

**INTERACTIVE MULTIMEDIA LEARNING: A COMPARATIVE  
STUDY OF STUDENTS' RESPONSES TOWARDS THE USE OF  
EMOTIVE AND STATIC PEDAGOGICAL AGENTS**

By

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## **ABSTRACT**

### **INTERACTIVE MULTIMEDIA LEARNING: A COMPARATIVE STUDY OF STUDENTS' RESPONSES TOWARDS THE USE OF EMOTIVE AND STATIC PEDAGOGICAL AGENTS**

**Erwin Tjew**

Interactive multimedia learning has gradually moved from presenting text, image, video, or animation, to the use of virtual Pedagogical Agent (PA) to enhance learning. Despite technological advancement, the use of visual and audio characteristics of PAs requires empirical scrutiny. This research aims to achieve three research objectives: (1). Design and develop one Interactive Multimedia Module with Animated PA (IMMAPA) and another Interactive Multimedia Module with Static PA (IMMSPA) in the context of teaching and learning of Introductory Psychology; (2) Conduct a comparative study to investigate and evaluate students' learning achievement using two different types of PAs, i.e. the animated and emotive PAs (IMMAPA) and the static and non-emotive PAs (IMMSPA); and (3) Find out students' perceptions towards the features incorporated in IMMs such as the educational multimedia content and instructional role, characteristics and presentation styles of PAs, and students' learning motivation. This study examined how students who learned using IMMAPA and IMMSPA perceived the effects of simulated human-like communication in the two modules, and how two different PAs facilitated the teaching-learning process in a multimedia learning environment.

The research instruments, i.e. two IMMs with different types of PAs were developed, an achievement test to evaluate students' learning achievement, and a set of questionnaires to assess students' perceptions. Research findings show the results of the testing of six null hypotheses using descriptive statistics and Independent t-test. The research samples comprised 32 undergraduate students divided into the experiment group (IMMAPA) and the control group (IMMSPA). There was indication of significant differences in students' learning achievement and their perceptions towards IMMAPA and IMMSPA. This study contributes to the understanding of teaching and learning using differentiated PA features in an interactive multimedia learning environment of a university in Malaysia.

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## APPROVAL SHEET

This dissertation entitled “**INTERACTIVE MULTIMEDIA LEARNING: A COMPARATIVE STUDY OF STUDENTS’ RESPONSES TOWARDS THE USE OF EMOTIVE AND STATIC PEDAGOGICAL AGENTS**” was prepared by ERWIN TJEW and submitted as partial fulfilment of the requirements for the degree of Master of Communication (Structure B) at Universiti Tunku Abdul Rahman.

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**SUBMISSION OF DISSERTATION**

It is hereby certified that **Erwin Tjew** (ID No: **1600009**) has completed this dissertation entitled “INTERACTIVE MULTIMEDIA LEARNING: A COMPARATIVE STUDY OF STUDENTS’ RESPONSES TOWARDS THE USE OF EMOTIVE AND STATIC PEDAGOGICAL AGENTS” under the supervision of Dr. Ngeow Yeok Meng (Supervisor) from the Department of Multimedia Design & Animation, Faculty of Creative Industries, and Dr. Siew Pei Hwa (Co-Supervisor) from the Department of Multimedia Design & Animation, Faculty of Creative Industries.

I understand that University will upload softcopy of my dissertation in pdf format into UTAR Institutional Repository, which may be made accessible to UTAR community and public.

Yours truly,

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(ERWIN TJEW)

## DECLARATION

I hereby declare that the dissertation is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTAR or other institutions.

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## LIST OF ABBREVIATIONS

APA	Animated Pedagogical Agent
EMC	Educational Multimedia Content
IMM	Interactive Multimedia Module
IMMAPA	Interactive Multimedia Module with Animated PA
IMMSPA	Interactive Multimedia Module with Static PA
ITS	Intelligent Tutoring System
LM	Learning Motivation
MRT	Media Richness Theory
PA	Pedagogical Agent
PAC	Pedagogical Agent Characteristics
PAIR	Pedagogical Agent as Instructional Role
PAPS	Pedagogical Agent Presentation Style
SPA	Static Pedagogical Agent
UTAR	Universiti Tunku Abdul Rahman



## CHAPTER 1

### 1.0 INTRODUCTION

The early era of multimedia learning began with the use of computerized graphic and audio components such as photos, images and sound rather than textual base presentation. Richard E. Mayer (1947 – present) expressed that through well-designed instructional multimedia in learning, extraneous processing such as excessive textual content can be reduced, hence improving learning (Moreno & Mayer, 2003), fostering generative thinking and increasing motivation (Mayer, 2005; 2014).

The applications of multimedia communication teaching and learning has progressively improved since then. In 2001, Gunther Kress introduced multimodality theory was introduced in the field of communication. Kress (p.186) claimed that language in the spoken mode is yet another multimodal system; it uses the whole plethora of devices available to speech - pace, pitch variation, rhythmic variations, tone of voice. Kress contended that in the event of verbal communication there are multiple visual and audio modes involved in the process of sending and receiving information rather than reading written text. Kress's multimodality theory contributes to multimedia technology communication as the common verbal communication in many similar ways.

Numerous studies ever since have brought multimedia learning

technology to the invention of Pedagogical Agent (PA), an intelligence tutoring system (ITS) in computer science, primarily used to simulate the interaction between learners and computerized characters (Mabanza & de Wit, 2014). In the past decades, over hundreds of studies in PA were tested to investigate its impact in teaching and learning, varied to their designs and features, effects and affects, and even learning subjects and outcomes (e.g. Kim & Baylor, 2016, Schroeder; 2013; Romero-Hall, 2051).

In many recent studies (Schroeder, 2017; Reeves, 2015; Ryu & Ke; 2018), PAs are designed with available computer technology to mimic the appearance and functions close to human-like characters. The idea is to reduce stagnant interaction with learners hence to improve quality of communication during knowledge transfer. Johnson and Lester (2014) pointed out interactive features (with PAs) are aligned with the evolving computer technology. Various growing contemporary multimedia technology are applied to various PA designs in order to study their effects and affects to teaching and learning. Several studies (e.g. Chen and Wang, 2018; Yung & Paas, 2015) implied using animation in PA graphics instead of static generated more positive results. Besides, there were some studies (e.g. Ryu & Ke, 2018; Schroeder, Romine & Craig, 2017) emphasized the importance of human voice attribute combined with sophisticated PA design helps to improve learning further.

Despite numerous of prior pedagogical agent studies, there is a grey area that needs to be investigated further, specifically in PA designs (audio and appearance) in order to simulate emotive behaviour to communicate with

learners. This research seeks to enhance multimedia learning by comparing data differences in students' response between two types of PA designs (emotive and static).

## **1.1 Research Background**

PAs are virtual characters developed with the purpose to assist teaching and learning (Chou; 2015; Davis, 2018; Mabanza & deWit, 2014). The agents are commonly designed and projected as humanoid computer graphic. The intention is to instil the presence of familiar educator's figure in providing knowledge. However, PAs are often presented with lack of human-like attributes, such as adequate appearance, social feature, or even artificial emotions despite of current graphical computer technology (e.g. Pi et al., 2018; van derMeij, van derMeij, 2015). Additionally, designing a PA with higher human-like attributes could result in distinguishable learning responses compared with a PA with lower attributes, or known as static PA (Johnson & Lester, 2016; Tegos & Demetriadis, 2017).

Numerous studies and advancement in multimedia learning technology have led to the invention of Pedagogical Agent (PA), primarily used to simulate the interaction between learners and computerized characters (Mabanza & de Wit, 2014). PAs were featured in intelligence tutoring system (ITS) in computer science, and were tested to investigate its impact in teaching and learning, varied to their designs and features, effects and affects, and even

learning subjects and outcomes (e.g. Kim & Baylor, 2016, Schroeder; 2013; Romero-Hall, 2015).

In recent studies (Reeves, 2015; Ryu & Ke; 2018; Schroeder, Romine, & Craig, 2017), PAs have been designed to mimic the appearance and functions close to human-like characters. The idea is to reduce stagnant interaction with learners hence to improve quality of communication during knowledge transfer. Johnson and Lester (2016) pointed out that PA interactive features are aligned with the evolving computer technology. Contemporary multimedia technology are increasingly applied to various PA designs in order to study their effects and affects to teaching and learning. Several studies (e.g. Chen & Wang, 2018; Yung & Paas, 2015) implied that using animation in PA graphics instead of static texts and images reaped greater benefits and more positive results. In addition, researchers (Ryu & Ke, 2018; Schroeder, Romine & Craig, 2017) emphasized the importance of human voice attribute when combined with sophisticated PA design, helps to improve learning further.

## **1.2 Problem Statement**

Many studies suggested that using PAs had positive impacts on learning (Chen & Wang, 2018; Dincer & Dagonay, 2015; Swartout et al., 2013; Takacs, Swart & Bus, 2015; Yung & Paas, 2015). Despite the different emphasis of prior PA-related studies, there is a gap to be filled, particularly in the use of PA (both audio and appearance) that simulate human-like behaviour when

communicating with target learners. Thus, this study seeks to look into the possible disparity between emotive PA (comprising interactive multimedia design, animation and human voice) and static PA (without emotive features).

With the escalating technology in multimedia learning, different PA designs and functions have resulted in various outcomes from previous studies. To highlight the issue, some PA appearances found in these studies are varied, ranging from the use of simple graphic as agent's representation, to a close-human-look designed with advance computer program. The PAs are presented to learners with various combinations of multimedia elements, i.e. interactivity, audio assistance, and animation.

Although few studies have applied the interactive and two dynamic media design features (e.g. Dincer & Doganay, 2015; Johnson & Lester, 2016; Ryu & Ke, 2018), portrayal of all three features as mentioned above (i.e. interactive, animation and audio) were scarce in past studies. Furthermore, various findings about learning outcomes found from previous PA studies, has given rise to a question of whether or not using PA in multimedia learning truly affect learning; if so, how and why. Based on the summary of numerous prior studies, this research is believed to fill the gap of the lack of interactive and dynamic multimedia features in prior PA designs, by developing PAs that incorporate three essential elements i.e. interactive, animation and audio. The findings would contribute to a deeper understanding of how PA contributes positive impact to learning effectiveness.

However, there were other similar studies suggested that PA might not be as effective as it had been tested. Some studies claimed that there was no or small significant different in the use of PA as learning medium (Craig & Schroeder, 2017; Guo & Goh, 2015), the use of PA might have benefiting influence in learning motivation, but not the influence of its persona and learning outcome (Schroeder & Adescope, 2015), and continuous use of animation offers no real advantage (Riaz & Zaman, 2013). Ahdon (2013) claimed that much work needed to improve the use of PA in promoting learning.

### **1.3 Research Questions**

Given the background of the research, the primary aim of this research is to examine the impact of the use of two interactive multimedia modules (IMMs) with different types of PAs on students' learning achievement in Introductory Psychology. These two types of PAs are as follows:

- i. An emotive and animated type of PAs; and
- ii. A non-emotive and static type of PAs.

To achieve the primary aim, the research attempts to answer the following research questions:

- i. **Research Question 1:** How to design and develop two IMMs with different types of PAs, i.e. animated with emotive features and static with non-emotive features for Introductory Psychology teaching and learning at tertiary level?

- ii. **Research Question 2:** Is there any significant difference in students' learning achievement between the learning of Introductory Psychology using IMM comprising animated and emotive PAs with spoken-text (human recorded voice) (IMMAPA) and the learning of Introductory Psychology using IMM comprising static and non-emotive PAs with written text (IMMSPA)?
- iii. **Research Question 3:** Is there any significant difference in students' perceptions towards the IMM comprising animated and emotive PAs with spoken text (human recorded voice) (IMMAPA), and IMM comprising static and non-emotive PAs with written text (IMMSPA) in giving positive effects to simulate human-like communication that facilitate teaching-learning process in a multimedia learning environment?

#### **1.4 Research Objectives and Hypotheses**

The three main objectives of this research are:

- i. To design and develop IMMs with different types of PAs, i.e. animated pedagogical agents (APA) with emotive features, and static pedagogical agents (SPA) with non-emotive features in delivering Introductory Psychology lessons as learning subjects;

- ii. To conduct a comparative study to investigate the effectiveness of teaching and learning Introductory Psychology by evaluating students' learning achievement between students who learned using IMM with emotive and animated PAs (IMMAPA) and students who learned using IMM with non-emotive and static PAs (IMMSPA);
- iii. To find out students' perceptions towards the features incorporated in IMMs such as Educational Multimedia Content (EMC), Pedagogical Agents' Instructional Role (PAIR), Learning Motivation (LM), Pedagogical Agents' Characteristics (PAC), and Pedagogical Agents' Presentation Styles (PAPS) in giving positive effect to simulate human-like communication that facilitate teaching-learning process in a multimedia learning environment between students who learned using IMMAPA and students who learned using IMMSPA.

The second research objective above, it was hypothesized that-students in the group who learned Introductory Psychology lessons using the IMM with emotive and animated PAs would have higher leaning achievement compared to the students in the group who learned using the IMM with non-emotive and static PAs. Thus, the following null hypothesis was tested:

**H<sub>0</sub>1: There is no significant difference between the learning of Introductory Psychology using IMMAPA and IMMSPA on students' learning achievement.**



Further, from the third research, the following five hypotheses were tested to investigate whether or not students who learned Introductory Psychology using two IMMAs with different content and PA features would have different perceptions towards the features incorporated in IMMAs such as EMC, PAIR, LM, PAC (animated or static PAs), and PAPS (using spoken text, i.e. recorded human voice or written text to present the PAs' conversation in the delivery of instructional content):

**H<sub>02</sub>: There is no significant difference in students' perceptions towards educational multimedia content in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.**

**H<sub>03</sub>: There is no significant difference in students' perceptions towards pedagogical agents' instructional role in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.**

**H<sub>04</sub>: There is no significant difference in students' perceptions towards learning motivation in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.**

**H<sub>05</sub>: There is no significant difference in students' perceptions towards pedagogical agents' characteristics in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who**

**learned using IMMSPA.**

**H<sub>06</sub>: There is no significant difference in students' perceptions towards pedagogical agents' presentation styles in enhancing students' learning of Introductory Psychology between students who learned using IMMSPA and students who learned using IMMSPA.**

## **1.5 Research Significance**

This research sought to further contribute to the development of PA technology and integration of PA in multimedia applications. There are two positive sides of the general contribution of IMMs designed with emotive and animated PAs:

- i. This research aims to harness the power interactive PA in multimedia learning in order to increase learners' attention span, particularly those who are having difficulties with textual-based media learning;
- ii. This research develops two educational modules that use human-like interaction are likely to link learners to more user-friendly virtual social interaction.

Both IMMs can introduce alternative e-learning tool to learn basic psychology or non-psychology students in UTAR. It can enhance interactive learning features which are currently available in the University's online portal.

Using similar types of emotive PA for multimedia instructional role is expected to potentially increase students' motivation to access the portal for the purpose of gaining introductory psychology knowledge.

IMMAPA and IMMSPA that have been developed for the purpose of Introductory Psychology teaching and learning in this research are expected to be the initial main contribution. Emotive and animated pedagogical agents are potentially play a significant pedagogy roles as social agents (Schroeder, Adesope & Gilbert, 2013), as motivator in learning (Low & Jin, 2009; Park, 2015; van der meij, van der meij & Harmsen, 2015), or even as instructors for academic successors (Dincer & Doganay, 2017; Ozdemir, Izmirli & Shahin-Izmirli, 2016), depends on learner's perception toward the characteristics of PA they are interacting with.

The creation of these two IMM s on Introductory Psychology lessons provided learners an option to experience multimedia learning environment with PA designs to enhance non-psychology major students learning. It is hoped that IMMAPA and IMMSPA instil interest and stimulate their inquisitive minds, to acquire general psychology knowledge. Nevertheless, both IMM s are prototypes at their early stage. IMMAPA is presumed to be enhanced from animation to a more immersive visual and audio technology available contemporary.

## 1.6 Definition of Terms

There are several terms used in the research as follows:

- i. **Pedagogical agent:** A pedagogical agent is an intelligent tutoring system (ITS) in computer science primarily used to simulate the interaction between learners and computerized characters (Mabanza & de Wit, 2014, p. 147). Commonly presented in a form of 2D or 3D computer generated human characters to assist or enact a role in teaching and learning.
- ii. **Emotive pedagogical agent:** Emotive pedagogical agent is a lifelike, deictic, animated pedagogical agents to communicate with visually expressive and full-body gesture to communicate problem-solving advice and simultaneously have a strong motivating effect on students (Lester et al., 2000, p. 125).
- iii. **Static pedagogical agent:** Static pedagogical agent is a much simpler design of than the animated/emotive pedagogical agent, can be a use of an image of a character as visual stimuli with text on screen (Schroeder, Adesope & Gilbert, 2013, p. 2). Commonly developed in early years of PA invention for multimedia learning.
- iv. **Interactive multimedia:** Interactive multimedia or “hybrid technology” refers to any package of materials that includes some combination of texts, graphics, still images, animation, video, and audio (Bass, 2019). With today’s computer technology, these materials are made to send, obtain, and retain

information with the user through interactions.

- v. **Multimedia Learning:** Multimedia refers to the presentation of material using both words and pictures (Mayer, 2002). The case for multimedia rests in the premise that learners can better understand an explanation when it is presented in words and pictures than when it is presented in words alone. Multimedia messages can be described in terms of the delivery media (e.g., amplified speaker and computer screen), presentation mode (e.g., words and pictures), or sensory modalities (e.g., auditory and visual).
- vi. **Introductory Psychology:** Introductory Psychology refers to the course content developed in both IMMs, referring to the fundamental knowledge of general psychology which is simplified to most discussed subjects such as its definition, branches of psychology, common dichotomies, and introversion-extraversion personalities.

## **1.7 Chapterisation**

Chapter 1 covers introduction, research background, problem statements, research questions, research objectives, research hypotheses, and research significance.

Chapter 2 reviews literature related to this research, particularly about multimedia learning and pedagogical agents. Recent literature in research journals, books, and online sources are reviewed with topics ranging from the early development of multimedia learning in education, types of pedagogical agents used and their effects in learning, critiques and support of PA developments in education, to the application of animation and human voice to simulated emotive behaviour in PA.

Chapter 3 presents the research methodology used in this research, including research design, samples, research instruments, data collection procedure, and appropriate statistical methods of data analysis for null hypotheses testing. And more importantly, this chapter discusses about the design, development, and characteristics of the two IMMs as the instrument of the research.

Chapter 4 reports the results produced from the data analysis through null hypotheses testing using appropriate statistical methods, which have been discussed in chapter 3. The corroboration of hypotheses from the findings are presented as a conclusion of the examination of the impact of emotive and

animated PAs in IMMAPA compared to non-emotive and static PAs on students' learning achievement in Introductory Psychology. It also reports the results of the evaluation of students' perceptions towards the features incorporated in IMMs.

Chapter 5 summarises the discussion of the research findings by presenting the overall conclusions to the research findings in accordance to the research objectives set at the early stage of this research. It also includes research contributions, research limitations and recommendations, as well as research implications.

## CHAPTER 2

### 2.0 LITERATURE REVIEW

This chapter discusses several topics pertinent to this research about pedagogical agents and multimedia learning as follows:

- i. Evolution of multimedia learning using multimodal computerized characters.
- ii. Theoretical background
- iii. Pedagogical agents (PA)
- iv. Emotive features of PA
- v. Emotive versus static PA
- vi. Introductory Psychology as learning topic

### 2.1 Evolution of multimedia learning using multimodal computerized characters.

Multimedia learning was defined by Richard E. Mayer as presentation of learning materials in textual content, graphic, illustration, graphs, diagram, even animation or videos (Mayer, 2002). Ever since instructional learning in multimedia used as alternative educational tool to support and complement conventional verbal delivery, scholars have been conducting studies about potential ways to enhance learning using multimedia technology beyond graphics and texts. Soon after the turn of the century, there was a growing



number of studies about how visual and audio in multimedia enhance learning outcomes (e.g. Low & Jin, 2009; Mayer & Estrella, 2014); including the use and development of computerized characters, known as pedagogical agents or PA (e.g. Lester et al., 2000; Liew, Tan, & Jayothisa, 2013; Mabanza & de Wet, 2014; Murray, 2008).

When a semiotic communication was introduced by Gunther Kress's multimodality in 2001, there was significant growing interest in the use of the theory in its application of PA designs. Kress (2001) suggested that a more effective interaction consists of various types of visual and audio presentation. Multiple modes/modalities in communicating, such as body language, eye gaze, facial expressions, voice tones all contribute to the increased level of attention. In computer mediated communication such as virtual agents like PA, the same principle is applied with same intention to enhance communication with learners in multimedia learning environment.

The understanding of multiple visual and audio representation in virtual characters application has opened up more possibilities for scholars to explore PA designs. This led to more studies generating PA design with various modalities rather than a single mode (e.g. Lusk & Atkinson, 2007; Zha & Bourguet, 2016). Both studies by Lusk and Atkinson, and Zha and Bourguet pointed out that multi modalities in PA presentations result in a difference in students' responses. According to Anderson et al. (1999), a multimodal approach to theories of literacy emphasizes communication through a wide range of forms and materials; the agency and interest of individuals in the

making of messages; and genres and other forms are hence to be reshaped (as cited in Jewitt , 2003)

Multimedia technology rapid advance has made possible of producing more creative multimedia usage, inclusively for education purposes (Johnson & Lester, 2016; Mayer & Estrella, 2014). This sparked many other studies whom also agree in the potential of using multimedia-based instructional medium to foster learning (e.g. Pang, 2013; Surjono, 2015; Yap, 2016). Yap (2016) pointed out that multimedia technology can motivate students to continue their attention span with the presentation, which allow them to engage in the learning process if the process goes on.

### **2.1.1 Multimedia learning and animation**

Animation is a type of pictorial introduction. It has turned into an evident component of innovation based learning conditions (Abhishek, Vengatesan, Rajesh & Singhal, 2019). Along the way, the study of multimedia and instructional design moved forward to the use of animation and narrative contents to aid learning (e.g. Lamb & Johnson, 2006; Mayer & Anderson, 1992; Mayer & Moreno, 2002).

In recent studies, animation is still an essential aid in multimedia learning environment. Chiou, Tien and Lee (2015) used combination of animation in multimedia learning to improve learning achievement, retention, and satisfaction in Taiwan. Rao (2016) examined the usage and the degree of “success that animation has achieved in simplifying complex concepts,

strengthening long term memory retention, and addressing why is animation more effective than other teaching pedagogies.

Tversky and Morrison (2002) however, questioned whether animation can facilitate learning, they doubted the proclaimed of significant increase in effectiveness as pointed by prior studies? Tversky and Morrison argued that it is the interactive feature such as play, pause, stop, or replay command which comprised in instructional multimedia learning that help students to learn, not the animation (p.258).

### **2.1.2 Interactive multimedia with animation and narration features**

Multimedia teaching has many advantages of that it is convenient, vivid informative and interesting, can greatly improve the efficiency of teaching (Xu, 2017). Citing the work of Malik and Agarwal, I Made and I Made (2018) noted that multimedia has a full potency as a new educational technology tool by providing educators and students with endless possibilities of teaching and learning quality considering its pedagogical strength and limitations.

Multimedia technology continuously progressed with varied of additional features. As information technology progresses, multimedia design stepped into more interesting features to aid immersive computer learning. The use of interactive features or animation and narrative were no longer can be used independently only. Lin (2015) found that interactivity has a game-based simulation factor with potential and effectiveness towards multimedia learning.

Interactivity and games challenges their ability to think, explore, and respond (Lieberman, 2006), unlike those using only video, graphic, illustration, or animation presentations. In addition, Litman (2005) explained that interest and motivation of learning are stimulated from wanting and liking, which are driven from curiosity of new experience and new knowledge uncertainty.

## **2.2 Theoretical Background**

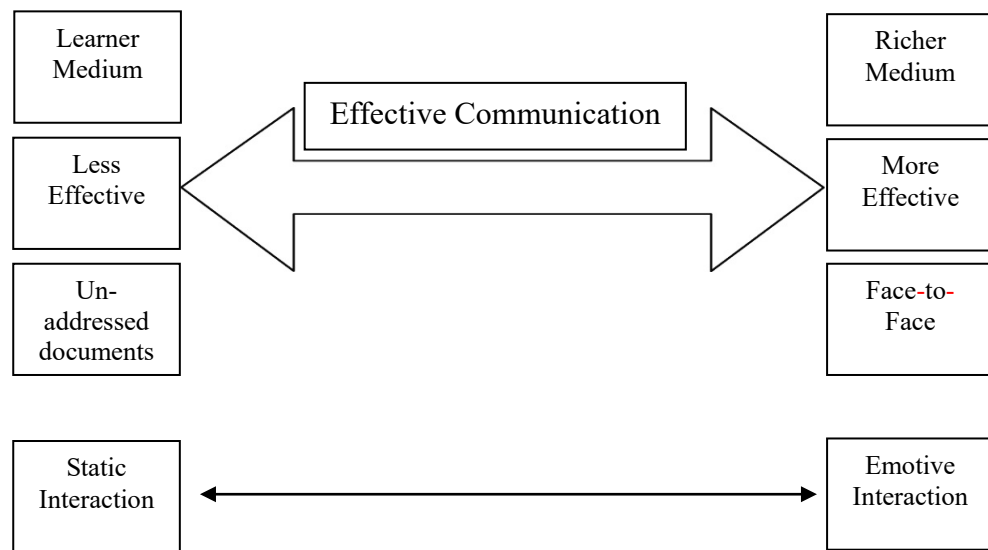
This research are using deductive approach whereas the design of research instrument were developed based from two media theories, namely media richness theory and multimodality theory.

### **2.2.1 Media Richness Theory**

Media richness theory (MRT) emphasises the way message is presented based on media type, effecting communication effectiveness as shown in figurer 2.1 (Daft & Lengel, 1986). According to Daft and Lengel, the richer the media, the better. But how is a media considered richer than the other? Media richness is varied based on multiplicity of cues, immediacy of feedback, language variety, and personal focus in medium capacity. Hence, medium content with more of these four criteria, is richer.

Using multimedia in learning allows extended features such as narration, animation, voice, and interaction; compared to word, text, and graphic presentation (Mayer & Moreno, 2003; Moreno & Mayer, 2002).

Throughout the years, multimedia content in learning has been continuously enriched with more engaging visual and audio features, which came to the creation of PA. Although MRT described richness level in PA, the theory is limited in perceiving communication outcome due to individual computer literacy level, complexity of media used, and personal interaction experience.



Source: Daft & Lengel (1986)

**Figure 2.1: Level of effective communication in Media Richness Theory proposed by Richard Daft and Robert Lengel**

Why MRT? As can be perceived through Figure 2.1, Daft and Lengel (1986) explained the less use of textual usage and the more visual-audio representation, the more communication effectiveness. This explanation is very close to what Richard E. Mayer has been stating in his series of research, that learning effectiveness is correlational with the higher use of visual-audio contents in multimedia rather than extraneous graphic and text using (Mayer, 1997; 2001; 2003). Emotive interaction and voice features through animated character is the richest media concept in this study, and its learning effectiveness is measured in parallel with communication effectiveness.

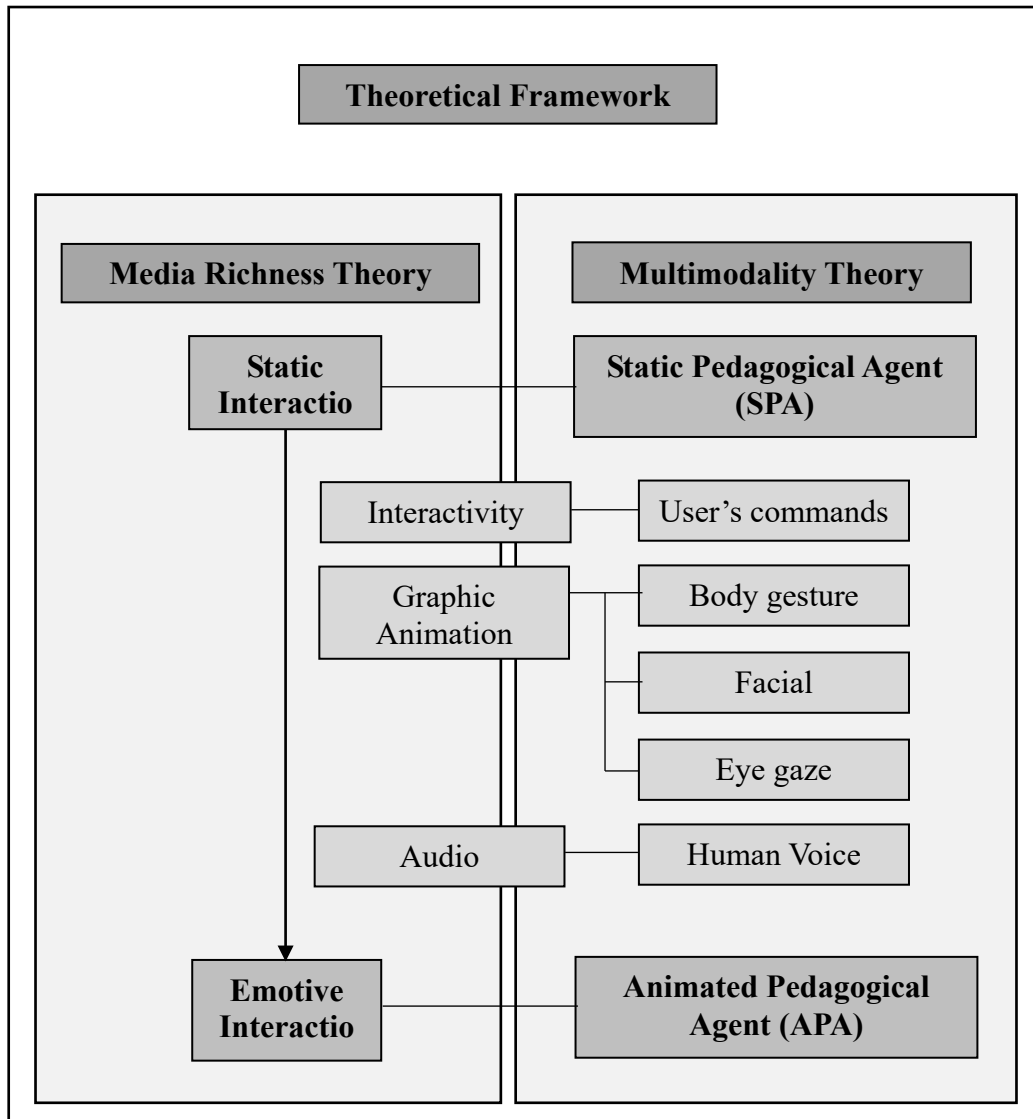
### **2.2.2 Multimodality Theory**

Multimodality is a communication theory introduced by Gunther R. Kress (2001) describing human's interpretation ability of communication practices in using different modes such as text, audio, with semiotic representation, and spatial literacy. The idea within multimodality theory according to Kress (2001) was the use of voice, body gesture, as a more expressive language in social communication rather than just spoken or written language (mono-modal). Kress suggested that visual language plays important part when combines with audio language. In educational technology era, the theory has been used for investigate users' learning outcome in instructional multimedia design.

In this research, multimodality theory is used to identify users' learning effectiveness from interacting with the pedagogical agents. The theory plays a role in describing pedagogical agent's audio and visual behaviour that affect users' communication effectiveness. Communication effectiveness is measured based on learners' perception about agent's animation and voice interaction. The animation concepts follow Kress's idea of gesture language, which include, facial expression, body gestures, hand movements, agent's look (head and torso) (Kress, 2001).

Despite its idea similarity with multimodality theory, this research chooses to adapt Kress's Multimodality theory instead of Mayer's Cognitive theory due to the focus in area of research. Cognitive theory is more suitable in its application of broader context in multimedia study. Meanwhile, this

research has a more specific aims in studying the effect of animation and human voice represented in PAs' body language and expressions. Hence, the Multimodality application for this research is more suitable.



