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Animated Pedagogical Agent’s Roles and English Learners’ Prior Knowledge: The Influence on Cognitive Load, Motivation, and Vocabulary Acquisition

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Animated Pedagogical Agent’s Roles and English Learners’ Prior Knowledge: The Influence on Cognitive Load, Motivation, and Vocabulary Acquisition

by

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A dissertation submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy in Curriculum and Instruction with an emphasis in Instructional Technology Department of Educational and Psychological Studies College of Education University of South Florida

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DEDICATION

This dissertation is dedicated to my father, Yasin Flemban, whose love and prayers kept me sustained over the years and enabled me to achieve this dream. You were there every step of this journey.

It is also dedicated to my husband, Nuaman Abdulaziz, for his unconditional support and endless patience in the pursuit of my goals.
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DEFINITIONS OF TERMS

Animated Pedagogical Agents (APA): Animated Pedagogical Agents (APAs) are “on-screen characters who help guide the learning process during e-learning episode” (Clark & Mayer, 2008, p. 191). The agent is embodied, or a visual representation as cartoon-like character, as talking-head video, or as virtual avatars, and can detect external stimuli such as keyboard input and mouse clicks (Clark & Mayer, 2008; Slater, 2000). APA can also be a life-like characters enabled with speech, gesture, and movement (Park, 2015).

Cognitive Load: “The amount of mental resource in working memory required by a task” (Clark & Mayer, 2011, p. 455).

Computer-Assisted Language Learning (CALL): “Learners learning language in any context with, through, and around computer technologies” (Egbert, 2005). It can be any of the world’s language; however, this study focuses on English as a second or foreign language. Computer technologies include any form of electronic and the software that makes it run e.g. laptops, cell phones, or software like word processors (Egbert, 2005).

English as a Second Language (ESL): English as a Second Language refers to teaching or learning English language in a country where English is spoken as an official language (Horwitz, 2013).

Extraneous Cognitive Load: It is a cognitive load related to feature of instructional design (Bruning, Schraw, & Norby, 2011). It can be eliminated by altering learning instructions or procedures (Sweller, 2010).

Germane Cognitive Load: Cognitive load concern with the knowledge acquisition. “It refers to the working memory resources that the learner devotes to dealing with the intrinsic cognitive load associated with the information” (Sweller, 2010, p. 126).

Input: “The process of receiving information, either verbally or visually” (Plass & Jones, 2005, p. 483).

Input Enhancement: It is “promoting students’ noticing of a particular language feature, such as putting in boldface type a particular structure in a reading passage” (Larsen-Freeman, & Anderson, 2011, p. 241).

Intrinsic Cognitive Load: Cognitive load is caused by the materials themselves (Bruning et al., 2011). It cannot be eliminated without altering the nature of to-be-learned materials (Sweller, 2010).
Language Proficiency: a language learner’s overall ability in the target language (Horwitz, 2013).

Meaningful learning: Learning involves the connection of new material to the learner’s existing knowledge or schema (Horwitz, 2013).

Morpheme: “The smallest unit of language that indicates a difference of meaning” (Horwitz, 2013, p. 275).

Multimedia: It is presenting words and pictures. “The word can be printed text or spoken text. The pictures can be in static form, illustration, photos… or in dynamic form, such as animation or video” (Mayer, 2008, p. 761). “Multimedia requires two or more delivery devices such as computer screen and amplified speakers… Multimedia requires verbal and pictorial representation such as on-screen test and animation … Multimedia requires auditory and visual sense such as narration and animation” (Mayer, 2005, p. 2).

Output: “The process of assigning meaning to verbally or visually input” (Plass & Jones, 2005, p. 484).

Pedagogical Agent Persona: It is described by some researchers as the personification or personal nature of the presented agent. Others have described the persona as the agent’s ability to positively affect learners’ perception of the learning experience (Schroeder & Adesope, 2014).

Pedagogical Agent Role: There are several instructional roles playing by pedagogical agents such as expert, instructor, mentor, motivator, or learning companion. They present different agents’ functions for supporting learning. These roles are operationalized by image, animation, affect, voice, and script (Baylor & Kim, 2005).

Scaffolding: It is “an instructional technique placed in instructional environments that provide sufficient support to ensure the achievement of the intended instructional outcome. Scaffolds assume a variety of formats including worked examples, learning agents, or visual aids.” (Mayer, 2005, p. 614). The notion of scaffolding in technology with embedding animated pedagogical agents has been linked in many studies (Yung & Dwyer, 2010).

Second Language Acquisition (SLA): it is an emerging scientific research and a contemporary language instruction (Takač, 2008). It is the basis for the academic discipline practice that all language teachers should employ (Horwitz, 2013).

Target Language: The second or foreign language of instruction (Horwitz, 2013).

Tutorial: A broad method involves instructional events to provide the individual needs of the student (Reigeluth & Keller, 2009).
ABSTRACT

Note to Reader

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Researchers and educators have always strived for creating appropriate instructional tools and resources that help students to acquire knowledge. Animated pedagogical agents (APAs) embedded within multimedia learning settings are one of the emerging technologies that provide a powerful and supportive learning environment. According to previous studies, APAs can effectively promote learning and support social interaction with learners (Johnson & Lester, 2016; Lane, 2016). However, APAs also may cause cognitive load without providing motivational benefits in some cases and distract learners during the learning process. In other words, the results of previous studies on APAs do not provide enough evidence to argue that APA may be able to decrease cognitive load, promote motivational effects, or facilitate meaningful learning. The lack of enough evidence in the research findings seems to be variable depending upon the APA’s features, the learners, and the difficulty of the learning materials (Schroeder & Adesope, 2014). By focusing on these factors, this study provided new considerations related to embedding an APA’s role that facilitates “Word Parts” for adult
students who speak English as a Second Language (ESL) with concentrating on their cognition, motivation, and vocabulary acquisition. Presenting two APA’s roles (expert model and peer model) differently influenced ESL learners’ motivation, specifically their satisfaction feelings. In addition, ESL learners’ prior knowledge affected their intrinsic and extraneous cognitive load, motivation, and vocabulary acquisition. The two different APA’s roles and their effects on ESL learners’ perceptions and learning outcomes serve as a media comparison research. Further, examining APA as a model to teach ESL students vocabulary acquisition skills serves a Computer-Assisted Language Learning (CALL) research.
CHAPTER ONE:
INTRODUCTION

Among this digital era, growing interest emerges in how technology might be best utilized for learners. A plethora of emerging technology urges educators to use different kinds and features of technology to facilitate an appropriate learning environment. The appropriate learning environment is an influential factor that affects gaining knowledge, specifically Second Language Acquisition (SLA). Students who speak English as a Second Language (ESL) need adequate exposure to the target language that guides linguistics forms and rules, models tasks, and provides a safe and comfortable environment for trying and taking risks with English (Robinson, Keogh, & Kusuma-Powell, 2000; Horwitz, 2013; Florez & Burt, 2001). Further, language learners’ motivation and anxiety are other concerns for SLA (Horwitz, 2013). The real language classrooms have scarcity of these essential needs for improving language acquisition. Lack of availability of a guidance and a motivational model in a less-anxiety environment can negatively influence language learners especially adult learners. Adolescents are commonly anxious about learning a language and being naïve in that language. Their anxiety and lack of motivation can have a negative impact on their academic success (Horwitz, 2013).

The integration of pedagogy and technology within a multimedia instructional environment has shown significant results related to learning, retention, and transfer improvement (Doolittle, McNeill, Terry, & Scheer, 2005). In a multimedia environment, embedding an animated pedagogical agent is an effective integration tool to support meaningful
learning (Moreno, Mayer, Spires, & Lester, 2001). Based upon previous studies, pedagogical agents can reduce learner anxiety (Veletsianos & Russell, 2014). They also have strong persona effect on students’ perception of their learning experience, as well as students’ perception of agent’s credibility and utility (Lester, Converse, Kahler, Barlow, Stone, & Bhogal, 1997).

Regarding learner’s perception, prior knowledge is another influential factor affecting individual’s perception of new knowledge and building meanings (Bruning, Schraw, & Norby, 2011). Hence, these influential factors, an animated agent and a learner’s prior knowledge, have influenced perception as well as learning outcomes and taking them into consideration is necessary. Furthermore, previous studies found inconsistent results regarding agent’s effects on learners’ cognitive and motivational outcomes in addition to a deficiency in accurate results of agent’s effects in specific subject area, learning task, learner’s demographics, or learners’ prior knowledge (Lane, 2016; Schroeder & Gotch, 2015; Veletsianos & Russell, 2014; Heidig & Clarebout, 2011).

Animated Pedagogical Agents (APAs) are visible characters designed to facilitate learning in computer-based environment (Moreno, 2005). They are designed differently in terms of their internal and external properties. In this study, the APAs provided students a model and guidance (the internal properties) and were presented as an expert and a peer agent (the external properties). With these properties, APAs can draw ESL learners’ attention to notice linguistic features of the input by modeling these linguistic features in audio and visual aids. They also can elicit learners’ output through providing activity in a less anxiety environment where scores are not recorded and feedback are provided. Regarding instructional effectiveness, the look of an agent alone does not perceived as a significant element in cognitive and affective outcomes, but the agent’s roles with the learning tasks do (Woo, 2009). Therefore, this study examined the
agent’s roles as functions for supporting learning and operationalized by image, animation, affect, voice, and script (Baylor & Kim, 2005).

Through exploiting the multimedia, these APAs would enhance the input and offer organized materials. Presenting words and sentences onscreen with boldface key words to support noticing them enhances the input and facilitates SLA (Plass & Jones, 2005; Larsen-Freeman, & Anderson, 2011). Providing introductory material before learning content and then activating students’ prior knowledge presents an advance organizer before receiving the new input. Research found that advance organizers presented in verbal and visual modes are more effective for ESL students than presented in only verbal mode (Plass & Jones, 2005). These APAs were designed to help students to feel comfortable and to avoid such nervousness or shyness as negative anxieties during learning process, unlike real instructors in real classrooms (Sabot, Zolkifly, & Lew, 2005).

Thus, utilizing animated pedagogical agents (APAs) as models that provide cognitive and motivational scaffoldings within multimedia environments can provide ESL learners what they need such as guidance, model, English audio-visual aid, and meaningful learning within less-anxiety climates. In sum, this study investigated whether embedding APAs through two different roles offered what ESL students need for enhancing their cognition, motivation, and vocabulary acquisition.

**Statement of the Problem**

The APA’s image and function are significant factors in learning environments (Baylor & Kim, 2005) and designing appealing appearance and voice of APA is also important and should be considered (Domagk, 2010; Mayer, Sobko, & Mautone, 2003). The qualified design of APA
is critical to maximize their effectiveness and need for further research (Johnson & Lester, 2016; Gulz & Haake, 2006). The field also needs empirical research to demonstrate what type of APA is most appropriate for what learners’ populations, subject matter, and what context (Johnson & Lester, 2016; Heidig & Clarebout, 2011). For that aim, this study concentrated on specific APA design for teaching ESL learners a vocabulary strategy and embraced two different roles. Generally, in the real classroom, teacher and peer are considered as routine resource providers who help students to achieve the desired outcomes (Wentzel, Battle, Russell, & Looney, 2010). These provided resources can be a form of information, advice, or modeled behavior. Both teacher and peer can develop students’ academic and social competencies. Furthermore, the interactions and emotional support of teachers and peers are relevant to creating a safe environment for students (Wentzel et al., 2010). Hence, APAs were designed to mimic these two provider’s roles, teacher and peer. Animated agents have been perceived differently because of their roles and visual appearance and have differently impacted learning, motivation, and students’ perception of their learning experience (Liew, Tan, & Jayothisa, 2013; Veletsianos, 2010; Baylor & Kim, 2005; Lester et al., 1997). On the other hand, there is another important factor influencing learning and should be considered, which is learner’s prior knowledge (Kalyuga, 2013). Therefore, an APA’s role as well as an individual’s prior knowledge are influential factors and could lead to different perceived learning, cognitive load, and motivation.

**Purpose of the Study**

The purpose of this study was to examine the effects of two APA’s roles, an expert/teacher and a peer, with two levels of ESL learners’ prior knowledge in the English proficiency, high level and low level, on the learners’ cognitive load, motivation, and vocabulary
acquisition. This study utilized different instruments to measure variables under this investigation when the agents facilitated a vocabulary strategy.

**Significance of the Study**

1. This study would make a significant contribution to the field of APA design. Previous studies showed that presenting a simple pedagogical agent is not sufficient to facilitate learning process (Domagk, 2010; Mayer et al., 2003). Additionally, since previous studies showed that APAs have been perceived differently because of their roles and visual appearance and have differently impacted learning, motivation, and students’ perception of their learning experience, this study examined how and under which conditions an agent role would affect ESL students who have different English levels.

2. This study would make a significant contribution to the computer-assisted language learning (CALL) research. A knowledge gap appears related to using APA as a tool for supporting ESL learners. Several researchers in CALL studies have claimed that there is an absence of opportunities for language learners to engage in the meaningful language use (Chapelle, 2005). Embedding an APA in a multimedia environment is an effective integration to support meaningful learning (Moreno et al., 2001). Thus, this study investigated the efficiency of using APA as a model and facilitator for ESL learners. It also investigated ESL learners’ interactions within their minds in the electronic setting through examining the three types of cognitive load and motivation.

3. Despite studies having emerged to examine the effects of pedagogical agents within the last two decades, their effects on learning, cognitive load, and motivation remain debatable (Clarebout, Elen, Johnson, & Shaw, 2002; Lane, 2016; Schroeder & Gotch, 2015). Limited
studies have been done to investigate cognitive load and learner’s motivation that are engendered by learning with pedagogical agents (Schroeder & Adesope, 2014; Domagk, 2010). In addition, most of the empirical studies have ignored learners’ characteristics such as learners’ prior knowledge when they interact with pedagogical agents in the multimedia environments (Heidig & Clarebout, 2011). Therefore, this study investigated the desired outcomes by considering ESL learners’ cognitive factor including prior knowledge.

4. “Analyzing word parts” as a strategy for vocabulary acquisition is one of the four essential components of vocabulary instruction (Hanson & Padua, 2011) and a major strategy helping learners to remember new words and access word meanings (Nation, 2001). Teacher should model the way of analyzing the words and re-expressing their meanings, devote time in class to studying and practicing the word parts, and explicitly draw learners’ attention to word parts (Nation, 2001). Learners also need to discover the patterns in the language beginning from phonological categories, phonotactic sequences, and morphemes (Takač, 2008). However, these recommendations are not always the case inside the real classroom because of the limited time of the class. Regarding the APAs’ advantages, they can draw learners’ attention to notice linguistic features of the input by modeling this vocabulary strategy in audio and visual aids, enhance the input, and offer organized materials.

In brief, this study would extend the existing knowledge in the APA research as well as in the CALL research. It inspected agent’s roles with considering ESL learners’ prior knowledge and investigated their influence on several overlooked outcomes such as cognitive load, motivation, and vocabulary acquisition. It also focused on facilitating a major vocabulary strategy that has not been always available inside the real classrooms.
Research Questions

1) What is the effect of the role of Animated Pedagogical Agent (Expert vs. Peer) and the ESL students’ level of prior knowledge (High vs. Low) on students’ cognitive load (intrinsic, extraneous, and germane cognitive load)?

2) What is the effect of the role of Animated Pedagogical Agent (Expert vs. Peer) and the ESL students’ level of prior knowledge (High vs. Low) on students’ motivation?

3) What is the effect of the role of Animated Pedagogical Agent (Expert vs. Peer) and the ESL students’ level of prior knowledge (High vs. Low) on students’ vocabulary acquisition?

Research Hypotheses

Based on the three research questions, nine hypotheses were proposed. Some hypotheses have been directed with expected outcomes based on previous comparisons from previous research, while others have been anticipated as inference hypotheses based on theories or previous research findings. Based on this study design, three hypotheses were assumed under each research question: two hypotheses for each independent variable and one hypothesis for the interaction effect between these two variables. The hypotheses are presented next followed by the rationales behind them.

