media export option.

No sound track or sound effects were added to the piece. This is primarily due to the possibility of sounds deterring from the visuals, as well as audio accompaniments in multimedia learning being outside of the scope of this study/accompanying practice piece.

HIGHLIGHTS

Utilizing symbolic display of ellipses in the background to compound the action of hinting in the foreground was a key point of success for this piece (Figure 4.6). The balance achieved between the, essentially, subtle action of hinting with the clarity that a simple and symbolic display (in the background) can offer a nascent goal for various APA animations in future.

DIFFICULTIES AND CONCERNS

The primary concern is that APAs are, objectively, auxiliary additions to any e-learning environment. They are supplementary rather than foundational to the learning activity, and should be produced as such. Expounding on that concern is the possibility that APAs may be misrepresented as foundational, thereby distracting from the learning activity rather than aiding it.

In the same vein of my primary concern is the particular difficulty faced trying to tailor an APA without any knowledge of the end user: their level of prior knowledge or preferences towards design aspects (such as the perceived race of the APA). Notably, this difficulty is easily overcome by simply researching on the targeted learners prior to producing the learning activity as a whole, inclusive of the APA. The prerequisite research is crucial more so in terms of their prior knowledge, as the action of hinting may be perceived as arbitrary to a learner with a high-

level of prior knowledge whereas the same would be an integral addition to a low-level prior knowledge learner.

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Mayer, Richard, Clark C. Ruth. *e-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning*. 3rd ed., Pfeiffer Publishing, 2011, San Francisco.

McCloud, Scott. *Understanding Comics: The Invisible Art*. Kitchen Sink Press, Harper Collins, 1993.

Blair, Preston. *Advanced Animation: Learn How to Draw Animated Cartoons*. Walter Foster Publishing, 1949.

IMAGES

Figure 4.1 Munyao, Isabella. "Rounded shape informing the basis of the APA's design." *Author's own production*, 2017.

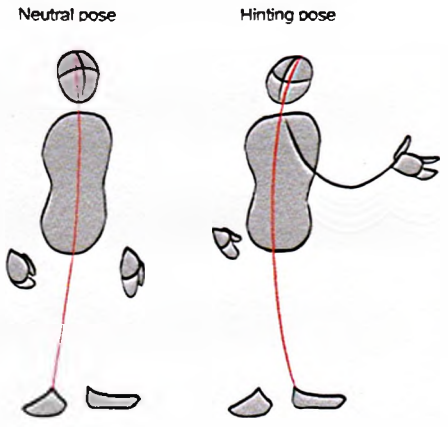

Figure 4.2 Munyao, Isabella. "Line of action curved for neutral and hinting key poses of the APA." *Author's own production*, 2017.

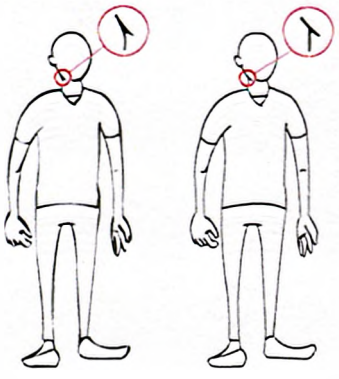

Figure 4.3: Munyao, Isabella. "Comparative between brush tool line art and line tool line art in Adobe Animate program." *Author's own production*, 2017.

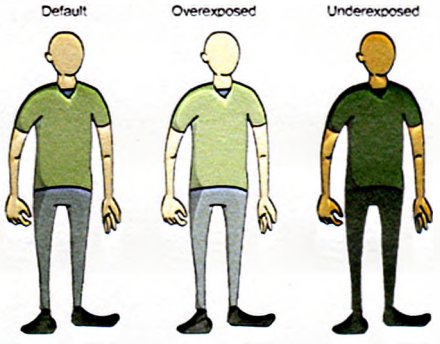

Figure 4.4: (Left) Munyao, Isabella. "APA coloured/inked. Inclusive of shadows and highlights." *Author's own production*, 2017. (Right) Munyao, Isabella. "Comparative images showcasing overexposed and underexposed colour." *Author's own production*, 2017.

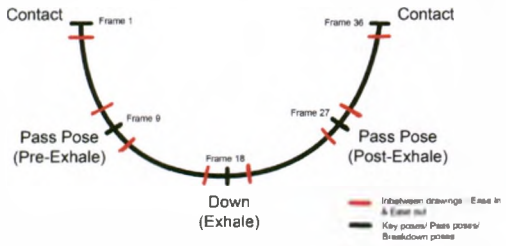

Figure 4.5 Munyao, Isabella. "Idle sequence/moving hold mapped along an arc." *Author's own production*, 2017.

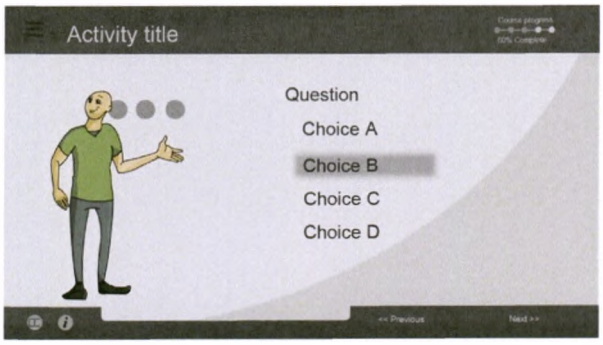

Figure 4.6 Munyao, Isabella. "Strengthening the hinting pose in Adobe Animate. The ellipses add on emphasis to action." *Author's own production*, 2017.

Image list

Figure 1.1 Ford, Mellisa. 3D Animation Pre-production. *Mel's Blog: Animation Pre-production and Modeling*, Wordpress, March 2016, www.melissafordsite.wordpress.com/2016/03/06/animation-pre-production-and-3d-modeling/ (Accessed 2nd November 2017)

Figure 1.2 Mayer, Richard. "Three demands on cognitive capacity during multimedia learning". *Cognitive Theory of Multimedia Learning, The Cambridge Handbook of Multimedia Learning*, Cambridge University Press, 2014, 59.

Figure 2.1 (Left) Gulz, Agenta and Haake, Magnus. "The three body stereotypes (somatotypes) defined by Sheldon et al. (1940)". *International Journal of Human-Computer Studies*, vol. 64, PsychInfo, 2006, 333. Compared with (Right) Blair. Preston. "Heavy-pugnacious character", *Advanced Animation*, Walter Foster Publishing, 1949, 15.

Figure 2.2 McCloud, Scott. "The Picture Plane". *Understanding Comics: The Invisible Art,* Kitchen Sink Press, HarperCollins, 1993, 51.

Figure 2.3 Munyao, Isabella. "Symbolic lines with emotive ties in APA designs; embodiment of an APA through lines." *Author's own production*, 2017.

Figure 2.4: McCloud, Scott. "Expressive Lines". *Understanding Comics: The Invisible Art,* Kitchen Sink Press, HarperCollins, 1993, 120.

Figure 2.5 (Left) Munyao, Isabella. "Colour emphasizing emotive capacity in a character: anger is illustrated & emphasized." *Author's own production*, 2017. Compared to (Right) Munyao, Isabella. "Colour emphasizing the "otherness", and separation, in background characters." *Author's own production*, 2017.

Figure 2.6 Mayer, Richard. "The Thought Bubble Makes Thinking Explicit". *E-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning*, 3rd Ed., Pfieffer Publishing, 2011, 358.

Figure 2.7 Chart centralizing the role of an APA within the broader field of multimedia learning and design

Tables