**Figure 2.2: Level of effective communication in Media Richness Theory proposed by Richard Daft and Robert Lengel**

Source: Adapted from Kress, 2001

### **2.3 Pedagogical Agent**

The evolution of multimedia learning has led to the application of virtual characters as multimedia elements. The virtual characters are often equipped with animated features (e.g. Chen & Wang, 2018; Romero-Hall, 2015; van derMeij, van derMeij & Harmsen, 2015), interactive feature (e.g. Ahdon, 2013; Surjono, 2016), or even combination or both (e.g. Chen & Wang, 2018; Yung & Paas, 2015). Regardless, the purpose and function of pedagogical agent are commonly aimed to assist and improve multimedia teaching and learning.

PA is an autonomous agent that acts as a guide of instructor for education and training purposes. (Ahdon, 2013; Mabanza & de Wit, 2014). Pedagogical agent or intelligent agent is a cartoon character designed to help learning process in computer aided learning (Tien & Osman, 2010). Life-like computerized characters designed to facilitate learning in interactive environments (Romero-Hall, 2015; Schroeder, 2013). These life-like autonomous characters cohabit learning environments with students to create rich, face-to-face learning interactions (Kim & Baylor, 2016). APAs are software agents that guide users through virtual (computer-based) environments. They are commonly presented as an image and voice (van der Meij, van der Meij & Harmsen, 2015).

Gulz, Haake, Silvervarg, Sjöden and Veletsianos (2011) defined PA as “a computer-generated character employed in an educational setting in order to fulfil pedagogical purposes. Such agents (or characters) can serve numerous



pedagogical roles” (p. 129). Likewise, according to Schroeder, Adesope and Gilbert (2013), PAs are referred to as “on-screen characters that facilitate instruction to the learner” (p. 1). However in another study, Yung and Paas (2015) found that instructional animation learning challenges learner to extract relevant information from transient information they received in order to form better understanding.

Its definition is varied from one study to another, but means the same as its function, a computer generated representative designed to enact teaching and learning functions as either an assisting or instructional being.

### **2.3.1 Animated versus static PA**

Daly, Bulloch, Ma, and Aidulis (2016) point out that “with the trend toward online delivery of teaching materials as well as the availability of powerful hardware and software, we predict a continued growth in the use of animations for teaching purposes.” Ware Bolan, Miller, Rogers, & Ahrens (2016) discovered that moving graphic representation is more effective in gaining faster responses compared to common static graphic representation (p. 77). Similar result were found in studies (Moreno & Mayer, 2003) in which the presence of animation in graphical instructional multimedia reduce learners’ cognitive load in receiving information. Whether or not animation versus static in pedagogical agents’ application can cause the same positive learning effect, further study is required.

Animated Pedagogical Agents (APAs) are software agents that guide users through virtual (computer-based) environments. They are commonly presented as an image and voice (Vander Meij, Van derMeij, & Harmsen, 2015). Citing past research work, Wang et al. (2018) noted that the recent advancement in computer technology, artificial intelligence, and virtual reality technology, allow instructional designers to create vivid onscreen PAs in multimedia learning environments. Wang et al. (2018) described a PA as “an image of a character presented on a screen intended to help student learning” (p. 250).

Schroeder, Adesope and Gilbert (2013) noted that pedagogical agents can be as simple as static characters which respond through visual stimuli, such as text on the screen, to as complex as life-like three-dimensional characters which can provide visual signalling through gestures and body language, as well as auditory cues through narration. Chen et al. (2012) stated that animated pedagogical agents (APAs) with characteristics such as facial expressions, gestures, human emotions, and an interactive user interface are attractive to students. Wang Li Mayer and Liu (2018) contended that static image is not particularly conducive to learning, adding that “people do not learn better from an onscreen multimedia lesson when a static image of a pedagogical image is added to the screen” and hence concluded that “simply adding the image of a PA is not helpful.” (p. 264). Their findings prompted more creative and emotive features to be created to enhance the gratification and effectiveness of using multimodal PAs in teaching and learning.

## 2.4 Emotive features of PA

Some studies used term “life-like” agent (Johnson & Lester, 2016; Kim & Baylor, 2016). While some other called it “human-like” agent (Guo & Goh, 2015; Mayer & Estrella, 2015; Schroeder & Adesope, 2015), animated pedagogical agents are the best instructional approach they should be designed with important character building qualities as well as the psychological (Romero-Hall, 2015). Romero-Hall pointed out that animated PAs is an effective instructional approach when designed with important character building qualities such as being motivational and psychologically engaging. Nevertheless, combining the elements of body gestures, facial expressions, and human voice in PAs are more efficient towards learning. This idea is supported by several PA studies in the past (i.e. Kim & Baylor, 2016; Ryu & KE, 2018; Schroeder, Romine, & Craig, 2017).

The concept of an agent, especially when modified by the terms intelligent, animated, or conversational, brings forth images of human-like androids, working without supervision on tasks thought to be for our benefit but not necessarily to our liking (Romero-Hall, 2015). Emotion from facial expressions is contagious communication, the observers can unconsciously mimic the person (character) they observed (Frith, 2009). It is not only facial expressions of emotion that are processed rapidly and without awareness. Gaze direction is another important facial cue when observing the behaviour of others, Frith added (p. 3455).

Mayer and Estrella (2014) found that redesigning multimedia lessons to incorporate emotional design (such as eyes expressions) provides consistent evidence that principles significantly improves learning outcomes. Johnson, Rickel and Lester (2000) studied the use of animated pedagogical agent (animated character) provides a face-to-face tutoring interaction, allowing life-like communication modalities, a technology with significant impact to education and training. They claims that animated pedagogical agents are capable to illustrate the intelligence behavior of tutoring system.

Emotion from facial expressions is contagious communication, the observers can unconsciously mimic the person (character) they observed (Frith, 2009). Mayer and Estrella (2014) concluded that emotional design cues cause learners to exert more effort (i.e., motivation) to make sense of the presented material during learning (i.e. generative processing), which in turn leads to better learning outcomes (i.e. mental models) capable of supporting performance on comprehension tests (i.e. post-test performance) (p. 17).

In the application, pedagogical agent are presented with body gestures, facial expressions, or even voice activation as artificial emotive communication function of animated characters. Animators and character designers are required to adhere to close resemblance of human-like movement and law of physics (Lester et al., 1999). But again, the character's main function is to incorporate certain knowledge and interaction. Whether cartoony or realistic human-like behavior will do as long as it serves to promote learning.

Students who received human-voice induced in PA are more likely respond with social connection behaviour (facial, verbal, body gestures responses) as impact of conversational nature, than the ones who do not (Atkinson, Mayer, & Merrill, 2005). Atkinson, Mayer, and Merrill added, “a voice effect in which students achieved better transfer performance when the on-screen agent spoke in a human voice than when the on-screen agent spoke in a machine synthesized voice. Importantly, learners also gave more positive ratings to the on-screen agent who spoke with a human voice rather than a machine voice on an instrument designed to capture the social characteristics of speakers.” (p. 136)

Similar results can also be found in a research conducted by Craig and Schroder (2017), which states that “It appears as though machine synthesized voices have reached a point where they can result in similar or improved learning outcome and efficiency scores compared to recorded human voices”. A study about pedagogical agent by Van der Meij et al (2015) explained voice interaction with facial expressions increase students' motivation by showing the agent's mood change in spoken words or sentence. Similar study conducted by Baylor, Ryu, and Shen (2003) whom claim that A main effect for voice indicated that participants rated the agent persona as more engaging and human-like when it had a human voice. Not fail to mention, Mayer also agrees that human-like, animated and voice foster social cues in multimedia learning (Atkinson, Mayer, & Merrill, 2005).

## **2.5 Emotive versus static PA**

This research intends to investigate specific human-like attributes in PA as the area of study, focusing on the visual (appearance) and audio (voice) aspect of the PAs. Mayer (2003) as well as Mayer and Moreno (2003) claimed that visual and audio aids in multimedia learning are to be applied together to achieve optimal learning effectiveness. Mayer and Estrella (2014) suggested that emotional design in multimedia learning is a beneficial factor, whereas Schroeder, Romine and Craig (2017) implied that using human voices in PA increases learners-virtual human communication. Romero-Hall (2015) acknowledged that human qualities such as movement and human voice reflects emotive behaviour in PA.

In this research, emotive animated PAs are simulated by combining both their human like-appearance and voice features, while non-emotive static PAs are presented without them. This research attempts to explore the possible effects caused by applying emotive animated behaviour in PAs, and at the same time to find possible differences caused by PAs with non-emotive static behaviour in the teaching and learning processes.

Many studies suggested that using pedagogical agents had positive impact to effect learning (Chen & Wang, 2018; Dincer & Dagonay, 2015; Swartout et al., 2013; Takacs, Swart, & Bus, 2015; Yung & Paas, 2015). However, there were also studies speculated PA capabilities to enhance learning results. Johnson and Lester (2016) argued that PA-based learning effect was changing situating the advancing technology. Kim and Baylor

(2016), as well as Schroeder, Adesope, and Gilbert (2013) found that agent-based learning were favouring one gender group more than the other. Wang et al. (2017) examined that PA could effectively improve learning outcome but did not facilitate learners' motivation and interests. Besides the arguments of whether or not PAs improve learning, more in-depth investigation is required to examine the types of PA used in those studies, particularly with the multimedia elements used to design the agents.

Literature search and prior studies using evidence-based outcomes and findings have shown elements such as interactivity, animation and audio (voice-over) as essential dynamic multimedia features in designing PA for learning. For example, interactivity enhances human-computer interaction (Pang, 2013; Reeves, 2015) whilst animation and audio (voice-over) using expressive words are more engaging (Schroeder, Romine & Craig, 2017; van der Meij et al., 2015).

Some studies claimed the use of animation in multimedia and PA designs improved learning (Kim & Baylor, 2016; Rizzo et al., 2015; Romero-Hall, 2015; Takacs & Swart, 2015). Besides, studies on redesigned multimedia lessons to incorporate emotional design principles are evidently proven to have significantly improved learning outcomes (Mayer & Estrella, 2014; Yung & Paas, 2015).

Using PA in learning proven to be an effective and affective tool to increase learning motivation and performance (Dincer & Dagonay, 2017; Guo,

Goh & Luyt, 2014; Kim & Baylor, 2016; Low & Jin, 2009; Mayer, 2014; Park, 2015; Parong & Mayer, 2018; Shiban et al., 2015).

To mention a few, comparative studies between animated PA and static PA (e.g. Chen & Wang, 2018; Van der Meij, Van der Meij, & Harmsen, 2015; Yung & Paas, 2015) acknowledge that animated PA show noticeably more positive outcome compared to common static PA. The reason is because richer medium type of pedagogical agents are capable to provide higher learning quality (Guo et al., 2014; Patrut & Roxane, 2016; Pi et al., 2018). They are equipped with computer generated human qualities such as animated facial expressions and body movements, text-speech voices, and even emotion to socialize.




Following are several examples which assumed to have room for PA design improvements. van der Meij, van der Meij and Harmsen (2015) utilised animated PA to enhance motivation in science learning. However, the PA was displayed only from shoulder to head as shown in Figure 2.3. Although the agent is equipped with multiple facial expressions, there is no room for body gestures and interactive features.



**Figure 2.3: PA appearance found in the study of van der Meij, van der Meij and Harmsen (2015)**

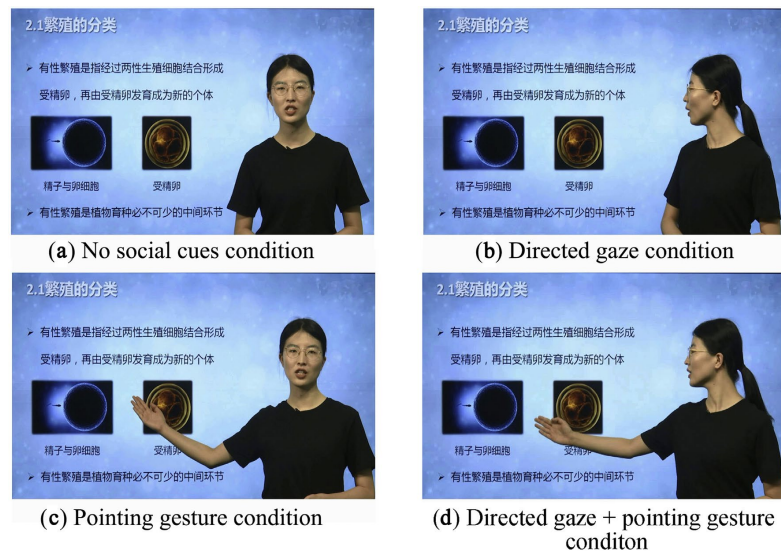


Similar PA design from the study of Kim and Baylor (2016) used limited head animation for three types of PAs (i.e. expert, motivator, and mentor) in learning (see Figure 2.4)

	Expert	Motivator	Mentor
Appearance (image)			
Animation	Deictic	Emotional	Deictic & Emotional

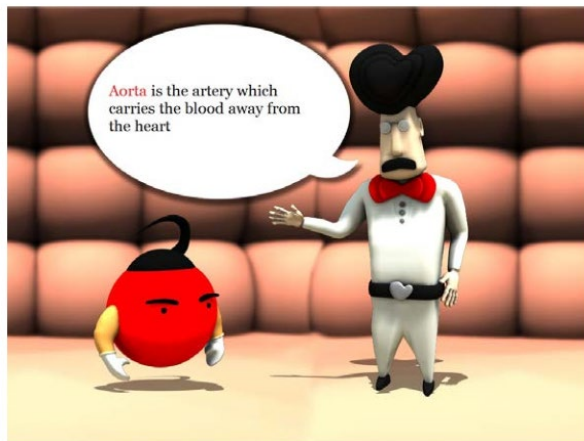
**Figure 2.4: PA design used in the study of Kim and Baylor (2016)**

Meanwhile, Pi et al. (2010) used a life person as PA to induce direct gaze in lecture videos (see Figure 2.5). The agents were capable to deliver natural facial expressions and body gestures with human voice; however, the absence of interactive feature suggests only one-way communication for learners.



**Figure 2.5: PA designs found in the study of Pi et al. (2019)**

Another type of PA, which is equipped with only animation feature can be found in the study of Yung and Paas (2015) that involved PA. In the study, an educational video with animated PA was delivered. As can be perceived through Figure 2.6, the PA showed the lack of human voice (which was replaced with a text callout), as well as the lack of interactive features that indicated only one-way communication.



**Figure 2.6: Cartoon characters as PA design used in the study of Yung and Paas (2015)**

## **2.6 Related Studies**

In this section, several similar prior studies related to this research are discussed. Park (2015) randomly assigning 127 students into six different experiment group, whereas each group was interacting with different elements in multimedia (i.e. image and text, image and narration, no text or narration). The method was using PA with and without human voice to measure learning achievement via comprehension test. Park's findings suggest that human voice narration presented by PA was effective to improve learning.

Yung and Paas (2015) conducted similar experiment involving 133 seventh-grade student in using animated PA as instructional role medium to measure cognitive load and learning outcomes. And findings from Yung and Paas' research indicated using PA as instructional role had positive improve learning achievement (outcomes).

Wang, Mayer, Li, and Liu (2018) conducted a study in using animated PA to measure students' learning perception for online multimedia learning. 51 undergraduate students from China were participating in the experiment. The study measures student's perception toward eye fixation with the PA during learning, which affects their learning performance and motivation according to the research findings.

Another study by Cheng and Wang (2018) finds that students' enjoyment during engagement with PA motivates cognitive impact hence perceived as enhancing learning. Cheng and Wang designed static and animated animal characters as educational companions. The comparative study involved 18 students grouped into static, animated, tangible types of agents, to measure their perceptions and motivation. The findings suggest that animated and tangible agents are beneficial to student's attention, emotion, as well as perceived interaction.

Learning perceptions were affected by the combination between PA's audio and visual representation. Craig and Schroeder (2017) claim that human synthesized or human recorded voice are potentially improving learning

outcomes. Carlotto and Jacques (2016) claims that learning outcomes effected by the presence of the embodied agent effect might be due more to the presence of the voice of the agent. Tegos and Demetriadis (2017) finds that agents' conversational intervention contributes to improve individual or group learning.

The primary function of animated pedagogical agent is to support human in accordance with the application pedagogical theory within learning environments (Ahdon, 2013). Ahdon also suggest that the application of PA in education showed that students have higher positive perceptions in delivering educational multimedia content. Pi et al. (2019) claims that human gaze in PA effects students' perception as instructional role and enhance attention span.

Kim and Baylor (2016) agree PA perceived as human like instructor plays a very important role in impacting learning and motivational outcomes. van der Meij, van der Meij and Harmsen (2015) stated that animated pedagogical agent do have effect in enhancing student motivation in learning environment. Guo, Luyt and Goh (2015) found the effects of embodied pedagogical agents on the motivation of learning performance, knowledge retention, and knowledge transfer. Dincer and Dagonay (2015) as well as Ryu and Ke (2018) claimed that personalised pedagogical agents (with animation and human voice features) can significantly increase students' perceived motivation in learning.

## 2.7 Introducing the Psychology content

In the past studies, learning contents were used in interactive multimedia learning with pedagogical agent as instructional role had covered various topics as subjects of teaching and learning, such as English language (Carlotto & Jaques, 2016), Chinese language (Piet al., 2019), gaming (Nunes, Bittencourt, Isotani & Jaques, 2016), medical (Wang, Li, Mayer & Liu, 2018; Yung & Paas, 2015;), graphic design (Tegos & Demetriadis, 2017), engineering (Paik, 2010), and so forth.

Norcross et al. (2016) suggested that introducing the introductory and minor psychology programmes shapes the discipline of undergraduate students. Despite there were only few prior studies in the field of psychology, they were meant for non-educational purpose (Provoost, Lau, Ruwaard & Riper, 2017; Rizzo et al., 2016). Provoost et al. (2017) conducted a study with an embodied conversational agent (ECA) to interact with psychiatric patients. Rizzo et al. (2016) analysed psychological signals using a virtual human interviewing agent. This research focuses on the use of interactive multimedia and animated PAs in multimedia learning particularly to introduce fundamental psychology lessons to non-psychology undergraduate students. Further explanations about this topic are discussed in Chapter 3, Section 3.1.2 which includes psychology knowledge references and content presentation details.

## 2.8 Chapter Summary

The history of multimedia learning evolved from the use of simple graphic or image to the invention of pedagogical agents in aiding learning. Along the way, more advance in computer technology allows the addition of animation, interactivity, and audio features to enhance the design of PAs in multimedia learning environment. Although many positive results in using PAs for learning, there are some studies disagree that PAs can be as potent. Further steps such as methodology, findings, and analysis will be carried out in the next chapters with the guidance of the two media theories as explained above. Due to inconsistent findings and remarks from the past studies, the current study attempted to perform further investigation about the use of PA technology to the impact of learning. It is hoped that this research could provide some convincing evidence of how the use of PA in a multimedia learning environment can have positive effect to teaching and learning.

## **CHAPTER 3**

### **3.0 RESEARCH METHODOLOGY**

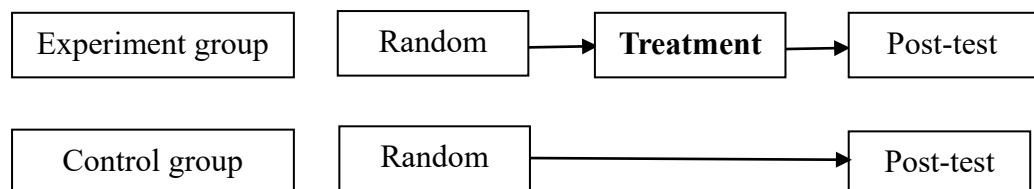
This chapter discusses the important aspects in designing and conducting the research, which include research design, research methods, research instruments, research samples, data collection procedure, and data analysis.

#### **3.1 Research Design**

This research used post-test only experimental design to evaluate the difference of the use of interactive multimedia modules (IMMs) with different types of pedagogical agents (PAs) in Introductory Psychology teaching and learning. The post-test only experimental design also known as the two-group post-test only experimental randomized (true) design (Trochim, 2006; Trochim, Donnelly & Arora 2015). It is a simple and straight-forward experiment design to compare the outcome difference of only two groups, the control group and treatment group, where subjects are randomly assigned and given a test only after the experiment. According to Trochim (2006), this type of research design is valid if it meets the requirements as such, has two groups of research subject, use only a post-test measure (pre-test is not needed), has two measurement distributions, and using statistical comparison between the group to measure

the treatment effect, such as simple t-test and analysis of variance (ANOVA).

The use of the post-test only experimental design has been used in several past studies pertaining to multimedia learning with pedagogical agent (Gou, Goh & Luyt, 2014; Ozdemir, Izmirli & Sahin-Izmirli, 2016; Yung & Paas, 2015). The current research aimed to compare the learning achievement, students' perceptions, and students' learning motivation between a control and a treatment group, which employed two-group experimental design. The disparity evaluation of IMM with different PAs in this research used a straight forward test after the experiment, which matched the post-test only design. Participants in this research were randomly selected into either the control or treatment group (see Figure 3.1), hence two-group post-test only experiment randomized (true) design was well-applied.



**Figure 3.1: Two-group post-test only experiment randomized (true) design pattern**

Source: Trochim, 2006

Trochim (2006), as well as Trochim, Donnelly and Arora (2015) claimed that the key of this experimental design relied on random assignment of the same participants' type into both control and experiment groups. Trochim (2006) also reminded that this design might have limitation in pertaining to sampling ethics. Some selected participants may feel biased



assignment when they discover they have been assigned to one group instead of the other. This may cause rejection or drop out in the midst of experiment which may influenced the outcome of the study. Therefore, it is discreet to keep confidential for both groups' random assignment before and during the experiment by the facilitator.

According to Trochim, Donnelly and Arora (2015), control group is conditioned to an experiment where they do not receive the test variable treatment), while the experimental group participants (i.e. used IMM with animated PAs and spoken text) do. In this research, participants were assigned into a control group (used interactive multimedia module with static pedagogical agents or IMMSPA, where animation and recorded audio features were absent), and an experiment group (used interactive multimedia module with animated pedagogical agents or IMMAPA, which equipped with both animation and recorded audio features).

In order to achieve probabilistic equivalence, it is important to keep the conditions of both groups as equal as possible, including the number of subject participating, their background, experiment execution context and time duration, and measurement tools. Probabilistic equivalence means that we know perfectly the odds can be found in the difference between two groups (Trochim, 2006; Trochim, Donnelly & Arora, 2015). Figure 3.2 depicts the research process model.

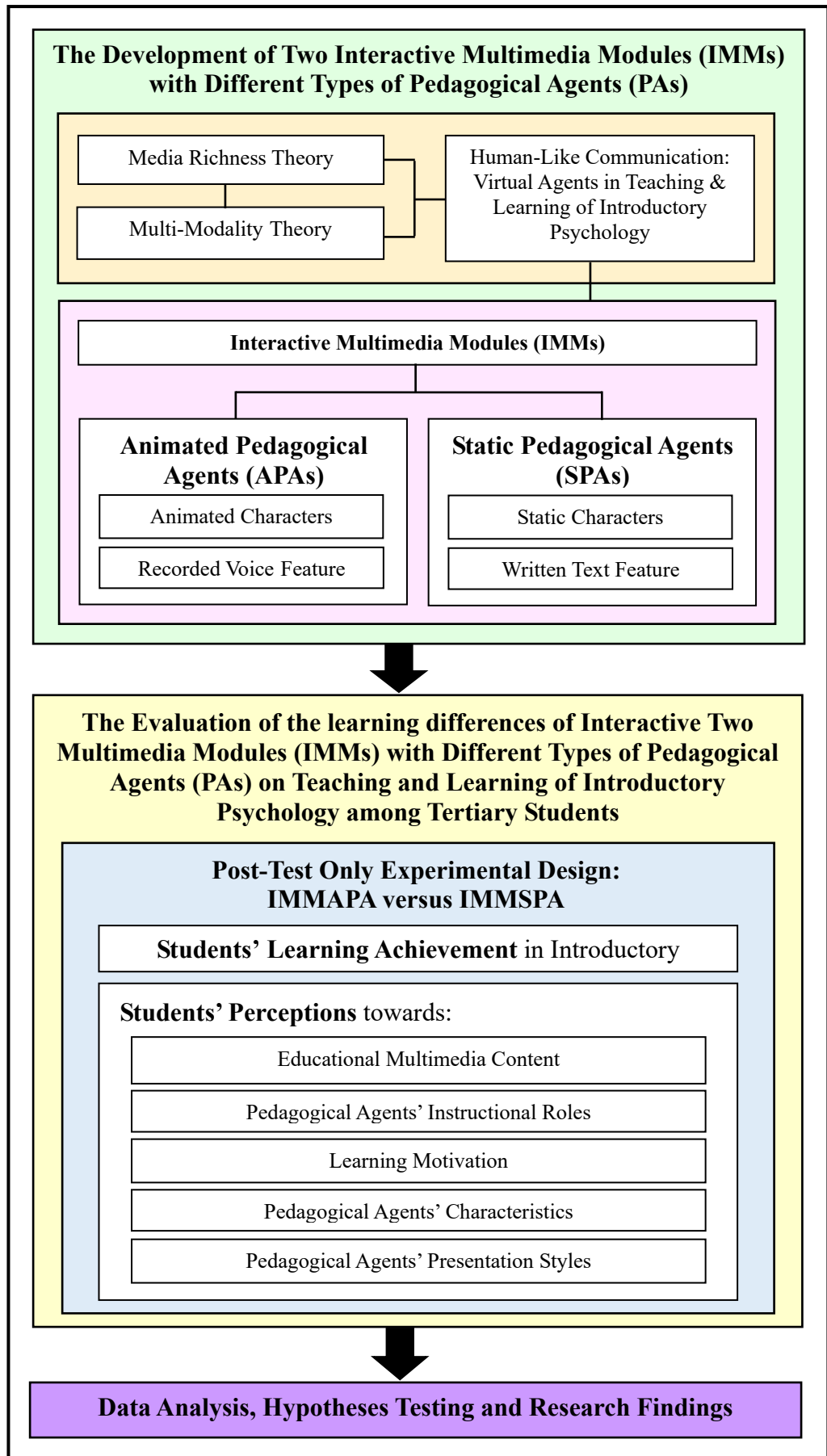


Figure 3.2: Research process model

Two media theories which had been discussed in chapter 2, i.e. media richness theory and multimodality theory, were adopted to form an idea of using virtual agents to promote teaching and learning of Introductory Psychology lessons. In order to find learning disparity between two different types of pedagogical agents, two types of media were required either equipped with human-like communication pedagogical agent features or without the features. The idea led to the development of two Interactive Multimedia Modules (IMMs) with different types of pedagogical agents, namely Animated Pedagogical Agents (APAs) and Static Pedagogical Agents (SPAs). IMMAPA is equipped with animated agent characteristics with recorded voice feature (i.e. spoken text), while IMMSPA is equipped less rich media features such as characters in the form of static image and written-text feature. The comparison of both IMMs with different types of Pedagogical Agents (PAs) is hypothetically assumed to result differences in learning.

Once the two IMMs with different types of PAs (i.e. APA and SPA) conducting Introductory Psychology lessons were completely developed, students' learning outcomes of using these two IMMs were evaluated via hypotheses testing using post-test only experimental design. The evaluation was mainly to measure two major learning attributes, i.e. students' learning achievement and their perceptions towards several research constructs pertaining to the instructional content and PAs in IMMs (i.e. educational multimedia content, PA instructional roles, learning motivation, PA characteristics and PA presentation styles). Data collected from the evaluation were analysed using appropriate statistical methods to test the hypotheses

formulated at early stage of the research.

### **3.2 Research Instruments**

The discussion of research instruments are divided into sections as below:

- i. Two IMMs with different types of PAs (i.e. APAs and SPAs) for the teaching and learning of Introductory Psychology,
- ii. The comprehension test for the evaluation of the effects of IMMs with two different types of PAs (i.e. APAs and SPAs) on students' learning achievement in Introductory Psychology, and
- iii. The questionnaire for the evaluation of students' perceptions towards the instructional content and PAs in IMMs with two different types of PAs (i.e. APAs and SPAs).

#### **3.2.1 IMMs with different types of PAs**

The main objective of the research was to find out which type of PAs contributed higher impact to teaching and learning. Hence, the essence of this research lied on the design and development of two different types of instructional media for a comparative study as follows:

- i. **Interactive Multimedia Module with Animated Pedagogical Agents (IMMAPA):** IMM with animated characters as PAs, and spoken text (i.e. human voice) was used in the delivery of instructional content, and

- ii. **Interactive Multimedia Module with Static Pedagogical Agents (IMMSPA):** IMM with static characters as PAs, and written text (without the voice and the animation of PAs) was used in the delivery of instructional content.

Both IMMSPAs were developed using Adobe Animate CC (formerly known as Adobe Flash). The idea was adopted from several past studies for interactive multimedia learning (e.g. Chen & Wang, 2018; Darmawan & Khairuddin, 2018; Guo, Goh & Luyt, 2014; Ozdemir, Izmirli & Sahin-Izmirli, 2016).

Besides, both IMMSPAs were designed with identical graphics, the same illustrated characters, the same background setting (a school library), the same story narration, the same instructional content, and same agents' dialogues. However, the agents' dialogues were presented using different media element, i.e. spoken text via human recorded voice versus written text. Ryu and Ke (2018) suggested providing audio enhancement such as agent's voice and dialogue increases animated pedagogical agent's human-like characteristic. Figure 3.3 shows the sample screenshots from the same instructional content in both IMMSPAs, but contained different types of PAs and medium of presentation designs.



Sample screenshot from the Introduction scene in IMMSPA



Sample screenshot from the Introduction scene in IMMAPA



**Figure 3.3: Sample screenshots from IMMSPA and IMMAPA with different types of PAs (static versus animated characters) and medium of presentation (written text versus spoken text)**

In addition to medium of presentation, both IMMJs also adopted different PAs as follows:

- i. **Animated Pedagogical Agents (APAs)**, were designed with full animated body gestures and facial expression, following the conversation situations. The agents were equipped with recorded speaking voice and voice over acting during the delivery of instructional content.
- ii. **Static Pedagogical Agents (SPAs)**, were presented with only static graphics facing towards users all the time without body movement. Instructional content were presented in written text with no lip-sync or agent's voice equipped.

The comparison of features equipped in both IMMJs with different types of PAs can be seen in Table 3.1.

**Table 3.1: The comparison of features embedded in IMMJs with different types of PAs (APAs versus SPAs)**

Feature	APAs	SPAs
<b>Embodiment</b>	 <p>- <b>Advanced/ high embodiment:</b> The agent's ability to use his/her body (e.g., engage in gaze, movement, gesture, etc) in full animation.</p>	 <p>- <b>Minimal/ low embodiment:</b> The agent being represented as static graphics, constantly facing towards users all the time without body movement.</p>

**Table 3.1 (Continued)**

<b>Feature</b>	<b>APAs</b>	<b>SPAs</b>
<b>Facial expressions</b>	- <b>Constantly changing expressive facial movements</b> , such as raises up eyebrows, and eyes that open wide during conversations.	- <b>Limited facial movements</b> such as eye and eyebrow only during extreme interaction. Non-animated characters.
<b>Body Gesture</b>	- <b>High level of animated body movements</b> , such as head and hand movements, body leaning forward and backward, reading book, etc.	- <b>No body movement animation.</b> - Stay static in one default pose.
<b>Medium of Presentation – Audio Feature</b>	- <b>Spoken text via recorded audio</b> , in which female voice for Karen and male voice for Joe. - Voice over acting such as various tones and speed following conversation situations.	- <b>No recorded audio was embedded in the module</b> - Use written text (i.e. animated text) to present the instructional content. - Soothing background music to aid learning.
<b>Medium of Presentation – Textual Feature</b>	- <b>Subtitle aid</b> at the bottom screen of each scene to complement the presentation of instruction content in recorded speaking voice.	- <b>Animated texts</b> flow on top of the screen as main feature in the delivery of instructional content.