Hypotheses regarding the first research question:

H1: ESL students who interact with an APA as a peer role will show significantly lower extraneous cognitive load scores and higher germane cognitive load scores measured by a ten-item cognitive load questionnaire than ESL students who interact with an APA as an expert role.
H2: ESL students with high prior knowledge in English will show significantly higher extraneous cognitive load scores and lower germane cognitive load scores measured by a ten-item cognitive load questionnaire than ESL students with low prior knowledge in English.

H3: There will be an interaction effect between the role of APA and the students’ level of prior knowledge in English on the scores of the three types of cognitive load.

Previous study found that presenting a peer or motivator agent has been highly rated in terms of motivating college students (Baylor & Kim, 2009). That means the motivation caused by the agent can increase a learner’s cognitive capacity and enhance the sense of understanding of the presented material. That is, motivated learners devote more working memory resources to understand the presented content. Regarding prior knowledge, students who are familiar with a topic will encounter extraneous cognitive load because of dealing with redundant material. This redundancy affects their cognitive load by demanding cognitive resources to process unnecessary and additional information (Sweller, Ayres, & Kalyuga, 2011). Additionally, high prior knowledge students may not need additional encouragement from a peer agent or facilitation from an expert agent, which may cause them more cognitive load than their counterparts who have low prior knowledge.

**Hypotheses regarding the second research question:**

H4: ESL students who interact with an APA as a peer role will show significantly higher motivation scores measured by Instructional Materials Motivational Survey (IMMS) than ESL students who interact with an APA as an expert role.

H5: ESL students with low prior knowledge in English will show significantly higher motivation scores measured by IMMS than ESL students with high prior knowledge in English.
H6: There will be an interaction effect between the role of APA and the level of prior knowledge in English on the motivation scores measured by IMMS.

The motivational agent with its appearance such as a voice, motivational message, and dialogue has a significant impact on learners’ attitudes, changing behaviors, or positively influencing others (Baylor, 2011). A motivational agent has been significantly perceived as more motivational than expert agent (Baylor & Kim, 2005), highly rated on lesson enjoyment (Liew et al., 2013), and highly rated as motivating college students (Baylor & Kim, 2009). Furthermore, an agent with similar competence to learners, such as a peer with students who have low prior knowledge, would be more influential than an agent with higher competence, such as an expert, in terms of enhancing self-efficacy beliefs. One’s self-efficacy indirectly influences future learning by leading him or her to become involved in challenging tasks and to overcome any initial failures (Bruning et al., 2013).

**Hypotheses regarding the third research question:**

H7: ESL students who interact with an APA as an expert role will show significantly higher vocabulary acquisition scores measured by the posttest than ESL students who interact with an APA as a peer role.

H8: ESL students with high prior knowledge in English will show significantly higher vocabulary acquisition scores measured by the posttest than ESL students with low prior knowledge in English.

H9: There will be an interaction effect between the role of APA and the level of prior knowledge in English on the vocabulary acquisition scores measured by the posttest.

Some research has found that undergraduate students who interacted with agents who have expertise such as an expert and a mentor outperformed the other group who interacted with less
expertise agent such as a motivator on the transfer test (Baylor, 2003). Knowledge transfer is the ability to use previous learned knowledge and skills (Clark, 2008). Thus, encouragement alone is not sufficient for transfer learning, whereas credible information is necessary (Baylor, 2003). Furthermore, researchers found that using an expert agent led to increase information acquisition and the agent was rated as more facilitative teacher (Baylor & Kim, 2005). It appears that using an expert model provides cognitive support to learners for performing a task more so than motivational support (Belland, Kim, & Hannafin, 2013). Another study found that the presence of animated agent with hand gestures to the relevant information had a positive impact on learning. It showed that students with high prior knowledge (HPK) had significantly outperformed the low prior knowledge (LPK) students in the posttest. That is, the students effectively organize the verbal and visual information and then integrated that information with their prior knowledge. The analyses of the posttest scores as learning outcomes indicated a significant interaction effect between learners’ prior knowledge and agent presence (Johnson, Ozogult, & Reisslein, 2015).

**Delimitations**

This study was conducted during the fall semester in 2017 and located in an English language institution at a public university on the west coast of Florida. The sample of the study included adult English Language learners. The researcher predetermined certain boundaries regarding the academic literature and the population under this study. Regarding the literature review, conversational agents in virtual environment or simulation training had been excluded. Studying animated conversational agents took place in the intelligent tutoring system and in simulation training. While this study concentrated on APAs that facilitate learning, the
conversational agents are artificial intelligence and designed to answer user’s questions (Schroeder & Gotch, 2015). Virtual environments had also been excluded. These environments are valuable when a real-life training is essential such as surgery, air combat, handling complex equipment, or training are expensive or hazardous (Rickel & Johnson, 1997) and that did not align with this study’s case.

Regarding the research population, this study targets ESL students at the college level. Therefore, studies involving students in early childhood and elementary schools were not included. Studies among students in middle school, high school, undergraduate or college levels served the research. One study with preservice teachers was included here. The time span of the included experimental research papers was limited between 1997 and 2016 to capture findings of applying APAs in the instructional materials.

**Limitations**

This study was conducted in an English language institution at a public university. The enrolled students in this institution’s programs were exclusive to specific ethnicities or countries. Most of the students were from the Arabic gulf countries such as Saudi Arabia and Kuwait. The rest of the students were from Asian countries such as China and Taiwan, while a very small percentage of students were from Europe and South America. This accessible sample consisted of Asian and Arabic ethnics for more than half of the sample. That may affect the results because of the common educational backgrounds and learning cultures among those students. Briefly, the participants of this study lacked the diversity of the population and culture. In addition, the online tutorial in this study facilitated only one vocabulary strategy, which is “analyzing word parts”. The last limitation in this study was applying paralleled pretest and posttest to measure
students’ progress in the vocabulary acquisition. The students’ sensitization from the pretest and posttest may affect the outcomes of this research (Gall, Gall, & Borg, 2007).

**Description of the Chapters**

This paper is organized into five chapters, including the current introductory chapter, then References and Appendixes in the following manner. This chapter provides a general explanation of this study, the statement of the problem, the purpose of the study, the research questions and hypotheses driving this study, delimitations and limitations. The second chapter outlines the conceptual framework that has been used as the basis of this study. It also presents a review of the related literature dealing with currently known about animated agents design and their effects on learners’ cognitive load, motivation, learning, and language learning. It also contains the instructional design of the tutorial and both agent’s roles. In Chapter Three, a detailed description of the research method is presented. It also includes descriptions of the study participants, research design, measures, overview of the data analysis methods, and the study timeline. An analysis of the collected data and a discussion of the findings are presented in Chapter Four. Chapter Five consists of the summary, conclusions, and recommendations for future study. Then, References and Appendixes are following.
CHAPTER TWO:
LITERATURE REVIEW

Preview

In this chapter, explanations of the adopted theories as well as the findings of previous studies in APAs are presented. It begins with the conceptual framework that comprises several theories in multimedia learning and second language acquisition. The framework is divided into three constructs: animated agent in multimedia design, learners’ prior knowledge, and SLA. Next follows a general review of the codes that have been used for searching relevant studies. Then the literature review is discussed through three parts: literature review regarding APAs, literature review of studies in prior knowledge effects, and literature review in the CALL research.

Conceptual Framework

It is important to emphasize the integration of learning theories in this proposed study. This conceptual framework consists of several theories and findings from other studies. It has been divided into three constructs: animated agent in multimedia design, learners’ prior knowledge, and SLA. In terms of animated agent in multimedia design, social agency theory and theory-grounded guidelines for designing computer-based scaffolds are included. Regarding learners’ prior knowledge, the effect of learners’ characteristics including prior knowledge on learning and understanding is discussed. Lastly, the SLA construct comprises two theories:
cognitive load theory for SLA and interactionist SLA theory in CALL research. Next, each construct is discussed in more detail.

**First Construct: Animated Agent in Multimedia Design**

Learners’ cognitive load while learning with APA through multimedia environment was the first concern in this study. The first theory, social agency theory, supports utilizing social cues, such as human voice and eye contact, in multimedia environment for deeper learning. The second component in this construct was theory-grounded guidelines for designing computer-based scaffolds. These guidelines support the ideas of embedding expert models and peer models for motivating learners and augmenting their knowledge. Thus, considering the theory of social agency demonstrates how presenting a social agent could influence learners’ cognition and learning. Additionally, by considering expert and peer modeling, learners encounter multimedia scaffoldings that boost motivation and learning.

1. **Social agency theory**

Social agency theory relies upon the “Media Equation” that argues people interact and interpret computers as a social partner (Reeves & Nass, 1996). The notion of social agency theory contends that “learner can interpret a multimedia learning episode as either a case of information delivery or a case of social communication” (Mayer et al., 2003, p. 420). A multimedia message with social cues can be presented through a narration in the first person, a human voice speaking in a standard accent, or an on-screen pedagogical agent with a humanlike gesture, eye contact, or facial expression (Clark & Mayer, 2008; Park, 2015). Presenting the multimedia messages with social cues can stimulate the social conversation schema in learners, which in turn, inspires the learners to become more likely to act as if are in a conversation with a
real person rather than simply receiving information from the computer. Consequently, a human-to-human communication occurs and that urges the learner to make sense of what a computer is saying by engaging in deep cognitive process (Mayer et al., 2003). Thus, the effort of interpreting the multimedia messages influences the type of activated schemata in the learner’s mind, the type of cognitive process during learning, and then the quality of learning outcome (Mayer et al., 2003). These social cues induce the sense of obligation in learners to response and interact (Ormrod, 2011). Therefore, employing social cues within multimedia instructions primes deep learning, which means the instructions activate a sense of social presence and cause learners to work harder to understand the presented content. Due to the social cues presented through the APAs, this theory has been adopted in the current study.

2. Theory-grounded guidelines for designing computer-based scaffolds

Contemporary psychologists and educators have advocated supporting learners to construct and enrich knowledge bases. Several approaches are recommended to help knowledge construction such as presenting expert’s perspectives and peer model (Belland et al., 2013). Belland, Kim, and Hannafin (2013) provide theory-grounded guidelines for designing computer-based scaffolds. Their guidelines are for designing computer scaffolds that support students’ motivation and engagement in problem-based learning (PBL). PBL in teaching foreign language is different from PBL that is applied in knowledge-oriented subject such as math or history. PBL in teaching foreign language has multiple meanings and one of them is “involvement of students in the forming of grammatical rules and elicitation of vocabulary meanings from the given examples” (Doghonadze & Gorgiladze, 2008, p. 104). Accordingly, two strategies have employed in this study, the expert and peer models, as computer scaffoldings for teaching ESL students. The expert model is discussed first, then the peer model is following.
The expert models

Establishing attainment value by embedding expert modeling is a suggested strategy for building computer scaffolding in PBL (Belland et al., 2013, p. 252). By presenting high expectations and task value through an expert mode, students will increase their learning potential. Here, learners observe the expert agent demonstrating how to solve a problem (Belland et al., 2013; Clarebout et al., 2002) and explaining appropriate strategies for a task. Thus, this expert modeling presents highly officious strategies that could be used to solve the problem, and in this case, this model is characterized by formal appearance in formal speech manner demonstrating how to analyze word parts. Once students perceive the expert performance, they will perform similarly to the way a person would.

Expert models help learners construct knowledge. Generally, once a pedagogical agent is presented, learners apply their stereotypes to the agent’s contextual relevance, which is agent’s image and content area (Veletsianos, 2010; Liew et al., 2013). Therefore, the agent’s visual and voice features will influence learners’ stereotypical perceptions and expectations of the presented agent (Liew et al., 2013). Similarly, expectations and attributions of teachers or instructors affect students’ achievement (Ormrod, 2011). That is, the higher a teacher’s expectations are, the more learning students will achieve. When multimedia learning is accompanied by an expert interpretation, students become more likely to construct productive knowledge (Ormrod, 2011). For example, presenting an expert explains a phenomenon, students are likely to gain positive attitudes toward the presented subject. Further, any influential models typically have power and prestige. A classroom teacher is an influential model and more likely to be perceived by students as a competent, powerful, and prestigious model. Once this influential model obtains learner’s attention or asks learners for retention or reproduction, learners become motivated (Ormrod,
This influential model appears to provide cognitive support and it is assumed that most cognitive support can improve motivation by increasing learners’ expectancies for success (Belland et al., 2013). Additionally, presenting agent with high competent, as an expert agent, aims learners to acquire knowledge and skills (Tien & Osman, 2010). Thus, the expert agent would help learners in knowledge construction and learning acquisition.

**The peer models**

Based on Belland, Kim, and Hannafin’s (2013) theory-grounded guidelines for designing computer-based scaffolds to improve motivation and cognition, there is another strategy applied in this study. This second strategy is enabling students to see the task as neither too hard nor too easy through peer modeling (Belland et al., 2013, p. 259). This type of modeling promotes learners’ desire to succeed and enjoy the task by perceiving optimal challenge. This peer modeling shows similar abilities to achieve a task successfully without being overwhelmed or bored (Belland et al., 2013). This method persuades students that they can succeed, which in turn promotes their expectations for success at that task. It helps students learn how to complete procedures and apply strategies with medium to low competence, which aims learners to build confidence and self-efficacy. Self-efficacy refers to one’s beliefs of his or her ability to execute certain behaviors or achieve certain goals (Ormrod, 2011). Researchers found that students with high sense of self-efficacy tend to learn and achieve more than their counterparts who have low self-efficacy (Ormrod, 2011). Self-efficacy indirectly influences future learning by leading learner to be involved in challenging tasks and to overcome any initial failures (Bruning et al., 2013). Thus, the peer agent would increase learning and achieving tasks through promoting one’s expectations and self-efficacy.
Summary of the first construct

Considering humanlike agents delivering multimedia messages with social cues, learners will receive these messages as human-to-human communication. This social communication activates schemata in the learners’ mind and engages learners in the cognitive process, which in turn, influences the quality of learning outcomes. The humanlike agents with their two roles, expert and peer, provides cognitive and motivational scaffoldings which help learners to construct knowledge. These expert and peer models also support learners’ motivation and engagement in eliciting vocabulary meanings.

Second Construct: Learners Prior Knowledge

The second construct in the conceptual framework was related to the learners’ characteristic of prior knowledge. Besides the limitation of human working memory, learner’s prior knowledge is another factor that can affect cognitive load when learners interact with multimedia presentations. Prior knowledge has been shown as an important mediator that influences the effectiveness of instructional support (Sweller et al., 2011) and the most important factor influencing learning (Kalyuga, 2013). It also directly influences one’s perception, recognition pattern, and building a meaning. Thus, knowing and perceiving what one sees or hears depends on the knowledge she or he already has. One’s knowledge allows perception to occur and guides the interpretation of new information (Bruning et al., 2011). Additionally, cognitive processes depend significantly on the individual’s early perception. That is, the ways of displaying visual and auditory materials have an influence on the perception process (Woo, 2009).
The prior knowledge is envisioned as many schemata stored in long-term memory (LTM). These schemata incorporate prototypes, analyses, and descriptions of related information. Once people recognize something they have learned, seen, or heard, the appropriate schemata are activated. Accordingly, experts or novices on a topic may understand and focus on different parts of presented information. That is, prior knowledge is significant in terms of an individual’s perception and understanding of information.

Furthermore, learning context affects one’s perception as well. Context is a body of multilevel factors that influence learning and performance. These contextual or multilevel factors consist of one’s work environment, work practice, technology utilized, and differences of individual attitude and background (Richey, Klein, & Tracey, 2011). The learning context of this study is representing as a scaffold or support context through a tutorial. This context type presents new information and provides a certain degree of practice applying the information in some way (Sherman, 2002). This instructional context comprises environmental factors that directly affect the delivery of instructions (Richey et al., 2011), and here are delivered by an animated agent and through multimedia messages.