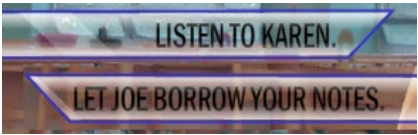
Further, the built-in interactive features equipped in both IMMs enabled users to learn the instructional content on Introductory Psychology with the assistance of virtual PAs. The past studies (e.g. Chen & Wang, 2016; Dincer & Dagonay, 2017; Surjono, 2015) had proved that the interactive features in learning materials could enhance the learning process. The interactive features were limited to basic computer mouse-over and mouse-click onto the interactive objects, allowing the each user to experience different lessons flow and PA’s reaction.

The built-in interactive features equipped in both IMMs are the interactive buttons and instructional indicators. The buttons are functioned not

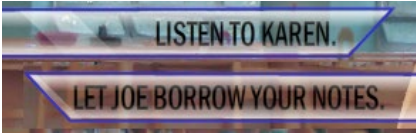

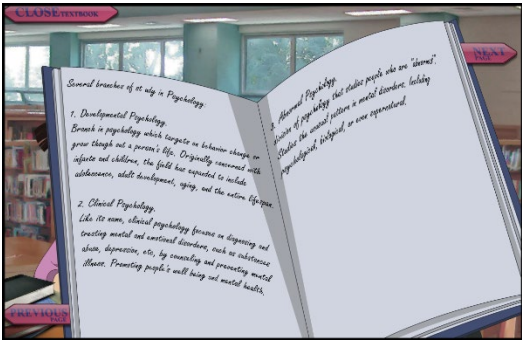


only as conduit to gain input from the users, but also represents the options users have during the interaction. The instructional indicators are useful guides either to lead users for additional information, or to notify the PAs reactions. Nevertheless, they have simple animation when users interact with them. Types of buttons and interactive objects embedded in both IMMAs are shown in Table 3.2.

**Table 3.2: Interactive features in both IMMAPA and IMMSPA**

Interactive Features		Function
	<p>“START” button</p>	<p>Appear only once at the beginning of the module.</p>
	<p>Option buttons</p>	<ul style="list-style-type: none"> <li>- Appear occasionally and alternatively with agents’ conversation cues.</li> <li>- Number of options varied of two or three depending on on-going discussion topic.</li> <li>- Option choices depend on on-going discussion topic by the agents.</li> </ul>

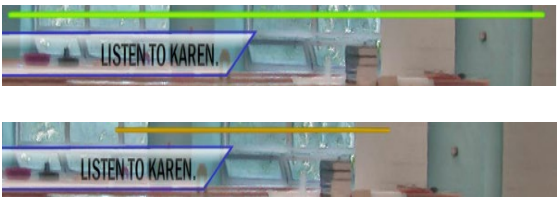
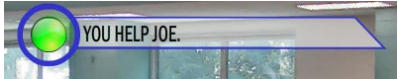
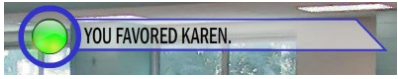
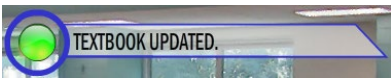
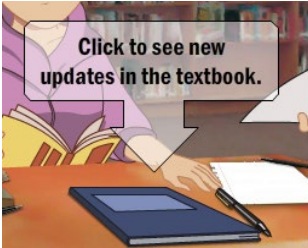
**Table 3.2 (Continued)**

Interactive Features		Function
	Option buttons	<ul style="list-style-type: none"> <li>- Appear occasionally and alternatively with agents' conversation cues.</li> <li>- Number of options varied of two or three depending on on-going discussion topic.</li> <li>- Option choices depend on on-going discussion topic by the agents.</li> </ul>
	Interactive Textbook	Appear few times in the modules, whenever there are cues for users to access the discussed topics.
	“NEXT” button	Go to next page of the interactive textbook.
	“PREVIOUS” button	Go to previous page of the interactive textbook.
	“CLOSE Textbook” button	Close the textbook and continue to interact with agents.

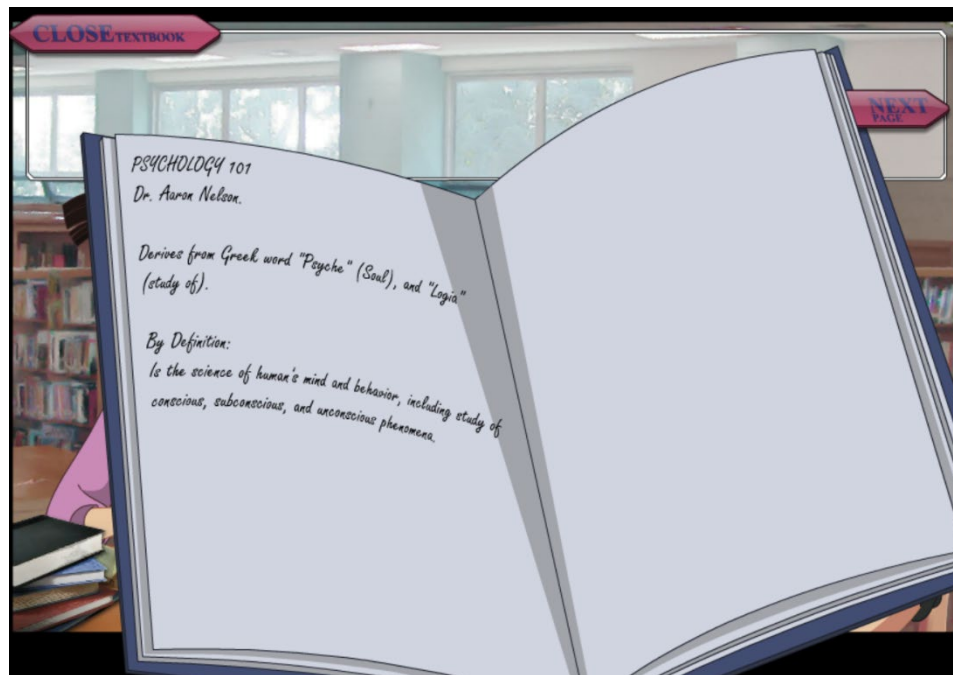
In addition, Table 3.3 shows the available indicators integrated in both IMMs. The main function of these indicators is to guide users to understand several circumstances during their interaction with modules such as agents' responses, lesson update notification, and activated textbook pointer. Using

interactive buttons, graphical indicators in pedagogical agent based multimedia designs are essential to improve users learning about the modules (Tegos & Demetriadis, 2017).

**Table 3.3: Sample indicators used in both IMMAPA and IMMSPA**

Graphical Indicator	Description
	<p><b>Time indicator:</b></p> <ul style="list-style-type: none"> <li>- Users are given 10 seconds to decide which options they would like to choose.</li> <li>- After 10 secs time up and any of the option button has not been clicked, the module will continue with random choice of either of the options.</li> <li>- This is to prevent overtime interaction during the experiments.</li> </ul>
	<p>Indicator stating user's option siding/ favouring with Joe.</p>
	<p>Indicator stating user's option siding/ favouring with Joe.</p>
	<p>When new lesson has just been discussed, an indicator appears on top of the screen suggesting there is a new content in the interactive textbook to be updated.</p>
	<p><b>Textbook indicator:</b></p> <p>Showing that the interactive textbook can be accessed at that moment.</p>

Besides various buttons throughout the modules, there is also an interactive textbook available to access from time to time in both IMMAPA and IMMSPA (see Figure 3.4). The primary function of the interactive textbook is to help users to keep in track with the given lessons by the PAs. The textbook is enhanced with animation (such as page flip, open and close), and sound effects, in both IMMAPA and IMMSPA.



**Figure 3.4: Sample screenshot from a scene in IMMs showing an interactive textbook would be updated as more lessons were taught/ revealed to assist users in learning**

### 3.2.2 Characteristics of the PA designs in IMMs

Two PAs with different computerized features and characters created in the IMMs in order to gauge learners' interaction and make comparison of their various responses. Animated PAs present certain characteristics and emotions to improve students' motivation. The quality and clarity of dramatic impact

from agents' emotional behaviours, were related to the age, status, attractiveness, and credibility of the agent (Romero-Hall, 2015).

Craig and Schroeder (2017) asserted that PA-based IMM learning with recorded human voice may be more effective than learning from a machine-synthesized voice. For the APA interactive module, Karen and Joe were equipped with different recorded human voices to play their own characters, and to deliver dialogues in different manner following the users' responses. Additionally, this allows the audio/speech modality to play in role for the interaction with the users.

Tegos and Demetriadis (2017) suggested that students has higher level of explicitness and comprehensiveness in response towards peer designed conversational agent. Karen (female pedagogical agent) and Joe (male pedagogical agent) are purposefully designed to match the age and status of targeted subjects of this research, i.e. students at tertiary level between 18 to 24 years old. Both PAs in the IMM represented their typical classmates' characteristics (peer). Karen played the character of a high-achiever student who spent her time mostly for studying. In contrast, Joe is depicted as otherwise. However, both Karen and Joe shared the same instructional roles in assisting and leading learners to understand the Introductory Psychology lessons delivered in IMM.

### 3.2.3 Effects of PA genders and roles

Prior PA studies that examines the effect of PAs on learning outcomes were concluded with varied findings. For example, Kim and Baylor (2016) found that the presence of male agents led to more confident behavior in students compared to female agents. Dincer and Doganay (2017) found that there was no significant difference in learning motivation between interacting with male and female agents. Shiban et al. (2015) suggested that female agent had more positive impact toward learners compared to male agents. Johnson and Lester's study (2016) reported although female and male student tend to choose different characters, it was found that there was no significant effect on motivation between female and male pedagogical agents.

However this research did not intend to measure the effect of PA's gender on learning outcomes. The gender role played by the male or female PA is not part of this research. Although agent Karen was designed with a character who shows high-achiever student and Joe shows the opposite character, there is no intention of gender dominance between the two agents in the purpose of this research. The characteristics of the two agents were developed with a mere random personality selection, meaning that every aspect of this research would still go the same way if the roles of Karen and Joe were switched (in the case if Joe were designed with high-achiever traits and Karen is the opposite). Johnson and Lester (2016) argued that there should not be any respect engendered by PA since they are computer generated virtual characters.

### 3.2.4 Introductory Psychology as instructional content

As explained in Chapter 1 (section 1.2.2 Introductory Psychology as learning topic), this research uses the knowledge of basic psychology lesson as the main subject delivery for the educational multimedia content.

The basic psychology as instructional content presented in both IMMs in this research were taken from several published psychology books such as “Psychology an Introduction” (Lahey, 2009), “Understanding Abnormal Psychology” (Ramsden, 2013), “Atkinson & Hilgard’s Introduction to Psychology” (Fredrickson & Loftus, 2003; Smith, Nolen-Hoeksema, Fredrickson & Loftus, 2003), and other relevant sources. There were 14 topics of rudimentary psychology knowledge built into both IMMs, as can be perceived through Table 3.4.

**Table 3.4: Introductory Psychology topics presented in both IMMs and their sources**

No.	Topics presented in both IMMs	Sources
1.	Definition, and etymology of psychology	Lahey, 2009, p. 2; Meriam-Webster.com, 2016
2.	Branches (types) of psychology	Lahey, 2009
3.	Developmental psychology (term and definition)	Smith et al., 2003, p. 311-312
4.	Clinical psychology (term and definition)	Ramsden, 2013
5.	Mental illness (definition)	Lahey, 2009; Smith et al., 2003, p. 5, 66
6.	Abnormal psychology	Lahey, 2009, p. 471-472; Smith et al., 2003, p. 528
7.	Nature and nurture in psychology	Lahey, 2009, p. 93-104; Smith et al., 2003, p 5, 66

**Table 3.4 (continued)**

<b>No.</b>	<b>Topics presented in both IMMs</b>	<b>Sources</b>
8.	Hereditary and psychology	Smith et al., 2003, p. 444
9.	Psychologist vs psychiatrist	EFPA, 2016; Leaderonomics.com, 2018
10.	Psycho-analysis – hypnotherapy	Lahey, 2003, p. 513; Smith et al., 2003, p. 208, 459
11.	Introversion and extraversion	Smith et al., 2003, p. 454-456
12.	Ambiversion	Ramsden, 2013.
13.	Anti-social behaviour	Smith et al., 2003, p. 557
14.	Darwin's theory of evolution and hereditary	Lahey, 2009, p. 114

### **3.3 Instruments and Measurement**

There are two instruments used in this research measuring students learning achievements and their perceptions towards the IMMs with different types of PAs delivering the lessons of Introductory Psychology.

#### **3.3.1 Comprehension test measuring students' learning achievement**

One of the objectives for the research was to find out which type of PA features in IMMs could help the respondents to attain higher learning achievement score. Measuring learning achievement after multimedia learning with PA could be found in several past studies (e.g. Morrison & Frick, 2014; Ozdemir, Izmirli, & Sahin-Izmirli, 2016; Surjono, 2015; Wei, Peng & Chou, 2015). The research of Morrison and Frick (2014), Ozdemir, Izmirli and Sahin-Izmirli (2016), as well as Surjono (2015) examined students' academic



achievement, while Wei, Peng and Chou (2016) investigated students' learning achievement and perceptions.

Learning achievement in this research was measured using a set of comprehension test (see Appendix B) after intervention, i.e. learning Introductory Psychology either using IMMAPA or IMMSPA. The first section of the test consisted of 10 multiple-choice questions, and the second section consisted of 10 true-or-false questions. These questions were built based on the selected Introductory Psychology topics that had been included in the IMMSPA and IMMAPA. Additionally, the questions also consisted of information about pedagogical agents (i.e. agents' behaviours, narrative settings, etc.). Each question from both sections granted 1 point for a correct answer and 0 point for incorrect answer.

Total scores obtained through the comprehension test were calculated by summing up the score for each correct answer to measure students' achievement in Introductory Psychology knowledge acquisition after intervention (i.e. learning Introductory Psychology using IMMs with different types of PAs). The IMM group with higher score was assumed to successfully retain the instructional content more effectively in this research. The evaluation of the effects of IMMs with different types of PAs on students' learning achievement in Introductory Psychology was measured through hypothesis testing. The following null hypothesis was tested:

**H<sub>01</sub>: There was no significant difference between the learning of Introductory Psychology using IMMAPA and IMMSPA on students' learning achievement.**

### **3.3.2 Questionnaire measuring students' perceptions**

The development of both IMMAPA and IMMSPA was to convey the Introductory Psychology content with different features of PAs that led to the evaluation of students' perceptions towards the learning of Introductory Psychology between students who learned using IMMs with two different types of PAs. The scope of evaluation included:

- i. Respondents' perceptions towards educational multimedia content (EMC) and pedagogical agents' instructional roles (PAIR) in enhancing Introductory Psychology learning between respondents who learned using IMMs with two different types of pedagogical agents,
- ii. Respondents' perceptions towards learning motivation (LM) between respondents who learned using IMMs with two different types of pedagogical agents, and
- iii. Respondents' perceptions towards pedagogical agents' characteristics (PAC) and presentation styles (PAPS), i.e. animated characters with spoken text (or recorded voice) features versus static characters with written text features between respondents who learned using IMMs with two different types of pedagogical agents.

A set of questions as appended in Appendix C was constructed to evaluate the above-mentioned areas through an extensive review of literature.

There are a total of 49 items which consisted five sections as follows:

- Section A: 13 items to measure educational multimedia content,
- Section B: 6 items to measure pedagogical agents' instructional roles,
- Section C: 7 items to measure students' perceptions towards learning motivation,
- Section D: 10 items to measure students' perceptions towards pedagogical agents' characteristics and
- Section E-A (PAs via recorded voice) or section E-B (PAs via written text): 9 items each to measure students' perceptions towards pedagogical agents' presentation styles.

Questions in the questionnaire, which were used to measure students' perceptions towards the features integrated in IMM (i.e. EMC, PAIR, PAC, and PAPS) and LM were adapted from the questionnaires used in related prior studies (e.g. Fredrickson & Loftus, 2003; Lahey, 2009; Ramsden, 2013; Smith, Nolen-Hoeksema, Fredrickson & Loftus, 2003).

The formation of each item in the questionnaires was also adapted from several relevant studies in the past about using PA in measuring students' perceptions towards content presentation, PA as instructional role in multimedia learning (e.g. Murray, 2008; Pang, 2013; Schroeder, 2013), perception of learning motivation (e.g. Murray, 2008; Schroeder, 2017; Teoh &

Neo, 2007), animation and static features in PA (e.g. Schroeder, 2017; Teoh & Neo, 2007; Vogel-Walcutt, Gebrim & Nicholson, 2010), and PA interactive feature (e.g. Pang, 2013; Teoh & Neo, 2007).

The evaluation of differences in students' perceptions between variables were measured through hypotheses testing. The following null hypotheses were tested:

**H<sub>02</sub>: There is no significant difference in students' perceptions towards educational multimedia content in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.**

**H<sub>03</sub>: There is no significant difference in students' perceptions towards pedagogical agents' instructional role in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.**

**H<sub>04</sub>: There is no significant difference in students' perceptions towards learning motivation in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.**

**H<sub>05</sub>: There is no significant difference in students' perceptions towards pedagogical agents' characteristics in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who**

**learned using IMMSPA.**

**H<sub>06</sub>: There is no significant difference in students' perceptions towards pedagogical agents' presentation styles in enhancing students' learning of Introductory Psychology between students who learned using IMMSPA and students who learned using IMMSPA.**

### **3.4 Pilot study**

Prior to the implementation of main study, survey questionnaire was pilot-tested in a pilot study to validate the content and test the reliability of questionnaire. Pilot study is conducted on a smaller scale than main or full-scale study to improve the quality and efficiency of the main study (In, 2017). Leon, Davis and Kraemer (2011) noted that the fundamental purpose of conducting a pilot study is to examine the feasibility of an approach that is intended to ultimately be used in a larger scale study. According to Trochim, Donnelly and Arora (2018), the pilot study intended to find out whether the instruments were easily or hardly measured from feedback data.

Leon, Davis and Kraemer added, pilot study data generally should not be combined with data from the subsequent larger scale study. This is because it is quite likely that the methods will be modified after the pilot study. Furthermore, a pilot results that are presented tend to be selective, overly optimistic and, at times, misrepresentational.

Before the main study was carried out, a pilot or small-scale study was conducted to evaluate the validity and reliability of the survey questionnaire, which was used as one of the instruments in this research. Masuwai, Tajudi, and Saad (2016) stated that “Reliability and validity are important aspects of a quantitative research inquiry” (p. 11). Citing several past studies, Masuwai, Tajudi, and Saad (2016) added that “Reliability and validity of the instrument is a vital analysis to consider as a good instrument...If an instrument provides a measure of what it actually measures, validity is established” (p.12). Both instrument validity and reliability test are equally and importantly finalized before research instrument were to put in use.

In this research, the pilot study had been conducted among 24 Year 2 university students in which 12 students in the IMMAPA group and 12 in the IMMSPA group. Criteria of the selection of participants for both the pilot and main studies were same, and are discussed in section 3.3.

#### **3.4.1 The questionnaire validation**

The validity of a questionnaire is evaluated by analysing whether the questionnaire measures what it is intended to measure (Bordeianu and Morosan-Danila, 2013; Shrotryia & Dhanda, 2019; Tsang, Royse & Terkawi, 2017).

In this research, the content validity by two experts was used to evaluate the questionnaire in measuring students’ perceptions towards the five

research variables, i.e. EMC, PAIR, LM, PAC, and PAPS. Citing the work of Schultz and Whitney, Tsang, Royse and Terkawi (2017) defined content validity as “the extent to which the items in a questionnaire are representative of the entire theoretical construct the questionnaire is designed to assess”. According to Bums and Grove (as cited in Yaghmale, 2003), content validity could be obtained from three sources, i.e. literature, representatives of the relevant populations, and experts. Bordeianu and Morosan-Danila also added that “content validation is often inferred from comments of experts...” (p. 275).

### **3.4.2 Reliability testing of the questionnaire**

Bordeianu and Moroșan-Dănilă (2013) defined reliability testing as below:

While the validity determines the appropriateness of an instrument and its veracity, reliability refers to the consistency of the instrument, its stability and repeatability... Reliability testing is concerned with accuracy evaluation, or the extent to which assessment results are having no unexpected errors (random errors) (p. 276).

Although instrument reliability can be determined in several ways, the most widely used indicator of assessing internal consistency is Cronbach alpha coefficient (Bordeianu & Moroșan-Dănilă, 2013). Cronbach's alpha ( $\alpha$ ) measures the stability of test or instruments from a single administration in obtaining test data (Taber, 2018). According to Taber, the acceptable alpha value is 0.7 or greater, a considerably desirable value. Taber also added that the value below 0.69 is not satisfactory or low, meanwhile 0.79 and above is excellent, or highly reliable and consistent.

In this research, a reliability test was carried out using Cronbach’s alpha, which measured the internal consistency of the survey questionnaire that consisted of 49 items measuring the research construct built into each section as depicted in Table 3.5. The questionnaire has demonstrated a high level of internal consistency and reliability among items in which the Cronbach’s alpha coefficient of the five research constructs ranging from 0.828 to 0.915 as shown in Table 3.5.

**Table 3.5: Cronbach’s alpha ( $\alpha$ ) coefficient for the survey questionnaire**

<b>Research Construct</b>	<b>Number of Items</b>	<b>Cronbach’s Alpha (<math>\alpha</math>) Coefficient</b>
Education Multimedia Content	13	0.915
Pedagogical Agents’ Instructional Roles	6	0.837
Learning Motivation	7	0.828
Pedagogical Agents’ Characteristics	10	0.891
Pedagogical Agents’ Presentation Styles (via Human Recorded Voice)	9	0.907
Pedagogical Agents’ Presentation Styles (via Written Text)	9	0.856

Since the Cronbach’s alpha value for all the five research constructs was higher than 0.79 as recommended by Taber (2018), indicating high level of consistency and internal reliability of survey questionnaire, Therefore, the results of Cronbach’s analysis show that the questionnaire was well constructed and reliable.



### 3.5 Research Samples

Participants of the research were recruited from the Faculty of Accountancy and Management (FAM) of Universiti Tunku Abdul Rahman (UTAR), Malaysia aged 18 to 24 years old. The students ( $n = 32$ ) were taking the course “Ethnic Relation (*Hubungan Etnik*)” in Trimester 2, May 2018. They had given their consent to participate in the empirical study by signing the consent form as appended in Appendix A, before the commencement of the experiment.

Respondents for this research are purposely selected with a brief pre-interview session, mainly to ensure that they do not have the prior knowledge of psychology before the treatment. Each of the respondents are neither psychology major nor multimedia major. They are recruited from the Faculty of Accounting and Management (FAM), which are the combination of students from the four programmes, i.e. Bachelor of Accounting (Hons), Bachelor of Economics (Hons) Global Economics, Bachelor of International Business (Hons), and Bachelor of Building and Property Management (Hons). The four programmes do not offer any course related to psychology, as shown in their Programme Structure Guide in the University’s web-portal (UTAR Portal, 2018). Therefore, the students have not undertaken any formal psychology education as a criterion for selection.

Pett (2016) pointed out that there is no definitive guideline as what size sample is too small for use with a particular parametric test. If the sample size

is very small, there may be no alternative to use a nonparametric test, but there is no limit specified of what is “very small” (p. 286-287). Pett added “the choice of using parametric and nonparametric test depends on the available sample, variable's level of measurement and the shape of distribution in the population.” (p. 287)

### 3.5.1 Parametric test normal distribution test

According to Pett, one of the most common characteristics of parametric tests are “dependent variables are drawn from normally distributed population” (p. 131). In other words, shape of distribution should be a shape of a bell curve. One way to assess normally distributed data is to run a normality test by calculating the “skewness” and “kurtosis” level in SPSS. Hae (2013) pointed out that a z-test is applied for normality test using skewness and kurtosis. Hae added that a z-score could be obtained by dividing the skewness/kurtosis values by their standard errors as shown below:

$$Z = \frac{\text{Skew value}}{SE_{\text{skewness}}}, Z = \frac{\text{Excess kurtosis}}{SE_{\text{excess kurtosis}}}$$

Hae stated that “normal distribution is indicated by how close z-score is to 0 value (implying a symmetric distribution)”. In small sample scenario, if z-score is greater than 1.96 (or less than -1.96 for left tail skewness), then the data is not normally distributed (p. 53). In this research, to find out whether the data was normally distributed, skewness statistic value on second left column needed to be divided with its standard error (SE) on right column. Data in Table 3.6 was obtained from the total of 16 respondents of each IMM group

using descriptive analysis in SPSS.

**Table 3.6: Descriptive statistics of Mean, SD, Skewness, and Kurtosis level from respondents' learning achievement scores in both IMMAPA and IMMSPA groups**

IMMAPA and IMMSPA		Statistic	Std. Error	
Learning achievement score	APA	Mean	18.0625	0.40279
		Std. Deviation	1.61116	
		Skewness	-0.443	0.564
		Kurtosis	0.749	1.091
	SPA	Mean	16.1250	0.45529
		Std. Deviation	1.82117	
		Skewness	-0.135	0.564
		Kurtosis	1.185	1.091

Following are the skewness and kurtosis values calculation for both IMMAPA and IMMSPA groups (see Table 3.6):

**IMMAPA:**

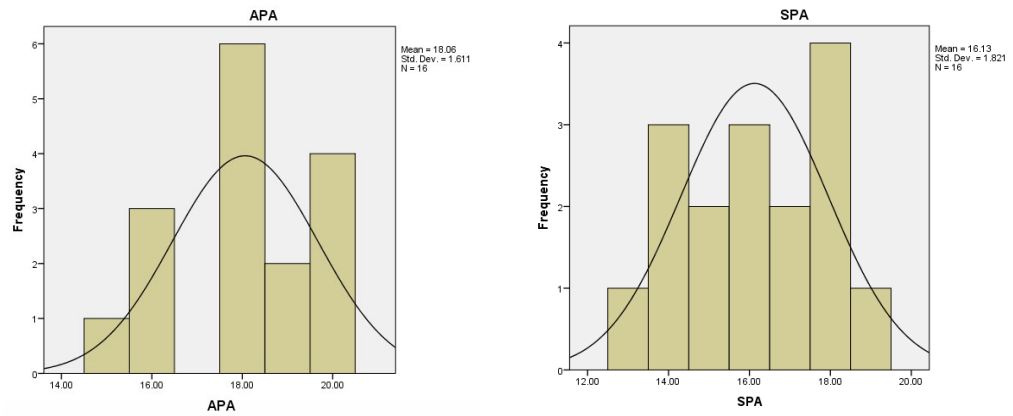
- Skewness value (-0.443) divided by Std. Error (0.564) equals to z-score (-0.785), which is not less than -1.96.
- Kurtosis value (0.749) divided by Std. Error (1.091) equals to z-score (0.686), which is not greater than 1.96.

**IMMSPA:**

- Skewness value (-0.135) divided by Std. Error (0.564) equals to z-score (-0.239), which is not less than -1.96.
- Kurtosis value (1.185) divided by Std. Error (1.091) equals to z-score (1.086), which is not greater than 1.96.

Calculation above resulting both APA and SPA groups' data are within the acceptable z-score value as stated by Hae, which is not less than -1.96 and not greater 1.96. Thus, a small sample study involving 16 participants in each

group was reported to be statistically and normally distributed. Similarly, Figure 3.5 clearly shows the normal distribution histograms of IMMAPA and IMMSPA groups.



**Figure 3.5: Normality test bell curve distribution of IMMAPA and IMMSPA groups**

Therefore corresponding with Trochim, Donnelly and Arora (2015), and Pett (2016), small sample data from this study could be analysed using the parametric statistical tests such as independent sample t-test.

### 3.6 Data Collection Procedure

Firstly, total of selected participants (N=32) are invited into a computer laboratory. 16 computers in the computer lab were installed with IMMAPA, and the other 16 computers were installed with MMSPA programme without the participants' knowledge. Trochim, Donnelly and Arora (2015) reported that "in randomized or true experiment method, to create truly comparable two groups is to randomly assign each person into either group" (p. 215). Hence,

the participants were asked to take any seats in which they did not know which type of PA in IMM they would use.

Once seated, the participants were briefed with basic information about the IMMs such as the IMMs consisted of pedagogical agents they would be interacting with, simple navigational buttons and indicators in the modules, duration of interactivity (30 minutes), and Introductory Psychology as instructional content. Trochim, Donnelly and Arora (2015) claimed that randomized assigned experiment participants believe they are receiving the same treatment, whereas only one of the groups is, and both receive a post-test” (p. 405). Therefore, there are information refrained to be shared to participants such as there are actually two types of IMMs involved in the empirical study, hence they did not know which IMM they were interacting with.

When the time was up, participants were asked to stop interacting with the IMMs and proceeded with the distribution of comprehension test and survey questionnaire. Each survey questionnaire included a page of consent form (with participants’ signatures), and a page of demographic information. The participants took about 20 minutes to complete the test and survey.

### 3.7 Data Analysis

Collected data were coded, analysed, and interpreted through the use of SPSS (Statistical Package for Social Science) programme to start the data analysis. Both descriptive and inferential statistics (such as independent samples t-test) were used to analyse the data collected and to test the hypotheses formulated. Descriptive statistics were used to analyse and present respondents' demographic data. The research findings are presented through the use of tables and figures (e.g. pie and bar charts), which are further described in sections 4.2.

According to Trochim (2006) as well as Trochim, Donnelly and Arora (2015), the typical inferential statistical analysis used in two-group post-test only experimental method is independent sample t-test. Kim (2015) explained that an independent-group t-test can be carried out for a comparison of means between two independent groups. As the t test is a parametric test, samples should meet certain preconditions, such as normality, equal variances and independence.

The use of independent sample t-test results a probability level of difference, or known as p value (the significance of difference). According to some statistic studies (e.g. Gignac & Szodorai, 2016; Trochim, 2006; Trochim Donnelly & Arora, 2015; van Assen, van Aert & Wicherts, 2015), p value is accepted as statistically and significantly difference when it within the alpha level ( $p < 0.05$ ). Null hypothesis should be rejected if p value is lesser than

0.05, while null hypothesis should not be rejected if it is equal or larger than 0.05. Results in independent sample t-test are typically at 2 tailed level. Meaning the differences could go two directions, negative difference or positive. Nonetheless, either direction does not matter in this hypothesis since the target is only to find their significance values.

### **3.7.1 Testing of null hypothesis 1 ( $H_01$ )**

Since the first hypothesis 1 intended to find out if there is a statistical significant difference on students' learning achievement between the two groups, i.e. the IMMSPA and IMMAPA groups, thus independent samples t-test was used to test the null hypothesis 1 ( $H_01$ ). The independent samples t-test was used to determine whether the mean difference for the dependent variable (learning achievement) due to the independent variables (students in IMMAPA versus IMMSPA groups) is a real difference or the result of some other chance factor.

Before testing the null hypothesis 1 ( $H_01$ ) using appropriate inferential statistics, the total score of students' learning achievement was computed. The scores were then being categorised into several categories (i.e. Poor, Fair, Good and Very Good), and generated percentages of respondents at each category.

### 3.7.2 Testing of null hypotheses 2 (H<sub>02</sub>) through 6 (H<sub>06</sub>)

Also, the independent samples t-test was used to test null hypotheses 2 through 6 (H<sub>02</sub> through H<sub>06</sub>), to determine whether there was a statistically significant difference between the perceptions of students who learned using IMMAPA and perceptions of students who learned using IMMSPA. The dependent variables were students' perceptions towards several constructs related to the use of IMMAPA versus IMMSPA in Introductory Psychology learning (i.e. educational multimedia content, pedagogical agents' instructional role, learning motivation, pedagogical agents' characteristics, and pedagogical agents' presentation styles), whereas the independent variables were IMMAPA versus IMMSPA.