**Summary of the second construct**

Considering learners’ cognitive factor, prior knowledge, is significant due to its influence on one’s perception, recognition pattern, and meaning building. All these effects can guide one’s perception and understanding of new information. In addition, the instructional context of delivering the instructions impacts learning and performance. Thus, learners perceive, understand, and construct knowledge depending upon their prior knowledge as well as the delivery of instructions.
Third Construct: Second Language Acquisition (SLA)

The third construct in the conceptual framework was related to a specific learning outcome, which is SLA. Applying technology in language learning has been discussed for a long time. Garrett (1991) demonstrated the language acquisition theory as a dynamic and interactive system that conveys meaning. She posed educators’ duty as to create an environment that allows students to work on acquiring an ability of constructing meaningful communication. This environment could be in the class or in the educational materials (Chapelle, 2009). This view of language acquisition aligns with the pragmatic aim of computer-assisted language learning (CALL). Technology, including computers, with its advantages can offer intensive interactive and linguistic rich environment (Chapelle, 2009). That manifests the possibility of using technology to promote SLA. From this cooperation between language acquisition theory and practical aspects of CALL research, two SLA theories have been adopted in this study. These theories are the cognitive learning theory for SLA and interactionist SLA theory. The first theory explains the cognitive processes during learning a foreign language. These processes start when learners pay attention while they produce the language, and then after practicing, learners will possess more capacity to produce language with less attention. The second theory in this construct sheds a light on the significant impact of the interaction between the language learners and the computer inside the learners’ mind.

1. Cognitive learning theory for SLA

Cognitive load theory of second language acquisition is based on “the concept of attention and automatic control of the language” (Horwitz, 2013, p. 32). This theory includes the ideas that language learners start with three different types of processing: information processing, controlled processing, and then automatic processing. These processes represent the
sequence of learners’ cognitive load while improving their language proficiency. The first process, *information processing*, occurs when language learners pay focal attention as they produce the language, search for meaning, and remember to use grammatical rules. Then the second process, *controlled processing*, happens when learners possess limited capacity to produce language. With practicing using the language, learners become more automatic in some aspects and will not need to devote much direct attention as before. Lastly, the *automatic processing*, the third process, exists when producing language becomes more automatic and learners need to devote only peripheral attention. In this phase, language learners gain automatic control of more words, sounds, expressions, and grammatical rules, which allows them to speak more easily (Horwitz, 2013). These processes of language learners’ cognitive load refer to the importance of attracting learners’ attention and practicing the language. Language materials should attain impact on language learners by exposing them to materials drawing their attention to linguistic features (Chapelle, 2009). In other words, developing language materials should align with ESL learners’ needs for directing their attention and providing them practice opportunities.

2. **Interactionist SLA theory**

Interactionist theory in Second Language Acquisition perspectives has a fundamental influence on CALL research regarding building solid grounding for applied linguistics areas (Chapelle, 2005). Interactionist theory suggests that the process of interaction provides good motivation toward language acquisition. This theory anticipates a great potential for language development when activities are designed with learners’ interaction in mind. Chapelle hypothesized three types of interactions in SLA: interaction between people, interaction between person and computer, and interaction within the person’s mind. For this study’s sake, one type is
considered, which is the interaction within a person’s mind. This hypothesized benefit of intrapersonal interaction occurs inside the learner’s mind. It is “the type of cognitive activity that might be engaged by observable negotiation or requests for modification but may consist of unobserved processes as well” (Chapelle, 2005, p. 56). This intrapersonal interaction is supposed to occur through presenting the instructions via the model agent. The model agent is designed to guide learners’ attention to linguistic input, while language learners observe modeling tasks and receive feedback. Based on social agency theory, presenting the animated agent with social cues will inspire learners to act as being in a human-to-human communication. That will induce the sense of obligation to response and interact (Ormrod, 2011). Then, the learners will exert an effort to interpret the multimedia messages by engaging in the cognitive process, which activate the schemata in the learners’ mind (Mayer et al. 2003). Additionally, a “multiple choice” activity as a practice activity will offer an opportunity to practice the new information and to modify learners’ inputs by providing feedback. This is an opportunity to strengthen the fragile linguistics system of ESL learners (Chapelle, 2005). Thus, observing modeling tasks and guidance through the APA who has social cues would activate the intrapersonal interaction inside a learner’s mind.

**Summary of the third construct**

Based on cognitive load theory for SLA, language learners require materials that attract and attain their attention to linguistic features. Presenting animated agents to direct learners’ attention, model analyzing word parts, and provide practice with feedback supplies what ESL learners need. Attaining learners’ attention to linguistic forms would improve their cognitive process of producing the language. Regarding the intrapersonal interaction inside learner’s mind, the humanlike agents with social cues induce the sense of obligation inside the learners to response and interact with the presented materials. Additionally, the practice activity after
presenting the instructions strengthens the fragile linguistic systems inside the learners. It elicits language outcomes from learners and forces them to produce words meanings. Therefore, learners would move on from the first stage of cognitive process (information processing) to controlled processing and might improve for some learners to automatic processing. The figure below summarizes the included theories and their rationales.

**Figure 1.** Conceptual Framework

**The Literature Review**

For the literature review, studies on the independent variables (animated agents and learner’s prior knowledge) as well as on the second language acquisition (learning outcome) have been examined. The table below presents the used searching codes to identify the reviewed documents.

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To keep the literature review section organized and consistent with the conceptual framework, both sections have the same three themes: animated agents, learners’ prior knowledge, and SLA. Therefore, the literature review is presented in three parts: literature review regarding APAs, literature review regarding learners’ prior knowledge, and literature review regarding the impacts of computer as well as APA on SLA. The first part of literature review focuses on APAs in diverse subject matters with concentration on the agents’ design features. It also consists of several subheadings to classify the former findings into themes. The second part includes studies of animated agents with considering learner’s prior knowledge in the research. The third part of the literature review focuses on ESL learners and how computers as well as APA have influenced their language acquisition.
First: Animated Pedagogical Agents (APAs)

One effective method to support meaningful learning and to integrate with a multimedia environment is embedding an animated pedagogical agent (Moreno et al. 2001). APAs are interactive and animated characters that have a strong positive effect to be perceived as engaging and as instructor-like (Baylor & Ryu, 2003a). There are several systematic literature reviews as well as many empirical studies examining APAs in learning environments. Different APA features have been reviewed such as APA’s presence, APA’s visual appearances, APA’s roles, APA’s voice and narration, APA and cognitive load, and APA and motivation. A summary of recent systematic literature reviews is discussed first. Then, for each of the APAs features, a summary of what previous research have found is presented.

APA in systematic literature review

Facilitating learning by applying animated agents induces researchers to scrutinize different types of agents and different ways of implementing them in the learning environments. The embedding of an animated pedagogical agent within a multimedia instructional environment has shown as an effective tool to support meaningful learning (Moreno et al., 2001). That means, the meaningful learning of selecting, organizing, and then integrating the appropriate materials inside the learners’ memory would be enhanced. On the other hand, instructional effectiveness is another significant point and should be considered. Regarding the effectiveness of instructions in the multimedia environment with APAs, the look of an agent alone is not perceived as a significant element in cognitive and affective outcomes, but the agent’s roles with the learning tasks do (Woo, 2009). Thus, an agent’s role is a critical element influencing cognitive and affective outcomes. An agent can embody different roles such as demonstrating/modeling,
coaching/scaffolding, information source, or test administrator role. Some of these roles have often been employed such as coaching/scaffolding and information source agents, while others are rarely applied in the educational materials such as demonstrating/modeling and test administrator agents (Schroeder & Gotch, 2015). Despite the diversity of APA’s roles and designs used in the empirical studies, a meta-analysis of 43 studies found that a small but positive effect on learning had been shown in learning environments with pedagogical agents (Schroeder, Adesope, & Gilbert, 2013). Furthermore, there are positive results supporting the idea that pedagogical agents can promote computer-based learning experience for learners and embedded pedagogical agent promotes learning because of the social interaction between agents and learners (Lane, 2016). This occurred social interaction between the agents and learners stimulates learners to work harder to understand the presented content. It also instills the obligation sense to respond to the agents.

However, researchers could certainty not conclude the effectiveness level of applied animated agents within specific subject areas, learning tasks, learner’s demographics, or learners’ prior knowledge (Schroeder & Gotch, 2015; Heidig & Clarebout, 2011). Thus, future researchers should consider those elements when conducting animated agent studies. The cost-effectiveness of pedagogical agent research should also be considered. For instance, researchers might examine an agent-based system fostering a conceptual change, which can reach a broad audience. This potential of reaching a broad audience should be taken and examined even if the initial costs of the system development are high (Schroeder & Gotch, 2015).

Briefly, systematic literature reviews found that APA studies have a dearth of literature related examining the agent as a model or test administrator and a deficiency in accurate results of agents’ effects in specific subject area, learning task, learner’s demographics, or learners’
prior knowledge. There is also a need to investigate the agents' visual presence and their potential influence on learning and motivation. Additionally, systematic reviews found a lack of consistent conclusions regarding learners’ cognitive load and motivation that are engendered by interacting with APAs. More studies in these regards are needed.

**APA in experimental research**

1. **APA’s Presence**

   The presence of an agent image, whether the image was animated or static, has a positive influence on users within learning environment. Both static and animated agent’s images have been perceived significantly more credible than the condition of absent image. Regarding perceiving the agent as a person-like, a positive effect of animated agent over the static image was found. Lester, Converse, Kahler, Barlow, Stone, and Bhogal (1997) found that the presence of APAs have a significant, strong, and positive influence on students' perception of their learning experiences. In their study, middle school participants encountered one of five “clones” of agents. These agents were different in their modes of expression and in the level of advice offered in response to students' problem-solving activities. The modes of communication had three types: short animated segment combining animated object (e.g. the plant and spoken description to convey principle-based advice about the object), spoken advice without accompanying animation, and direct and task-specific spoken advice. The five agents were presented as Fully Expressive, Principle-Based Animated/Verbal, Principle-Based Verbal, Task-Specific Verbal, or Muted clone conditions. Through the learning session, the agent remains onscreen. At the end of the module, students were asked to evaluate their perception of agent’s affective characteristics (encouragement, utility, credibility, and clarity). The overall results
indicated that the persona effect of a lifelike agent in an interactive learning environment can have a positive effect on student's perception. This positive effect of the agent persona can even happen when the agent is not expressive as in the muted condition. The subjective assessment in this study had 8 questions and the participants rated the all five agents with mean ranging from 3.0 (neither good nor bad) to 4.6 (very good). There is no (poor) scale for assessing any agent clone, which refers to the powerful influence of the agent’s persona on learners (Lester et al., 1997). In another experiment, Moreno, Reislein, and Ozogul (2010) had recruited middle school students. The students were randomly signed in one of three treatment groups: no visual presence of APA and guiding students by voice only (Group C), animated arrow pointed simultaneously with the spoken explanation (Group A), and deictic movement of peer agent accompanied with the spoken explanation (Group P). The narration was identical for all three groups. The results show that Group (P) significantly reported higher posttest scores than Group (A) and Group (C). Group (P) also significantly highly reported that the participants liked the agent the most. Therefore, the APA may draw more attention than the arrow symbol because of the agent’s social stimuli. In addition, the learning benefit in the agent group is consistent with the persona effect that positively affects learners’ perception of the learning experience and engages them cognitively (Moreno, Reislein, & Ozogul, 2010). Furthermore, a study examined the effects of an agent’s image and animation on learners’ perceptions of that pedagogical agent persona as extent to which agent was a person-like, credible, engaging, and instructor-like (Baylor & Ryu, 2003). To achieve that, a 25-item survey was utilized, namely “Agent Persona Instrument (API)”. 75 preservice teachers were recruited in the study and randomly assigned into one of three treatment groups: fully animated agent, static agent image, and no agent presented. In these three conditions, several features were identical: the voice, advisements, and peaking-bubble that
displayed text of the spoken advisements. After completing the agent-based environment, the participants were asked to rate the perceived agent persona characteristics. The results show that a strong positive effect for the presence of animated agent to be perceived as engaging and as instructor-like. Briefly and based on these literature findings, employing animated agents and displaying them during the learning process could positively impact learning outcomes. It also positively influences the learners’ perceptions toward the perceived agents.

2. APA’s Visual Appearance

Moving from merely an agent presence into the visual appearance and nonverbal communicative behavior of an agent in the learning environment. The agent’s visual appearance and nonverbal communicative behavior have an influence on learners’ expectation, perception, and learning. They should be considered when designing an agent-based environment and designers should select the most appropriate features to the subject content as well as to the desired learning outcomes. That is, a pedagogical agent’s appearance is a critical feature that can have a deep influence on learning outcomes, especially motivational outcomes (Baylor & Kim, 2009). Several studies have indicated that the presented competency and appeal of the pedagogical agent may affect learning (Heidig & Clarebout, 2011; Domagk, 2010). Referring to presenting a simple pedagogical agent is not adequate for facilitating learning process whereas an inappropriate or unlikable design of an agent’s characters could hinder learning process (Domagk, 2010). Designing an agent’s visual appearance is critical and should align with the educational content. A contextually relevant agent supports participants in learning more than experiencing an agent that is contextually irrelevant (Veletsianos, 2010). Veletsianos (2010) compared the students’ stereotypical expectations and learning when they encountered two
different agent’s appearances. The agents were presented as Scientist or Artist within two types of tutorials: nanotechnology and punk music. In punk rock/music tutorial, the researcher found that the Artist agent was categorized as more knowledgeable than the Scientist agent and participants learned more. In nanotechnology/science tutorial, both agents were equally knowledgeable and participants with the two agents gained almost the same mean scores in the test. A main effect of the agent, the tutorial, as well as the interaction effect between both agents and tutorial types were significance. Thus, once a pedagogical agent is presented, learners apply their stereotypes to the agent’s contextual relevance. In other words, learners apply their stereotypes to the agent’s image and the content area (Veletsianos, 2010; Liew et al., 2013). These different stereotypes about agents may impact the stereotypic beliefs in learners’ mind, which may be useful in influencing learning behaviors (Liew et al., 2013).

Furthermore, designing an agent’s nonverbal communicative behavior should align with the learning outcomes. Baylor and Kim (2009) investigated the nonverbal communication of pedagogical agents (i.e. the gesture and facial expression) and its influence on learners’ attitude toward the content, perception of agent persona, and learning. The experiment employed 2x2x2 factorial design to examine the type of instruction (procedural instruction, attitudinal instruction), deictic gesture (presence, absence), and facial expression (presence, absence). 236 college students learned from the APAs that were varied by two factors (deictic gesture and facial expression) within one of two instructional modules (procedural instruction module for teaching how to use web-based software program, and attitudinal instruction module for eliciting more desired attitudes toward intellectual property rules and laws). The results show that the agent facial expression enhanced positive attitude in the attitudinal content, while the absence of the facial expression enhanced positive attitude in the procedural content. Regarding learners’
perception, the agent facial expression enhanced learners’ perception of agent persona. For learning, participants’ test scores revealed that facial expression positively affected learning in the two modules, while agent gesture enhanced procedural module. The bottom line of this study is facial expression is effective for attitudinal instruction, while gesture is desirable for procedural instruction. Therefore, one nonverbal communicative behavior should be employed in the agents based on the desired learning outcomes. In sum, based on these literature findings, any researcher or educator should carefully design the agent’s visual appearance and its nonverbal communicative behavior.

3. APA’s Roles

There are several instructional roles played by pedagogical agents such as expert, instructor, mentor, motivator, or learning companion. These roles present different agents’ functions for supporting learning. These roles are operationalized by image, animation, affect, voice, and script (Baylor & Kim, 2005). An agent role is an important aspect and should reflect its intended purposes such as providing extra information, providing needed advice, offering motivational messages, etc. Different roles presented by agents have been perceived differently by students. The also significantly influence motivation and learning. Each one of these roles has a common impression regarding the content credibility, enjoyment, and anxiety. A study examined a 3D human-like agent that was presented in three different roles: Motivator, Expert, and Mentor. The Mentor agent combines both motivation and expertise features. The results show that the Expert and Mentor agents led to better transfer of learning than the Motivator did, while the Motivator agent was better in terms of participants’ motivation and engagement (Baylor, 2003). Thus, providing encouragement alone is not sufficient to offer credible
information and does not support learning transfer (Baylor, 2003). Similar results found in another research. Baylor and Kim (2005) empirically validated these three roles of APA. They found that presenting the motivator agent affects learners’ motivation and self-efficacy, while the expert agent positively affects information acquisition and the mentor improved both learning and motivation (Baylor & Kim, 2005). Liew, Tan, and Jayothisa (2013) also investigated two agent’s roles, expert and peer. They studied the impact of agent stereotypes on learners’ agent perceptions, task-related attitudes, and learning achievement. They provided female agents that were presented as a peer-like and an expert-like and operationalized by agent’s image and voice. The researchers found that university freshmen assigned high ratings on lesson enjoyment with the peer-like agent. Female students with the expert-like agent were more trusting of the lessons than were with the peer-like agent. Additionally, the female students were less anxious in learning tasks with expert-like agent (Liew et al., 2013). However, the overall positive bias of male and female preservice teachers toward a male agent has been found when the participants interact with the agent at the first time as shown in Baylor and Kim’s experiment (2004) (Van der Meij, 2013). Concisely, utilizing different functional roles of the agents revealed different influences on motivation and learning. However, these influences are not clear in terms of the learner’s prior knowledge and being a language learner. It is also important to investigate the learner’s cognitive load when he or she learns with a specific agent’s role in order to find out the source of that load, i.e. from the presented material causing an intrinsic cognitive load, or from the presented agent causing an extraneous cognitive load.

4. APA’s Narration and Voice
Regarding the pedagogical agent’s presence with spoken words, an experiment with college students show that the agent’s presence with accompanied narration increased students’ motivation and interest in the learning materials when compared with students in “no agent/on-screen text” condition (Moreno et al., 2001). In addition, college students in the condition of presenting an agent with narration learned deeply. This means students were able to build a mental model of the presented scientific system and apply it to new problems (Moreno et al., 2001). Another study with undergraduate students in math revealed that agent with narration was effective at enhancing learning from examples (Atkinson, 2002). Students who were in the agent with narration group reported fewer perceived difficulties and outperformed others in near and far transfer. The last findings discussed here are for Craig, Gholson, and Driscoll’s (2002) study, for which researchers examined spoken agents with middle school students. They found that students with the spoken agents outperformed their counterparts who were in the agent printed-only condition in the retention test. They also outperformed agent printed-only and agent spoken-plus-printed conditions in the transfer test (Craig, Gholson, & Driscoll, 2002).

Employing human voice or machine voice on an agent are two methods affecting learners differently. When comparing the machine voice versus human voice, the human voice is preferable to reinforce agent social presence, opposed to a computer-generated voice (Baylor, 2011; Mayer et al., 2003). The human voice can increase learners’ interest and facilitate their interaction with technology through a social manner (Atkinson et al., 2005; Baylor et al., 2003; Nass & Brave, 2005; Reeves & Nass, 1996 as cited in Baylor, 2011). Furthermore, personalized human voice in narration attained higher arousal, attention, and improvement of the relevance and confidence perceptions in the students toward the learning materials (Park, 2015). That is, human voice enhances the social cues that are presented by an agent. These social cues, based on
social agency theory, stimulate human-to-human communication, which in turn, induce learners to work harder to understand the presented material. Therefore, presenting agent with spoken narration in human voice has a positive influence on the students’ motivation, interest, perception of their learning experience, retention, and transfer. Additional to the pedagogical agent’s voice, the appeal of the agent’s voice is also an important element and should be considered. Domagk (2010) in her second experiment, manipulated the agent’s appearance (likable, dislikable) and the agent’s voice (likable, dislikable) beside the control (no agent) group. The results showed that the group of dislikable appearance and dislikable voice gave lower scores in the transfer test among the treatment groups. Thus, presenting unappealing social cues (appearance and voice) may harm transfer performance when compared with presenting one appealing social cue (appearance or voice) (Domagk, 2010). Based on these experimental results, employing a spoken agent with a likable human voice positively influence learners’ performance.

5. APA and Cognitive Load

Processing verbal and visual materials occurs simultaneously through the dual-channel in the working memory (Clark & Mayer, 2008). In the case of presenting a spoken APA, the simultaneous narration and presence of the agent and on-screen text or pictures are consistent with the dual-processing model of a human’s working memory. To illustrate, during learning, the agent’s explanation may enter learners’ ears. Then learners need to select some words for further learning possessing in the verbal channel, organize the words into a “cause-and-effect chain”, and then integrate this verbal model with corresponding visual materials and their prior knowledge. Simultaneously, the agent’s image and text on screen may enter learners’ eyes and
learners need to select some printed words for further processing in the visual channel, organize them into a “cause-and-effect chain”, and then integrate this visual model with corresponding verbal materials and their prior knowledge (Moreno, 2005, p. 510). Additionally, due to the higher degree of entertaining factor resulting from the human-like agents, agents enhance learners’ motivation. That should support learners’ cognitive functions like learning, understanding, and problem-solving (Dehn & van Mulken, 2000 as it is cited in Moreno, 2005, p. 509).

Animated agent and learners’ perception of the content difficulty have been examined in limited research (Schroeder & Adesope, 2014). Atkinson (2002) examined the effectiveness of computer-based learning environment using animated agent that was designed to explain proportion problems in non-personalized fashion while using nonverbal cues such as gaze and gesture. His experiments compared visual presence of the animated agent, the Parrot, and the modality of the explanations (explanation via voice+agent, voice only, and text only). In both experiments, the researcher asked undergraduate students to rate the difficulty of each problem they solved during the multimedia module. The results showed that the participants who encountered the agent with human voice perceived the problems less difficult than did their counterparts (Atkinson, 2002). The value of difficulty was ranging from 1 (very easy) to 5 (very difficult) and the participants in the (voice+agent) group reported examples difficulty as 1.90 in the first experiment, and 2.17 in the second experiment. In another experiment, Park (2015) conducted 2x3 factorial design experiment: use of images (presence vs. absence) and source of narration (human voice delivered by agent, personalized on-screen text, no narration). The researcher tested the social cue principles—personalization, voice, and embodiment. Among 127 undergraduate students enrolled in “computer literacy” course, it was found that the
cognitive load was lower with human voice narration by agent than the case of no narration (Park, 2015). Their cognitive load was measured by using a single self-rating scale. Furthermore, the modality combination of narration and visual appearance of the agent increased the effectiveness of the participants’ working memory (Moreno et al., 2001). Moreno and her colleagues found in their fourth experiment that the participants rated higher interest in learning with the agent—Herman the bug—than learning with on-screen text explanations. In sum, based on the reviewed literature, employing narration with presenting visual agents would support learners’ working memory and increase their interest in learning.

6. APA and Motivation

Previous experiments found that the agent’s visual presence and narration support learner’s working memory and lower the perceived difficulty. The cognitive process affects motivation and vice versa; both cognition and motivation interact in their influence on learning and behavior (Ormrod, 2011). Therefore, presenting a likable pedagogical agent with a spoken narration would affect learners’ motivation. It also would promote the rate of content relevance and learners’ confidence as predictors of motivation. Furthermore, even the static picture of an agent enhances the participants’ beliefs of task relevance and self-efficacy when the agent’s comments were motivational or mix of motivational and cognitive content. In Domagk’s (2010) experiment, likable, neutral, and dislikable appearances of agents as well as the control group without the agent, revealed that working with likable agent causes higher state motivation than the three other groups (Domagk, 2010). State motivation was assessed at the middle and the end of the learning materials by applying Questionnaire on Current Motivation (QCM). Another approach for measuring learner’s motivation during learning with animated agents is using
Keller’s Instructional Material Motivation Survey (IMMS). This IMMS was utilized by Park (2015) who examined pedagogical agent with social cue-based multimedia design principles (multimedia, personalization, voice, and embodiment principles). He also examined the effects of the pedagogical agent with social cue-based multimedia on cognitive load, situational interest, motivation, and learning achievement. Regarding motivation, by investigating the four motivation’s components in ARCS model (Attention, Relevance, Confidence, & Satisfaction), he found significant differences in relevance and confidence scores. The groups of pedagogical agents with voice and on-screen text were rated highly in relevance than no narration condition. For confidence component, the group of pedagogical agent with voice was significantly higher than no narration condition (Park, 2015). Another researcher compared three agents’ conditions besides the control condition in enhancing Microsoft Word formatting tasks. He embedded a static picture of a girl to be presented as a pedagogical agent. The agent’s conditions were different in the agent’s internal property, which is the content of her comments. These conditions were: cognitive, motivational, and mixed (cognitive and motivational) agent’s comments. He found that the students in the motivational agent and mixed agent conditions had rated the tasks as significantly relevant and the students’ self-efficacy beliefs were higher after training with those two agents (Van der Meij, 2013). Task-relevance and self-efficacy beliefs are two important predictors of motivation in the study. Both align with Keller’s ARCS model that includes relevance and confidence as motivation’s components (Van der Meij, 2013).

Summary of APA literature review

Based on the reviewed experimental studies, displaying APAs during learning process could positively impact learning outcomes and influence learners’ perceptions toward the
perceived agents due to the powerful of the agent’s persona effect. Also, the agent’s visual appearance has a significant effect on learners’ perceptions and stereotypes to the agent’s image and the content area. thus, the appeal of agent’s visual appearance, voice, and appropriate functional roles should be carefully designed. Furthermore, APA with human voice narration could reduce the perceived difficulty of the content, increase students’ interest in learning with the agent, and enhance the sense of task relevance, confidence, and self-efficacy.

Second: learners’ prior knowledge

Prior knowledge effects in APA research

Speaking of the cognitive load, learners’ prior knowledge is a factor affecting cognitive load when they interact with multimedia presentations and influencing the effectiveness of instructional support (Sweller et al, 2011). Based on that, learners’ prior knowledge would influence the effectiveness of animated agent and its visual signaling techniques. Johnson, Ozogult, & Reisslein (2015) compared the effect of an APA’s presence with the signaling effect on middle school students who have different levels of prior knowledge (high and low). The experiment treatments groups were: visual APA+ visual signaling, visual APA+ no visual signaling, no visual APA+ visual signaling, no visual APA+ no visual signaling. In the simulation session, the presence of agent and signaling technique were different through explaining Ohm’s Law equation. The results revealed a significant main effect of prior knowledge on post-test scores as well as on the cognitive load. Students with high prior knowledge (HPK) had significantly outperformed the low prior knowledge (LPK) students in the post-test, while students with LPK had higher perceived difficulty than the HPK students. The analyses of the perceived difficulty items also indicated a significant interaction between prior
knowledge and agent presence. When no agent was used, LPK students rated the learning as significantly more difficult and reported higher difficulty ratings than HPK students. While presenting the agent showed that the difficulty ratings did not differ between HPK and LPK students (Johnson et al., 2015).

**Proficiency level effects in CALL research**

Considering an individual’s proficiency level (beginners, intermediate, and advanced) to differentiate learners is a new aspect that needs for more research to understand any potential differences (Grgurović, Chapelle, & Shelley, 2013). A meta-analysis examined the effectiveness of studies on computer technology-supported language learning. It considered several variables for categorizing the included thirty-seven studies. One of these variables was learners’ characteristics of proficiency level and native language. The results suggested that participants’ proficiency levels may make a difference in the study outcomes. Thus, the advanced and intermediate learners performed better than did beginner learners in the CALL conditions and as shown in post-tests. However, these effects of proficiency levels need further investigations. In terms of participants’ native language, this meta-analysis showed that CALL groups outperformed non-CALL groups regardless of which native language participants spoke (Grgurović et al., 2013).

**Summary of APA and prior knowledge literature review**

Studies revealed that learners’ prior knowledge with APA have affected learning, cognitive load, and motivation. Considering this learner characteristic, learner’s prior knowledge,
to investigate agent’s effects is necessary as a factor that differently influences learning and cognitive outcomes.

**Third: SLA in CALL research**

Regarding second language acquisition, there are several factors that can affect language learners. These factors have been divided into three basic categories: learner characteristics or personal traits, situational or environmental factors, and prior language development and competence. It is certain that these factors influence student’s learning outcomes and success in school. However, their roles in second language acquisition are not fully understood (Robinson et al., 2000). Starting with the first factor influencing language learners, learner characteristics, Horwitz (2013) has explained it in detail. *Learner characteristics* have been central factors in language learning with three types of characteristics: affective (attitude, motivation, and anxiety), cognitive (learning styles), and metacognitive factors (language learning strategies). The second factor influencing second language acquisition is situational or environmental situations. The *situational or environmental factors* refer to the external issues that are out of the learners’ control. They include the teaching style, the setting of the class and school, and the quality and extent of exposure to English. ESL students need to have enough exposure to native English speakers inside the classroom setting. Furthermore, in the case of high school students who are learning English as a foreign language, they need an environment that makes them familiar with the target language, has enough practice in English, and provides access to English audio-visual aid and English texts with interesting topics (Akbari, 2015). Based on this study’s purpose, two factors influencing second language acquisition, learner characteristics and environmental situations, are mentioned in this study investigation. This study examined the effects of two
different roles of APAs on ESL learners’ cognitive load, motivation and vocabulary acquisition. These two roles of APAs are presenting as motivational and cognitive scaffolds that provide audio and visual aids for learners.

Technology has been applied to provide language learners diverse types of aids. Different studies in SLA have been conducted to investigate different forms of technology as tools for teaching a language. Few of these studies are included here. One study is about using CD-ROM program with adult ESL learners, and two studies investigated animated agents with ESL learners. More details about these studies are discussed through the next two sections: multimedia for ESL learners, and APA for ESL learners.

**Multimedia for ESL learners**

There is a limited amount of research when considering CALL in Adult ESOL students. Ibarz and Weeb (2007) examined the viability of a CD-ROM program as a technology-driven pedagogy. This CD-ROM program offers simulating life-like dialogues and activities such as self-test, playback any dialogue at different speed, and sound recording. The participants were adult ESL learners belonging to the immigrant communities in the UK. The study indicated that this CD-ROM has been perceived as an effective tool because of the low-anxiety space for practicing and developing language skills. It also increases learners’ motivation and confidence. The researchers concluded that this technology-driven model has the potential of being presented as a technological tutor (Ibarz & Weeb, 2007).
APA for ESL learners

Regarding APA studies with language learners, Carlotto and Jaques (2016) investigated utilizing APAs in an English multimedia system for Brazilian undergraduate students. The content of the learning system was English grammar (the present perfect tense). Four treatment groups were recruited for the study: text-only without agent, voice-only without agent, text and voice with static image of the agent, fully embodied agent with movement, gestures, and gazes. The researchers found that the voice-only and fully embodied agent outperformed the no agent condition regarding the gain scores (the difference between the pretest and posttest scores). The effect size for the pairwise comparison was 0.86 (large effect for fully embodied agent over no agent conditions). That is, presenting a fully embodied agent can promote learning (Carlotto & Jaques, 2016). Additionally, Choi and Clark (2006) compared two narrative media (animated agent vs. animated arrow) for teaching ESL students the English relative clauses. The ESL students in college level were randomly assigned in one of two treatment groups, agent group and arrow group. The agent, Genie, displays with facial expression, motions, and voice. In the arrow group, Genie disappears and his pointing gestures are replaced by an electronic arrow. The findings showed that ESL students with low prior knowledge, who interacted with the animated agent, were cognitively more efficient than the participants in the arrow group. Cognitive efficiency was measured by dividing the gain scores by the mental effort scores. Thus, APA might stimulate students’ interest, which in turn, engages students in the deep cognitive processing that leads to more learning (Choi & Clark, 2006).