According to laerd.com (2018), the independent-samples t-test compares the means between two unrelated groups on the same continuous, dependent variable (i.e. it is measured at the interval or ratio level). Willett (2018) asserted that technically, Likert scale data are ordinal, for example, a scale with five options: Strongly disagree, disagree, neutral, agree, and strongly agree, where the response choices have a meaningful order, but the numbers themselves are not meaningful. Willett added that to statistically analyse ordinal data, non-parametric tests such as the Mann-Whitney U test or the Wilcoxon signed ranks should be used. Mogeey (1999 as cited in Warachan, 2011) also suggested that since the Likert rating scale is an ordinal scale, non-parametric procedure like the Mann-Whitney test can be used to compare the difference of two independent groups of Likert data, while the t-test for two



independent groups should not be applied because the ordinal data are discrete with no continuous value in between.

However, it is common to see ordinal data analysed using parametric tests, such as the t-test or an ANOVA (Willett, 2018). Clason and Dormody (1994 as cited in de Winter & Dodou, 2010) found that out of 95 relevant articles in their study, 13 per cent used a non-parametric test and 34 per cent used a parametric test. There existed arguments amongst scholars about whether Likert data should be analysed with parametric statistics such as the t-test, or non-parametric statistics such as the rank-based Mann-Whitney-Wilcoxon (MWW) (Carifio & Perla, 2008; Jamieson, 2004 as cited in de Winter & Dodou, 2010).

Willett noted that parametric tests, which are generally more sensitive and more powerful can be used on the ordinal data, which meets all of the assumptions of the parametric test as follows:

- 1) The sampling distribution is normally distributed. This will be true if:
  - Sample size is greater than 30 ( $N > 30$ ); or
  - Sample size is smaller than 30 ( $N < 30$ ), but the data appears to be normally distributed on inspection.
- 2) There are at least 5 levels to the ordinal scale.
- 3) There are no extreme scores - and it is essentially impossible to have extreme scores on a Likert scale since options are limited.

- 4) The variance of the two samples (or more) being compared is approximately equal. This is not an issue if a sample size is greater than 30 ( $N > 30$ ).

Hence, a parametric test such as the independent samples t-test was used to test the null hypotheses 2 through 6 with ordinal data since all of the Willett's assumptions of the parametric test had been met as follows:

- 1) Although the sample size for each of the experiment groups was 16 ( $N < 30$ ), however, the sampling distribution is normally distributed as has been discussed in section 3.5.1;
- 2) The evaluation of students' perception towards educational multimedia content, pedagogical agents' instructional roles, learning motivation, pedagogical agents' characteristics, and presentation styles were using a 5-point Likert scale ranging from 1 'Strongly Disagree' to 5 'Strongly Agree';
- 3) There were no extreme scores, and
- 4) The variance of the two samples (or more) being compared was equal in which the samples in this study were required to meet certain criteria as listed in section 3.4.

Before the testing of null hypotheses 2 through 6, descriptive statistics such as mean and standard deviation were used to present the results of respondents' level of agreement (from 1 to depicting lowest agreement level, to 5 depicting highest agreement level) with the items that measured the students' perceptions towards educational multimedia content, pedagogical agents'

instructional roles, learning motivation, pedagogical agents' characteristics, and pedagogical agents' presentation styles.

### 3.7.3 Summary of the statistical analysis methods used in the testing of null hypotheses

Table 3.7 summarises the statistical analysis methods that were used in null hypotheses testing.

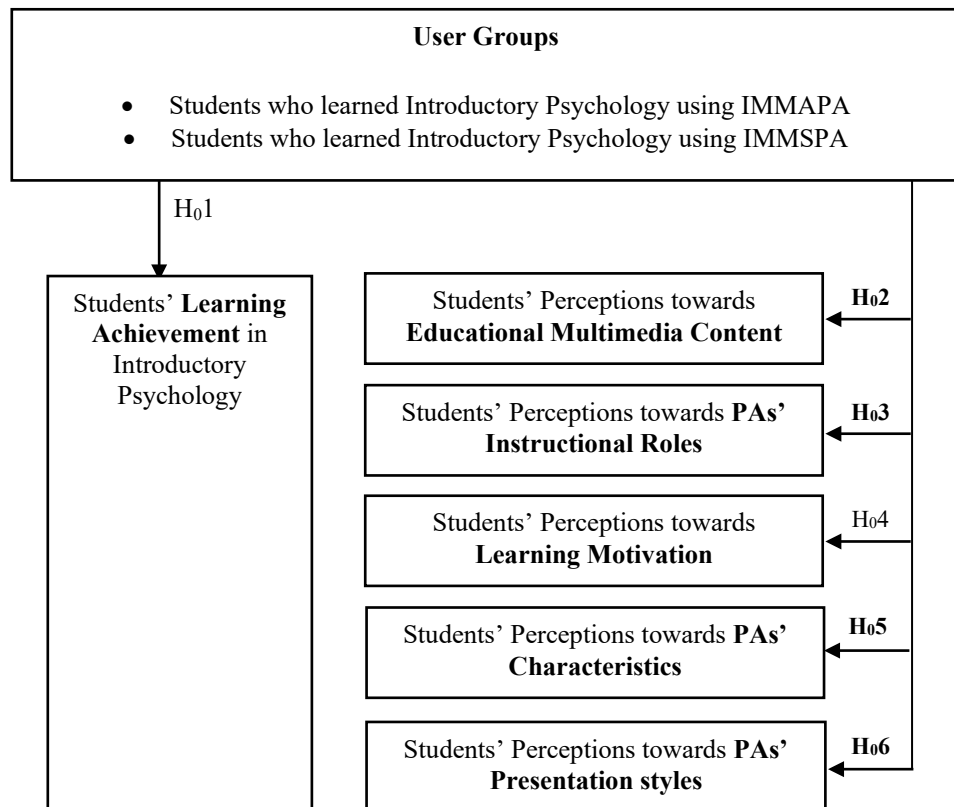
**Table 3.7: Statistical analysis methods for hypotheses testing (H<sub>01</sub> to H<sub>06</sub>)**

Null Hypothesis	Statistical Analysis Method
<b>H<sub>01</sub>:</b> There was no significant difference between the learning of Introductory Psychology using IMMAPA and IMMSPA on students' learning achievement.	Independent samples t-test
<b>H<sub>02</sub>:</b> There was no significant difference in students' perceptions towards educational multimedia content between students who learned using IMMAPA and students who learned using IMMSPA.	
<b>H<sub>03</sub>:</b> There was no significant difference in students' perceptions towards pedagogical agents' instructional roles between students who learned using IMMAPA and students who learned using IMMSPA.	
<b>H<sub>04</sub>:</b> There was no significant difference in students' perceptions towards learning motivation between students who learned using IMMAPA and students who learned using IMMSPA.	
<b>H<sub>05</sub>:</b> There was no significant difference in students' perceptions towards pedagogical agents' characteristics between students who learned using IMMAPA and students who learned using IMMSPA.	

**Table 3.7 (Continued)**

Null Hypothesis	Statistical Analysis Method
<p><b>H<sub>06</sub>:</b> There was no significant difference in students' perceptions towards pedagogical agents' presentation styles between students who learned using IMMAPA and students who learned using IMMSPA.</p>	<p>Independent samples t-test</p>

The research framework for the null hypotheses testing are depicted in Figure 3.7.



**Figure 3.6: Research framework**

### **3.8 Chapter Summary**

Thorough preparation is required to achieve optimal result. This chapter intends to provide substantial detail in every steps of preparing the research, ensuring all materials, subjects, and data are test-ready before the experiment procedure is performed. To recapitulate, there are five major topics of discussion in this chapter: (i) research design; (ii) research instruments, including the development of IMMAPA and IMMSPA, and the creation of comprehension test, and survey questionnaire; (iii) research samples; (iv) data collection procedure; and (v) determine appropriate statistical methods for data analysis.

In summary, this chapter presented the research methods used to evaluate students' learning achievement on Introductory Psychology between students who learned using IMMs with two different types of PAs, and students' perceptions towards interactive multimedia learning with two different types of PAs through a quantitative experimental research. Based on the research methodology explained in this chapter, the discussion of research findings are presented in chapter 4.

## CHAPTER 4

### 4.0 DATA ANALYSIS AND RESEARCH FINDINGS

The discussion of data analysis and research findings in this chapter is divided into four sections as below:

- i. The outcomes of the development of two interactive multimedia modules (IMMs) with different types of PA in promoting teaching and learning of Introductory Psychology
- ii. The results of data analysis about the respondents' demographic data
- iii. The data analysis and research findings of students' learning achievement evaluation in using two IMMs with different types of PAs in the teaching-learning of Introductory Psychology, and
- iv. The data analysis and research findings of students' perceptions towards the features incorporated in IMMs evaluation in using two IMMs with different types of PAs.

#### 4.1 The Outcomes of the Two IMMs with Different Types of PAs in Promoting Teaching and Learning of Introductory Psychology

As explained in section 3.2.1, two IMMs with different types of PAs were developed in this research, namely IMMAPA (IMM with animated pedagogical agents), which contained the emotive pedagogical agents equipped

with animation and recorded voice features, and IMMSPA (IMM with static pedagogical agents), which contained the non-emotive agents equipped without animation and audio. The effects of both types of PAs on the students' learning achievement in Introductory Psychology were evaluated. It intended to find out whether there were significant effects on students' learning achievement between the two. Nevertheless, both IMM s were designed with identical interactive navigation features, narrative setting, appearance of PAs (i.e. Karen and Joe), dialogue between the PAs, and learning contents as shown in Figure 4.1.



**Figure 4.1: Sample screenshot from the Introduction screen showing interactive navigation features (interactive buttons), narrative setting, and the look of both PAs, i.e. Karen and Joe**

#### **4.1.1 The setting and features of PAs Joe and Karen as learning companions in the IMM s**

The two IMM s depicted a school library as a background setting to establish an educational atmosphere for the users. A PA called Joe was

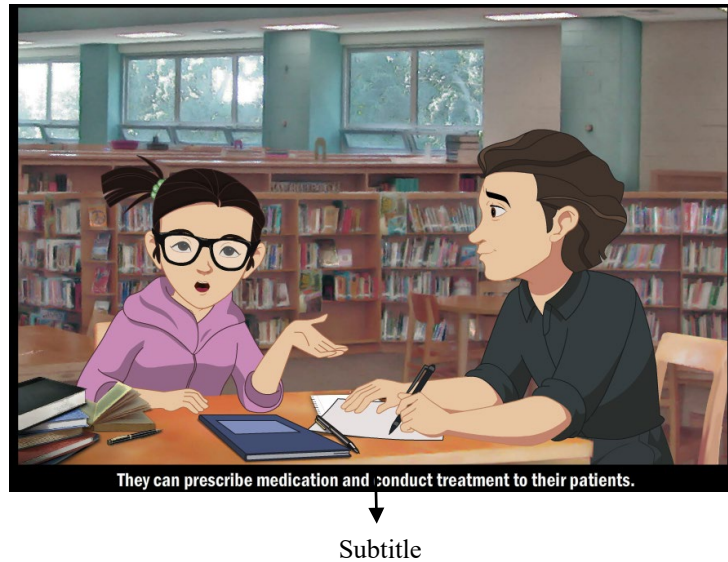
designed in a narrative-centred learning environment as a self-opinionated male student who consistently seeking help about learning topics. Meantime, a PA called Karen was designed as a rather intellectual female student who was in the same class with Joe and the users. Nonetheless, both PAs were designed to deliver in Introductory Psychology lessons integrated in the IMM, as well as to help module users to attain knowledge in Introductory Psychology.

Both PAs, i.e. Karen and Joe were designed as peer companions to subject of study, i.e. university students aged 18-24 years old in this research. Tegos and Demetriadis (2017) pointed out that using peer-focused design of conversational agents encourages more productive engagement to individual rather than the group. Both agents' appearance were designed as similar as regular undergraduate students, to attract familiarity of characters with users (i.e. agents wearing casual attire, and no distracting colour design). The design of companion conversational agents, which act as a peer to the students aimed to motivate users engage in learning which may have impact in their learning achievement and perceptions with different types of PA features, i.e. either animated characters with recorded voice or static characters with written text).

The animated pedagogical agents (APAs) with emotive features were designed in richer features compared to the static pedagogical agents (SPAs) with non-emotive features. The APAs were designed with both animated body gestures and expressions throughout the lessons in the IMM. Each Joe and Karen were equipped with their own distinctive voices in English for users to recognize. Additionally, subtitle about a dialogue were displayed at the bottom



of each scene as visual aid to the recorded audio feature. Figure 4.2 shows a sample screenshot from the IMMAPA showing how embodied Karen and Joe were interacting with users. Facial expressions and body gestures played the major roles of animated enactment representing emotive PA in this research.



**Figure 4.2: Sample screenshot from a lesson in IMMAPA showing Karen and Joe speaking in their own voices (recorded audio) as well as acting throughout the delivery of lessons in the module**

Meanwhile, the static pedagogical agents (SPAs) were designed without the features of animation and recorded audio. Instead of using animation, both Karen and Joe were presented as static graphics with unanimated face. There was no narration or audio feature in IMMSPA, which means Karen and Joe had no voice of their own; the audio was replaced with text-only feature. The dialogue about the lessons between PAs in the narrative-centred learning environment were delivered in animated text format inside a transparent dialogue box as can be seen in Figure 4.3. The text flow was designed in relatively low-reading speed for the users to have sufficient time obtaining the necessary information about a lesson.

Display the dialogue between PAs about a lesson in a transparent dialogue box



**Figure 4.3: Sample screenshots from a lesson in IMMSPA and IMMAPA showing the display of dialogue and text throughout the delivery of lessons in the module**

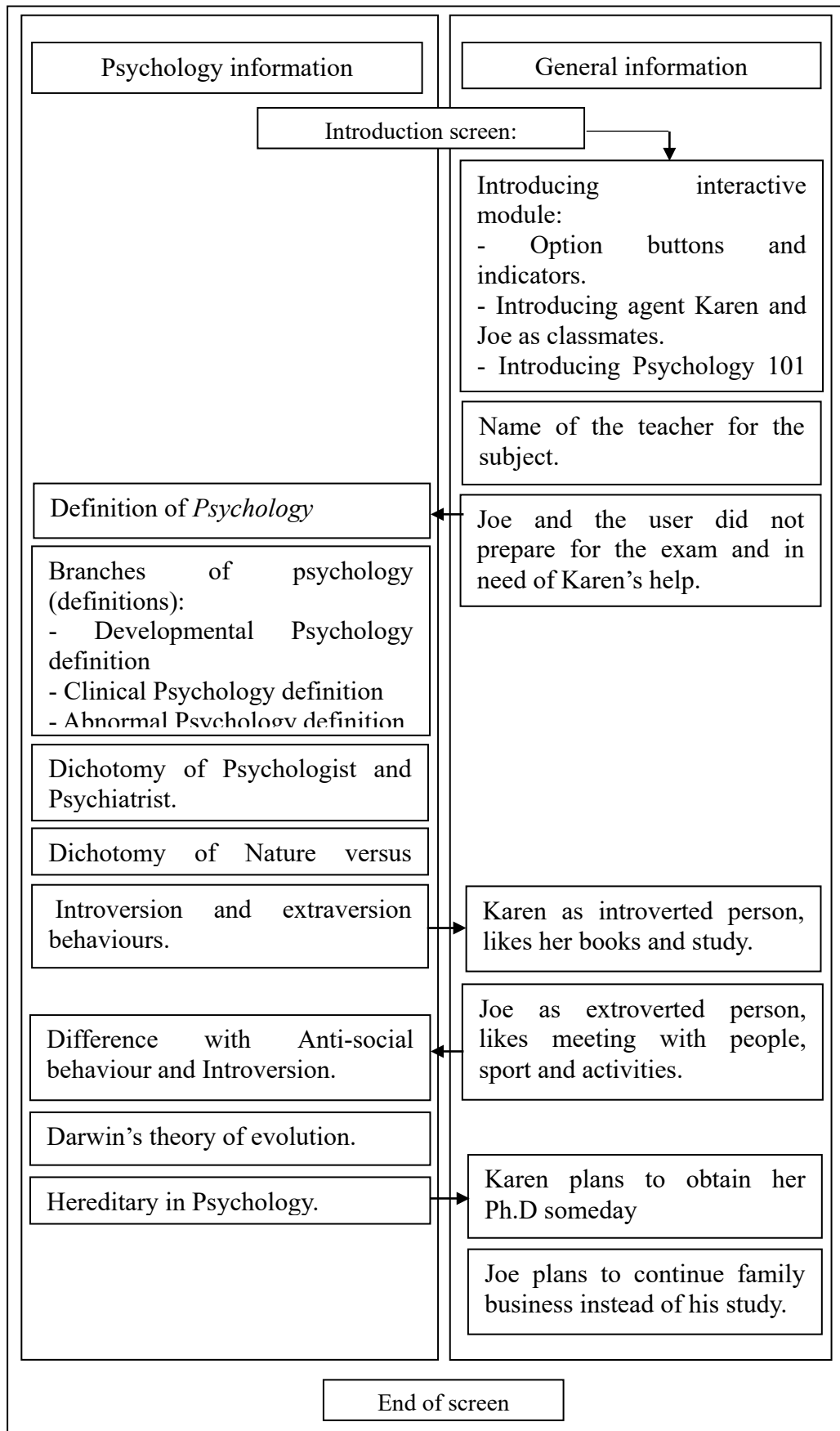
Figures 4.2 and 4.3 depict the comparison of same scene in IMMAPA and IMMSPA. Figure 4.2 shows facial expressions and body gestures in APAs when they were speaking to the users, and users could read the subtitle at the bottom of the scene, which synchronised to the agents' voices. Meanwhile, Figure 4.3 displays agents' image at static state. Users received information mostly from reading text flowed on top of each scene. Text flowing speed was

adjusted approximately 20 to 25 letters per second. When certain words (i.e. terms of psychology) was introduced, the text flow speed was slowed down to 15 letters per second, and the sentence was hold longer before disappeared. The adjustment of text flow speed was to ensure that users are able to receive the information optimally.

#### **4.1.2 Narration of educational content in IMMs**

Both introduction screen in IMMs began with the introduction of three conditions: narrative-centred interactive learning module, PAs called Joe and Karen, and Introductory Psychology lessons. Figure 4.1 shows the first selectable buttons after being questioned by agents, indicating that the interaction did not flow in monotonous manner; users could receive different responses from each chosen button click.

There IMMs encompassed two types of information: psychology and general information. Both types of information were presented alternately in the content flow during module interaction (see Figure 4.4). Psychology information consisted of 10 topics, and general information included background and characteristics of PAs, i.e. Joe and Karen, and name of their psychology lecturer.



**Figure 4.4: Narration/ lesson flow in IMMSPA and IMMSPA**

Some information were presented simultaneously, which gave users the liberty to choose which one they would like to uncover first, for example the options between branches of psychology which consists of developmental, clinical, or abnormal psychology. Every user in both IMMAPA and IMMSPA were presented with all information equally. Once a topic was revealed by the PAs, the interface automatically displayed the main option screen (see Figure 4.5), which allowed user to select other topics to learn.



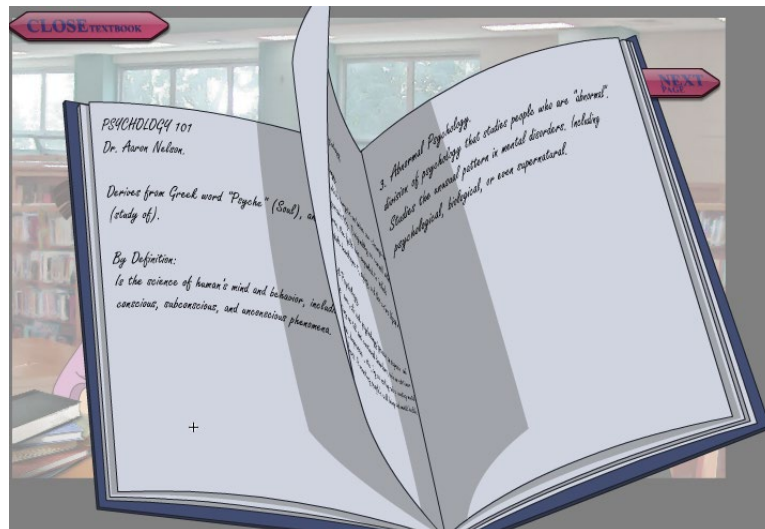
**Figure 4.5: Sample screenshot from IMM showing the options of topics for learning**

Besides, as shown in Figure 4.6, each new lesson of Introductory Psychology introduced by the PAs was automatically updated and recorded in a blue coloured interactive textbook located on the middle of the table. Indicator “Click on the book to check the contents” would appear at the designated time of when the users can access the textbook by clicking on it. The idea was to help the users to review uncovered lessons that they might have missed out during the delivery of lessons via conversation between PAs. The textbook as shown in Figure 4.7 could also be interacted by flipping through the pages, by clicking on interactive buttons available on each page (such as NEXT PAGE

button to go to the next page, PREVIOUS PAGE button to view the previous page, and a CLOSE TEXTBOOK button to close the textbook). Each textbook page consist of information in such order from the beginning of the IMMs to the end.



**Figure 4.6: Sample screenshot from IMMs showing an interactive textbook, which aimed to help users to recall uncovered lessons during the delivery of lessons**

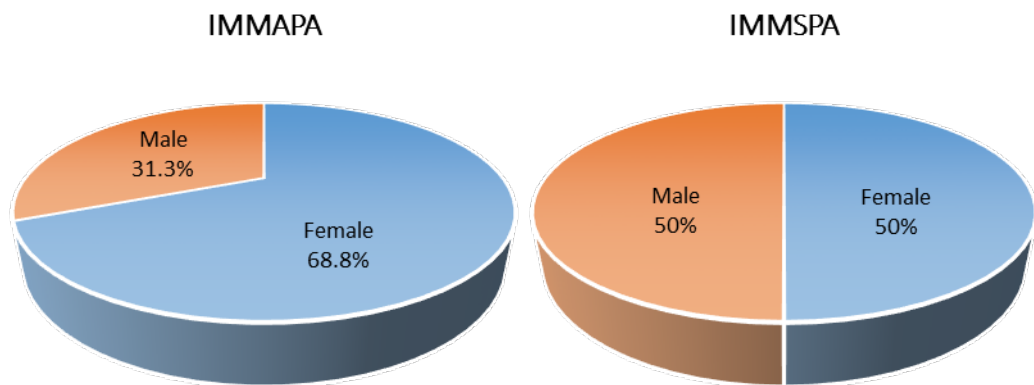


**Figure 4.7: Sample screenshot from IMMs showing lessons that had been discovered were updated and recorded automatically into the textbook**

## 4.2 Results of the Respondents' Demographic Data Analysis

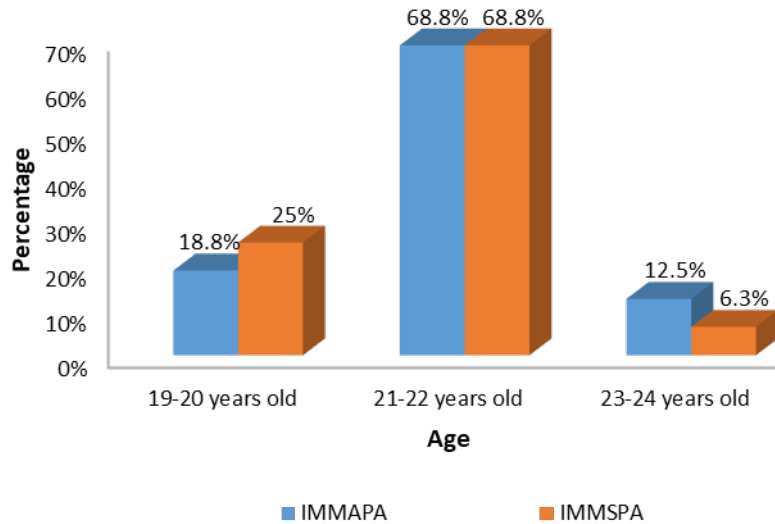
The number of respondents participated in the evaluation of both IMMAPA and IMMSPA consisted of 32 students in total, with 16 respondents of each group.

Of the 16 respondents in IMMAPA group, there were 11 (68.8 per cent) females, and five (31.3 per cent) males. Besides, of the 16 respondents in IMMSPA group, eight (50 per cent) of them were females and the rest were males as shown in Figure 4.8.



**Figure 4.8: The percentage of male and female respondents in both groups**

Besides, as shown in Figure 4.9, most of the respondents participated in the study aged 21-22 years old (both 68.8 per cent in IMMAPA and IMMSPA groups), followed by 19-20 years old (18.8 per cent in IMMAPA group and 25 per cent in IMMSPA group), and (12.5 per cent in IMMAPA group and 6.3 percent in IMMSPA group).



**Figure 4.9: The percentage of respondents in both IMMAPA and IMMSPA groups by age**

#### **4.3 The Data Analysis and Research Findings of Students' Learning Achievement Evaluation in using Two IMM with Different Types of PAs in the Teaching-Learning of Introductory Psychology**

Learning achievement was measured in this research using a set of comprehension test (see Appendix B) after the intervention (i.e. learning Introductory Psychology either using IMMAPA or IMMSPA). The first section of the test consisted of 10 multiple-choice questions, and the second section consisted of 10 true-or-false questions. These questions were built from occurrences, lessons, or agents' behaviour that had been included in the modules. Each question from both sections granted 1 point for a correct answer and 0 point for incorrect answer. Total scores obtained through the comprehension test were calculated to measure students' achievement in psychology knowledge acquisition after intervention using IMM with different types of PAs. The total score of the 20 questions was then classified



into four levels of learning achievement as below:

- i. **Poor:** Total score of the comprehension test between 0-5 points
- ii. **Fair:** Total score of the comprehension test between 6-10 points
- iii. **Good:** Total score of the comprehension test between 11-15 points
- iv. **Very Good:** Total score of the comprehension test between 16-20 points

#### **4.3.1 The findings of the testing of null hypothesis 1 ( $H_01$ )**

Descriptive statistical data were used to present the results of students' achievement with 20 questions that measured the knowledge of psychology. Means (M), standard deviation (SD), and percentage were generated to find out students' learning achievement using IMM with different types of PAs. In relation to the testing of null hypothesis 1 ( $H_01$ ), as have been discussed in section 3.6.1, the independent samples t-test was used to test the following null hypothesis 1 ( $H_01$ ) to examine if there was a significant difference between the use of IMMAPA and IMMSPA on students' learning achievement in Introductory Psychology:

**$H_01$ : There was no significant difference between the learning of Introductory Psychology using IMMAPA and IMMSPA on students' learning achievement.**

The independent samples t-test was conducted to determine whether there was a significant difference between the mean scores of students'

achievements under two different conditions (i.e. learning Introductory Psychology using IMMAPA and IMMSPA) among respondents. The results are shown in Tables 4.1 and 4.2.

**Table 4.1: Descriptive statistics for learning achievement between students in IMMAPA and IMMSPA groups**

<b>Learning achievement</b>			
<b>Type of IMMs</b>	<b>N</b>	<b>M</b>	<b>SD</b>
IMMAPA	16	18.06	1.611
IMMSPA	16	16.13	1.821

**Table 4.2: Independent samples t-test results for learning achievement and type of IMMs**

<b>Learning achievement</b>	<b>Levene's Test for Equality of Variance</b>		<b>T-test for Equality of Means</b>		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	0.815	0.374	3.187	30	0.003**
Equal variances not assumed			3.187	29.561	0.003

\*\* p < 0.01

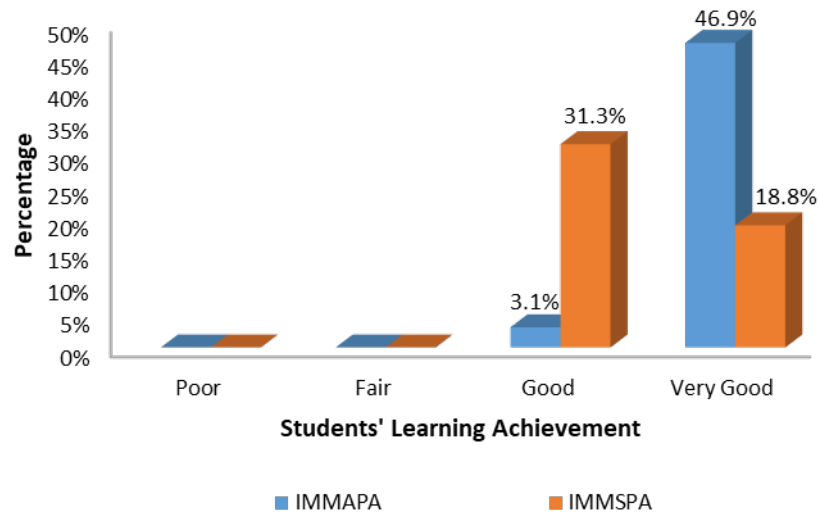
**Note:**

The value of equal variance assumed is applicable if the significance of the Levene's test is high, i.e. greater than 0.05 (Gignac & Szodorai, 2016; Trochim, Donnelly & Arora, 2015; van Assen, van Aert & Wicherts, 2015). Since the p-value for Levene's test is large (p=0.374), which is greater than 0.05, so we can assume that the equal variances assumed is not violated.

Through the results as shown in Table 4.2, the p-value was 0.003 (p<0.01) indicating that the data provides enough evidence to reject null hypothesis 1 (H<sub>01</sub>) at a 0.01 significance level (t=3.187, p=0.003). The results explain that there was strong evidence to support the hypothesis 1 (H<sub>1</sub>), which corroborated the assumption that **“there was a significant difference between the learning of Introductory Psychology using IMMAPA and IMMSPA on students' learning achievement”** with significant difference in mean scores between the two (M<sub>IMMAPA</sub>=18.06, SD<sub>IMMAPA</sub>=1.611; M<sub>IMMSPA</sub>=16.13, SD<sub>IMMSPA</sub>=1.821) as shown in Table 4.1. The results also imply that different

types of PAs in the IMMs had a significant effect on students' performance in psychology learning.

In addition, the difference between students' achievements in both IMMAPA and IMMSPA groups is clearly shown in Figure 4.10.



**Figure 4.10: Students' learning achievement on comprehension test to measure their knowledge of psychology**

Figure 4.10 reveals that none of the respondents in either group fell into "Poor" and "Fair" categories, i.e. scored less than 11 points in the total score of the comprehension test. The research findings proved that the IMMs with PAs had a positive impact on students' learning achievement, in which both IMMAPA and IMMSPA groups scored well, i.e. 11 points and above in the total score of the comprehension test.

Figure 4.10 also shows obvious difference in the total score of the two groups where the percentage of students in the IMMAPA group that contributed to the value "Very Good" (scored 16-20 points in total) was higher

(46.9 per cent) than the students in the IMMSPA group (31.3 per cent). However, 18.7 per cent of students in the IMMSPA group's rating fell in the value "Good," (scored 11-15 points in total) whereas the students in the IMMAPA group was only 3.1 per cent.

The current research findings are coherent with several similar past studies (e.g. Kervellec et al., 2016; Park, 2015; Wei, Peng & Chou, 2015; Yung & Paas, 2015). These studies found that the use of animated pedagogical agent in multimedia learning had positive impact on students' achievement in various learning topics.

#### **4.4 The Data Analysis and Research Findings of Students' Perceptions towards the Features incorporated in IMM Evaluation in using Two IMM with Different Types of PAs**

The research aimed to investigate whether or not students who learned Introductory Psychology using two IMM with different features of content and PAs would have different perceptions towards the features incorporated in IMM such as educational multimedia content (EMC), pedagogical agents' instructional role (PAIR), learning motivation (LM), pedagogical agents' characteristics (PAC), and pedagogical agents' presentation styles (PAPS).

Past studies (e.g. Wang et al., 2018; Wei, Peng & Chou, 2015) reported that students' performance and motivation were affected by their perceptions towards PA designs and characteristics related to study subjects and roles.