Concisely, presenting an animated agent with narrative to teach ESL learners has been found as an effective learning tool. A fully embodied agent has fostered learning over no agent
environment. It also helped ESL students with low prior knowledge to achieve higher level of cognitive efficiency.

**Summary of SLA in CALL literature review**

A low-anxiety environment has been offered when language learners worked individually on the computer with life-like dialogue. It has increased learners’ motivation and confidence. Narrated agent with social cues enhances language learning. It seems that the agent can help learners with low prior knowledge more regarding cognitive efficiency. Based on these findings, a similar low-anxiety environment, with self-test, and narrated agents were provided in this proposed study to satisfy language learners’ needs.
INSTRUCTIONAL DESIGN

This section describes the instructional design of the whole tutorial, the design of the tutorial as well as the animated agents, and the applied multimedia and cognitive principles. It is divided into three sections where the first section describes the theory behind designing the whole tutorial. The second section depicts the design of the tutorial and the agents’ roles. The third section explains the rationales behind the content material and demonstrates the applied method and techniques for teaching language.

First: The Instructional Design (ID)

The whole learning tutorial was designed based on the condition-based theory. This theory is essentially a cognitive orientation that is focused on selecting and design instructional strategies (Richey et al., 2011). It evolved from psychological research and expanded into the instructional design field in the late 1970s. This theory assumes that teaching should be modified based on the unique nature of the content and the complexities of the subject matter. These variations in teaching can parallel the conditions of learning (the internal and external conditions). Regarding the internal learning conditions, they are related to what learners already know. While the external learning conditions are presenting information in meaningful chunks without overload the learner’s cognitive system (Driscoll, 2000).

When the learning conditions align with what is happening inside learner’s mind, the connection between the internal and external learning conditions occurs. By creating this
connection, learning becomes more effective (Richey et al., 2011). With respect to the external conditions, they consist of learning tasks and activities. These conditions should be effectively designed. Hence designers can manipulate the external learning conditions, Robert Gagne (1985) summarized the effective steps for designing activities in his “Events of Instruction.” The conditions-based theory has three key premises; these premises are rooted in Gagne’s work. Another design model, Keller’s ARCS model, was incorporated with the nine Event of Instruction when design the peer agent’s model. Both Gagne’s nine Events of Instruction and Keller’s ARCS model is discussed next. In addition, Mayer’s (2005) principles of multimedia design is presented.

1. Gagne’s Events of Instruction

Robert Gagne is a pioneer of Instructional Design (ID) theory and research. His notion is that the ID is a generic process that can be implemented in all disciplines (Richey et al., 2011). Gagne’s nine events of instruction provide “a basic structure for designers to follow” when they “proceed into determining the strategies that will be employed to facilitate learning” (Richey et al., 2011, p. 112). The nine instructional events and corresponding cognitive processes are:

1. Gaining attention (Reception)
2. Informing learners of the objective (Expectation)
3. Stimulating recall of prior learning (Retrieval)
4. Presenting the stimulus (Selective perception)
5. Providing learning guidance (Semantic encoding)
6. Eliciting performance (Responding)
7. Providing feedback (Reinforcement)
8. Assessing performance (Retrieval & Reinforcement)

9. Enhancing retention and transfer (Generalization) (Richey et al., 2011; Driscoll, 2000).

This model is adopted for creating this study’s tutorial. Designing both roles of APAs within the tutorial followed these nine events. For more details about how the Events of Instruction were applied in the design, check the tutorial’s script in appendix (G).

2. Keller’s motivational model

Several theorists have extended the condition-based theory notion to embrace other principles that are found in the recent theories of learning and motivation (Richey et al., 2011). One of these theoretical refinements is a motivational design of instruction by John Keller (1987-2010). He created steps for instructions to positively impact a learner’s effort and satisfaction (Keller, 1987; Richey et al., 2011). He argued learning and performance are influenced by learning design that aligns with learner’s abilities, skills, and prior knowledge. After extensive review of the motivational literature by Keller, he found that motivational concepts can be sorted into four categories: attention, relevance, confidence, and satisfaction. These four categories are the four components of his ARCS model. This ARCS model was incorporated with the “nine Events of Instruction” in the peer agent’s script.

Starting with Attention, the first category in Keller’s ARCS model, refers to capturing learners’ interest and learners’ curiosity to learn. Perceptual Arousal and Variability are two types of activities to attain the attention category. Perceptual Arousal was applied when the agent starts introducing himself and shows the audience his expertise in teaching ESL students. The Variation in the agent’s tone presented as a change in the voice level while he is talking. For example, a high voice level applied to refer to the excitement when he introduces himself, and a
little low volume when he shares his experience or presents facts/roles. Variable Situations while the agent facilitates the content employed when he asks a question that requires students to think and guess before continuing the explanation. For example, when the peer agent asks “Can you guess the meaning of the word … if I told you …?” The peer here waits for 5 seconds before revealing the correct meaning.

Relevance as a second category contains connecting learners’ personal needs or goals into learning experience to affect a positive attitude. Familiarity with a situation was applied by stimulating personal involvement through tying the instruction to the learner’s experience. For example, the peer agent asks: “Have you been in a zoo? Goal Orientation also was applied. It relates the benefits of the course to improve the users’ performance by describing what the learner would be able to do after finishing this instructional material. The agent says, “word parts is an important strategy to get information about the word meaning. It helps you find out…, remember…, increase…”

Confidence, the third category, is promoting learners’ expectations and feelings of being successful. Building a Positive Learning Expectation was employed by defining the criteria that would be used to determine the observed behaviors as evidence of successful learning. For example, the peer agent states “I expect you to understand… remember… connect…”

The final category is learners’ satisfaction with the learning processes or learning results. This desired satisfaction can occur through extrinsic and intrinsic factors. Extrinsic factors are presented as grades, certificates, or any other rewards, while intrinsic factors are enhancing learners’ feeling of self-esteem, feeling of competence, or positive interactions with others (Keller, 2010). With the peer agent, Extrinsic reward was given as a positive consequence after completing the tutorial’s activities. There are two completion badges given and printed on the
screen, one after completing the Roots activity and the second one is after Prefixes activity. For more details about how the ARCS model was applied in the design, check the tutorial’s script in appendix (G).

3. Multimedia design principles and cognitive load effects

Several design principles emerge from Sweller’s (2010) cognitive load theory and Mayer’s (2005) principles of multimedia learning as well. A number of these principles are applied in this study intervention. Each principle is discussed below. Since the instructional design models, Gagne’s events of instruction and Keller’s model, provide an effective learning environment (Richey et al., 2011), the design principles bolster learners’ cognition by reducing and managing the load on working memory (Sweller, 2010) and harness the verbal and visual modalities in the working memory (Clark & Mayer, 2008). The applied principles in this study are:

1) **Personalization principle.** It states that people learn more deeply when the texts are presented in a conversational style rather than presented in a formal style. This principle has revealed evidence for fostering generative processing. That means applying this principle supports learner’s cognitive capacity to engage in the learning process (Mayer, 2008).

2) **Coherence Principle.** Multimedia design with fewer features (e.g. minimal words on a page, no sound effects, etc.) directs learners’ attention and memory. For increasing the effectiveness of the learning presentations, the tutorial focused on goal-relevant context with no embellishments. Applying this principle reduces extraneous process, thus learners can devote the cognitive capacity to understand the essential material (Mayer, 2008).
3) To facilitate SLA, **boldface key words and sentences** were printed onscreen synchronously with the agent’s narration. These synchronous bold words and sentences support noticing them and enhance the language input (Plass & Jones, 2005; Larsen-Freeman, & Anderson, 2011). This way also directs learners’ attention to the printed material and connects the audio and visual information, which in turn, liberates cognitive resources from searching the learning environment. This feature is an application of signaling principle.

4) **Worked example effect.** Agents demonstrated the word analyzing strategies through presenting worked example for each word’s parts (words’ roots & prefixes). Presenting worked examples ensures students’ working memory resources are devoted to understanding each problem state. Therefore, the germane cognitive load increases while the extraneous cognitive load goes down (Sweller, 2010).

However, there are two multimedia design principles that do not extend smoothly to second language acquisition (Plass & Jones, 2005). These two design principles are modality principle and redundancy principle. These two principles are not applicable for ESL students:

1) **Modality Principle.** As working memory has two separate channels (visual and auditory), the modality principle intends to avoid the visual overload in learner’s cognitive capacity. Thus, presenting information through narration rather than on-screen text is better. However, in this tutorial for teaching ESL students, APA narrated the content and present simultaneously the key words as printed text on the screen.

2) **Redundancy Principle.** In multimedia instruction, presenting redundant information in the same channel (visually or auditory) is ineffective. It is likely to place too many demands on one channel. However, this tutorial used animated agent (processed visually), on-screen key words and sentences (also processed visually), and narrated text (processed auditory).
Second: The visual design of the tutorial and APA

Tutorial design

The tutorial consisted of 9 to 12 web-screens of spoken agents. More web-screens were displayed to present activities as well as tables of common roots and prefixes. The instructions were structured from resources about “Analyzing word parts: roots and prefixes” and developed according to the learning objectives. The tutorial instructions, scripts, activities, and tests had been designed to fit the intermediate level of English proficiency. They were designed collaboratively with a subject matter expert (SME). This SME has a Master degree in TESOL, Teaching English to Speakers of Other Languages. She is an ESOL instructor with 10-year experience of working with adult ESL and EFL, academic and non-academic environments in the United States and abroad. Her experience enhances her ability to design and implement ESOL courses with the integration of various teaching methods and techniques.

The tutorial’s web-screens divided into two portions: the left portion of the screen is to present the APA videos, and the right portion is to print the key words and sentences synchronously with the narration. These boldface key words and sentences support noticing them and enhance the input, which facilitate SLA (Plass & Jones, 2005). The screenshot below displays the layout of the tutorial in the expert agent version. Appendix (H) includes screen captures of the whole tutorial in both agent’s versions: expert and peer.
To describe the applied agents in this learning environment, a Pedagogical Agents-Conditions of Use Model (PACU) is applied here. This model is invented by Domagk (2008) and recommended for describing the agent environment due to its comprehensive points (Heidig & Clarebout, 2011). It consists of four conditions of using pedagogical agents: the learning environment, the characteristics of the learner, the functions that the pedagogical agent, and the pedagogical agents design. This model is adopted here to provide a thorough understanding of the applied agents.

First condition, based on PACU model, is the learning environment. It was a web-based tutorial employed animated agents to teach ESL students. The students learned individually with the agent in the tutorial where a single student sit on a single computer and wore a headphone. The content of the tutorial was about analyzing the word parts (roots and prefixes).

The second condition is the characteristics of the learners. This tutorial was designed for teaching international students who learn English as a Second Language. They were divided into two levels of prior knowledge based on their current level in the English institution. The ESL students in levels 1, 2, and 3 were described as low prior knowledge (LPK), and ESL students in
levels 4, 5, and 6 were described as high prior knowledge (HPK). That is, the learners’ characteristic is international students with different levels in English proficiency.

The third condition of PACU model to describe the applied agents is the functions of the pedagogical agents. The agents provided information and guidance for learners. These agents explained strategies to be used and modeled the way to guess words meanings.

The fourth and last condition of this learning environment is the pedagogical agents design. The agents were designed as human-like male with human voice. They were presented in two different roles (expert and peer). Both agents were native speakers who speak American English with the standard accent. The male agent was utilized here because of the overall positive bias of male and female students toward a male agent when they interact with it at the first time as shown in Baylor and Kim’s experiment (2004) (Van der Meij, 2013).

To differentiate the two roles of the agents, their image, affect, voice tone, and script were varied (Baylor & Kim, 2005). Researchers found that both look and voice of a character are significant cues to that character’s personality and interest profile (Gulz & Haake, 2006).

According to Nass and Brave (2005), there are four influential key dimensions of voice: volume, pitch, pitch range, and speed rate (Baylor, 2011). In this study, the visual design and the voice of the two agents’ roles, the expert agent and the peer agent, were different. There were two voice dimensions had been manipulated, volume and pitch of the both agents. In addition, their scripts during the tutorial were different. However, the provided content by both agents and onscreen printed text are identical. In sum, the agents were designed differently in terms of their visual appearance, voice’s volume and pitch, and their script. These differences are described next. A detailed script of both agents is provided in appendix (G).
APA Design

1. Expert Agent Design

The expert agent talked in a formal manner and was presented in a formal appearance (i.e. a male in his late 40s and wearing formal shirt and glasses). He used a formal manner for showing high competence. He had a soft voice tone and a quiet pitch voice. Regarding his formal manner, the expert agent said, for example, “This tutorial will commence shortly, so please click the (start) button to start our lesson.” Some words were changed to be appropriate with the instructor’s formal style.

2. Peer Agent Design

The peer agent talked in informal manner and was presented in the same age range as the participants with casual appearance (i.e. a male in his early 20s and wearing teen shirt). He used an informal manner and expressing sympathy. He had a booming voice tone with an enthusiastic pitch. Regarding his informal language style, he said, “let’s get started and hit the (start) button.” Some words were changed to be appropriate with the peer’s informal style.

Table 2. APAs Features According to Pedagogical Agents-Levels ff Design Model (PALD) (Domagk, 2010)

<table>
<thead>
<tr>
<th>PALD</th>
<th>APA as an expert</th>
<th>APA as a peer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global level</td>
<td>3D Human-like character</td>
<td>3D Human-like character</td>
</tr>
<tr>
<td>Medium level</td>
<td>TESOL instructor speaks in formal manner and showing high competence</td>
<td>TESOL student speaks in an informal manner and expressing sympathy</td>
</tr>
<tr>
<td></td>
<td>Has a soft voice tone</td>
<td>Has a booming voice tone</td>
</tr>
<tr>
<td></td>
<td>Has a quiet pitch voice</td>
<td>Has an enthusiastic pitch</td>
</tr>
<tr>
<td>Detail level</td>
<td>A male in his mid-40s, who wears formal shirt</td>
<td>A male in his early 20s and wears teen shirt</td>
</tr>
</tbody>
</table>
Third: Method and Techniques in Language Teaching

The content of the tutorial was designed for ESL students. It aimed to teach one strategy for vocabulary acquisition, which is analyzing word parts. This strategy is classified as one of the four essential components of vocabulary instruction (Hanson & Padua, 2011). Using and analyzing word parts is a major vocabulary strategy that helps learners to remember new words and access word meanings. Many studies have investigated English affixes and confirmed their widespread and frequent occurrence. For this reason, teacher should model the way of analyzing the words and re-expressing their meanings. Time in class devoted to studying the word parts as well as simple tests should be given to encourage learning vocabulary (Nation, 2001). Mere exposure to new vocabulary from written materials does not guarantee a rapid growth in vocabulary knowledge. Learners need to discover the patterns in the language beginning from phonological categories, phonotactic sequences, and morphemes (Takač, 2008). Researchers emphasize that learners’ attention should be explicitly drawn to word parts (Nation, 2001). In addition, researchers found the effectiveness of directing vocabulary instruction for both English learners and English-only students. They found that teaching strategies for inferring the meaning of unknown words is effective once it builds on well-defined procedures such as morphological analysis (Wallace, 2007).
Language learners need training in learning strategies (Larsen-Freeman, & Anderson, 2011). Learning strategy training is the methodological practice for teaching language. Presenting the agent as a model and facilitator is a computer-assisted language learning (CALL) technique. In this study’s tutorial, agents facilitated word parts (roots and prefixes) and modeled how to analyze words into parts to guess their meanings or to remember the meaning of new words. That is, the agents draw explicitly the learners’ attention to word parts. The agents also modeled this vocabulary strategy, provided English audio-visual aid, and elicited learners’ output through providing practice activity in a lowered anxiety environment. This learning condition of low anxiety and embarrassment supports learning to be done effectively.
CHAPTER THREE:

METHOD

Preview

The purpose of this study was to examine the effects of pedagogical agent’s roles and ESL learners’ prior knowledge on the learners’ cognitive load, motivation, and vocabulary acquisition. A quantitative research was employed using a 2x2 factorial experimental design. Two agent roles were designed (Expert agent vs. Peer agent) and two levels of ESL students’ prior knowledge were classified based on their current English level (High prior knowledge vs. Low prior knowledge). Several instruments were used to gather the data for answering the three research questions:

1) What is the effect of the role of Animated Pedagogical Agent (Expert vs. Peer) and the ESL students’ level of prior knowledge (High vs. Low) on students’ cognitive load (intrinsic, extraneous, and germane cognitive load)?

2) What is the effect of the role of Animated Pedagogical Agent (Expert vs. Peer) and the ESL students’ level of prior knowledge (High vs. Low) on students’ motivation?

3) What is the effect of the role of Animated Pedagogical Agent (Expert vs. Peer) and the ESL students’ level of prior knowledge (High vs. Low) on students’ vocabulary acquisition?

The findings of this experiment demonstrated the appropriate design of an agent’s external and internal properties for teaching ESL students a vocabulary strategy with taking into consideration the students’ prior knowledge. The results revealed the effects of two agent’s roles and the ESL
students’ prior knowledge on the students’ cognitive load, motivation, and vocabulary acquisition. This chapter describes the research participants, research design, research instruments, data collection procedures, and data analysis performed in this quantitative study.

Participants

The international students who were learning and speaking English as a Second Language (ESL) at the college level inside the USA was the target population for this study. The sampling frame was all international students who were enrolling in institutions for learning English Language. For this research sample, participants were recruited from an English institution located in a large southeast public university. This institution offers several English Language programs with different levels for ESL students to fulfill their different needs. It also serves as a site on the campus for researchers who are interested in examining international students and/or second language learning. Due to the federal and state agencies and programs for assuring research integrity and compliance, a permission for conducting this social-behavioral research with human subjects is required. This necessary approval was granted by the Institutional Review Board (IRB). The IRB approval letter is attached in appendix (I).

During the semester of Fall 2017, the institution had 250 students with 24 different nationalities from Asia, Europe, South America, and Africa. Since my research had been agreed to be conducted during the “Extended Learning Sessions”, these sessions were designed and required for only sponsored students and their attending for these sessions were elective. The total number of 105 sponsored students out of 250 students were supposed to attend my research during the Extended Learning Sessions.
Students from two different academic programs had been involved in this study. For the pilot study, students from the “Undergraduate Pathway Program” were recruited for testing the study’s tutorial and evaluating the applied animated agents. 14 students participated in this test and the demographic data indicated that they were 10 males and 4 females; 12 of them were 18-23 years old, one was 24-29 years old, and one was 30-35 years old. Regarding their native language, 21.4% was Arabic, 21.4% was Mandarin, 7.1% was for each of these languages: Malaya, Korean, Japanese, and Spanish/French/Portuguese, and 28.6% for other languages. All the participants studied English for more than 6 months in USA and 50% of them had 60-93 score in the TOEFL test, which is referred to intermediate level in English proficiency based on TOEFL test’s criteria.

For the main research, total of 91 students from the “Academic English Program” were recruited for gathering this study’s data. This number represents as a 86.67% response rate from the students who the “Extended Learning Sessions” were designed for them. The demographic data for them showed that they were 50.5% male and 49.5% female; 38.5% of them were 18-23 years old, 46.2% was 24-29 years old, 9.9% was 30-35 years old, 4.4% was 36-40 years old, and only one person was 41-46 years old. Regarding their native language, 62.6% was Arabic, 6.6% was Mandarin, 4.4% was Spanish/French/Portuguese, 2.2% was Vietnamese, 1.1% was Russian, and 23% for other languages. 44% of the participants were classified as low prior knowledge based on their current levels in English (levels 1, 2, and 3), while 56% was classified as high prior knowledge based on their current levels in English (levels 4, 5, and 6). Most of the participants studied English in USA for more than 6-12 months, 61.6%, while 38.5% studied for less than 6 months in USA. Most of them had not taken the TOEFL test, while 39.6% had 4.5-5.5 score in IELTS test, which is referred to lower intermediate level in English proficiency
based on IELTS test’s criteria. They also had been asked to choose their preferred learning style and found that 30.8% preferred auditory learning style, 29.7% did not have a specific learning style, 26.4% was visual learning style, and 13.2% was kinesthetic learning style. Below, a table represents the participants’ demographic information by groups.

Table 3. The Participants’ Demographic Information.

<table>
<thead>
<tr>
<th>Experimental Group a</th>
<th>Number of Participants b</th>
<th>Gender</th>
<th>Age</th>
<th>Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>EH: Expert agent, ESL with HPK</td>
<td>26 (28.6%)</td>
<td>Male: 11 (42.3%)</td>
<td>18-23: 4 (15.4%)</td>
<td>Arabic: 17 (65.4%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female: 15 (57.7%)</td>
<td>24-29: 17 (65.4%)</td>
<td>Mandarin: 2 (7.7%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30-35: 3 (11.5%)</td>
<td>Vietnamese: 1 (3.8%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>36-40: 2 (7.7%)</td>
<td>Spanish/French/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Portuguese: 1 (3.8%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Other: 5 (19.2%)</td>
</tr>
<tr>
<td>EL: Expert agent, ESL with LPK</td>
<td>20 (22%)</td>
<td>Male: 11 (55%)</td>
<td>18-23: 13 (65%)</td>
<td>Arabic: 9 (45%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female: 9 (45%)</td>
<td>24-29: 4 (20%)</td>
<td>Mandarin: 1 (5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30-35: 1 (5%)</td>
<td>Spanish/French/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>36-40: 1 (5%)</td>
<td>Portuguese: 1 (5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>41-46: 1 (5%)</td>
<td>Russian: 1 (5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Other: 8 (40%)</td>
</tr>
<tr>
<td>PH: Peer agent, ESL with HPK</td>
<td>25 (27.5%)</td>
<td>Male: 12 (48%)</td>
<td>18-23: 9 (36%)</td>
<td>Arabic: 22 (88%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female: 13 (52%)</td>
<td>24-29: 12 (48%)</td>
<td>Mandarin: 1 (4%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30-35: 4 (16%)</td>
<td>Vietnamese: 1 (4%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Other: 1 (4%)</td>
</tr>
<tr>
<td>PL: Peer agent, ESL with LPK</td>
<td>20 (22%)</td>
<td>Male: 12 (60%)</td>
<td>18-23: 9 (45%)</td>
<td>Arabic: 9 (45%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female: 8 (40%)</td>
<td>24-29: 9 (45%)</td>
<td>Mandarin: 2 (10%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30-35: 1 (5%)</td>
<td>Spanish/French/</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>36-40: 1 (5%)</td>
<td>Portuguese: 2 (10%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Other: 7 (35%)</td>
</tr>
</tbody>
</table>

Note. a HPK: high prior knowledge. LPK: low prior knowledge. b Total n=91.

As presented in the table above, the gender distribution among the four groups can be described as relatively equivalent except for group (PL) where male gender dominated by 60%.
Regarding the native language distribution, the Arabic language dominated among the four groups.

**Research Design**

This is a pragmatic study, which emphasizes effects and consequences. Learners are active; they have different abilities and desires. Thus, they must try scaffolding tools out in order to satisfy them (Paul, 2005). The essence of pragmatics as Dewey (1929, 1960) wrote is "to conceive of both knowledge (theory) and practice as means of making goods—excellences of all kinds—secure in experienced existence" (Paul, 2005, p. 57).

A quantitative research was employed using a 2x2 factorial experimental design. “The experiment is the most powerful quantitative method for establishing cause-and-effect relationship between two or more variables” (Gall et al., 2007, p. 379). This study aimed to investigate the effects of two factors: APA’s roles and ESL learners’ prior knowledge. Each one of these two factors has two levels: expert agent vs. peer agent, and ESL students with high prior knowledge (HPK) vs. ESL students with low prior knowledge (LPK). In most educational conditions, an experimental treatment cannot be isolated from other factors. There may be an effectiveness of the two factors both singly and in interaction with each other on a dependent variable (Gall et al., 2007). This is a between-subject experiment formulates four treatment groups with a different combination of the two factors. These four treatment groups are: expert agent x ESL students with HPK (EH), expert agent x ESL students with LPK (EL), peer agent x ESL students with HPK (PH), and peer agent x ESL students with LPK (PL). The dependent variables of this study are: students’ cognitive load, motivation, and vocabulary acquisition. The tables below summarize the 2x2 factorial design and the study conditions.
Table 4. 2x2 Factorial Design

<table>
<thead>
<tr>
<th>Group</th>
<th>Stimulus</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>O Xaa</td>
</tr>
<tr>
<td>R</td>
<td>O Xab</td>
</tr>
<tr>
<td>R</td>
<td>O Xba</td>
</tr>
<tr>
<td>R</td>
<td>O Xbb</td>
</tr>
</tbody>
</table>

R = Random assignment  
O = Observation, a pretest and a posttest  
Xaa = Expert agent tutorial for ESL students with HPK  
Xab = Expert agent tutorial for ESL students with LPK  
Xba = Peer agent tutorial for ESL students with HPK  
Xbb = Peer agent tutorial for ESL students with LPK

Table 5. Four Research Conditions Based on Two Categorical Variables

<table>
<thead>
<tr>
<th>IVa: Agent role</th>
<th>IVb: ESL learners’ prior knowledge</th>
<th>Expert agent</th>
<th>Peer agent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HPK</td>
<td>Group EH</td>
<td>Group PH</td>
</tr>
<tr>
<td></td>
<td>LPK</td>
<td>Group EL</td>
<td>Group PL</td>
</tr>
</tbody>
</table>

Apparatus

The instructional treatment of the study was conducted in the computer lab at the English institution. The capacity of the computer lab was 24 persons. Each computer was equipped with a 17-inch color monitor, a computer mouse, keyboard, and headset. The agents’ visual appearance, voice, and body movements were developed by using iClone6. The verbal script was recorded by using Audacity to produce MP3 files. Then, these voice files were integrated with the iClone projects and rendered as MP4 files. The on-screen texts were designed to be synchronously printed with the agent’s narration and created as HTML files. The whole tutorial, a combination of MP4 and HTML files, was incorporated into the iMapBook™. iMapBook™ is
a web-based application designed to develop research materials besides improving reading comprehension among elementary, secondary, and adult learners.

Measures

Several instruments were employed in the main study to collect students’ information and assess their cognitive load, motivation, and vocabulary acquisition. These instruments include a demographic survey, a ten-item questionnaire for measuring the cognitive load, an Instructional Materials Motivational Survey (IMMS), and a pretest and a posttest to examine the students’ vocabulary acquisition. Next, each instrument will be discussed.

1) Demographic Survey

This survey collected demographic information about the participants. It is a multiple-choice survey and requests students to report their gender, age, native language, current English level in the institution, preferred learning style (visual, auditory, or kinesthetic), and, if it is applicable, their latest scores of English skill tests such as TOEFL (Test of English as a Foreign Language) or IELTS (International English Language Testing System). See Appendix (A) for this demographic survey.

2) Cognitive Load

To measure the cognitive load, rating scale techniques have been widely used by researchers (Cook, Zheng, & Blaz, 2009) and extensively been used without requiring any advanced equipment as other instruments such as secondary tasks (Leppink, van Gog, Paas, & Sweller, 2015). This study used an instrument that is developed to measure three types of
cognitive load: intrinsic load (IL), extraneous load (EL), and germane load (GL). It is a ten-item questionnaire divided into sets for measuring each type of cognitive load: IL (through items 1, 2, and 3), EL (through items 4, 5, and 6), and GL (through items 7, 8, 9, and 10). Leppink, Paas, Van Der Vleuten, Van Gog, and Van Merrienboer (2013) conducted four lectures studies to validate this ten-item questionnaire. They called this questionnaire as a three-factor solution to measure the three types of cognitive load (IL, EL, and GL). They found that the four studies support the consistency of their three-factor solution underlying the ten-item questionnaire (Leppink, Paas, Van Der Vleuten, Van Gog, & Van Merrienboer, 2013). The first question of this research was answered through the collected data via this instrument. Appendix (B) presents this cognitive load instrument.

3) Motivation

The Instructional Materials Motivational Survey (IMMS) was used to measure the four components of motivation (ARCS): Attention, Relevance, Confidence, and Satisfaction. This motivation survey was developed by John Keller (1993) and utilized to find out “how motivated students are, were, or expect to be, by a particular course” (Keller, 2006, p. 1). To measure the four components of motivation, this survey includes 36 items with five scales that range from 1 as “not true” to 5 as “very true”. This survey has been examined and found as a valid instrument (Keller, 2006). The collected data answered the second question of this research. See Appendix (C) for reviewing this IMMS.
4) Vocabulary Acquisition

The vocabulary pretest and posttest are two approaches to measure the degree of learning change. These pretest and posttest had been designed collaboratively with a subject matter expert (SME). This SME has a Master degree in TESOL, Teaching English to Speakers of Other Languages. She is an ESOL instructor with 10-year experience of working with adult ESL and EFL, academic and non-academic environments in the United States and abroad. Her experience enhances her ability to design and implement ESOL courses with the integration of various teaching methods and techniques. Regarding the pretest and posttest, both were consistent with the intermediate English level. The two tests were designed as multiple-choice questions and had the same length (10 items). Both tests were designed as paralleled tests by concentrating on the same roots and prefixes; however, these roots and prefixes were embedded in different vocabularies and sentences. For example, the pretest question about the root “cide” was to choose the right meaning of the word "insecticide". While the posttest question asked the meaning of "homicide" and both vocabularies were included in different sentences. That is, the length of the test, the roots, prefixes, and the type of question (multiple choice) were identical in both tests. All the responses weighted one point, whether the items included one root or one prefix such as in our previous example "insecticide" and "homicide" or the items combining root and prefix such as the word “premortem”. The collected data answered the third research question. See Appendix (E) for both pretest and posttest.
Data Collection Procedure

Pre-study

To determine the visual appearance of the two agents, a pre-study was conducted first. This pre-study was an online survey including several videos of spoken animated agents who have different visual appearances and body movements. 25 ESL participants in the college level, who are similar to the target audience, were asked to choose two agents (one as an expert and another one as a peer) out of six animated agents. First question was asking to watch three short videos and then choose one most likely animated agent to be described as an expert/instructor. The second question was also asking to watch three short videos and then choose one most likely animated agent to be described as a peer/college student. The two agents, that were highly voted to be presented as an expert/instructor (52% of the participants) and as a peer/college student (48% of the participants), have been implemented into the study’s intervention/tutorial.

![The Two Highly Voted Agents as an Expert (Left) and a Peer (Right)](image)

Figure 3. The Two Highly Voted Agents as an Expert (Left) and a Peer (Right)

Pilot Test

A pilot test took a place after completely design the online tutorial and before conducting the main research. Its goal was to revise any included instruction or media prior conducting the main study. On October 3rd, 2017, 14 ESL students were recruited from “Undergraduate Pathway
Program”. The participants were randomly assigned into two groups, Expert group and Peer group. To ensure that, the researcher mixed 7 cards containing passwords for login in the expert tutorial with 7 cards containing passwords for login in the peer tutorial. Then, participants were asked to pick up one card and use its username as a login code to the iMapBook.