Some studies (e.g. Chen & Wang, 2018; Guo, Luyt & Goh, 2014) suggested that students' enjoyment during engagement with PA motivates cognitive impact hence perceived as enhancing learning. Also, there were past studies (e.g. Carlotto & Jacques, 2016; Stef et al., 2016; Tegos & Demetriadis, 2017) noted that learning perceptions were affected by the combination between PA's audio and visual representation.

Drawing upon these past studies, this study assumes that students' perceptions towards the use of PA in IMM learning might vary depending on different factors and variables presented. In this study, students were asked for their perceptions towards the educational multimedia content and features of PAs after experiencing the learning process of Introductory Psychology using two IMMs with different types of PAs (i.e. APA and SPA). In regard to their perceptions towards the educational multimedia content and features of PAs incorporated in two IMMs, the following five null hypotheses were tested:

**H<sub>0</sub>2: There was no significant difference in students' perceptions towards educational multimedia content in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.**

**H<sub>0</sub>3: There was no significant difference in students' perceptions towards pedagogical agents' instructional role in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.**

**H<sub>04</sub>:** There was no significant difference in students' perceptions towards learning motivation between students who learned using IMMAPA and students who learned using IMMSPA.

**H<sub>05</sub>:** There was no significant difference in students' perceptions towards pedagogical agents' characteristics in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.

**H<sub>06</sub>:** There was no significant difference in students' perceptions towards pedagogical agents' presentation styles in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.

The subsequent sections reports the findings for the five hypotheses measuring students' perceptions towards EMC, PAIR, LM, PAC, and PAPS.

#### **4.4.1 The findings of the testing of null hypothesis 2 (H<sub>02</sub>)**

13 statements as listed in Table 4.3 were incorporated into Section A in Part 1 of the questionnaire (see Appendix C) to find out students' perceptions towards EMC using a 5-point Likert scale ranging from 1 'Strongly Disagree' to 5 'Strongly Agree'. The students were requested to tick the corresponding numbers (i.e. 1-5). Table 4.3 depicts descriptive statistics i.e. Mean (M) and Standard Deviation (SD) for students' perception towards the 13 items of EMC

between respondents in the groups of IMMAPA and IMMSPA. Respondents who learned Introductory Psychology using different IMM were coded with 1=IMMAPA (N=16) and 2=IMMSPA (N=16), whereas their replies were coded with 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, and 5=Strongly Agree.

**Table 4.1: Descriptive statistics for the evaluation of students' perceptions towards "Educational Multimedia Content" (EMC) by IMM groups**

Item No.	Educational Multimedia Content (EMC) statement	IMMAPA (N=16)		IMMSPA (N=16)	
		M	SD	M	SD
EMC 1	The content is pretty clear to me.	3.81	0.834	3.38	0.957
EMC 2	The content looks reliable to me.	3.50	1.095	2.88	1.025
EMC 3	The content is easy to understand.	3.94	0.854	3.56	0.892
EMC 4	Language used to present the content is simple and easy to understand.	4.00	0.516	4.00	0.632
EMC 5	The information is well-structured (systematic) from the beginning.	3.81	1.223	2.81	1.109
EMC 6	The content gives me many new information.	4.31	0.479	3.69	0.793
EMC 7	The content made me aware about psychology.	3.94	1.237	3.06	1.181
EMC 8	The psychology terms are easy to remember.	3.56	1.031	2.69	1.078
EMC 9	This psychology information is useful for me.	3.50	1.211	2.88	1.088
EMC 10	I can learn and understand every section of the lessons by the end of the programme.	3.38	1.088	3.13	1.147
EMC 11	I found the content is useful for learning.	3.94	0.574	3.69	0.793
EMC 12	I prefer to learn psychology lessons like this (with multimedia features and pedagogical agents).	3.88	0.957	3.06	1.181
EMC 13	I tried to pay attention in every part of the content.	4.06	1.289	2.63	1.088
EMC (Overall)		3.82	0.695	3.19	0.668

As shown in Table 4.3, all the 13 mean scores for students' perceptions towards EMC statements ranging from 3.38 to 4.06 among students in the IMMAPA group were above the midpoint (3) of the 5-point Likert scale. The results in Table 4.3 indicate that the respondents found that the content in IMMAPA gave them many new information (IMMAPA:  $M_{EMC6}=4.31$ ,  $SD = 0.479$ ), made them tried to pay attention to in every part of the content (IMMAPA:  $M_{EMC13}=4.06$ ,  $SD_{EMC13}=1.289$ ), the language used to present the content was simple and easy (IMMAPA:  $M_{EMC4}=4.00$ ,  $SD_{EMC4}=0.516$ ), the content was easy to understand (IMMAPA:  $M_{EMC3}=3.94$ ,  $SD_{EMC4}=0.854$ ), the content made them aware about psychology (IMMAPA:  $M_{EMC7}=3.94$ ,  $SD_{EMC7}=1.237$ ), the content was useful for learning (IMMAPA:  $M_{EMC11}=3.94$ ,  $SD_{EMC11}=0.574$ ), they preferred to learn psychology lessons with multimedia features and pedagogical agents (IMMAPA:  $M_{EMC12}=3.88$ ,  $SD_{EMC12}=0.957$ ), the content was pretty clear to them (IMMAPA:  $M_{EMC1}=3.81$ ,  $SD_{EMC1}=0.834$ ), the information was well-structured (systematic) from the beginning (IMMAPA:  $M_{EMC5}=3.81$ ,  $SD_{EMC5}=1.223$ ), the psychology terms were easy to remember (IMMAPA:  $M_{EMC8}=3.56$ ,  $SD_{EMC8}=1.031$ ), the content looked reliable to them, (IMMAPA:  $M_{EMC2}=3.50$ ,  $SD_{EMC2}=1.095$ ), the psychology information was useful for them (IMMAPA:  $M_{EMC9}=3.50$ ,  $SD_{EMC9}=1.211$ ), and they could learn and understand every section of the lessons by the end of the programme (IMMAPA:  $M_{EMC10}=3.38$ ,  $SD_{EMC10}=1.088$ ).

Comparatively, only eight mean scores for the students' perceptions towards EMC statements were above the midpoint (3) of the 5-point Likert scale among the students in IMMSPA group. It is ranging from 3.06 to 4.00 as



shown in Table 4.13. The results in Table 4.3 indicate that the respondents found that the language used to present the content in IMMSPA was simple and easy (IMMSPA:  $M_{EMC4}=4.00$ ,  $SD_{EMC4}=0.632$ ), the content gave them many new information (IMMSPA:  $M_{EMC6}=3.69$ ,  $SD_{EMC6}=0.793$ ), the content was useful for learning (IMMSPA:  $M_{EMC11}=3.69$ ,  $SD_{EMC11}=0.793$ ), the content was easy to understand (IMMSPA:  $M_{EMC3}=3.56$ ,  $SD_{EMC3}=0.892$ ), the content was pretty clear to them (IMMSPA:  $M_{EMC1}=3.38$ ,  $SD_{EMC1}=0.957$ ), they could learn and understand every section of the lessons by the end of the programme (IMMSPA:  $M_{EMC10}=3.13$ ,  $SD_{EMC10}=1.147$ ), the content made them aware of the psychology (IMMSPA:  $M_{EMC7}=3.06$ ,  $SD_{EMC7}=1.181$ ), and they preferred to learn psychology lessons with multimedia features and pedagogical agents (IMMSPA:  $M_{EMC12}=3.06$ ,  $SD_{EMC12}=1.181$ ).

Based on the results shown in Table 4.3, there were 13 statements that measured students' perceptions towards EMC among the students in IMMSPA group possessed mean scores above the midpoint (3) of 5-point Likert scale, but only eight statements among students in IMMSPA group possessed mean scores above the midpoint (3). The findings indicate that students in IMMSPA group generally had more positive perceptions towards the educational multimedia content in enhancing students' learning of Introductory Psychology than students in IMMSPA group.

In order to investigate whether there was a statistically significant difference existed in students' perceptions towards EMC between the students in IMMSPA and IMMSPA groups, as have been described in section 3.6.2,

independent samples t-test was used to test the following null hypothesis 2 (H<sub>02</sub>):

**H<sub>02</sub>: There was no significant difference in students' perceptions towards educational multimedia content in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.**

The t-test analysis results are shown in Table 4.4.

**Table 4.2: Independent sample t-test results for the evaluation of students' perceptions towards the overall EMC and type of IMMs**

EMC (Overall)	Levene's Test for Equality of Variance		T-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	0.003	0.958	2.613	30	0.014*
Equal variances not assumed			2.613	29.950	0.014

\*\* p < 0.05

**Note:**

The value of equal variance assumed is applicable if the significance of the Levene's test is high, i.e. greater than 0.05 (Gignac & Szodorai, 2016; Trochim, Donnelly & Arora, 2015; van Assen et al., 2015). Since the p-value for Levene's test is large (p=0.958), which is greater than 0.05, so we can assume that the equal variances assumed is not violated.

Through the results of independent samples t-test analysis as shown in Table 4.4, the p-value was 0.014 (p<0.05) indicating that the data provides enough evidence to reject the null hypothesis 2 (H<sub>02</sub>) at a 0.05 significance level (t=2.613, p=0.014). The results explain that there was enough evidence to support the hypothesis 2 (H<sub>02</sub>), which indicates that **“there was a significant difference in students' perceptions towards educational multimedia content in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned**

**using IMMSPA”** with significant difference in mean scores between the two ( $M_{IMMAPA}=3.82$ ,  $SD_{IMMAPA}=0.695$ ;  $M_{IMMSPA}=3.19$ ,  $SD_{IMMSPA}=0.668$ ) as shown in Table 4.3.

However, among the 13 items, in only six items, the mean scores for the perceptions of students in IMMAPA group regarding EMC were significantly ( $p \leq 0.05$ ) higher than the students in IMMSPA group as below (see Tables 4.3 and 4.5):

- EMC 13 ( $M_{IMMAPA}=4.06$ ,  $SD_{IMMAPA}=1.289$ ;  $M_{IMMSPA}=2.63$ ,  $SD_{IMMSPA}=1.088$ ;  $t=3.408$ ,  $p=0.002$ )
- EMC 6 ( $M_{IMMAPA}=4.31$ ,  $SD_{IMMAPA}=0.479$ ;  $M_{IMMSPA}=3.69$ ,  $SD_{IMMSPA}=0.793$ ;  $t=2.068$ ,  $p=0.011$ );
- EMC 5 ( $M_{IMMAPA}=3.81$ ,  $SD_{IMMAPA}=1.223$ ;  $M_{IMMSPA}=2.81$ ,  $SD_{IMMSPA}=1.109$ ;  $t=2.423$ ,  $p=0.022$ );
- EMC 8 ( $M_{IMMAPA}=3.56$ ,  $SD_{IMMAPA}=1.031$ ;  $M_{IMMSPA}=2.69$ ,  $SD_{IMMSPA}=1.078$ ;  $t=2.346$ ,  $p=0.026$ );
- EMC 12 ( $M_{IMMAPA}=3.88$ ,  $SD_{IMMAPA}=0.957$ ;  $M_{IMMSPA}=3.06$ ,  $SD_{IMMSPA}=1.181$ ;  $t=2.137$ ,  $p=0.041$ ); and
- EMC 7 ( $M_{IMMAPA}=3.94$ ,  $SD_{IMMAPA}=1.237$ ;  $M_{IMMSPA}=3.06$ ,  $SD_{IMMSPA}=1.181$ ;  $t=2.046$ ,  $p=0.050$ ).

**Table 4.5: Independent samples t-test results for the evaluation of students' perceptions towards the 13 items of EMC and type of IMMs**

		Levene's Test for Equality of Variance		T-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
EMC 1	Equal variances assumed	1.297	0.264	1.378	30	0.178
	Equal variances not assumed			1.378	29.448	0.179
EMC 2	Equal variances assumed	0.498	0.486	1.667	30	0.106
	Equal variances not assumed			1.667	29.867	0.106
EMC 3	Equal variances assumed	0.091	0.765	1.215	30	0.234
	Equal variances not assumed			1.215	29.943	0.234
EMC 4	Equal variances assumed	0.556	0.462	0.000	30	1.000
	Equal variances not assumed			0.000	28.846	1.000
EMC 5	Equal variances assumed	0.009	0.927	2.423	30	<b>0.022*</b>
	Equal variances not assumed			2.423	29.715	0.022
EMC 6	Equal variances assumed	3.183	0.085	2.698	30	<b>0.011*</b>
	Equal variances not assumed			2.698	24.647	0.012
EMC 7	Equal variances assumed	0.209	0.651	2.046	30	<b>0.050*</b>
	Equal variances not assumed			2.046	29.938	0.050
EMC 8	Equal variances assumed	0.145	0.706	2.346	30	<b>0.026*</b>
	Equal variances not assumed			2.346	29.940	0.026
EMC 9	Equal variances assumed	0.248	0.622	1.536	30	0.135
	Equal variances not assumed			1.536	29.661	0.135
EMC 10	Equal variances assumed	0.039	0.844	0.632	30	0.532
	Equal variances not assumed			0.632	29.915	0.532
EMC 11	Equal variances assumed	5.546	0.025	1.022	30	0.315
	Equal variances not assumed			1.022	27.322	0.316
EMC 12	Equal variances assumed	0.332	0.569	2.137	30	<b>0.041*</b>
	Equal variances not assumed			2.137	28.765	0.041
EMC 13	Equal variances assumed	0.135	0.716	3.408	30	<b>0.002**</b>
	Equal variances not assumed			3.408	29.173	0.002

\*\*  $p < 0.01$

\*  $p \leq 0.05$

**Note:**

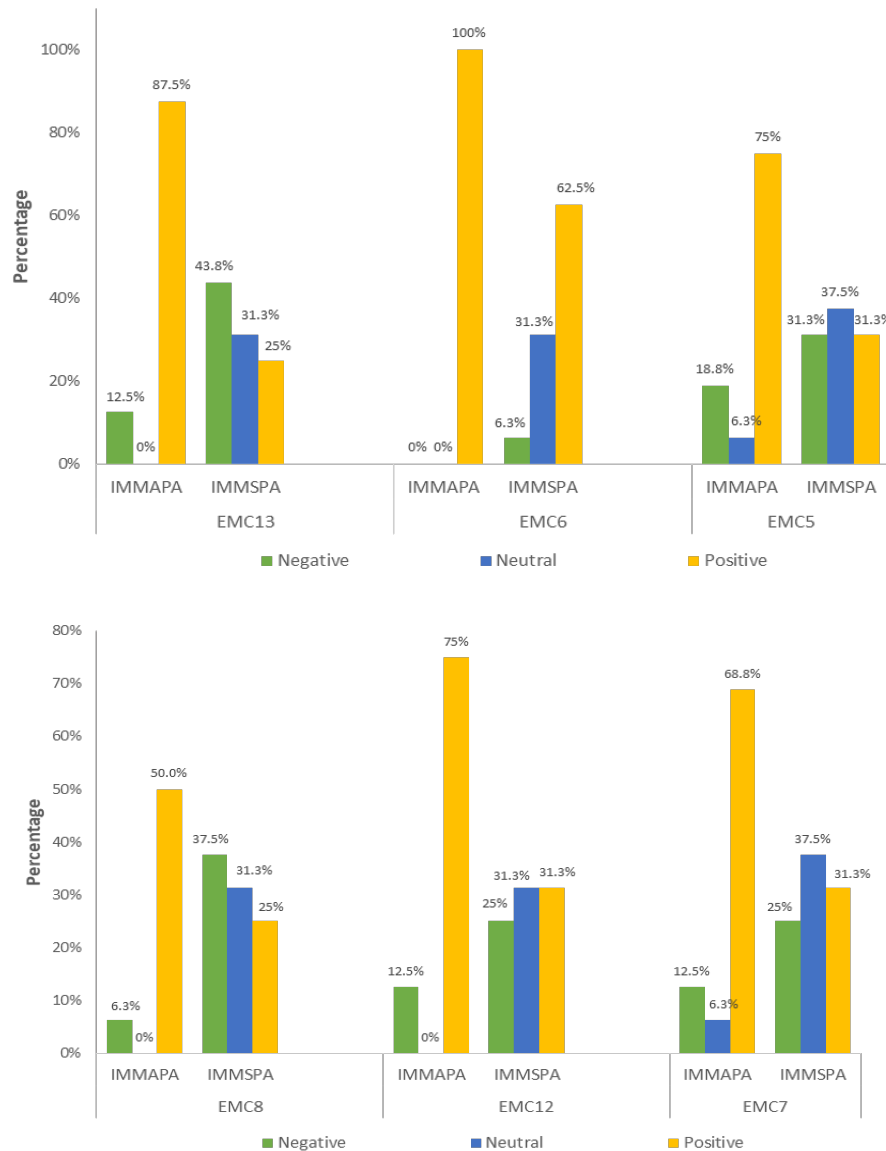
The value of equal variance assumed is applicable if the significance of the Levene's test is high, i.e. greater than 0.05 (Gignac & Szodorai, 2016; Trochim, Donnelly & Arora, 2015; van Assen, van Aert & Wicherts, 2015). Since all the p-values for Levene's test are large ( $p > 0.05$ ), which are greater than 0.05, so we can assume that the equal variances assumed for all the EMC statements were not violated.

Also, the results of t-test analysis in Table 4.5 show that no significant differences were found between IMMAPA and IMMSPA groups for the other seven items of EMC at a 0.05 significance level: EMC 1 ( $t=1.378$ ,  $p=0.178$ ), EMC 2 ( $t=1.667$ ,  $p=0.106$ ), EMC 3 ( $t=0.215$ ,  $p=0.234$ ), EMC 4 ( $t<0.001$ ,  $p=1.000$ ), EMC 9 ( $t=1.536$ ,  $p = 0.135$ ), EMC 10 ( $t=0.632$ ,  $p=0.532$ ), and EMC 11 ( $t=1.022$ ,  $p=0.315$ ).

The results suggest that the mean scores on these dependent variables (i.e. EMC 1, EMC 2, EMC 3, EMC 4, EMC 9, EMC 10, and EMC 11) are relatively close to each other among students in both IMMAPA and IMMSPA groups (EMC 1:  $M_{IMMAPA}=3.81$ ,  $M_{IMMSPA}=3.38$ ; EMC 2:  $M_{IMMAPA}=3.50$ ,  $M_{IMMSPA}=2.88$ ; EMC 3:  $M_{IMMAPA}=3.94$ ,  $M_{IMMSPA}=3.56$ ; EMC 4:  $M_{IMMAPA}=4.00$ ,  $M_{IMMSPA}=4.00$ ; EMC 9:  $M_{IMMAPA}=3.50$ ,  $M_{IMMSPA}=2.88$ ; EMC 10:  $M_{IMMAPA}=3.38$ ,  $M_{IMMSPA} = 3.33$ ; EMC 11:  $M_{IMMAPA}=3.94$ ,  $M_{IMMSPA}=3.69$ ) as shown in Table 4.3. In other words, the perceptions of students in both IMMAPA and IMMSPA groups towards these seven items of EMC were similar.

In addition, the significant differences between the perceptions of students' towards the six items of EMC in IMMAPA and IMMSPA groups are clearly shown in Figure 4.11. Data of respondents' perceptions towards the six items of EMC have been analysed by combining respondents' answers into three categories: Negative, Neutral and Positive. Negative category refers to the 'Strongly Disagree' and 'Disagree', Neutral category refers to the 'Not Sure' answer, and Positive category refers to the 'Strongly Agree' and 'Agree'.

Figure 4.11 shows the comparison between these three categories of answers for students' perceptions towards the six items of EMC that show significant differences between the IMMAPA and IMMSPA groups.



**Figure 4.11: Percentage of students' perceptions towards the six items of EMC that show significant differences between IMMAPA and IMMSPA groups**

More respondents in IMMAPA group were reported to have positive perceptions than neutral and negative perceptions towards all the six items that show significant differences in perceptions between groups, i.e. "they tried to

pay attention in every part of the content” (EMC 13), “the content gives them many new information” (EMC 6), “the information was well-structured (systematic) from the beginning (EMC 5), “the psychology terms were easy to remember” (EMC 8), “they prefer to learn psychology lessons like with multimedia features and pedagogical agents” (EMC 12), and “the content made them aware about psychology” (EMC 7). The same result is shown in the perception of students in IMMSPA towards an item, i.e. “the content gives them many new information” (EMC 6). Additionally, more respondents in IMMSPA group were reported to have negative and neutral perceptions towards two items of EMC.

As a whole, the percentage of respondents in IMMSPA group indicated positive perceptions towards the seven items that show significant differences is higher than the respondents in IMMSPA group. These findings are congruent with the findings from past studies (i.e. Ahdon, 2013; Wei, Peng & Chou, 2015), which showed that students have higher positive perceptions in delivering educational multimedia content with animated PA.

#### **4.4.2 The findings of the testing of null hypothesis 3 (H<sub>03</sub>)**

Six statements as listed in Table 4.6 were incorporated into Section B in Part 1 of the questionnaire (see Appendix B) to find out students’ perceptions towards PAIR using a 5-point Likert scale ranging from 1 ‘Strongly Disagree’ to 5 ‘Strongly Agree’. The students were requested to tick the corresponding numbers (i.e. 1-5). Table 4.6 depicts descriptive statistics, i.e. Mean (M) and

Standard Deviation (SD) for students' perceptions towards the six items of PAIR between respondents in the groups of IMMAPA and IMMSPA. Respondents who learned Introductory Psychology using different IMM were coded with 1=IMMAPA (N=16) and 2=IMMSPA (N=16), whereas their replies were coded with 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, and 5=Strongly Agree.

**Table 4.6: Descriptive statistics for the evaluation of students' perceptions towards "Pedagogical Agents' Instructional Roles" (PAIR) by IMM groups**

Item No.	Pedagogical Agents' Instructional Roles (PAIR) statement	IMMAPA (N=16)		IMMSPA (N=16)	
		M	SD	M	SD
PAIR 1	The pedagogical agents are interesting.	3.56	1.094	3.69	0.479
PAIR 2	The pedagogical agents have human-like emotive appearance during the delivery of lessons.	3.63	1.025	3.44	0.629
PAIR 3	The pedagogical agents show appropriate body gestures during the delivery of lessons.	4.19	0.403	3.56	0.512
PAIR 4	The pedagogical agents show appropriate facial expression during the delivery of lessons.	4.00	0.516	3.81	0.655
PAIR 5	The pedagogical agents are knowledgeable.	4.06	0.574	3.25	0.856
PAIR 6	The learning environment design with pedagogical agents is appropriate.	4.13	0.500	3.88	0.342
PAIR (Overall)		3.93	0.505	3.60	0.264

As shown in Table 4.6, all the six mean scores for perceptions towards PAIR statements ranging from 3.56 to 4.19 among respondents in the IMMAPA group were above the midpoint (3) of 5-point Likert scale. The results in Table 4.5 shows that the respondents found that the animated PAs showed appropriate body gestures during the delivery of lessons (IMMAPA:  $M_{\text{PAIR3}}=4.19$ ,  $SD_{\text{PAIR3}}=0.403$ ), the learning environment design with PAs was



appropriate (IMMAPA:  $M_{\text{PAIR6}}=4.13$ ,  $SD_{\text{PAIR6}}=0.500$ ), the PAs were knowledgeable (IMMAPA:  $M_{\text{PAIR5}}=4.06$ ,  $SD_{\text{PAIR5}}=0.574$ ), the PAs showed appropriate facial expressions during the delivery of lessons (IMMAPA:  $M_{\text{PAIR4}}=4.00$ ,  $SD_{\text{PAIR4}}=0.516$ ), the PAs had human-like emotive appearance during the delivery of lessons (IMMAPA:  $M_{\text{PAIR2}}=3.63$ ,  $SD_{\text{PAIR2}}=1.025$ ), and the animated PAs were interesting (IMMAPA:  $M_{\text{PAIR1}}=3.56$ ,  $SD_{\text{PAIR1}}=1.094$ ).

Similarly, the data in Table 4.6 shows that all the six mean scores for perceptions of students in the IMMSPA group towards PAIR statements were also above the midpoint (3) of 5-point Likert scale. However, the range of these mean scores were slightly lower than the mean scores for perceptions of students in the IMMAPA group towards PAIR statements, which ranged from of 3.25 to 3.88. The respondents in IMMSPA group found that the learning environment design with PAs was appropriate (IMMSPA:  $M_{\text{PAIR6}}=3.88$ ,  $SD_{\text{PAIR6}}=0.264$ ), the PAs showed appropriate facial expressions during the delivery of lessons (IMMSPA:  $M_{\text{PAIR4}}=3.81$ ,  $SD_{\text{PAIR4}}=0.655$ ), the PAs were interesting (IMMSPA:  $M_{\text{PAIR1}}=3.69$ ,  $SD_{\text{PAIR1}}=0.479$ ), the PAs showed appropriate body gestures during the delivery of lessons (IMMSPA:  $M_{\text{PAIR3}}=3.56$ ,  $SD_{\text{PAIR3}}=0.512$ ), the PAs had human-like emotive appearance during the delivery of lessons (IMMSPA:  $M_{\text{PAIR2}}=3.44$ ,  $SD_{\text{PAIR2}}=0.629$ ), and the PAs were knowledgeable (IMMSPA:  $M_{\text{PAIR5}}=3.25$ ,  $SD_{\text{PAIR5}}=0.856$ ).

Since the results from both IMMAPA and IMMSPA groups had shown positive perceptions towards PAIR statements, in which the mean scores for all the six PAIR statements were above the midpoint (3) of 5-point Likert scale,

thus the independent samples t-test was conducted to investigate whether or not there was a statistically significant difference existed in students' perceptions towards PAIR between students in the IMMAPA and IMMSPA groups as has been described in section 3.6.2. The following null hypothesis 3 (H<sub>03</sub>) was tested:

**H<sub>03</sub>: There was no significant difference in students' perceptions towards pedagogical agents' instructional roles in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.**

The t-test analysis results are shown in Table 4.7.

**Table 4.7: Independent samples t-test results for the evaluation of students' perceptions towards the overall PAIR and type of IMMs**

PAIR (Overall)	Levene's Test for Equality of Variance		T-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	2.302	0.140	2.265	30	<b>0.031*</b>
Equal variances not assumed			2.265	22.638	0.033

\*\* p < 0.05

**Note:**

The value of equal variance assumed is applicable if the significance of the Levene's test is high, i.e. greater than 0.05 (Gignac & Szodorai, 2016; Trochim, Donnelly & Arora, 2015; van Assen, van Aert & Wicherts, 2015). Since the p-value for Levene's test is large (p=0.140), which is greater than 0.05, so we can assume that the equal variances assumed is not violated.

Through the results of independent samples t-test analysis as shown in Table 4.7, the p-value was 0.031 (p<0.05) indicating that the data provides enough evidence to reject the null hypothesis 3 (H<sub>03</sub>) at a 0.05 significance level (t=2.265, p=0.031). The results explain that there was enough evidence to support the hypothesis 3 (H<sub>03</sub>), which indicates that **“there was a significant**

**difference in students' perceptions towards pedagogical agents' instructional roles in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA”** with significant difference in mean scores between the two ( $M_{IMMAPA}=3.93$ ,  $SD_{IMMAPA}=0.505$ ;  $M_{IMMSPA}=3.60$ ,  $SD_{IMMSPA}=0.264$ ) as shown in Table 4.6.

However, among the six items, in only two items, the mean scores for the perceptions of students in IMMAPA group regarding PAIR were significantly ( $p<0.01$ ) higher than the students in IMMSPA group as below (see Tables 4.6 and 4.8):

- PAIR 3 ( $M_{IMMAPA}=4.19$ ,  $SD_{IMMAPA}=0.403$ ;  $M_{IMMSPA}=3.56$ ,  $SD_{IMMSPA}=0.512$ ;  $t=3.835$ ,  $p=0.001$ ); and
- PAIR 5 ( $M_{IMMAPA}=4.06$ ,  $SD_{IMMAPA}=0.574$ ;  $M_{IMMSPA}=3.25$ ,  $SD_{IMMSPA}=0.856$ ;  $t=3.153$ ,  $p=0.004$ ).

Also, the results of t-test analysis in Table 4.8 show that no significant differences were found between IMMAPA and IMMSPA groups for the other four items of PAIR at a 0.05 significance level: PAIR 1 ( $t=-0.419$ ,  $p=0.678$ ), PAIR 2 ( $t=0.624$ ,  $p=0.538$ ), PAIR 4 ( $t=0.899$ ,  $p=0.376$ ), and PAIR 6 ( $t=1.651$ ,  $p=0.109$ ). The results suggest that the mean scores on these dependent variables (i.e. PAIR 1, PAIR 2, PAIR 4, and PAIR 6) are relatively close to each other among students in both IMMAPA and IMMSPA groups (PAIR 1:  $M_{IMMAPA}=3.56$ ,  $M_{IMMSPA}=3.69$ ; PAIR 2:  $M_{IMMAPA}=3.63$ ,  $M_{IMMSPA}=3.44$ ; PAIR 4:  $M_{IMMAPA}=4.00$ ,  $M_{IMMSPA}=3.81$ ; PAIR 6:  $M_{IMMAPA}=4.13$ ,  $M_{IMMSPA}=3.25$ ) as

shown in Table 4.6. In other words, the perceptions of students in both IMMAPA and IMMSPA groups towards these four items of PAIR were similar.

**Table 4.8: Independent samples t-test results for the evaluation of students' perceptions towards the six items of PAIR and type of IMMs**

		Levene's Test for Equality of Variance		T-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
PAIR 1	Equal variances assumed	6.265	0.018	-0.419	30	0.678
	Equal variances not assumed			-0.419	20.545	0.680
PAIR 2	Equal variances assumed	2.474	0.126	0.624	30	0.538
	Equal variances not assumed			0.624	24.902	0.538
PAIR 3	Equal variances assumed	8.324	0.007	3.835	30	0.001
	Equal variances not assumed			3.835	28.426	<b>0.001**</b>
PAIR 4	Equal variances assumed	1.195	0.283	0.899	30	0.376
	Equal variances not assumed			0.899	28.448	0.376
PAIR 5	Equal variances assumed	3.152	0.086	3.153	30	<b>0.004**</b>
	Equal variances not assumed			3.153	26.208	0.004
PAIR 6	Equal variances assumed	0.953	0.337	1.651	30	0.109
	Equal variances not assumed			1.651	26.496	0.110

\*\* p < 0.01

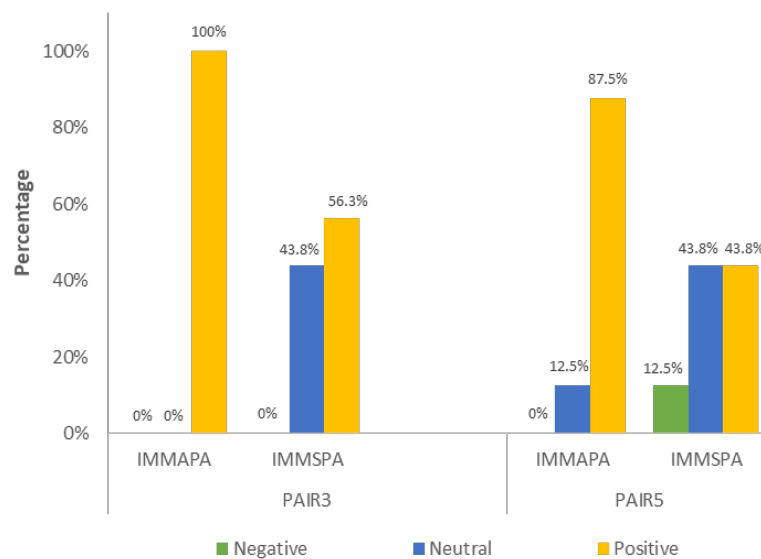
\* p < 0.05

**Note:**

The value of equal variance assumed is applicable if the significance of the Levene's test is high, i.e. greater than 0.05 (Gignac & Szodorai, 2016; Trochim, Donnelly & Arora, 2015; van Assen, van Aert & Wicherts, 2015). Since the p-values of PAIR 5 for Levene's test is rather large (p=0.086), which is greater than 0.05, so we can assume that the equal variances assumed of PAIR 5 was not violated. However, since the p-value of PAIR 3 for Levene's test is small (p=0.007), which is smaller than 0.05, so we can assume that the equal variances assumed of PAIR 3 was violated.