In this pilot test, the participants were asked to fill in a demographic survey, proceed to the tutorial, and then complete an Agent Person Instrument (API). This API is a validated instrument used for assessing a pedagogical agent persona to be perceived as a person-like (Baylor & Ryu, 2003b). This instrument consists of four key factors: facilitating learning, credible, human-like, and engaging. The capacity of each key factor has been considered to design expert-like and peer-like agents. See appendix (D) to review the 25 elements of this instrument. The results of the API revealed how the participants have perceived the presented agent as person-like in terms of its informational usefulness and emotive interaction. Regarding the 7 participants who proceeded the Expert agent, they agree to perceive the agent as facilitating learning and credible with means 3.614 and 3.629 respectively. They also naturally perceived the agent as human-like and engaging with means 3.229 and 3.143 respectively. Regarding the 7 participants who proceeded the Peer agent, they strongly agree to perceive the agent as a credible agent with mean 4.371 and agree to perceive the agent as a facilitating learning, human-like, and engaging with means 4.114, 3.886, and 4.114 respectively. Based on these findings, both agents were perceived satisfactory from naturally to strongly agree to be a person-like. Appendix (L) provides this test results.
Main Study

The data collecting began on October 30\textsuperscript{th} of 2017 and was completed by December 7\textsuperscript{th} of the same year. In the beginning of October, the academic advisor in the English institution had sent an email to the Academic English program’s instructors informing them the dates and times of conducting my research with their students at the computer lab. Since my research had been agreed to be conducted during the “Extended Learning Sessions” that students’ attending were elective, another email had been sent to the students urging them to attend the research as a workshop. On October 30\textsuperscript{th}, the first session had been held. By December 7\textsuperscript{th}, the last session had been done. At the end, there were a total of 91 ESL students involved in this study out of 105, as 86.67 percent response rate.

This main research consisted of one session of 25-30 minutes online tutorial including the surveys and tests. It conducted during the “Academic Extended Learning” session that lasts for 75 minutes in the computer lab. Each session was designed for a specific English level, which helps the researcher to classify the level of the participants’ prior knowledge (HPK for students in levels 4, 5, 6 and LPK for students in levels 1, 2, 3). The participants chose their spots inside the lab to work individually (a single student working on a single computer and wearing a headset). The participants in each English level were randomly and equally assigned into two groups, Expert group vs. Peer group. To accomplish that, the number of usernames for assigning into a specific agent tutorial was equal for both agents. Then the participants drew a username to login into one tutorial, the expert or the peer agent tutorial. For example, in the session for students in level 6, they were 16 attendees and all of them classifying as HPK. So, the researcher mixed 8 cards containing passwords for login in the expert tutorial with 8 cards containing passwords for login in the peer tutorial. Both tutorials were placed in the HPK cohort. While
students, for example, in level 2 were given usernames for login in the expert or peer tutorial that were placed in the LPK cohort.

After logging in into the online tutorial, the participants were asked to complete a demographic survey and a vocabulary pretest before being exposed to the research intervention. Then, the tutorial started displaying the narrative information by animated agent along with synchronous on-screen key words and sentences. After completing the tutorial, participants answered a cognitive load questionnaire, a motivation questionnaire, and then a posttest in vocabulary. Below is a chart to depict the experiment procedure.

![Main Research Procedure](image)

**Figure 4.** Main Research Procedure
Data Analysis

This study was a 2 x 2 factorial design experiment. Its independent variables consist of the agent roles (expert vs. peer) and the levels of students’ prior knowledge (high prior knowledge vs. low prior knowledge). The first step in analyzing this factorial experiment was computing the descriptive statistics for each treatment group. Each treatment group represents a certain combination of factors (i.e. expert agent and ESL students with high prior knowledge, expert agent with low prior knowledge, peer agent with high prior knowledge, and peer agent with low prior knowledge). In addition, the overall means and standard deviations of each group were calculated. The data were tested for the normality of population distribution and homogeneity of variance. Then, comparing the scores of the dependent variables of the four treatment groups were executed. Below, a table summarizes the data source and data analyses per research question. More details are discussed in Chapter Four.

Table 6. Data Source and Analyses for Each Research Question

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Data Source</th>
<th>Data Analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the effect of the role of APA (Expert vs. Peer) and the level of prior knowledge (High vs. Low) on ESL students’ cognitive load (IL, EL, and GL)?</td>
<td>Ten-item questionnaire for measuring (IL, EL, &amp; GL). See appendix (B).</td>
<td><strong>One 2-way ANOVA</strong>&lt;br&gt;Compare the total scores of the “cognitive load”.*</td>
</tr>
<tr>
<td>What is the effect of the role of APA (Expert vs. Peer) and the level of prior knowledge (High vs. Low) on ESL students’ motivation?</td>
<td>Instructional Materials Motivational Survey (IMMS). See appendix (C).</td>
<td><strong>One 2-way ANOVA</strong>&lt;br&gt;Compare the total scores of the “Motivation”.</td>
</tr>
<tr>
<td>What is the effect of the role of APA (Expert vs. Peer) and the level of prior knowledge (High vs. Low) on posttest.</td>
<td>Posttest. See appendix (E).</td>
<td><strong>One 2-way ANOVA</strong>&lt;br&gt;Two main effects (agent’s role and student’s prior knowledge) and one interaction effect for one dependent variable, posttest score.</td>
</tr>
</tbody>
</table>
Internal Validity

Internal validity refers to “the extent to which extraneous variables have been controlled” (Street, 1995, p. 174). In other words, it questions whether the experimental manipulations cause a difference and only independent variables make changes in the dependent variables. A random assignment of subjects into the four treatment groups ensures that the four groups are statistically equal regarding all the variables. This randomization of treatment minimizes the impact of the researcher’s internal and uncontrolled bias, which could influence the experiment outcomes (Street, 1995).

Some actions were taken to apply a control over extraneous variables. In this experiment, a selective and statistical control were applied. For the selective control, experimental groups were recruited from the same English institution. They all were international and ESL students. During the experiment, participants had been asked to sit in any spot inside the computer lab. Then, random passwords for logging in the online tutorial were distributed among the students. By this way, participants were assigned randomly in one tutorial version of the two animated agents (expert or peer). Regarding the statistical control in the stage of data analysis, Analysis of variance (ANOVA) were used. This ANOVA test allows an inclusion of extraneous variables that cannot be removed from the study. It also allows including the effects of multiple independent variables (Street, 1995).
Validity of the Agents’ Appearance

The pre-study survey enhanced the validity of the visual appearance of the expert/instructor and peer/motivator agents. Sample of ESL students who are similar to the target audience of this study had been asked to rate several animated agents. The two highly rated agents of being perceived as expert and peer were implemented into the online tutorial. Furthermore, the pilot test had been conducted with the completed tutorial to revise any included instruction or media prior to the main study. In the pilot study, participants were asked to fill in the Agent Persona Instrument (API), which is a validated instrument for assessing a pedagogical agent being perceived as person-like. The results of the pilot test showed that the ESL students agreed and strongly agreed to perceive the peer agent as a person-like. They also naturally perceived and agreed that the expert agent was as a person-like in the tutorial.
CHAPTER FOUR:

RESULTS

As stated in Chapter one, the study reported in this dissertation examined in detail the effects of two pedagogical agents’ roles (an expert agent and a peer agent) along with prior knowledge on ESL learners’ cognitive load, motivation, and vocabulary acquisition. This chapter describes the data that was gathered from the participants’ responses. It is organized in terms of the three research questions posed in Chapter one. The participants in this study were ESL students enrolled in an English institution located in a large southeast public university in the USA. These students were recruited from the “Academic English program” and included six levels of English proficiency based on the institution’s placement test. Students in levels 1, 2, and 3 were classified as students with low prior knowledge (LPK), while students in levels 4, 5, and 6 were classified as students with high prior knowledge (HPK). The 91 student participants in this study were divided into four groups: expert agent with high prior knowledge students (EH), expert agent with low prior knowledge students (EL), peer agent with high prior knowledge students (PH), and peer agent with low prior knowledge students (PL).

Data analysis was executed by using SPSS software version 24. For each dependent variable, the significance level for all the analyses was set at $p < .05$. Bonferroni adjustments were made when multiple comparisons were performed. The results of two-way ANOVA tests are reported next based on each research question.
The first step of this experimental data analysis is to determine if there was a difference between the four groups (EH, EL, PH, and PL) regarding their pretest scores. Two-way ANOVA was conducted after testing the normality and homogeneity of the scores. In terms of the normal test, the data was normally distributed, as assessed by Shapiro-Wilk's test ($p > .05$). As for the homogeneity assumption, there was homogeneity of variances, as assessed by Levene's test for equality of variances, $p = .452$. Based on the ANOVA test, there was no statistically significant interaction effect of the agent role and ESL learners’ prior knowledge on their pretest scores ($p > 0.05$). There was also no statistical significant effect of the agent role on the pretest score ($p > 0.05$), which is true because the participants had not been exposed to the APA yet. However, there was a statistical significant effect of the students’ level of prior knowledge on the pretest score ($p = 0.003$). It confirmed this study’s grouping as high and low prior knowledge. The partial estimated squared was (0.100). This means being a member in one group (i.e. HPK group) versus the other group (i.e. LPK group) shows 10% of improvement in the pretest score. This drop-in pretest scores between the HPK and LPK groups can be seen in the pretest chart below. Therefore, the pretest scores could not be used as a covariate. The four groups (EH, EL, PH, and PL) were not equal in their prior knowledge and they had been already divided by considering their prior knowledge level as an independent variable. See appendix (J) to review the tables of normality, homogeneity, and between-subjects effects tests.
Table 7. Descriptive Statistics for Pretest Score

<table>
<thead>
<tr>
<th>Experimental Groups a</th>
<th>Mean b</th>
<th>Std. Deviation</th>
<th>N</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>EH</td>
<td>6.04</td>
<td>2.20</td>
<td>26</td>
<td>-0.028</td>
<td>-0.865</td>
</tr>
<tr>
<td>EL</td>
<td>4.65</td>
<td>2.06</td>
<td>20</td>
<td>0.525</td>
<td>1.144</td>
</tr>
<tr>
<td>PH</td>
<td>5.48</td>
<td>1.76</td>
<td>25</td>
<td>-0.164</td>
<td>-0.854</td>
</tr>
<tr>
<td>PL</td>
<td>4.10</td>
<td>2.43</td>
<td>20</td>
<td>-0.080</td>
<td>-1.250</td>
</tr>
</tbody>
</table>

Note. a Note. a EH: Expert agent, learners with High prior knowledge. EL: Expert agent, learners with Low prior knowledge. PH: Peer agent, learners with High prior knowledge. PL: Peer agent, learners with Low prior knowledge. b Pretest score range: 0-10.

Below, for the first research question, statistical analyses are presented and discussed along with the first three hypotheses.

Research Question 1

APA’s Role, Students’ Prior Knowledge, and Cognitive Load:

1. What is the effect of the role of Animated Pedagogical Agent (Expert vs. Peer) and the ESL students’ level of prior knowledge (High vs. Low) on students’ cognitive load (intrinsic load IL, extraneous load EL, and germane load GL)?

Based on this study design and the applied measurements, a series of four two-way ANOVA tests had been conducted on the dependent variable cognitive load score as well as on the three
dependent variables: IL, EL, and GL scores. The combined IL, EL, and GL scores were used to assess the whole cognitive load.

In analyzing the cognitive load score, one group showed that it was not normally distributed. Since ANOVA tests are considered to be fairly "robust" to deviations from normality (Maxwell & Delaney, 2004), the sample sizes were not too small, and they fairly skewed distributions, hence, conducting ANOVA in this case might not be too problematic. There was also homogeneity of variances, as assessed by Levene's test for equality of variances, \( p = .433 \). Based on the ANOVA test, there was no statistically significant main effect of agent role, student’s prior knowledge, and no interaction effect between agent role and level of PK on the cognitive load score, \( p > .05 \).

### Table 8. Descriptive Statistics for Cognitive Load Score

<table>
<thead>
<tr>
<th>Experimental Groups (^a)</th>
<th>Mean (^b)</th>
<th>Std. Deviation</th>
<th>N</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>EH</td>
<td>54.35</td>
<td>24.54</td>
<td>26</td>
<td>-0.269</td>
<td>0.641</td>
</tr>
<tr>
<td>EL</td>
<td>49.75</td>
<td>18.48</td>
<td>20</td>
<td>-0.094</td>
<td>0.089</td>
</tr>
<tr>
<td>PH</td>
<td>52.20</td>
<td>17.20</td>
<td>25</td>
<td>0.855</td>
<td>2.770</td>
</tr>
<tr>
<td>PL</td>
<td>63.80</td>
<td>20.55</td>
<td>20</td>
<td>-0.074</td>
<td>-0.163</td>
</tr>
</tbody>
</table>

*Note.* \(^a\) Note. \(^b\) EH: Expert agent, learners with High prior knowledge. EL: Expert agent, learners with Low prior knowledge. PH: Peer agent, learners with High prior knowledge. PL: Peer agent, learners with Low prior knowledge. \(^b\) Cognitive load score range: 0-100.

Next, the three subscales of cognitive load scores (IL, EL, and GL) were investigated. Regarding the assumptions of ANOVA test, normality test showed that some groups’ scores were not normally distributed, as assessed by Shapiro-Wilk's test \( (p < .05) \). However, the test was run regardless of the normality violation because the ANOVA is fairly "robust" to deviations from normality (Maxwell & Delaney, 2004). As assessed by Levene's Test, there was homogeneity of variances for IL, EL, and GL \( (p > .05) \). A two-way ANOVA had been
performed. For the dependent variable “intrinsic load”, there was no statistically significant effect of agent roles, nor was it of the interaction effect on IL ($p > .05$). However, there was a statistical significant main effect of student’s prior knowledge on IL score, $F= 11.910, p = .001$, partial $\eta^2 = .120$. Regarding extraneous load, the only statistical significant effect was found in the effect of ESL learners’ prior knowledge, $F= 21.826, p \leq .001$, partial $\eta^2 = .201$. Lastly, the germane load score was not statistically affected by any main effects, agent roles or ESL prior knowledge, and was not statistically affected by the interaction effect of agent roles with ESL prior knowledge ($p > .05$).

Table 9. Descriptive Statistics for IL, EL, GL Scores

<table>
<thead>
<tr>
<th>Experimental Groups $^a$</th>
<th>Mean $^b$</th>
<th>Std. Deviation</th>
<th>N</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>EH</td>
<td>11.50</td>
<td>9.11</td>
<td>26</td>
<td>0.438</td>
<td>-0.565</td>
</tr>
<tr>
<td>IL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EL</td>
<td>16.35</td>
<td>8.29</td>
<td>20</td>
<td>-0.136</td>
<td>-0.353</td>
</tr>
<tr>
<td>PH</td>
<td>10.40</td>
<td>8.62</td>
<td>25</td>
<td>0.756</td>
<td>0.166</td>
</tr>
<tr>
<td>PL</td>
<td>18.10</td>
<td>8.20</td>
<td>20</td>
<td>-0.143</td>
<td>-1.068</td>
</tr>
<tr>
<td>EL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EH</td>
<td>6.23</td>
<td>6.99</td>
<td>26</td>
<td>0.947</td>
<td>-0.027</td>
</tr>
<tr>
<td>PH</td>
<td>15.10</td>
<td>8.77</td>
<td>20</td>
<td>-0.203</td>
<td>-0.248</td>
</tr>
<tr>
<td>PL</td>
<td>8.28</td>
<td>9.07</td>
<td>25</td>
<td>0.860</td>
<td>-0.284</td>
</tr>
<tr>
<td>GL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EH</td>
<td>29.77</td>
<td>10.82</td>
<td>26</td>
<td>-1.176</td>
<td>0.893</td>
</tr>
<tr>
<td>EL</td>
<td>27.20</td>
<td>11.72</td>
<td>20</td>
<td>-0.690</td>
<td>-0.114</td>
</tr>
<tr>
<td>PH</td>
<td>33.52</td>
<td>9.98</td>
<td>25</td>
<td>-1.920</td>
<td>3.263</td>
</tr>
<tr>
<td>PL</td>
<td>29.60</td>
<td>8.99</td>
<td>20</td>
<td>-0.722</td>
<td>-0.033</td>
</tr>
</tbody>
</table>

Note. $^a$ EH: Expert agent, learners with High prior knowledge. EL: Expert agent, learners with Low prior knowledge. PH: Peer agent, learners with High prior knowledge. PL: Peer agent, learners with Low prior knowledge. $^b$ IL scores range: 0-30. EL scores range: 0-30. GL scores range: 0-40.