In addition, the significant differences between the perceptions of students' towards the two items of PAIR in IMMAPA and IMMSPA groups are clearly shown in Figure 4.12. Data of respondents' perceptions towards the two items of PAIR have been analysed by combining respondents' answers

into three categories: Negative, Neutral and Positive. Negative category refers to the ‘Strongly Disagree’ and ‘Disagree’, Neutral category refers to the ‘Not Sure’ answer, and Positive category refers to the ‘Strongly Agree’ and ‘Agree’. Figure 4.12 shows the comparison between these three categories of answers for students’ perceptions towards the two items of PAIR that show significant differences between the IMMAPA and IMMSPA groups.



**Figure 4.12: Percentage of students’ perceptions towards the two items of PAIR that show significant differences between IMMAPA and IMMSPA groups**

From Figure 4.12, it can be seen that IMMAPA groups gave more positive responses than neutral or negative towards two items which show significant difference between the two groups. They are “the pedagogical agents show appropriate body gestures during the delivery of lessons” (PAIR 3), and “The pedagogical agents are knowledgeable” (PAIR 5). Overall, the statistic shows that IMMAPA respondents have significantly more positive feedback than the respondents in IMMSPA group.

The results correspond with several past studies to measure students' perceptions towards PA as instructional role in enhancing learning (i.e. Kim & Baylor, 2016; Ozdemir, Izmirly & Izmirly, 2016; Pi et al., 2019; Yung & Pass, 2015). These studies shared a common result, which indicated that animated and emotive PAs had higher potential to increase students' perception compared to non-animated PAs in general.

#### **4.4.3 The findings of the testing of null hypothesis 4 (H<sub>04</sub>)**

Valerio (2012) postulated that intrinsic motivation can be increased through engaging learning experiences. Creative teaching pedagogies, interest-based texts and a variety of quality resources can significantly impact the engagement of students and assist in the making of connections to curriculum content (NSW DET, 2004 as cited in Valerio, 2012). In short, content needs to be delivered in a way that grabs the attention students. This research intended to find out students' perception towards the LM in the multimedia learning environment using IMMAPA and IMMSPA.

Students' intrinsic motivation in this research was measured using seven statements that was built into Section C in Part 1 of the questionnaire (see Appendix B) using a 5-point Likert scale ranging from 1 'Strongly Disagree' to 5 'Strongly Agree'. The students were requested to tick the corresponding numbers (i.e. 1-5), to rate how IMMAPA and IMMSPA motivated them in the learning of Introductory Psychology.

Table 4.9 depicts descriptive statistics i.e. Mean (M) and standard deviation (SD) for students' perceptions towards the seven items of LM between respondents in the groups of IMMAPA and IMMSPA. Respondents who learned Introductory Psychology using different IMM were coded with 1=IMMAPA (N=16) and 2=IMMSPA (N=16), whereas their replies were coded with 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, and 5=Strongly Agree.

**Table 4.9: Descriptive statistics for the evaluation of students' perceptions towards the seven items of "Learning Motivation" (LM) by IMM groups**

Item No.	Learning Motivation (LM) statement	IMMAPA (N=16)		IMMSPA (N=16)	
		M	SD	M	SD
LM 1	The content makes me feel more interested in learning psychology.	3.94	0.574	3.13	0.885
LM 2	The content makes me want to find out more about psychology (stimulates my curiosity).	3.75	0.577	2.69	0.946
LM 3	I find the pedagogical agents motivate my learning.	3.94	0.443	3.06	1.063
LM 4	I was encouraged by the pedagogical agents to pay attention in learning.	3.50	0.894	2.50	0.730
LM 5	I would like to find out more about the lessons because of the pedagogical agents.	3.69	0.793	2.63	0.957
LM 6	The pedagogical agents increased my interest in learning.	3.88	0.806	2.94	1.063
LM 7	The pedagogical agents are entertaining. The learning is enjoyable.	3.75	0.683	2.81	0.981
LM (Overall)		3.78	0.430	2.82	0.677

As shown in Table 4.9, all the seven mean scores for perceptions towards LM statements, ranging from 3.50 to 3.93 among respondents in the IMMAPA group were above the midpoint (3) of 5-point Likert scale. The results in Table 4.9 shows that respondents in the IMMAPA group found that the content made them feel more interested in learning psychology (IMMAPA:

$M_{LM1}=3.94$ ,  $SD_{LM1}=0.574$ ), the PAs motivated their learning (IMMAPA:  $M_{LM3}=3.94$ ,  $SD_{LM3}=0.443$ ), the PAs increased their interest in learning (IMMAPA:  $M_{LM6}=3.88$ ,  $SD_{LM6}=0.806$ ), the content made them want to find out more about psychology, i.e. stimulates their curiosities (IMMAPA:  $M_{LM2}=3.75$ ,  $SD_{LM2}=0.577$ ), the PAs were entertaining and enjoyable (IMMAPA:  $M_{LM7}=3.75$ ,  $SD_{LM7}=0.683$ ), they would like to find out more about the lessons because of the PAs (IMMAPA:  $M_{LM5}=3.69$ ,  $SD_{LM5}=0.793$ ), and they were encouraged by the PAs to pay attention in learning (IMMAPA:  $M_{LM4}=3.50$ ,  $SD_{LM4}=0.894$ ).

As for the respondents in the IMMSPA group, the results in Table 4.9 reveals that only two out of seven LM statements had mean score above the midpoint (3) of 5-point Likert scale, i.e. 3.06 and 3.13. The respondents in the IMMSPA group found that the content made them more interested in learning psychology (IMMSPA:  $M_{LM1}=3.13$ ,  $SD_{LM1}=0.885$ ), and the PAs motivated their learning (IMMSPA:  $M_{LM3}=3.06$ ,  $SD_{LM3}=1.063$ ).

The descriptive statistics as shown in Table 4.9 depicts that the mean scores for the perceptions of students in IMMAPA group for all the seven LM statements were above the average point, i.e. 3 compared to only two LM statements for the perceptions of students in IMMSPA group. The results indicate that the respondents in the IMMAPA group generally had more positive perceptions towards the emotive PAs with the features of animated characters and recorded voice (or spoken text) in motivating psychology learning compared to non-emotive PAs with the features of static characters



and written-text.

In addition, further investigation was conducted to find out whether or not a statistically significant difference existed between the mean scores of students' perceptions in the IMMAPA and IMMSPA groups towards LM using an independent samples t-test as have been described in section 3.6.2. The independent samples t-test was used to test the following null hypothesis 4 (H<sub>04</sub>):

**H<sub>04</sub>: There was no significant difference in students' perceptions towards learning motivation in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.**

The t-test analysis findings are depicted in Table 4.10

**Table 4.10: Independent samples t-test results for the evaluation of students' perceptions towards the overall LM and type of IMMs**

LM (Overall)	Levene's Test for Equality of Variance		T-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	0.750	0.394	4.764	30	<b>0.000**</b>
Equal variances not assumed			4.764	25.408	0.000

\*\* p < 0.05

**Note:**

The value of equal variance assumed is applicable if the significance of the Levene's test is high, i.e. greater than 0.05 (Gignac & Szodorai, 2016; Trochim, Donnelly & Arora, 2015; van Assen, van Aert & Wicherts, 2015). Since the p-value for Levene's test is large (p=0.394), which is greater than 0.05, so we can assume that the equal variances assumed is not violated.

Through the results of independent samples t-test analysis as shown in Table 4.10, the p-value was smaller than 0.001 (p<0.01) which statistically according to Trochim, Donnelly and Arora (2015) is highly significant. The

findings provide a strong evidence to reject the null hypothesis 4 ( $H_04$ ) at a 0.01 significance level ( $t=4.764$ ,  $p<0.001$ ), which indicate that **“there was a significant difference in students’ perception towards learning motivation between students who learned using IMMAPA and students who learned using IMMSPA”** with significant difference in mean scores between the two ( $M_{IMMAPA}=3.78$ ,  $SD_{IMMAPA}=0.430$ ;  $M_{IMMSPA}=2.82$ ,  $SD_{IMMSPA}=0.677$ ) as shown in Table 4.9.

Also, the research findings report that in all the seven items, the mean scores for the perceptions of students in IMMAPA group regarding LM were significantly ( $p<0.01$ ) higher than the students in IMMSPA group as below (see Tables 4.9 and 4.11):

- LM 2 ( $M_{IMMAPA}=3.75$ ,  $SD_{IMMAPA}=0.577$ ;  $M_{IMMSPA}=2.69$ ,  $SD_{IMMSPA}=0.946$ ;  $t=3.833$ ,  $p=0.001$ )
- LM 4 ( $M_{IMMAPA}=3.50$ ,  $SD_{IMMAPA}=0.443$ ;  $M_{IMMSPA}=3.06$ ,  $SD_{IMMSPA}=1.063$ ;  $t=3.464$ ,  $p=0.002$ );
- LM 5 ( $M_{IMMAPA}=3.69$ ,  $SD_{IMMAPA}=0.793$ ;  $M_{IMMSPA}=2.63$ ,  $SD_{IMMSPA}=0.957$ ;  $t=3.418$ ,  $p=0.002$ );
- LM 1 ( $M_{IMMAPA}=3.94$ ,  $SD_{IMMAPA}=0.574$ ;  $M_{IMMSPA}=3.13$ ,  $SD_{IMMSPA}=0.885$ ;  $t=3.081$ ,  $p=0.004$ );
- LM 7 ( $M_{IMMAPA}=3.75$ ,  $SD_{IMMAPA}=0.683$ ;  $M_{IMMSPA}=2.81$ ,  $SD_{IMMSPA}=0.981$ ;  $t=3.137$ ,  $p=0.004$ );
- LM 3 ( $M_{IMMAPA}=3.94$ ,  $SD_{IMMAPA}=0.443$ ;  $M_{IMMSPA}=3.06$ ,  $SD_{IMMSPA}=1.063$ ;  $t=3.041$ ,  $p=0.006$ ); and

- LM 6 ( $M_{IMMAPA}=3.88$ ,  $SD_{IMMAPA}=0.683$ ;  $M_{IMMSPA}=2.94$ ,  $SD_{IMMSPA}=0.981$ ;  $t=2.811$ ,  $p=0.009$ ).

**Table 4.11: Independent samples t-test results for the evaluation of students' perceptions towards the nine items of LM and type of IMMs**

		Levene's Test for Equality of Variance		T-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
LM 1	Equal variances assumed	2.849	0.102	3.081	30	<b>0.004**</b>
	Equal variances not assumed			3.081	25.714	0.005
LM 2	Equal variances assumed	6.505	0.016	3.833	30	0.001
	Equal variances not assumed			3.833	24.805	<b>0.001**</b>
LM 3	Equal variances assumed	24.050	0.000	3.041	30	0.005
	Equal variances not assumed			3.041	20.051	<b>0.006**</b>
LM 4	Equal variances assumed	0.789	0.381	3.464	30	<b>0.002**</b>
	Equal variances not assumed			3.464	28.846	0.002
LM 5	Equal variances assumed	0.907	0.349	3.418	30	<b>0.002**</b>
	Equal variances not assumed			3.418	28.997	0.002
LM 6	Equal variances assumed	1.590	0.217	2.811	30	<b>0.009**</b>
	Equal variances not assumed			2.811	27.971	0.009
LM 7	Equal variances assumed	1.934	0.175	3.137	30	<b>0.004**</b>
	Equal variances not assumed			3.137	26.777	0.004

\*\*  $p < 0.01$

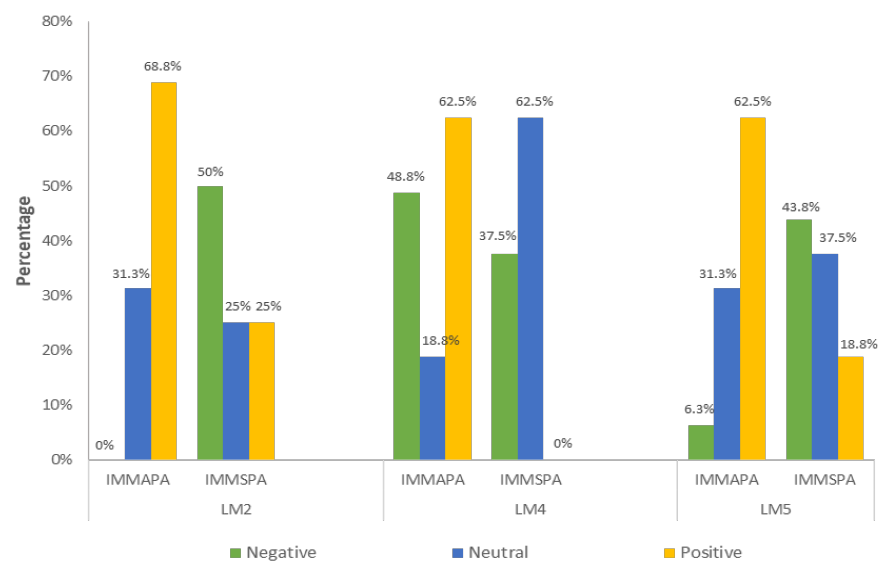
**Note:**

The value of equal variance assumed is applicable if the significance of the Levene's test is high, i.e. greater than 0.05 (Gignac & Szodorai, 2016; Trochim, Donnelly & Arora, 2015; van Assen, van Aert & Wicherts, 2015). Since the p-values of LM 1, LM 4, LM 5, LM 6, and LM 7 for Levene's test are large ( $p=0.102$ ;  $p=0.381$ ;  $p=0.349$ ;  $p=0.217$ ;  $p=0.175$ ), which are greater than 0.05, so we can assume that the equal variances assumed of LM 1, LM 4, LM 5, LM 6, and LM 7 were not violated. However, since the p-values of LM 2 and LM 3 for Levene's test are small ( $p=0.016$ ;  $p<0.001$ ), which are smaller than 0.05, so we can assume that the equal variances assumed of LM 2 and LM 3 were violated.

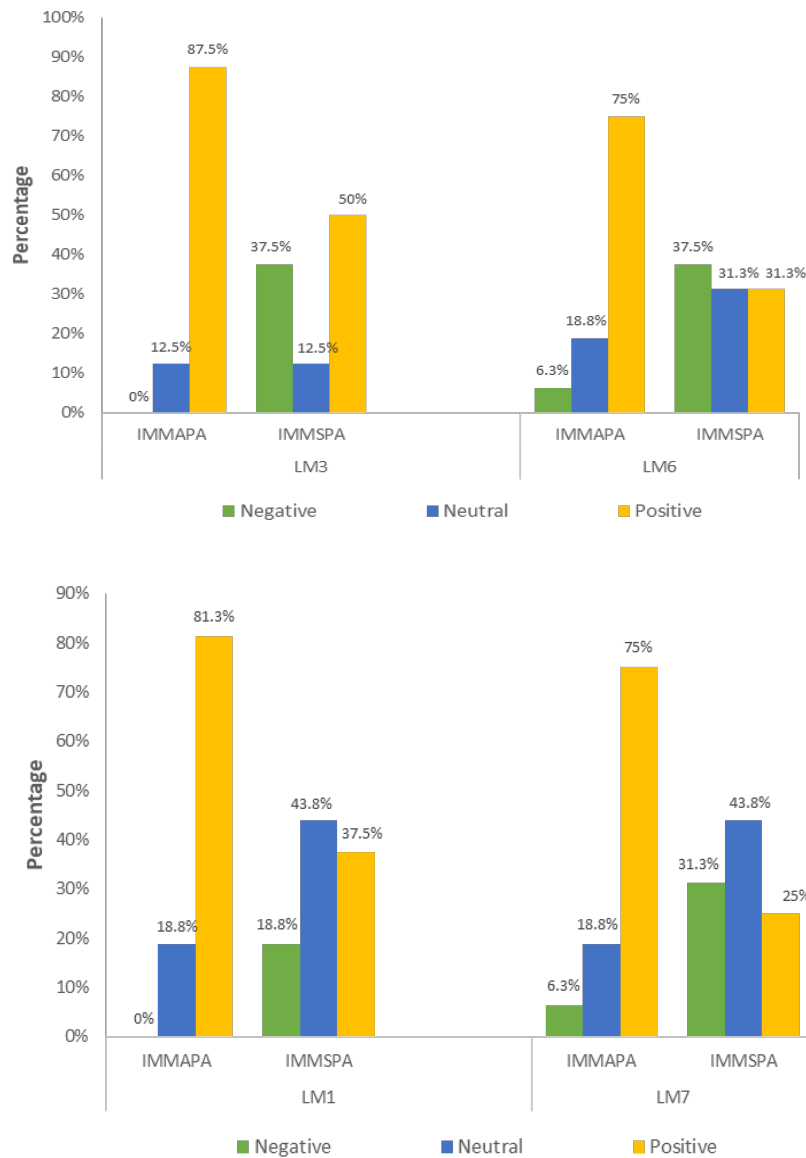
In addition, the significant differences between the perceptions of students' towards the seven items of LM in IMMAPA and IMMSPA groups are clearly shown in Figure 4.13. Data of respondents' perceptions towards the

seven items of LM have been analysed by combining respondents' answers into three categories: Negative, Neutral and Positive. Negative category refers to the 'Strongly Disagree' and 'Disagree', Neutral category refers to the 'Not Sure' answer, and Positive category refers to the 'Strongly Agree' and 'Agree'. Figure 4.13 shows the comparison between these three categories of answers for students' perceptions towards the seven items of LM that show significant differences between the IMMAPA and IMMSPA groups.

Figure 4.13 below shows the seven bar charts depicting there are more IMMAPA group were reported to have positive perception than neutral and negative perceptions towards all the seven items that show significant differences in learning motivation (LM) perceptions between groups.



**Figure 4.13: Percentage of students' perceptions towards all the seven items of LM that show significant differences between two groups**



**Figure 4.13 (continued)**

The findings of this research are congruent to several past studies. van der Meij, van der Meij and Harmsen (2015) stated that animated pedagogical agent do have effect in enhancing student motivation in learning environment. Guo, Luyt and Goh (2015) found the effects of embodied pedagogical agents on the motivation of learning performance, knowledge retention, and knowledge transfer. Past studies such as Dincer and Dagonay (2015) as well as Ryu and Ke (2018) claimed that personalised pedagogical agents (with

animation and human voice features) can significantly increase students' motivation in learning.

#### **4.4.4 The findings of the testing of null hypotheses 5 (H<sub>05</sub>) and 6 (H<sub>06</sub>)**

Romero-Hall (2015) stated that some key characteristics for designing motivational agents are pleasant physical appearance, which refers to the age, status, attractiveness, and credibility of the agent (p. 11). Additionally, combined with dialogue modality, interaction with questioning, animated pedagogical agents make the characteristic design more believable to enhance learning (p. 12).

As explained in section 3.3.1 regarding the types of pedagogical agents, there were two different characteristics of PAs' features to be compared in the research, i.e. PAs with the features of animated characters and recorded audio (or spoken text), versus PAs with the features of static characters and written text. The characteristics of pedagogical agents such as their appearance (i.e. animated or static characters) was tested using null hypothesis 5 (H<sub>05</sub>), whereas the presentation styles of the PAs (i.e. the delivery of the dialogues between the PAs in spoken text or written text) was tested using null hypothesis 6 (H<sub>06</sub>).

##### **4.4.4.1 The findings of the testing of null hypothesis 5 (H<sub>05</sub>)**

10 statements as listed in Table 4.12 were incorporated into Section D in Part 1 of the questionnaire (see Appendix B) to find out students'

perceptions towards PAC using a 5-point Likert scale ranging from 1 ‘Strongly Disagree’ to 5 ‘Strongly Agree’. The students were requested to tick the corresponding numbers (i.e. 1-5). Tables 4.12 depicts descriptive statistics i.e. Mean (M) and Standard Deviation (SD) for students’ perception towards the 10 items of PAC between respondents in the groups of IMMAPA and IMMSPA. Respondents who learned Introductory Psychology using different IMM were coded with 1=IMMAPA (N=16) and 2=IMMSPA (N=16), whereas their replies were coded with 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, and 5=Strongly Agree.

As shown in Table 4.12, all the 10 mean scores for students’ perceptions towards PAC statements in both IMMAPA and IMMSPA groups were above the midpoint (3) of 5-point Likert scale. However, the mean scores for IMMAPA group that ranged from 3.56 to 4.25 were higher than IMMSPA group (ranged from 3.13 to 3.44).

**Table 4.12: Descriptive statistics for the evaluation of students’ perceptions towards “Pedagogical Agents’ Characteristics” (PAC) by IMM groups**

Item No.	PA’s characteristics statement	IMMAPA (N=16)		IMMSPA (N=16)	
		M	SD	M	SD
PAC1	The pedagogical agents have interesting animation.	3.88	1.025	3.44	0.727
PAC 2	The pedagogical agents’ facial expression look natural.	4.13	0.619	3.25	0.683
PAC 3	The pedagogical agents’ give proper eye contact.	4.25	0.577	3.44	0.512
PAC 4	The pedagogical agents’ body movement look natural.	4.06	0.772	3.13	0.619
PAC 5	The pedagogical agents’ lip synchronization is easy to understand.	3.63	0.957	3.19	0.655
PAC 6	The pedagogical agents’ emotions look natural.	4.13	0.500	3.31	0.793
PAC 7	I find the pedagogical agents are close to human-like characters.	3.56	1.031	3.00	0.966

**Table 4.12 (continued)**

Item No.	PA's characteristics statement	IMMAPA (N=16)		IMMSPA (N=16)	
		M	SD	M	SD
PAC 8	The pedagogical agents' face expressions affects me in learning.	3.69	0.946	3.31	0.655
PAC 9	The pedagogical agents' body language affects me in learning.	3.88	1.025	3.44	0.512
PAC 10	I learn better with animated pedagogical agents.	4.13	.0500	3.13	0.619
PAC (Overall)		3.93	0.602	3.26	0.498

Table 4.12 reveals that the respondents in IMMAPA group found that the PAs gave proper eye contact (IMMAPA:  $M_{PAC3}=4.25$ ,  $SD_{PAC3}=0.577$ ), the PAs' facial expressions looked natural (IMMAPA:  $M_{PAC2}=4.13$ ,  $SD_{PAC2}=0.619$ ), the PAs' emotions looked natural (IMMAPA:  $M_{PAC6}=4.13$ ,  $SD_{PAC6}=0.500$ ), they learned better with animated PAs (IMMAPA:  $M_{PAC10}=4.13$ ,  $SD_{PAC10}=0.500$ ), the PAs' body movement looked natural (IMMAPA:  $M_{PAC4}=4.06$ ,  $SD_{PAC4}=0.772$ ), the PAs had interesting animation (IMMAPA:  $M_{PAC1}=3.88$ ,  $SD_{PAC1}=1.025$ ), the PAs' body language affected them in learning (IMMAPA:  $M_{PAC9}=3.88$ ,  $SD_{PAC9}=1.025$ ), the PAs' facial expressions affects them in learning (IMMAPA:  $M_{PAC8}=3.69$ ,  $SD_{PAC8}=0.946$ ), the PAs' lip synchronization was easy to understand (IMMAPA:  $M_{PAC5}=3.63$ ,  $SD_{PAC5}=0.597$ ), and the PAs were close to human-like characters (IMMAPA:  $M_{PAC7}=3.56$ ,  $SD_{PAC7}=1.031$ ).

As for the mean scores of students' perceptions towards PAC in IMMSPA group, the respondents found that the PAs had interesting animation (IMMSPA:  $M_{PAC1}=3.44$ ,  $SD_{PAC1}=0.727$ ), the PAs gave proper eye contact (IMMSPA:  $M_{PAC3}=3.44$ ,  $SD_{PAC3}=0.512$ ), the PAs' body language affected them in learning (IMMSPA:  $M_{PAC9}=3.44$ ,  $SD_{PAC9}=0.512$ ), the PAs' emotions looked



natural (IMMSPA:  $M_{PAC6}=3.31$ ,  $SD_{PAC6}=0.793$ ), the PAs' face expressions affected them in learning (IMMSPA:  $M_{PAC8}= 3.31$ ,  $SD_{PAC8}=0.655$ ), the PAs' facial expressions looked natural (IMMSPA:  $M_{PAC2}=3.25$ ,  $SD_{PAC2}=0.683$ ), the PAs' lips synchronization was easy to understand (IMMSPA:  $M_{PAC5}=3.19$ ,  $SD_{PAC5}=0.655$ ), the PAs' movement looked natural (IMMSPA:  $M_{PAC4}=3.13$ ,  $SD_{PAC4}= 0.619$ ), and they learned better with animated PAs (IMMSPA:  $M_{PAC10}=3.13$ ,  $SD_{PAC10}=0.619$ ).

Since the range of mean scores of the perceptions towards PAC for students in IMMSPA group were higher than the range of mean scores for students in IMMSPA group, it implies that respondents who interacted with emotive animated PAs had more positive perceptions towards the PAC statements compared to respondents who interacted with non-emotive (static characters) PAs. To find out whether or not a statistically significant difference existed between the mean scores in IMMSPA and IMMSPA groups for the PAs' characteristics, the independent samples t-test as have been described in section 3.6.2 was conducted. The independent samples t-test was used to test the following null hypothesis 5 ( $H_05$ ):

**$H_05$ : There was no significant difference in students' perceptions towards pedagogical agents' characteristics in enhancing students' learning of Introductory Psychology between students who learned using IMMSPA and students who learned using IMMSPA.**

The t-test analysis findings are shown in Table 4.13.

**Table 4.13: Independent samples t-test results for the evaluation of students' perceptions towards the overall PAC and type of IMMs**

PAC (Overall)	Levene's Test for Equality of Variance		T-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	0.608	0.442	3.425	30	<b>0.002**</b>
Equal variances not assumed			3.425	28.980	0.002

\*\* p < 0.05

**Note:**

The value of equal variance assumed is applicable if the significance of the Levene's test is high, i.e. greater than 0.05 (Gignac & Szodorai, 2016; Trochim, Donnelly & Arora, 2015; van Assen, van Aert & Wicherts, 2015). Since the p-value for Levene's test is large (p=0.442), which is greater than 0.05, so we can assume that the equal variances assumed is not violated.

Through the results of independent samples t-test analysis as shown in Table 4.13, the p-value was 0.002 (p<0.01), indicating that the data provides a strong evidence to reject the null hypothesis 5 (H<sub>05</sub>) at a 0.01 significance level (t=3.425, p=0.002). The results explain that there was enough evidence to support the hypothesis 5 (H<sub>5</sub>), which indicates that **“there was a significant difference in students' perceptions towards pedagogical agents' characteristics in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA”** with significant difference in mean scores between the two (M<sub>IMMAPA</sub>=3.93, SD<sub>IMMAPA</sub>=0.0602; M<sub>IMMSPA</sub>=3.26, SD<sub>IMMSPA</sub>=0.489) as shown in Table 4.12.

This findings imply that the animated PAs equipped with human-like characters such as body movements and facial expressions are associated with perceptions (Rizzo et al., 2015), several other studies suggest that interacting with animated pedagogical agents can positively increase perception and learning experience (i.e. Chen & Wang, 2018; Carlotto & Jacques, 2016; Rizzo

et al., 2015; Wang et al., 2018).

**Table 4.14: Independent samples t-test results for the evaluation of students' perceptions towards the 10 items of PAC and type of IMMs**

		Levene's Test for Equality of Variance		T-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
PAC 1	Equal variances assumed	1.043	0.315	1.393	30	0.174
	Equal variances not assumed			1.393	27.057	0.175
PAC 2	Equal variances assumed	0.811	0.375	3.796	30	<b>0.001**</b>
	Equal variances not assumed			3.796	29.714	0.001
PAC 3	Equal variances assumed	0.085	0.772	4.210	30	<b>0.000**</b>
	Equal variances not assumed			4.210	29.582	0.000
PAC 4	Equal variances assumed	0.029	0.866	3.790	30	<b>0.001**</b>
	Equal variances not assumed			3.790	28.651	0.001
PAC 5	Equal variances assumed	4.839	0.036	1.508	30	0.142
	Equal variances not assumed			1.508	26.520	0.143
PAC 6	Equal variances assumed	7.943	0.008	3.466	30	0.002
	Equal variances not assumed			3.466	25.295	<b>0.002**</b>
PAC 7	Equal variances assumed	0.370	0.548	1.593	30	0.122
	Equal variances not assumed			1.593	29.875	0.122
PAC 8	Equal variances assumed	0.247	0.623	1.215	30	0.234
	Equal variances not assumed			1.215	29.110	0.234
PAC 9	Equal variances assumed	3.942	0.056	1.528	30	0.137
	Equal variances not assumed			1.528	22.059	0.141
PAC 10	Equal variances assumed	0.609	0.441	5.026	30	<b>0.000**</b>
	Equal variances not assumed			5.026	28.727	0.000

\*\* p < 0.01

**Note:**

The value of equal variance assumed is applicable if the significance of the Levene's test is high, i.e. greater than 0.05 (Gignac & Szodorai, 2016; Trochim, Donnelly & Arora, 2015; van Assen, van Aert & Wicherts, 2015). Since the p-values of PAC 2, PAC 3, PAC 4, and PAC 10 for Levene's test are large (p=0.375; p=0.772; p=0.866; p=0.441), which are greater than 0.05, so we can assume that the equal variances assumed of PAC 2, PAC 3, PAC 4, and PAC 10 were not violated. However, since the p-value of PAC 6 for Levene's test is small (p=0.008), which is smaller than 0.05, so we can assume that the equal variances assumed of PAC 6 was violated.

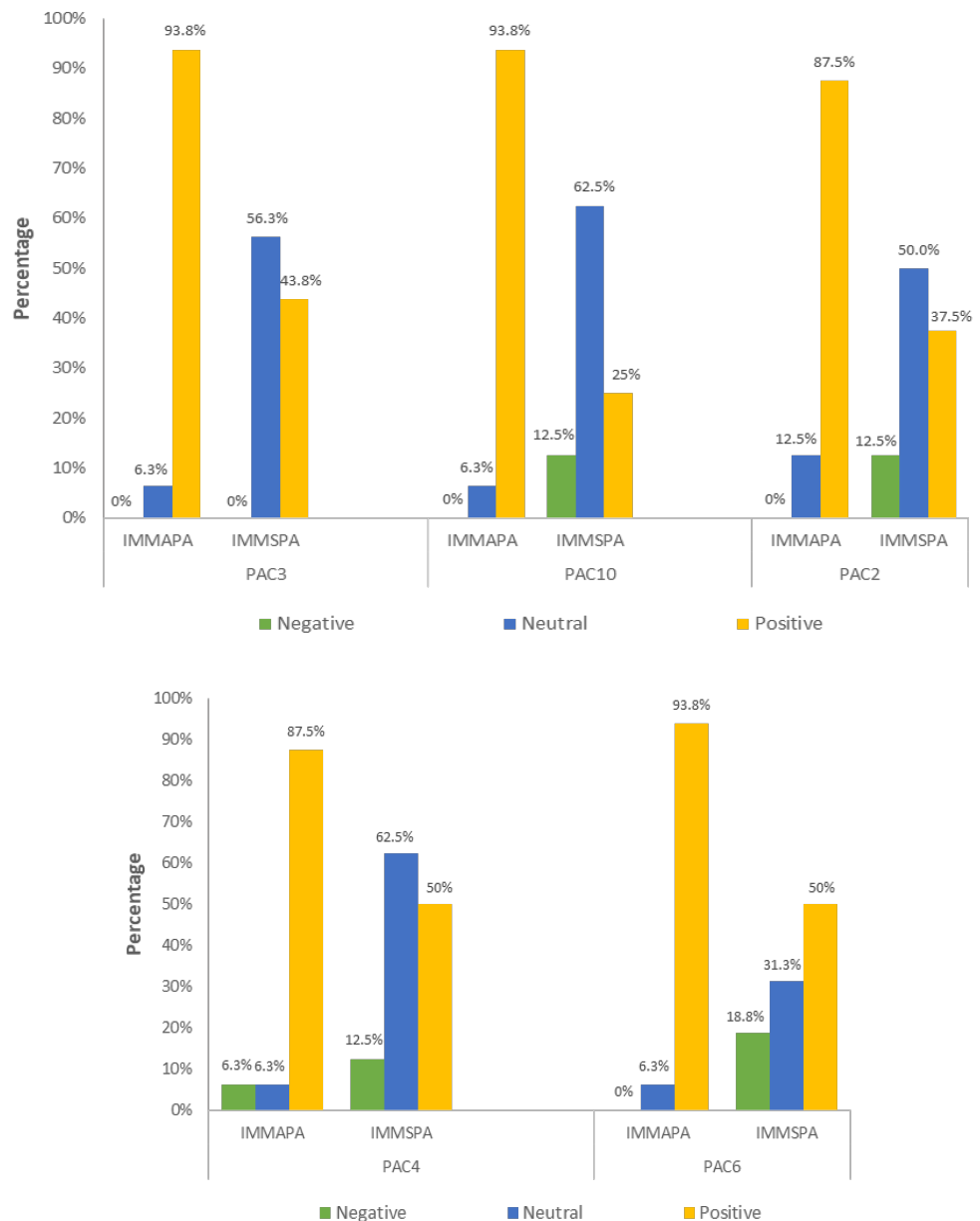
However, among the 10 items, in only five items, the mean scores for the perceptions of students in IMMAPA group regarding PAC were significantly ( $p < 0.01$ ) higher than the students in IMMSPA group as below (see Tables 4.12 and 4.14):

- PAC 3 ( $M_{IMMAPA}=4.25$ ,  $SD_{IMMAPA}=0.619$ ;  $M_{IMMSPA}=3.25$ ,  $SD_{IMMSPA}=0.683$ ;  $t=4.210$ ,  $p < 0.001$ )
- PAC 10 ( $M_{IMMAPA}=4.13$ ,  $SD_{IMMAPA}=0.500$ ;  $M_{IMMSPA}=3.13$ ,  $SD_{IMMSPA}=0.5026$ ;  $t=5.026$ ,  $p < 0.001$ );
- PAC 2 ( $M_{IMMAPA}=4.13$ ,  $SD_{IMMAPA}=0.619$ ;  $M_{IMMSPA}=3.44$ ,  $SD_{IMMSPA}=0.512$ ;  $t=3.796$ ,  $p=0.001$ );
- PAC 4 ( $M_{IMMAPA}=4.06$ ,  $SD_{IMMAPA}=0.772$ ;  $M_{IMMSPA}=3.13$ ,  $SD_{IMMSPA}=0.619$ ;  $t=3.790$ ,  $p=0.001$ ); and
- PAC 6 ( $M_{IMMAPA}=4.13$ ,  $SD_{IMMAPA}=0.500$ ;  $M_{IMMSPA}=3.31$ ,  $SD_{IMMSPA}=0.793$ ;  $t=3.466$ ,  $p=0.002$ ).

Also, the results of t-test analysis in Table 4.14 reveal that no significant differences were found between IMMAPA and IMMSPA groups for the other five items of PAC at a 0.05 significance level: PAC 1 ( $t=1.393$ ,  $p=0.174$ ), PAC 5 ( $t=1.508$ ,  $p=0.142$ ), PAC 7 ( $t=1.593$ ,  $p=0.122$ ), PAC 8 ( $t=1.215$ ,  $p=0.234$ ), and PAC 9 ( $t=1.022$ ,  $p=0.315$ ).

The results suggest that the mean scores on these dependent variables (PAC 1, PAC 5, PAC 7, PAC 8, and PAC 9) are relatively close to each other among students in both IMMAPA and IMMSPA groups (PAC 1:  $M_{IMMAPA}=3.88$ ,  $M_{IMMSPA}=3.44$ ; PAC 5:  $M_{IMMAPA}=3.63$ ,  $M_{IMMSPA}=3.19$ ; PAC 7:  $M_{IMMAPA}=3.56$ ,

$M_{IMMSPA}=3.00$ ; PAC 8:  $M_{IMMAPA}=3.69$ ,  $M_{IMMSPA}=3.31$ ; PAC 9:  $M_{IMMAPA}=3.88$ ,  $M_{IMMSPA}=3.44$ ) as shown in Table 4.12. In other words, the perceptions of students in both IMMAPA and IMMSPA groups towards these five items of PAC were similar.



**Figure 4.14: Percentage of students' perceptions towards the five items of PAC that show significant differences between IMMAPA and IMMSPA groups**

In addition, the significant differences between the perceptions of students' towards the five items of PAC in IMMAPA and IMMSPA groups are clearly shown in Figure 4.14. Data of respondents' perceptions towards five items of PAC in enhancing students' learning of Introductory Psychology have been analysed by combining respondents' answers into three categories: Negative, Neutral and Positive. Negative category refers to the 'Strongly Disagree' and 'Disagree', Neutral category refers to the 'Not Sure' answer, and Positive category refers to the 'Strongly Agree' and 'Agree'.

IMMAPA group respondents are found perceiving with higher "positive" feedback in the five items shown above. The IMMSPA group only given positive perception for item PAC 6 "the pedagogical agents' emotions look natural". However for item PAC 3, PAC 10, PAC 2, and PAC 4 they responded with "neutral" and "negative" feedback higher than responses from the IMMAPA group.

There are several past studies about the comparison between emotive animated and non-emotive static PAs (i.e. Chen & Wang, 2018; Carlotto & Jacques, 2016; Wang et al., 2018; Yung & Paas, 2015) conform to the findings in this research. These studies suggested that the use of animated pedagogical agents resulting a significant difference in students' perception towards pedagogical agent with animations.

#### **4.4.4.2 The findings of the testing of null hypothesis 6 (H<sub>06</sub>)**

Statements as listed in Table 4.15 were incorporated into Section E in Part 1 of the questionnaire (see Appendix B) to find out students' perceptions towards PAPS in enhancing students' learning of Introductory Psychology. The section E in the questionnaire were divided into two parts to investigate different perceptions of students who learned Introductory Psychology using IMMs with two types of PAs' presentation styles, i.e. section E-A to measure PAs' presentation of instructional content in human recorded voice (or spoken text), and section E-B to measure PAs' presentation of instructional content in human recorded voice (or spoken text). Students were given these two choices to indicate their perceptions towards the PAs' presentation styles (spoken text versus written text).

Before proceeding to answer relevant statements in section E, students were given a question for the type of PAs involved in their learning process. The question asked in the questionnaire was: "Do the pedagogical agents present their conversation during the delivery of lessons in human-speaking voices?" If a student answered 'Yes', he/ she would proceed to answer nine statements in section E-A, else he/ she would proceed to answer the other nine statements in section E-B. All the statements were built into sections E-A and E-B using a 5-point Likert scale ranging from 1 'Strongly Disagree' to 5 'Strongly Agree'.

Table 4.15 depicts descriptive statistic i.e. Mean (M) and Standard Deviation (SD) for students' perceptions towards the nine items of PAPS between respondents in the groups of IMMAPA and IMMSPA. Respondents who learned Introductory Psychology using different IMMs were coded with 1=IMMAPA (N=16) and 2=IMMSPA (N=16), whereas their replies were coded with 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, and 5=Strongly Agree.

**Table 4.15: Descriptive statistics for the evaluation of students' perceptions towards "PA's Presentation Styles (via Recorded Voice)" (PAPS-RV) or "PA's Presentation Styles (via Written Text)" (PAPS-WT)**

Item No.	PAs' Presentation Styles (via Recorded Voice) or (via Written Text) statement	IMMAPA (N=16)		IMMSPA (N=16)	
		M	SD	M	SD
PAPS-RV 1	The pedagogical agents' voices in their conversation during the delivery of lessons are clear.	3.63	1.088		
PAPS-WT 1	The pedagogical agents' content presentation (show the dialogues of their conversation) in animated text format during the delivery of lessons are clear.			3.00	1.317
PAPS-RV 2	The accent of the pedagogical agents during the delivery of lessons is easy to understand.	3.94	0.680		
PAPS-WT 2	The pedagogical agents' content presentation in animated text format during the delivery of lessons is easy to understand.			3.06	0.998
PAPS-RV 3	The language in explaining the content is appropriate.	4.19	0.403	3.50	0.8216
PAPS-WT 3					
PAPS-RV 4	The pedagogical agents' voices during the delivery of lessons matches their human-like emotive appearance.	4.19	0.403	2.94	0.929
PAPS-WT 4	The pedagogical agents' content presentation in animated text format during the delivery of lessons matches their non-emotive appearance.				
PAPS-RV 5	The conversation is interesting during the delivery of lessons since the pedagogical agents have their own voices.	3.63	1.025	3.44	0.814
PAPS-WT 5	The conversation is more interesting if the pedagogical agents have their own voices, instead of showing their dialogues of conversation in animated text format.				



**Table 4.15 (Continued)**

Item No.	PAs' Presentation Styles (via Recorded Voice) or (via Written Text) statement	IMMAPA (N=16)		IMMSPA (N=16)	
		M	SD	M	SD
PAPS-RV 6	The pedagogical agents' voices help stimulating the animation and content presentation.	4.06	0.680	3.00	1.317
PAPS-WT 6	The pedagogical agents' with voices may help stimulating the animation and content presentation, instead of showing their dialogues of conversation in animated text format.				
PAPS-RV 7	The pedagogical agents' voices during the delivery of lessons help me to understand the lessons better.	4.00	0.516	3.38	1.088
PAPS-WT 7	The pedagogical agents' voices during the delivery of lessons may help me to understand the lessons better, instead of showing their dialogues of conversation in animated text format.				
PAPS-RV 8	I can learn better if the pedagogical agents are not silent (i.e. present the dialogues of conversation during the delivery of content with recorded voices).	4.06	0.680	3.00	1.317
PAPS-WT 8	I can learn better if the pedagogical agents are not silent (i.e. present the dialogues of conversation during the delivery of content with recorded voices, instead of their dialogues of conversation in animated text format).				
PAPS-RV 9	Pedagogical agents' voices are important compared to their appearance.	4.19	0.403	3.31	1.014
PAPS-WT 9					
PAPS (Overall)		3.99	0.387	3.18	0.822

As shown in Table 4.15, all the nine mean scores for students' perceptions towards PAPS-RV statements in IMMAPA group were above the midpoint (3) of 5-point Likert scale ranging between 3.63 to 4.19. Table 4.15 reports that the respondents in IMMAPA group found that the language in explaining the content was appropriate (IMMAPA:  $M_{\text{PAPS-RV3}}=4.19$ ,  $SD_{\text{PAPS-RV3}}=0.403$ ), the PAs' voices during the delivery of lessons matches their human-like emotive appearance (IMMAPA:  $M_{\text{PAPS-RV4}}=4.19$ ,  $SD_{\text{PAPS-RV4}}=0.403$ ), PAs' voices were important compared to their appearance

(IMMAPA:  $M_{\text{PAPS-RV9}}=4.19$ ,  $SD_{\text{PAPS-RV9}}=0.403$ ), the PAs' voices help stimulating the animation and content presentation (IMMAPA:  $M_{\text{PAPS-RV6}}=4.06$ ,  $SD_{\text{PAPS-RV6}}=0.680$ ), they could learn better if the PAs were not silent (i.e. presented the dialogues of conversation during the delivery of content with recorded voices, instead of their dialogues of conversation in animated text format) (IMMAPA:  $M_{\text{PAPS-RV8}}=4.06$ ,  $SD_{\text{PAPS-RV8}}=0.680$ ), the PAs' voices during the delivery of lessons helped them to understand the lessons better (IMMAPA:  $M_{\text{PAPS-RV7}}=4.00$ ,  $SD_{\text{PAPS-RV7}}=0.516$ ), the accent of the PAs during the delivery of lessons was easy to understand (IMMAPA:  $M_{\text{PAPS-RV2}}=3.94$ ,  $SD_{\text{PAPS-RV2}}=0.680$ ), the PAs' voices in their conversation during the delivery of lessons were clear (IMMAPA:  $M_{\text{PAPS-RV1}}=3.63$ ,  $SD_{\text{PAPS-RV1}}=1.808$ ), and the conversation is interesting during the delivery of lessons since the PAs had their own voices (IMMAPA:  $M_{\text{PAPS-RV5}}=3.63$ ,  $SD_{\text{PAPS-RV5}}=1.025$ ).

Besides, there were five of the nine mean scores for students' perceptions towards the PAs' presentation styles via written text in IMMSPA group were above the midpoint (3) of 5-point Likert scale, ranging from 3.00 to 3.50. The respondents in IMMSPA group found that the language in explaining the content was appropriate (IMMSPA:  $M_{\text{PAPS-WT3}}=3.50$ ,  $SD_{\text{PAPS-WT3}}=0.816$ ), the conversation was more interesting if the PAs had their own voices, instead of showing their dialogues of conversation in animated text format. (IMMSPA:  $M_{\text{PAPS-WT5}}=3.44$ ,  $SD_{\text{PAPS-WT5}}=0.814$ ), the PAs' voices during the delivery of lessons may help them to understand the lessons better, instead of showing their dialogues of conversation in animated text format, (IMMSPA:  $M_{\text{PAPS-WT7}}=3.38$ ,  $SD_{\text{PAPS-WT7}}=1.088$ ), PAs' voices were important compared to their

appearance (IMMSPA:  $M_{\text{PAPS-WT9}}=3.31$ ,  $SD_{\text{PAPS-WT9}}=1.014$ ), and the PAs' content presentation in animated text format during the delivery of lessons was easy to understand (IMMSPA:  $M_{\text{PAPS-WT2}}=3.06$ ,  $SD_{\text{PAPS-WT2}}=0.998$ ).

Comparatively, only five out of nine mean scores for the perceptions of respondents towards the PAs' presentation styles via written text (PAPS-WT) statements in IMMSPA group were above midpoint (3) of 5-point Likert scale compared to all the nine PAs' presentation styles via recorded voice (PAPS-RV) statements in IMMSPA group. Moreover, the mean scores for PAPS-RV in IMMSPA group as shown in Table 4.11 were higher than the mean scores for PAPS-WT in IMMSPA group, which indicates that respondents that interacted with emotive animated PAs in presenting instructional content via recorded human voice had more positive perceptions towards PAs' presentation styles than the respondents that interacted with non-emotive PAs in presenting instructional content via written text.

Ryu and Ke (2018) noted that “the use of human voice and human like behaviour in APA demonstrates a more lifelike, and the stronger persona will occur” (p. 66). However, Craig and Schroeder (2017) found that recorded human voice in PA was just as effective as narrating agent-based (regardless the presence of human voice or not) in a multimedia learning environment (p. 201). Thus, further evaluation was conducted to investigate whether or not a statistically significant difference existed between the mean scores in IMMSPA and IMMSPA groups for the two different PAs' styles of content presentation. An independent samples t-test as have been described in section 3.6 was used

to test the following null hypothesis 6 (H<sub>06</sub>):

**H<sub>06</sub>: There was no significant difference in students’ perceptions towards pedagogical agents’ presentation styles in enhancing students’ learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.**

The t-test analysis findings are shown in Table 4.16.

**Table 4.16: Independent samples t-test results for the evaluation of students’ perceptions towards the overall PAPS and type of IMMs**

PAPS (Overall)	Levene’s Test for Equality of Variance		T-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	5.511	0.026	3.546	30	0.001
Equal variances not assumed			3.546	21.326	<b>0.002**</b>

\*\* p < 0.05

**Note:**

The value of equal variance assumed is applicable if the significance of the Levene’s test is high, i.e. greater than 0.05 (Gignac & Szodorai, 2016; Trochim, Donnelly & Arora, 2015; van Assen, van Aert & Wicherts, 2015). Since the p-value for Levene’s test is small (p=0.026), which is smaller than 0.05, so we can assume that the equal variances assumed is violated.

Through the results of independent samples t-test analysis as shown in Table 4.16, the p value was 0.002 (p<0.01), indicating that the data provides a strong evidence to reject the null hypothesis 6 (H<sub>06</sub>) at a 0.01 significance level (t=3.546, p=0.002). The finding indicates that there was enough evidence to support the hypothesis 6 (H<sub>6</sub>), which and states that **“there was a significant difference in students’ perceptions towards pedagogical agents’ presentation styles in enhancing students’ learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA”** with significant difference in mean scores

between the two ( $M_{IMMAPA}=3.99$ ,  $SD_{IMMAPA}=0.387$ ;  $M_{IMMSPA}=3.18$ ,  $SD_{IMMSPA}=0.8222$ ) as shown in Table 4.15.

Among the nine items, in only seven items, the mean scores for the perceptions of students in IMMAPA group regarding PAPS were significantly ( $p \leq 0.05$ ) higher than the students in IMMSPA group as below (see Tables 4.15 and 4.17):

- PAPS 2 ( $M_{IMMAPA}=3.94$ ,  $SD_{IMMAPA}=0.680$ ;  $M_{IMMSPA}=3.06$ ,  $SD_{IMMSPA}=0.998$ ;  $t=2.898$ ,  $p < 0.000$ )
- PAPS 4 ( $M_{IMMAPA}=4.19$ ,  $SD_{IMMAPA}=0.403$ ;  $M_{IMMSPA}=2.94$ ,  $SD_{IMMSPA}=0.929$ ;  $t=4.939$ ,  $p < 0.000$ );
- PAPS 9 ( $M_{IMMAPA}=4.19$ ,  $SD_{IMMAPA}=0.403$ ;  $M_{IMMSPA}=3.31$ ,  $SD_{IMMSPA}=1.014$ ;  $t=3.206$ ,  $p=0.005$ );
- PAPS 3 ( $M_{IMMAPA}=4.19$ ,  $SD_{IMMAPA}=0.403$ ;  $M_{IMMSPA}=3.50$ ,  $SD_{IMMSPA}=0.816$ ;  $t=3.020$ ,  $p=0.006$ );
- PAPS 6 ( $M_{IMMAPA}=4.06$ ,  $SD_{IMMAPA}=1.031$ ;  $M_{IMMSPA}=2.69$ ,  $SD_{IMMSPA}=1.078$ ;  $t=2.346$ ,  $p=0.009$ );
- PAPS 8 ( $M_{IMMAPA}=4.06$ ,  $SD_{IMMAPA}=0.680$ ;  $M_{IMMSPA}=3.00$ ,  $SD_{IMMSPA}=1.317$ ;  $t=2.868$ ,  $p=0.009$ ); and
- PAPS 7 ( $M_{IMMAPA}=4.00$ ,  $SD_{IMMAPA}=0.516$ ;  $M_{IMMSPA}=3.38$ ,  $SD_{IMMSPA}=1.088$ ;  $t=2.076$ ,  $p=0.050$ ).

**Table 4.17: Independent samples t-test results for the evaluation of students' perceptions towards the nine items of PAPS and type of IMMs**

		Levene's Test for Equality of Variance		T-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
PAPS 1	Equal variances assumed	1.812	0.188	1.464	30	0.154
	Equal variances not assumed			1.464	28.970	0.154
PAPS 2	Equal variances assumed	2.383	0.133	2.898	30	<b>0.000**</b>
	Equal variances not assumed			2.898	26.461	0.007
PAPS 3	Equal variances assumed	5.237	0.029	3.020	30	0.005
	Equal variances not assumed			3.020	21.902	<b>0.006**</b>
PAPS 4	Equal variances assumed	2.612	0.117	4.939	30	<b>0.000**</b>
	Equal variances not assumed			4.939	20.458	0.000
PAPS 5	Equal variances assumed	1.354	0.254	0.573	30	0.571
	Equal variances not assumed			0.573	28.539	0.571
PAPS 6	Equal variances assumed	6.746	0.014	2.868	30	0.007
	Equal variances not assumed			2.868	22.473	<b>0.009**</b>
PAPS 7	Equal variances assumed	9.976	0.004	2.076	30	0.047
	Equal variances not assumed			2.076	21.434	<b>0.050*</b>
PAPS 8	Equal variances assumed	13.405	0.001	2.868	30	0.007
	Equal variances not assumed			2.868	22.473	<b>0.009**</b>
PAPS 9	Equal variances assumed	7.734	0.009	3.206	30	0.003
	Equal variances not assumed			3.206	19.622	<b>0.005**</b>

\*\*  $p < 0.01$

\*  $p \leq 0.05$

**Note:**

The value of equal variance assumed is applicable if the significance of the Levene's test is high, i.e. greater than 0.05 (Gignac & Szodorai, 2016; Trochim, Donnelly & Arora, 2015; van Assen, van Aert & Wicherts, 2015). Since the p-values of PAPS 2 and PAPS 4 for Levene's test are large ( $p=0.133$ ;  $p=0.117$ ), which are greater than 0.05, so we can assume that the equal variances assumed of PAPS 2 and PAPS 4 were not violated. However, since the p-values of PAPS 3, PAPS 6, PAPS 7, PAPS 8, and PAPS 9 for Levene's test are small ( $p=0.029$ ;  $p=0.014$ ;  $p=0.004$ ;  $p=0.001$ ;  $p=0.009$ ), which are smaller than 0.05, so we can assume that the equal variances assumed of PAPS 3, PAPS 6, PAPS 7, PAPS 8, and PAPS 9 were violated.

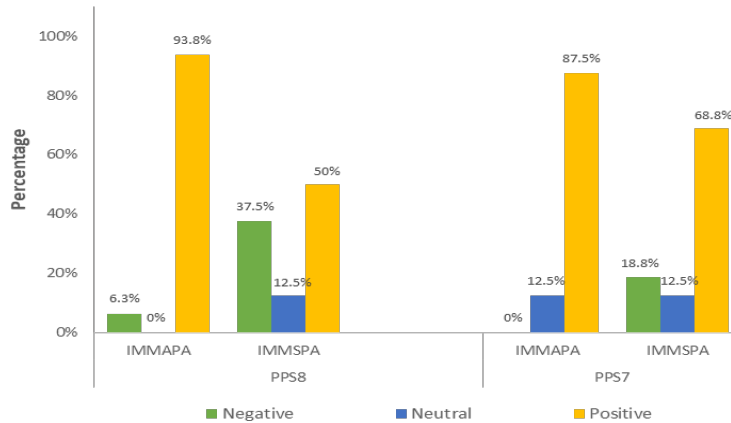
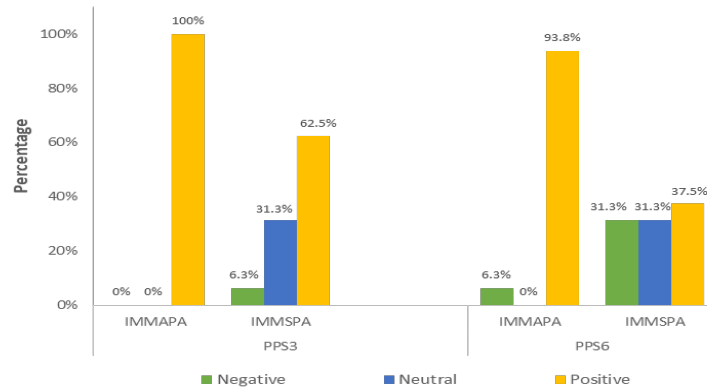
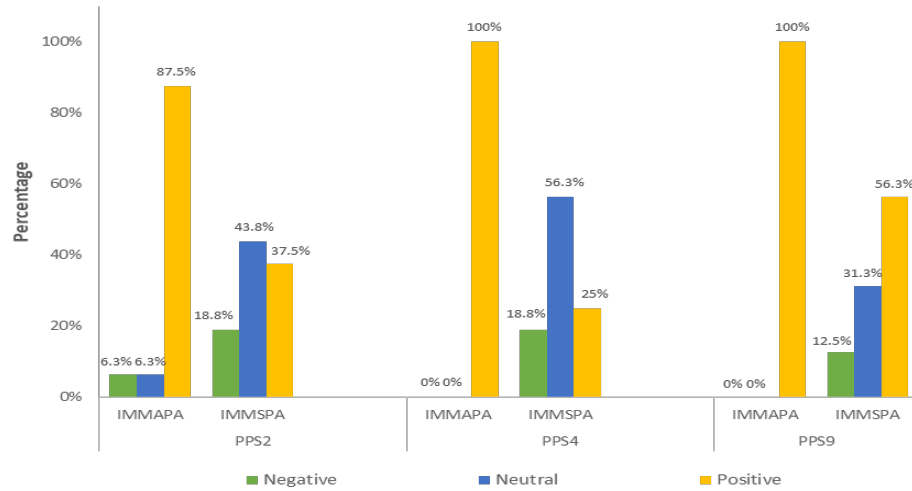
Also, the results of t-test analysis in Table 4.17 reveal that no significant differences were found between IMMSPA and IMMSPA groups for the other two items of PAPS at a 0.05 significance level: PAPS1 ( $t=1.464$ ,

$p=0.154$ ), and PAPS 5 ( $t=0.573$ ,  $p=0.571$ ).

The results suggest that the mean scores on these dependent variables (i.e. PAPS 1 and PAPS 5) are relatively close to each other among students in both IMMAPA and IMMSPA groups (PAPS 1:  $M_{IMMAPA}=3.63$ ,  $M_{IMMSPA}=3.00$ ; PAPS 5:  $M_{IMMAPA}=3.63$ ,  $M_{IMMSPA}=3.44$ ) as shown in Table 4.15. In other words, the perceptions of students in both IMMAPA and IMMSPA groups towards these two items of PAPS were similar.

Data of respondents' perceptions towards seven items of PAPS have been analysed by combining respondents' answers into three categories: Negative, Neutral and Positive. The significant differences between the perceptions of students' towards the seven items of PAPS in IMMAPA and IMMSPA groups are clearly shown in Figure 4.15.

More respondents in IMMAPA group were reported to have positive perception than neutral and negative perceptions towards all the seven items that show significant differences in perceptions between groups. However, more respondents in IMMSPA group were reported to have negative and neutral perceptions towards two items of PAPS 2, the pedagogical agents' content presentation in animated text format during the delivery of lessons is easy to understand. And PAPS 4, 'The pedagogical agents' content presentation in animated text format during the delivery of lessons matches their non-emotive appearance.



**Figure 4.15: Percentage of students' perceptions towards the seven items of PAPS that show significant differences between IMMAPA and IMMSPA groups**



In overall, the percentage of respondents in IMMAPA group indicated positive perceptions towards the seven items that show significant differences is higher than the respondents in IMMSPA group. The findings of this research are parallel with several prior studies in using recorded voice in PA (i.e. Craig & Schroeder, 2017; Park, 2015; Rizzo et al., 2014; Ryu & Ke, 2018). These studies implied that students' perception towards human-like voice in virtual agent (PA) is significantly higher than students' perceptions towards agents without human voice.

#### **4.5 Chapter Summary**

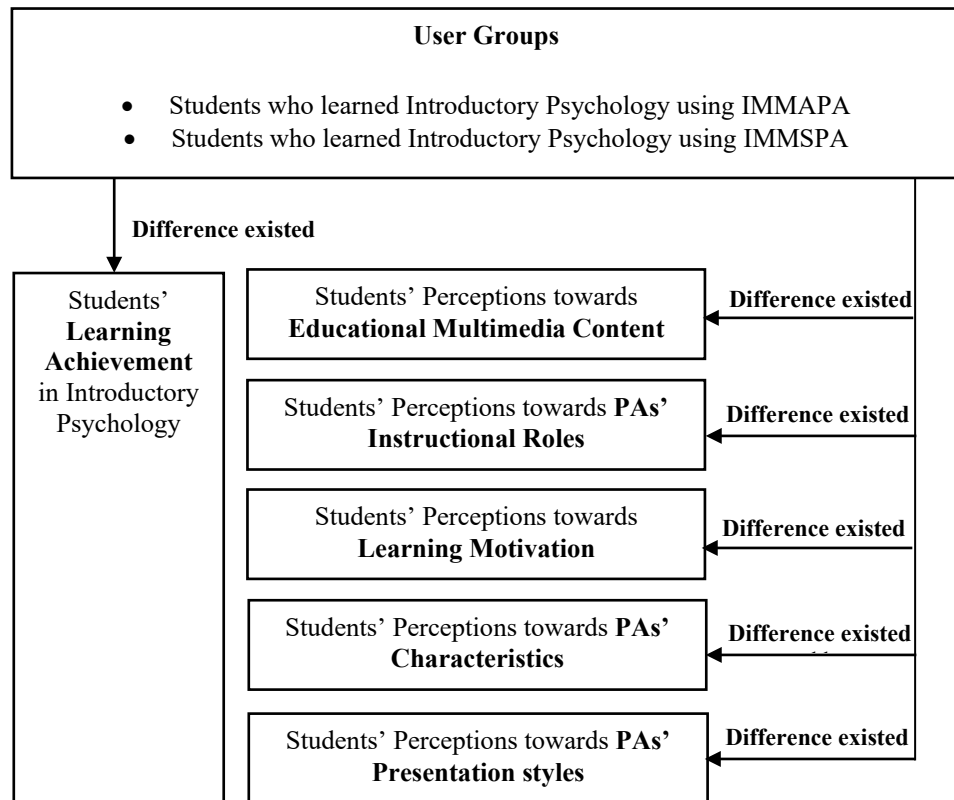
Inferential statistics such as independent samples t-test were used in the testing of six null hypotheses to find out whether or not statistically significant differences existed between: 1) students' learning achievement in Introductory Psychology and students' use of IMMs with two different types of PAs (emotive animated characters with recorded voice versus non-emotive static characters with written text); and 2) students' perceptions towards the five instructional content design matters and students' use of IMMs with two different types of PAs (emotive animated characters with recorded voice versus non-emotive static characters with written text). Table 4.18 and Figure 4.16 summarizes the findings of the six null hypotheses testing.

**Table 4.18: Summary of six null hypotheses testing and research findings**

Null Hypothesis	Research findings
<p><b>H<sub>01</sub>:</b> There was no significant difference between the learning of Introductory Psychology using IMMAPA and IMMSPA on students' learning achievement.</p>	<p><b>Rejected H<sub>01</sub></b></p> <p><b>H1 has been substantiated:</b> The findings indicate that there was a significant difference between the learning achievement in Introductory Psychology using IMMAPA and IMMSPA</p>
<p><b>H<sub>02</sub>:</b> There was no significant difference in students' perceptions towards educational multimedia content in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.</p>	<p><b>Rejected H<sub>02</sub></b></p> <p><b>H2 has been substantiated:</b> The findings indicate that there was a significant difference in students' perceptions towards educational multimedia content between students who learned using IMMAPA and IMMSPA.</p> <p>The findings also reports that among the 13 items, in only six items, the mean scores for the perceptions of students in IMMAPA group regarding education multimedia content were significantly (<math>p \leq 0.05</math>) higher than the students in IMMSPA group.</p>
<p><b>H<sub>03</sub>:</b> There was no significant difference in students' perceptions towards pedagogical agents' instructional roles in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.</p>	<p><b>Rejected H<sub>03</sub></b></p> <p><b>H3 has been substantiated:</b> The findings indicate that there was a significant difference in students' perceptions towards pedagogical agents' instructional roles between students who learned using IMMAPA and IMMSPA.</p> <p>The findings also reports that among the six items, in only two items, the mean scores for the perceptions of students in IMMAPA group regarding pedagogical agents' instructional roles were significantly (<math>p &lt; 0.05</math>) higher than the students in IMMSPA group.</p>

**Table 4.18 (Continued)**

Null Hypothesis	Research findings
<p><b>H<sub>04</sub>:</b> There was no significant difference in students' perceptions towards learning motivation in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.</p>	<p><b>Rejected H<sub>04</sub></b></p> <p><b>H<sub>4</sub> has been substantiated:</b> The findings indicate that there was a significant difference in students' perceptions towards educational multimedia content between students who learned using IMMAPA and IMMSPA.</p> <p>The findings also reports that in all the seven items, the mean scores for the perceptions of students in IMMAPA group regarding learning motivation were significantly (<math>p &lt; 0.01</math>) higher than the students in IMMSPA group.</p>
<p><b>H<sub>05</sub>:</b> There was no significant difference in students' perceptions towards pedagogical agents' characteristics in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.</p>	<p><b>Rejected H<sub>05</sub></b></p> <p><b>H<sub>5</sub> has been substantiated:</b> The findings indicate that there was a significant difference in students' perceptions towards pedagogical agents' characteristics between student who learned using IMMAPA and IMMSPA.</p> <p>The findings also reports that among the 10 items, in only five items, the mean scores for the perceptions of students in IMMAPA group regarding pedagogical agents' characteristics were significantly (<math>p &lt; 0.01</math>) higher than the students in IMMSPA group</p>
<p><b>H<sub>06</sub>:</b> There was no significant difference in students' perceptions towards pedagogical agents' presentation styles in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA.</p>	<p><b>Rejected H<sub>06</sub></b></p> <p><b>H<sub>6</sub> has been substantiated:</b> The findings indicate that there was a significant difference in students' perceptions towards pedagogical agents' presentation styles between students who learned using IMMAPA and students who learned using IMMSPA.</p> <p>The findings also reports that among the nine items, in only seven items, the mean scores for the perceptions of students in IMMAPA group regarding pedagogical agents' presentation styles were significantly (<math>p \leq 0.05</math>) higher than the students in IMMSPA group.</p>



**Figure 4.16: Research framework indicating the research findings from the testing of relevant null hypotheses**

This chapter concludes that all the six null hypothesis formulated from research objectives in chapter 1 have been rejected and substantiated. Consequently, the outcomes explained in this chapter provided inputs to the next chapter. Further explanation about research conclusions, research contributions, as well as research limitations and recommendations are discussed in chapter 5.

## **CHAPTER 5**

### **5.0 CONCLUSIONS AND RECOMMENDATIONS**

To wrap up the discussion of the research, this final chapter presents the following topics:

- i. Overall conclusions from the research findings
- ii. Research contributions
- iii. Limitations of research and recommendations
- iv. Research implications

### **5.1 Overall Conclusions from the Research Findings**

The research began with outlining the issue of using pedagogical agents design in multimedia learning environment found in several prior similar studies as have been discussed in chapter 1. Then, three primary research objectives were formed at the early stage of the research as follows:

- i. To design and create two interactive multimedia modules (IMMs) with different types of pedagogical agents (PAs) in delivering Introductory Psychology lessons as learning subjects.
- ii. To conduct a comparative study to investigate the effectiveness of teaching and learning Introductory Psychology by evaluating students' learning achievement between students who learned

using IMM with emotive and animated PAs (IMMAPA) and students who learned using IMM with non-emotive and static PAs (IMMSPA).

- iii. To find out students' perceptions towards the features incorporated in IMM such as educational multimedia content, pedagogical agents' instructional role, learning motivation, pedagogical agents' characteristics, and pedagogical agents' presentation styles in giving positive effect to simulate human-like communication that facilitate teaching-learning process in a multimedia learning environment between students who learned using IMMAPA and students who learned using IMMSPA.

Overall, the three primary objectives of this research have been achieved. The subsequent sections discuss the conclusions from the research findings, which have been presented in chapter 4.

### **5.1.1 The first research objective**

Both IMM with emotive and animated PAs (IMMAPA) and IMM with non-emotive and static PAs (IMMSPA) were designed and developed with the main intention of being used as the instructional tool for Introductory Psychology, in which to achieve the first research objective as below:

**To design and develop two IMM with different types of PAs, i.e. animated pedagogical agents (APA) and static pedagogical agents (SPA) in delivering Introductory Psychology lesson as learning**

**subject.**

As has been described in section 4, there are two interactive modules created in the favour of the research, the IMMAPA and IMMSPA. The two modules are developed based on two media theories (Media richness theory alludes to the modules design, and Multimodality theory alludes to the PAs design). The two modules are established using the 2D animation computer software Adobe Animate CC entirely. Hence, both IMM are similar in terms of their design and function to deliver the psychology lesson to the experiments, except for their features incorporated within. With the success of both IMM purpose in this research, the first objective is achieved.

### **5.1.2 The second research objective**

The following second objective has been achieved through the testing of null hypothesis 1 (H<sub>01</sub>):

**To conduct a comparative study to investigate the difference of teaching and learning Introductory Psychology by evaluating students' learning achievement between students who learned using IMM with emotive and animated PAs (IMMAPA) and students who learned using IMM with non-emotive and static PAs (IMMSPA).**

The results obtained from the testing of H<sub>01</sub> using the independent samples t-test (which have been discussed in section 4.4) indicated that there

was a significant difference between the learning of Introductory Psychology using IMMAPA and IMMSPA on students' learning achievement with significant difference in mean scores between the two ( $M_{IMMAPA}=18.06$ ,  $SD_{IMMAPA}=1.611$ ;  $M_{IMMSPA}=16.13$ ,  $SD_{IMMSPA}=1.821$ ) as shown in Table 4.1

The results also reported that different types of PAs (i.e. APA and SPA) in the IMMs had a significant effect on students' performance in psychology learning. Students who learned using IMMAPA performed better than students who learned using IMMSPA, where the percentage of students in the IMMAPA group that contributed to the value "Very Good" (scored 16-20 points in total) in the comprehension test was higher (46.9 per cent) than the students in the IMMSPA group (31.3 per cent) as shown in Figure 4.13.

The results coincide with the past studies such as Kervellec et al. (2016), Park (2015), Wei, Peng, and Chou (2015), and Yung and Paas (2015). These studies share a common finding which the use of animated pedagogical agent in multimedia learning positively effects students' achievement in various learning topics.

### **5.1.3 The third research objective**

The last objective of this research is as below:

**To find out students' perceptions towards the features incorporated in IMMs such as educational multimedia content, pedagogical agents' instructional role, learning motivation,**



**pedagogical agents' characteristics, and pedagogical agents' presentation styles in giving positive effect to simulate human-like communication that facilitate the teaching-learning process in a multimedia learning environment between students who learned using IMMAPA and students who learned using IMMSPA.**

This objective has been achieved through the testing of five null hypotheses, i.e. H<sub>02</sub> through H<sub>06</sub> using the independent samples t-test. The results are discussed in section 4.5.

Different number of statements that intended to find out students' perceptions towards the educational multimedia content (EMC), PA as instructional role (PAIR), learning motivation (LM), PAs' characteristics (PAC), and PAs' presentation styles (PPS) as listed in Tables 4.3 (EMC), 4.6 (PAIR), 4.9 (LM), 4.12 (PAC) and 4.15 (PPS) were incorporated into Sections A through E in Part 1 of the questionnaire (see Appendix B) using a 5-point Likert scale ranging from 1 'Strongly Disagree' to 5 'Strongly Agree'. The students were requested to tick the corresponding numbers (i.e. 1-5).

The findings in Tables 4.3 (EMC), 4.6 (PAIR), 4.9 (LM), 4.12 (PAC) and 4.15 (PPS) indicate that all of the mean scores for students' perceptions in IMMAPA group were above the midpoint (3) of 5-point Likert scale, compared to the mean scores for students' perceptions in IMMSPA group. The research findings also show that only eight of 13 statements for EMC, and five of the nine statements for PPS had means scores above the midpoint (3) for students'

perceptions in IMMSPA group. Meantime, research findings have shown that students in IMMAPA group generally had more positive perceptions towards the EMC, PAIR, PAS and PPS in enhancing students' learning of Introductory Psychology, as well as LM than students in IMMSPA group.

In addition, through the results of independent samples t-test analysis, the results as shown in Tables 4.4 (EMC), 4.7 (PAIR), 4.10 (LM), 4.13 (PAC), and 4.16 (PPS) are summarised as below:

- **Students' perceptions towards EMC (Table 4.4):** The p-value was 0.014 ( $p < 0.05$ ) indicating that the data provides enough evidence to reject the null hypothesis 2 ( $H_02$ ) at a 0.05 significance level. The results indicate that "there was a significant difference in students' perceptions towards EMC in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA" with significant difference in mean scores between the two ( $M_{IMMAPA}=3.82$ ,  $SD_{IMMAPA}=0.695$ ;  $M_{IMMSPA}=3.19$ ,  $SD_{IMMSPA}=0.668$ ) as shown in Table 4.3.
- **Students' perceptions towards PAIR (Table 4.7):** The p-value was 0.031 ( $p < 0.05$ ) indicating that the data provides enough evidence to reject the null hypothesis 3 ( $H_03$ ) at a 0.05 significance level. The results indicate that "there was a significant difference in students' perceptions towards PAIR in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA" with

significant difference in mean scores between the two ( $M_{IMMAPA}=3.93$ ,  $SD_{IMMAPA}=0.505$ ;  $M_{IMMSPA}=3.60$ ,  $SD_{IMMSPA}=0.264$ ) as shown in Table 4.6.

- **Students' perceptions towards LM (Table 4.10):** The p-value was smaller than 0.001 ( $p<0.01$ ), which provides a strong evidence to reject the null hypothesis 4 ( $H_04$ ) at a 0.01 significance level. The results indicate that “there was a significant difference in students' perception towards LM between students who learned using IMMAPA and students who learned using IMMSPA” with significant difference in mean scores between the two ( $M_{IMMAPA}=3.78$ ,  $SD_{IMMAPA}=0.430$ ;  $M_{IMMSPA}=2.82$ ,  $SD_{IMMSPA}=0.677$ ) as shown in Table 4.9.
- **Students' perceptions towards PAC (Table 4.13):** The p-value was 0.002 ( $p<0.01$ ), which provides a strong evidence to reject the null hypothesis 5 ( $H_05$ ) at a 0.01 significance level. The results indicate that “there was a significant difference in students' perceptions towards PAC in enhancing students' learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA” with significant difference in mean scores between the two ( $M_{IMMAPA}=3.93$ ,  $SD_{IMMAPA}=0.0602$ ;  $M_{IMMSPA}=3.26$ ,  $SD_{IMMSPA}=0.489$ ) as shown in Table 4.12.
- **Students' perceptions towards PPS (Table 4.16):** The p-value was 0.002 ( $p<0.01$ ), which provides a strong evidence to reject the null hypothesis 6 ( $H_06$ ) at a 0.01 significance level. The results

indicate “there was a significant difference in students’ perceptions towards PPS in enhancing students’ learning of Introductory Psychology between students who learned using IMMAPA and students who learned using IMMSPA” with significant difference in mean scores between the two ( $M_{IMMAPA}=3.99$ ,  $SD_{IMMAPA}=0.387$ ;  $M_{IMMSPA}=3.18$ ,  $SD_{IMMSPA}=0.8222$ ) as shown in Table 4.15.

Overall, all the five research findings through the independent samples t-test analysis were statistically resulting significant differences in perceptions between students who learned Introductory Psychology using IMMAPA and students who learned using IMMSPA.

These findings in the differences of students’ perceptions were also correspondent with several prior studies, for instances respondents’ perceptions towards:

- multimedia content (e.g. Ahdon, 2013; Wei, Peng and Chou, 2015),
- PA as instructional role (Kim & Baylor, 2016; Pi et al., 2019; Yung & Paas, 2015),
- learning motivation (e.g. Guo, Goh & Luyt, 2014; Ozdemir, Izmirly, and Izmirly, 2016; Shiban et al., 2015),
- Animated versus static PA (Carlotto & Jacques, 2016; Chen & Wang, 2018; Wang et al., 2018), and
- PA’s presentation via human voice versus written text (e.g. Craig & Schroeder, 2017; Ryu & Ke, 2018).

## 5.2 Research Contributions

The two IMMAs with different types of PAs (i.e. APA and SPA) that have been designed and developed as one of the research instruments are hold as the major contribution to this research. As explained in section 1.6 this research aimed to harness the power of interactive and animated PAs in multimedia learning in order to increase learners' attention span, particularly those who are having difficulties with textual-based media learning, as well as allow learners to experience human-like interaction are likely to bring a closer approach to virtual social interaction. It has been claimed that pedagogical agents facilitate social interactions between learners and computer-based contents through their human-like attributes (Ryu & Ke, 2018).

In the research, pedagogical agents called Karen and Joe, who play peer characters to assist the teaching-learning process among students are explicitly designed and built into the IMMAs. Thus, one of the contribution of this research would be the emotive animated characteristic enacted by both the PAs called Joe and Karen in IMMAPA whom purpose is to entice positive interaction with learners.

The pedagogical agents can be enjoyable not only among tertiary students, but also any eager learners who take pleasure in interacting with emotive virtual characters and simultaneously acquiring knowledge. Moreover, both IMMAPA and IMMSPA are also intended to aid learners who find difficulties with text-based learning. Optimistically, the interactive and emotive

animated PA features are capable to extend the attention span in order to achieve higher positive level of learning.

### **5.3 Research Limitations and Recommendations**

There were four major limitations found in the research, which need to be improved in future studies. These three limitations are:

- i. Small research sample size
- ii. Limited to students at a Malaysian university
- iii. Limited computer graphics technology used in the PAs design
- iv. Limited to Introductory level of psychology knowledge

#### **5.3.1 Small research sample size**

Trochim, Donelly and Arora (2016, p. 99) suggested that a sample size of 30 or more ( $N \geq 30$ ) is usually regarded as adequate in experimental design. However, as elaborated in section 3.4 the number of research samples used in the comparative study were 32 participants who had been divided equally into IMMAPA and IMMSPA groups. Therefore, this research used a small sample size of subjects, which was 16 participants ( $N \leq 30$ ) in each group. Due to the small sample size, all the participants were selected from a single class to keep the homogeneity of variance. All participants from both groups were selected on similar traits basis, where they were in the similar age group, i.e. aged between 18 to 24 years old; Year 2 university students that were major in

communication, non-psychology major students that were taking the same subject (i.e. Hubungan Etnik), and capable to operate basic command in computers.

However, similar to the current research, there were prior studies pertaining to the use of PA had used a small sample size ( $N < 30$ ). In the research of Liew, Tan and Jayothisa (2013) 56 samples were randomized into two groups (i.e. 28 in each group), Bönsch et al. (2016) used 27 volunteers in the experiment, Wang, Li, Mayer, & Liu (2018) assigned 20 to 26 participants in each experiment group, Ryu and Ke (2016) randomly assigned 48 students into four groups (i.e. 12 in each group), as well as Chen and Wang (2018) involved 18 participants in the experiment.

Despite the small sample size for the current research, a larger size can be suggested for future research to gain more reliable results with greater precision and power (Littler, 2019). Littler claimed that a sufficiently large sample size are able to draw meaningful conclusions.

### **5.3.2 Limited to students at a Malaysian university**

This research was conducted at a Malaysian University among Year 2 students that were major in communication. Consequently, the findings from this have limitations in terms of generalizability to the whole Malaysia because the data were only collected from a single private higher educational institution (HEI). Students from different higher HEIs may perform differently thus may

have different learning outcomes. Nonetheless, IMMAPA and IMMSPA were designed to suit various types of learners.

Therefore, future research may be conducted to investigate students' learning achievement in Introductory Psychology and their perceptions towards the educational content and features of PAs in the IMMAs among students of different Malaysian universities, which include both public and private HEIs.

### **5.3.3 Limited computer graphics technology used in the PAs design**

The two IMMAs (i.e. IMMAPA and IMMSPA) are the early prototypes of which the learning contents are limited to certain extent. Two IMMAs were designed and developed using Adobe Animate CC, a 2-dimensional graphic computer programme (formerly known as Adobe Flash). Therefore, the pedagogical agents' graphics in the IMMAPA and IMMSPA are displayed as 2-dimensional characters. However, the research's main target is the implementation of emotive animated features in PAs design, which allow users to experience human-like simulation of interaction.

Johnson and Lester (2016) urged that animated PA's future designers to focus on its potential to benefit learners without neglecting the available rapid advancing of computer technology. Since IMMAPA and IMMSPA prototypes in this research are merely adopted 2-dimensional graphics, thus, the most up-to-date advances in computer graphics technology such as immersive 3D-graphics or mixed reality can be used to enhance the design of PAs (i.e. Joe and



Karen) for further research.

#### **5.3.4 Limited to Introductory level of psychology knowledge**

The two modules are created with the intention to test research respondents' learning output with limited amount of psychology lesson topics. The field of psychology is vast and encompassing numerous sub-topics, but there are only 14 fundamental subtopics included as learning lessons in this research (refer to section 3.2.3). Only 14 subtopics are required to deliver the research intention through the use of IMMAPA and IMMSPA.

Nevertheless for future development, the psychology subject can be extended further boundless to any level or any number of topic discussions as intended. Furthermore, the IMMAPA and IMMSPA have the potency to re-designed and even enhanced to any other knowledge in order to promote teaching and learning with pedagogical agents.

#### **5.4 Research Implications**

Numerous virtual characters development in video games are designed closer to human like representation. Thus, video games industry escalates higher over time. Emotive animation, voices, and narrations in those characters drive the realistic aspect the gamers can experience. However, the purpose of video games virtual characters are not for education, unlike PA.

Emotive communication composed in PA are hoped to as much potential in the world of multimedia education as realistic and immersive video game characters.

The features of animation and human voice equipped in PA as intended in this research seek to contribute in finding more of such attentions in future research. Johnson and Lester (2016) claims that the envisioned PA is progressing quickly becoming a reality and more immersive. Emotive behaviour in educational virtual characters is an important factor (Ryu & Ke, 2018).

#### **5.4.1 Implication to Kress' Multimodality Theory in computerized character through emotive characteristics**

The research began as a deductive approach in the application of Gunther Kress' Multimodal Theory to the emotive PA development. Kress (2001) claims the use of multimodal allows semiotic identifications, such as the use of eye gaze, hand movements, body language and facial expressions, to enhance information sharing in human communication. While Kress' multimodality depicts how to enhance human interaction, the use of emotive characteristics (i.e. human-like animation and recorded human voice) can be used to depict multimodality in PA interaction. Jewitt (2003) mentioned that students can benefit in learning by engaging with animated computer characters, allowing students to access the characters' imagined movement and gesture (pp. 286-287). Finally, despite using animation in developing PA design can be found in many prior PA studies (e.g. Nunes et al., 2016; Romero-Hall,

Watson, & Papelis, 2014; Ryu & KE; 2018) animation itself is still a discipline that can be further explored based on available progressing technology. And furthermore, there are wide variation of animation styles in its application to create higher level emotive PA designs. In other words, the level of modalities in PA design depends heavily on the level of animation techniques used in computerized multimedia technology.

Thus, the research intends to point out the following study implications related to the theory.

Firstly, the emotive characteristics in PA was constructed from combination of animation, human voice, and interactive element. Secondly, the three elements represent the semiotic elements (visual, audio, and interaction) in communication according to Kress. And thirdly, the findings showed significant differences in students' responses towards the use of emotive PA compared to static PA in learning a psychology topic.

Thus, an assumption can be drawn in which animation and human voice in an interactive PA designs delivers similar communication enhancer method with Multimodality in multimedia learning.

## 5.5 Conclusions

Two primary conclusions are drawn from the overall research findings through both descriptive and inferential statistical analysis, as follows:

- i. Students who learned using IMMAPA which equipped with human like qualities of PAs such as body gestures, facial expression, and human voice have positive impact on students' learning achievement in Introductory Psychology, compared to students who learned using IMMSPA with PAs equipped with static visual and written text representation, and
- ii. Students who learned using IMMAPA had more positive perceptions towards the EMC, PAIR, PAS and PPS in enhancing students' learning of Introductory Psychology, as well as LM than students who learned using IMMSPA.

The conclusions from the research findings indicate that the combination of interactivity, animation, and recorded human voice that embedded in PAs aided the simulation of human-like communication in multimedia learning environment. Stef et al. (2019) suggested that emotions are the trigger factor of the expressions for communicating with other beings and indicating the traits. Craig and Schroeder (2017) implied that effect of human voice impacted greater when combined with virtual human.

Twenty years of PA technology has been studied and researchers are looking for better leaning outcomes by enhancing the designs and functions.

But, there is still much to figure out in making PA as an actual intelligent learning system (Johnson & Lester, 2016). Results in this research could provide insight to future similar studies, but it is only one of many researches that need to figure out of what factors to be considered in potentially enhancing the human-like communication in the use of pedagogical agent in teaching and learning processes.

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## Appendix A

### Consent Form

#### Objective:

The survey seeks to obtain your feedback and experience on your learning with interactive multimedia module for Introductory Psychology. The data that you provide will be vital to my research. Every answer of yours will add value not only to my current research but also to future studies. By taking part in this survey, you will be helping me to obtain an in-depth picture of the multimedia learning with pedagogical agents.

**Consent:** If you agree to participate, please sign the consent form below.

I have had the research project explained to me and have understood the research objectives. I understand that everything I say is confidential and none of the information I give will identify me and that the only persons who will know what I have said will be the researchers, FCI and UTAR.

I also understand that all the information that I give will be kept completely **confidential**. All information collected from me will be described as **anonymous** in the research reports. My name will not be mentioned in the reports.

I have had time to consider everything and I give my consent to be a part of this.

Participant Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**Name:**

**Contact Number:**

**Age:**

**Course of study:**

**Gender:**

**Year/ Trimester:**

## Appendix B

### Comprehension Test to Measure Respondents' Learning Achievement

#### Section A: Multiple-Choice Questions

**Instructions: CIRCLE the letter of the correct choice for each of the following questions.**

1. What is the name of the subject Joe, Karen, and You are going study for exam?
  - a. History of psychology.
  - b. Psychology 101.
  - c. Psychiatrist and medication.
  - d. Mental illness 101.
  
2. Who is the facilitator/lecturer teaching the subject, according to Karen and Joe?
  - a. Dr. Federick.
  - b. Dr. Aaron.
  - c. Dr. Larsen.
  - d. Dr. Nelson.
  
3. Where do you think the conversation in the module take place?
  - a. In the school library.
  - b. In a classroom.
  - c. At Joe's house.
  - d. At a school pantry.
  
4. What is the colour of the notebook on the table?
  - a. Red
  - b. Blue
  - c. Green
  - d. Grey
  
5. **Psychology** derives from the words...
  - a. Psyche & Logia
  - b. Psy & Ologic

- c. Psyche & Logic
  - d. Psyche & Logos
6. What are the **THREE (3)** branches of psychology mentioned by Karen and Joe?
- a. Developmental, Clinical, and Forensic Psychology
  - b. Clinical, Educational, and Child Psychology
  - c. Developmental, Clinical, and Abnormal Psychology
  - d. Clinical, Abnormal, and Forensic Psychology
7. Which psychology branch is **most** related to study of behaviour changes throughout life time, aging and health?
- a. Developmental Psychology
  - b. Clinical Psychology
  - c. Abnormal Psychology
  - d. Educational Psychology
8. What does **nurture** in psychology mean?
- a. Every human being's behaviour is complex and unique.
  - b. Our personalities are shaped and changed due to environment influence.
  - c. We inherit our personalities from birth.
  - d. Every human being may have mental issues once a lifetime.
9. A person who is both introvert and extravert?
- a. Extra-introvert
  - b. Extra-extravert
  - c. Ambivert
  - d. Extra-ambivert
10. What is Darwin's theory about?
- a. Evolution.
  - b. Social-acceptance.
  - c. DNA and inheritance.
  - d. Mental illness.

## Section B: True-False Questions

**Instructions: CIRCLE your choice (either True or False) for each of the following questions.**

1. *Educational psychology* is mentioned in the module.

**True / False**

2. Nature refers to the surroundings/environmental influence.

**True / False**

3. *Psychologists* are **not** allowed to prescribe any medication or drugs.

**True / False**

4. Clinical psychology focuses on diagnosing mental illness.

**True / False**

5. Extroverts are happier than introverts.

**True / False**

6. An anti-social person is introverted.

**True / False**

7. Joe is an ambivert.

**True / False**

8. *Psychiatrist* sometimes perform psycho-analysis, like hypno-therapy.

**True / False**

9. You can view the lessons again from the textbook on the table.

**True / False**

10. Joe is going to pursue his Ph.D like Karen too someday.

**True / False**

## **Appendix C**

### **Survey Questionnaire to Measure Respondents' Perceptions towards the Features incorporated in IMM**



## UNIVERSITI TUNKU ABDUL RAHMAN

Dear participant,

I am a postgraduate student from Faculty of Creative Industries, Universiti Tunku Abdul Rahman (UTAR), Malaysia. I would like to invite you take part in this survey to provide needed data and information for my research study entitled “Interactive Multimedia Learning: Emotive Animated Character in Simulating Human-Like Communication”. The aim of the research is to find out to what extent the interactive multimedia modules with pedagogical agents can affect teaching and learning effectiveness in Introductory Psychology. My target participants are university students aged between 18 to 22 years old without or have limited knowledge on Psychology. This questionnaire seeks to obtain your feedback and your perception after working on an interactive multimedia module with pedagogical agents for teaching and learning Introductory Psychology.

It will take about 10 minutes to complete this questionnaire. Because the statements in this questionnaire are about personal feelings, attitudes, and behaviours, there are no right and wrong answers. In order for the results of this survey to truly represent your thinking, **it is important that you fully complete the enclosed questionnaire**. Your response to this survey is very important to me in providing valuable information for my research. Please answer all questions as honestly as possible and return the completed questionnaire promptly after the survey. Your help would be greatly appreciated. Your name and information that identify you will be kept completely **CONFIDENTIAL**. All information collected from you will be described as **ANONYMOUS** in the dissertation or any forms of publication. The results of the research would be used for research and academic purposes only.

There are no known risks associated with this research nor there are benefits through participation, apart from enabling you to contribute to scientific research.

You are required to provide your basic demographic information by filling out the consent form in Page 2 to indicate your consent in taking part in this survey.

Thank you very much for your time and cooperation.

Yours sincerely,

*Erwin*

Erwin Tjew

Email: [erwintjew@yahoo.com](mailto:erwintjew@yahoo.com)

## Part 1: Student's Perception towards the Features in the Learning Module

**Instruction:** Please tick (✓) the most appropriate option in the relevant column [□] whether you Strongly Disagree, Disagree, Neither Agree nor Disagree (Neutral), Agree or Strongly Agree with each of the following statements.

Scoring	1	2	3	4	5
Level of Agreement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Section A: Educational Multimedia Content						
No.	Item	1	2	3	4	5
A1.	The content is pretty clear to me.					
A2.	The content looks reliable to me.					
A3.	The content is easy to understand.					
A4.	Language used to present the content is simple and easy to understand.					
A5.	The information is well-structured (systematic) from the beginning.					
A6.	The content gives me many new information.					
A7.	The content made me aware about psychology.					
A8.	The psychology terms are easy to remember.					
A9.	This psychology information is useful for me.					
A10.	I can learn and understand every section of the lessons by the end of the programme.					
A11.	I found the content is useful for learning.					
A12.	I prefer to learn psychology lessons like this (with multimedia features and pedagogical agents).					
A13.	I tried to pay attention in every part of the content.					

<b>Section B: Pedagogical Agents' Instructional Roles</b>						
<b>No.</b>	<b>Item</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
B1.	The pedagogical agents are interesting.					
B2.	The pedagogical agents have human-like emotive appearance during the delivery of lessons.					
B3.	The pedagogical agents show appropriate body gestures during the delivery of lessons.					
B4.	The pedagogical agents show appropriate facial expression during the delivery of lessons.					
B5.	The pedagogical agents are knowledgeable.					
B6.	The learning environment design with pedagogical agents is appropriate.					

<b>Section C: Learning Motivation</b>						
<b>No.</b>	<b>Item</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
C1.	The content makes me feel more interested in learning psychology.					
C2.	The content makes me want to find out more about psychology (stimulates my curiosity).					
C3.	I find the pedagogical agents motivate my learning.					
C4.	I was encouraged by the pedagogical agents to pay attention in learning.					
C5.	I would like to find out more about the lessons because of the pedagogical agents.					
C6.	The pedagogical agents increased my interest in learning.					
C7.	The pedagogical agents are entertaining. The learning is enjoyable.					

<b>Section D: Pedagogical Agents' Characteristics</b>						
<b>No.</b>	<b>Item</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
D1.	The pedagogical agents have interesting animation.					
D2.	The pedagogical agents' facial expression look natural.					
D3.	The pedagogical agents' give proper eye contact.					
D4.	The pedagogical agents' body movement look natural.					



<b>Section D (Continued)</b>						
<b>No.</b>	<b>Item</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
D5.	The pedagogical agents' lip synchronization is easy to understand.					
D6.	The pedagogical agents' emotions look natural.					
D7.	I find the pedagogical agents are close to human-like characters.					
D8.	The pedagogical agents' face expressions affects me in learning.					
D9.	The pedagogical agents' body language affects me in learning.					
D10.	I learn better with animated pedagogical agents.					

**Do the pedagogical agents present their conversation during the delivery of lessons in human-speaking voices?**

- **If YES, proceed to Section E-A**
- **If NO, proceed to Section E-B**

<b>Section E-A: Pedagogical Agents' Presentation Styles (via Recorded Voice)</b>						
<b>No.</b>	<b>Item</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
E-A1.	The pedagogical agents' voices in their conversation during the delivery of lessons are clear.					
E-A2.	The accent of the pedagogical agents during the delivery of lessons is easy to understand.					
E-A3.	The language in explaining the content is appropriate.					
E-A4.	The pedagogical agents' voices during the delivery of lessons matches their human-like emotive appearance.					
E-A5.	The conversation is interesting during the delivery of lessons since the pedagogical agents have their own voices.					
E-A6.	The pedagogical agents' voices help stimulating the animation and content presentation.					
E-A7.	The pedagogical agents' voices during the delivery of lessons help me to understand the lessons better.					

<b>Section E-A (Continued)</b>						
<b>No.</b>	<b>Item</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
E-A8.	I can learn better if the pedagogical agents are not silent (i.e. present the dialogues of conversation during the delivery of content with recorded voices).					
E-A9.	Pedagogical agents' voices are important compared to their appearance.					

<b>Section E-B: Pedagogical Agents' Presentation Styles (via Written Text)</b>						
<b>No.</b>	<b>Item</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
E-B1.	The pedagogical agents' content presentation (show the dialogues of their conversation) in animated text format during the delivery of lessons are clear.					
E-B2.	The pedagogical agents' content presentation in animated text format during the delivery of lessons is easy to understand.					
E-B3	The language in explaining the content is appropriate.					
E-B4.	The pedagogical agents' content presentation in animated text format during the delivery of lessons matches their non-emotive appearance.					
E-B5.	The conversation is more interesting if the pedagogical agents have their own voices, instead of showing their dialogues of conversation in animated text format.					
E-B6.	The pedagogical agents' with voices may help stimulating the animation and content presentation, instead of showing their dialogues of conversation in animated text format.					
E-B7.	The pedagogical agents' voices during the delivery of lessons may help me to understand the lessons better, instead of showing their dialogues of conversation in animated text format.					

Section E-B (Continued)						
No.	Item	1	2	3	4	5
E-B8.	I can learn better if the pedagogical agents are not silent (i.e. present the dialogues of conversation during the delivery of content with recorded voices, instead of their dialogues of conversation in animated text format).					
E-B9.	Pedagogical agents' voices are important compared to their appearance.					

## Part 2: Personal Details

**Instruction: Please tick (✓) the most appropriate option in the relevant circle or fill in the blanks for your answers.**

1. Gender:       Male.                       Female

2. Age: \_\_\_\_\_.

3. Nationality: \_\_\_\_\_

4. Student ID: \_\_\_\_\_

5. Semester: \_\_\_\_\_ Year: \_\_\_\_\_

6. Course of study: \_\_\_\_\_

7. How knowledgeable are you with Psychology study?

Very good       Not bad       Not at all

8. How familiar are you with Animation and Multimedia studies?

Very good       Not bad       Not at all.

**Thank you for taking the time to fill out this questionnaire**

Please take a minute to look back through the questionnaire to make sure you answered all of the questions, and then give your completed questionnaire to the researcher.