As shown in the marginal means tables, IL scores were 10.95 ± 1.21 for students with HPK and 17.23 ± 1.36 for students with LPK. There was also a statistically significant mean
difference between EL scores and the marginal means showed that EL scores were 7.26 ± 1.18 for the student group with HPK and 15.60 ± 1.34 for the student group with LPK.

Hypotheses regarding the first research question:
H1: ESL students who interact with an APA in a peer role will show significantly lower extrinsic cognitive load (EL) scores and higher germane cognitive load (GL) scores measured by a ten-item cognitive load questionnaire than ESL students who interact with an APA in an expert role.

Based on the statistical analyses, there was no significant effect of agent role on the cognitive load as combined scores of IL, EL, and GL. However, the higher mean score of the cognitive load was for the peer agent group ($M = 57.36$, $SD = 19.43$, $n = 45$) versus ($M = 52.35$, $SD = 22.00$, $n = 46$) for expert agent group. By looking at the cognitive load as three subgroups IL, EL, and GL, there was no significant effect of the agent role on them. Yet, the “Descriptive Statistics” table indicates that the mean score of EL was lower when students interacted with the expert agent ($M= 10.09$, $SD = 8.91$, $n = 46$) as compared to the peer agent ($M= 11.76$, $SD = 9.79$, $n = 45$). About interacting with the APA in peer role, the GL mean score was higher than the expert agent case ($M= 31.78$, $SD = 9.65$, $n = 45$) versus ($M = 28.65$, $SD = 11.17$, $n = 46$). These differences were not statically significant. This hypothesis is not supported statistically, and the differences in sample means could be attributed to sampling error. However, it is possible to suppose that the ESL student’s interaction with the expert agent may cause lower extraneous load while interacting with the peer agent may lead to a higher germane load by looking at their sample means.
H2: ESL students with high prior knowledge in English will show significantly higher extrinsic cognitive load scores and lower germane cognitive load scores measured by a ten-item cognitive load questionnaire than ESL students with low prior knowledge in English. There was a statistically significant effect of students’ prior knowledge for the dependent variables IL ($p = 0.001$) and EL ($p \leq 0.001$) but not for GL ($p = 0.144$). From the “Estimated Marginal Means” table, the ESL students with LPK had significant higher mean scores in their IL ($M = 17.23$, $SE = 1.36$) and EL ($M = 15.60$, $SE = 1.34$). It also showed that ESL students with HPK had a higher mean score in their GL than ESL students with LPK, but the difference was not significant ($M = 31.65$, $SE = 1.46$) versus ($M = 28.40$, $SE = 1.65$). Thus, this hypothesis is not supported and the marginal means suggested opposite findings.

H3: There will be an interaction effect between the role of APA and the level of prior knowledge in English on the scores of the three types of cognitive load measured by a ten-item cognitive load questionnaire. The interaction effect between the roles of APA and students’ level of prior knowledge was not statistically significant for the cognitive load scores ($p = .065$) and for each dependent variables IL, EL, and GL ($p > .05$). Therefore, this hypothesis is not supported statistically.

Research Question 2
APA’s Role, Students’ Prior Knowledge, and Motivation:
2. What is the effect of the role of Animated Pedagogical Agent (Expert vs. Peer) and the ESL students’ level of prior knowledge (High vs. Low) on students’ motivation?
Based on the used measurement tool, a total score of motivation had been collected as a sum of its four components: Attention (A), Relevance (R), Confidence (C), and Satisfaction (S). A series of five tests of two-way ANOVA had been conducted on the dependent variable “motivation” as well as on the four components “A, R, C, and S scores”. Starting with the motivation score, two groups showed that they were not normally distributed, \( p \leq .05 \). Since ANOVA tests are fairly "robust" to deviations from normality (Maxwell & Delaney, 2004), the violation of normality assumption was accepted. For homogeneity test, there was equality of variances as assessed by Levene's test \( p = 0.209 \). Based on ANOVA test, there was no statistically significant interaction effect of the agent role and PK on motivation score, \( p = 0.983 \). However, there was a statistical significant effect of the agent role on the motivation score \( (p = 0.027) \) as well as a statistically significant effect of the students’ levels of prior knowledge on the motivation score \( (p \leq 0.001) \). This shows the peer agent influenced the ESL learners’ motivation by 5.5% of increasing in the motivation score. The high prior knowledge also influenced the ESL learners’ motivation by 15% improving in the motivation score. The profile plot below provides an explanation of the changes.
Table 10. Descriptive Statistics for Motivation Score

<table>
<thead>
<tr>
<th>Experimental Groups</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>EH</td>
<td>138.88</td>
<td>22.98</td>
<td>26</td>
<td>-.0300</td>
<td>-0.955</td>
</tr>
<tr>
<td>EL</td>
<td>122.55</td>
<td>17.24</td>
<td>20</td>
<td>1.089</td>
<td>0.405</td>
</tr>
<tr>
<td>PH</td>
<td>148.36</td>
<td>20.31</td>
<td>25</td>
<td>-0.758</td>
<td>-0.344</td>
</tr>
<tr>
<td>PL</td>
<td>131.85</td>
<td>16.51</td>
<td>20</td>
<td>-0.103</td>
<td>-1.156</td>
</tr>
</tbody>
</table>


Next, the four components of the motivation score (A, R, C, and S) were studied. The normality test showed that some groups’ scores were not normally distributed, as assessed by Shapiro-Wilk's test ($p < .05$). However, the test was run regardless of the violation because the ANOVA is fairly "robust" to deviations from normality (Maxwell & Delaney, 2004). As assessed by Levene's Test of Homogeneity of Variance, there were homogeneity of variances for all A, R, C, and S scores ($p > .05$). A “Univariate test” at alpha=.0125 was run for each dependent variable (A, R, C, and S) to get a closer look at the main effect of the independent variables. The tests revealed a statistical significant effect of the agent’s roles on the ESL learners’ satisfaction ($p= 0.010$) with 7.4% of movement in the score when learners being members in one group (peer group) versus the other (expert group). The estimated means showed that ESL learners’ satisfaction was higher with the peer agent than the expert agent, ($M= 24.93, SE = 0.69$) vs. ($M= 22.36, SE = 0.68$). Therefore, the peer agent positively influenced the feeling of being satisfied with the learning course, so learners continued being more motivated to learn than learners with expert agent.

There was also statistically significant effect of students’ prior knowledge on A (attention score), $F= 14.777, p \leq .001$, partial $\eta^2 = .145$; for C (confidence score), $F= 22.280, p \leq .001$, partial $\eta^2 = .204$; and for S (satisfaction score) $F= 6.804, p < .0125$, partial $\eta^2 = .073$. However,
R (relevant score) was not statistically significant with students’ prior knowledge, $F= 5.031, p > .0125$

**Table 11.** Descriptive Statistics for A, R, C, S Score

<table>
<thead>
<tr>
<th>Experimental Groups</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EH</td>
<td>46.31</td>
<td>8.23</td>
<td>26</td>
<td>-0.150</td>
<td>-1.486</td>
</tr>
<tr>
<td>EL</td>
<td>40.70</td>
<td>6.47</td>
<td>20</td>
<td>1.047</td>
<td>0.847</td>
</tr>
<tr>
<td>PH</td>
<td>49.56</td>
<td>7.43</td>
<td>25</td>
<td>-0.511</td>
<td>-1.200</td>
</tr>
<tr>
<td>PL</td>
<td>43.20</td>
<td>6.93</td>
<td>20</td>
<td>0.557</td>
<td>-0.879</td>
</tr>
<tr>
<td><strong>R</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EH</td>
<td>33.69</td>
<td>6.20</td>
<td>26</td>
<td>-0.432</td>
<td>-0.303</td>
</tr>
<tr>
<td>EL</td>
<td>31.05</td>
<td>5.47</td>
<td>20</td>
<td>0.677</td>
<td>-0.311</td>
</tr>
<tr>
<td>PH</td>
<td>36.76</td>
<td>6.02</td>
<td>25</td>
<td>-0.557</td>
<td>-0.310</td>
</tr>
<tr>
<td>PL</td>
<td>34.05</td>
<td>4.44</td>
<td>20</td>
<td>0.347</td>
<td>-0.472</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EH</td>
<td>35.27</td>
<td>5.70</td>
<td>26</td>
<td>0.054</td>
<td>-1.599</td>
</tr>
<tr>
<td>EL</td>
<td>29.70</td>
<td>4.31</td>
<td>20</td>
<td>1.468</td>
<td>2.082</td>
</tr>
<tr>
<td>PH</td>
<td>35.84</td>
<td>5.63</td>
<td>25</td>
<td>-0.531</td>
<td>-0.150</td>
</tr>
<tr>
<td>PL</td>
<td>30.95</td>
<td>4.97</td>
<td>20</td>
<td>0.809</td>
<td>0.021</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EH</td>
<td>23.62</td>
<td>5.08</td>
<td>26</td>
<td>-0.531</td>
<td>-0.521</td>
</tr>
<tr>
<td>EL</td>
<td>21.10</td>
<td>4.24</td>
<td>20</td>
<td>0.167</td>
<td>-0.243</td>
</tr>
<tr>
<td>PH</td>
<td>26.20</td>
<td>3.78</td>
<td>25</td>
<td>-1.038</td>
<td>0.431</td>
</tr>
<tr>
<td>PL</td>
<td>23.65</td>
<td>5.17</td>
<td>20</td>
<td>-0.788</td>
<td>-0.429</td>
</tr>
</tbody>
</table>


The marginal means for A score were $47.93 \pm 1.032$ for students with high prior knowledge and $41.95 \pm 1.165$ for students with low prior knowledge. For C score, the marginal means were $35.56 \pm .735$ for students with high prior knowledge and $30.33 \pm .829$ for students with low prior knowledge. Finally, the marginal means for S score were $24.91 \pm .644$ for students with high prior knowledge and $22.38 \pm .727$ for the students with low prior knowledge.

Hypotheses regarding the second research question:
H4: ESL students who interact with an APA in a peer role will show significantly higher motivation scores measured by Instructional Materials Motivational Survey (IMMS) than ESL students who interact with an APA in an expert role.

Based on the statistical analyses, there was a statistical significant effect of the agent’s roles for the motivation score. Marginal means tables showed that ESL students who interacted with the peer agent had a higher mean ($M= 140.11$, $SE = 2.962$) than the ESL students who interacted with the expert agent ($M= 130.72$, $SE = 2.937$). Thus, this hypothesis is supported by this study.

H5: ESL students with low prior knowledge in English will show significantly higher motivation scores measured by IMMS than ESL students with high prior knowledge in English.

A statistical significant effect of the students’ level of prior knowledge for the motivation score was found. After reviewing the marginal means of the motivational scores based on the students’ level of prior knowledge, it was apparent that students with high prior knowledge reported a higher motivation score mean ($M= 143.62$, $SE = 2.766$) than students with low prior knowledge ($M= 127.20$, $SE = 3.123$). That is, ESL students with HPK were more motivated than students with LPK. This hypothesis is not supported by this data.

H6: There will be an interaction effect between the role of APA and the students’ level of prior knowledge in English on the motivation scores measured by IMMS.

There was no statistically significant interaction effect of the agent’s role and students’ prior knowledge for motivation score ($p = 0.983$). Thus, this hypothesis is not supported here.
Research Question 3
APA’s Role, Students’ Prior Knowledge, and Vocabulary Acquisition:

3. What is the effect of the role of Animated Pedagogical Agent (Expert vs. Peer) and the ESL students’ level of prior knowledge (High vs. Low) on the students’ vocabulary acquisition?

For measuring the participants’ vocabulary acquisition, a posttest was conducted at the end of the agent’s intervention. By considering the posttest score as a dependent variable for vocabulary acquisition, a two-way ANOVA was applied. For normality assumption, one group showed that it was not normally distributed. Since ANOVA test is considered to be fairly "robust" to deviations from normality (Maxwell & Delaney, 2004), the sample sizes were not too small, and they fairly skewed distributions, hence, conducting ANOVA in this case might not be too problematic. There was also homogeneity of variances, as assessed by Levene's test for equality of variances ($p = .174$). Based on the two-way ANOVA, there was no statistically significant main effect of agent role and no interaction effect between agent role and level of PK for posttest score ($p > .05$). However, there was a statistical significant effect of the students’ levels of prior knowledge on the posttest score, $p < 0.05$. The two groups (HPK and LPK), their marginal means of the posttest score were utilized to distinguish the difference between them. It was found that the ESL students with high prior knowledge had a higher posttest score mean ($M= 5.43$) than ESL students with low prior knowledge ($M= 4.33$). In other words, the posttest scores were $5.43 \pm 0.359$ for students with high prior knowledge and $4.33 \pm 0.406$ for students with low prior knowledge.

Table 12. Descriptive Statistics for Posttest Scores

<table>
<thead>
<tr>
<th>Experimental Groups a</th>
<th>Mean b</th>
<th>Std. Deviation</th>
<th>N</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>EH</td>
<td>5.77</td>
<td>2.80</td>
<td>26</td>
<td>0.433</td>
<td>-1.194</td>
</tr>
</tbody>
</table>

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Hypotheses regarding the third research question:

H7: ESL students who interact with an APA in an expert role will show significantly higher vocabulary acquisition scores measured by the posttest than ESL students who interact with an APA in a peer role.

Based on the statistical findings, there was no statistically main effect of the agent’s role on the posttest scores. Thus, this hypothesis is not statistically supported. Since the differences in sample means could be attributed to sampling error, it might be possible to suppose that ESL students’ interaction with the expert agent might cause higher posttest score ($M = 5.17, SD = 2.85, n = 46$) versus interaction with the peer agent ($M = 4.71, SD = 2.32, n = 45$) by looking at their sample means.

H8: ESL students with high prior knowledge in English will show significantly higher vocabulary acquisition scores measured by the posttest than ESL students with low prior knowledge in English.

This hypothesis is supported by the findings of this study. There was a statistical significant effect of the students’ level of prior knowledge for the posttest score. Since there were only two groups, HPK and LPK, the marginal mean of the posttest score for ESL students with high prior knowledge was higher ($M = 5.43$) than ESL students with low prior knowledge ($M = 4.33$).
H9: There will be an interaction effect between the role of APA and the students’ level of prior knowledge in English on the vocabulary acquisition scores measured by the posttest.

There was no statistically significant main effect of agent role and no interaction effect between agent’s role and level of PK for posttest score \((p = 0.620)\). This hypothesis is not statistically supported. After reviewing the groups’ sample means, there were differences that could be attributed to sampling error. However, it is possible to say that there was a difference between the sample means of the four groups. It showed that the EH group had a higher mean than PH group \((M = 5.77 \text{ vs. } M = 4.40)\), while EL group had a higher mean than PL group \((M = 5.08 \text{ vs. } M = 4.25)\). This might refer to a positive effect of expert agent when ESL learners have similar levels of English proficiency. Below is a table summarizing the result of each hypothesis.

**Table 13. Summary for The Results of Hypotheses Tested in This Study**

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1: ESL students who interact with an APA in a peer role will show significantly lower extrinsic cognitive load scores and higher germane cognitive load scores than ESL students who interact with an APA in an expert role.</td>
<td>Not supported</td>
</tr>
<tr>
<td>H2: ESL students with high prior knowledge in English will show significantly higher extraneous cognitive load scores and lower germane cognitive load scores than ESL students with low prior knowledge in English.</td>
<td>Not supported</td>
</tr>
<tr>
<td>H3: There will be an interaction effect between the role of APA and the students’ level of prior knowledge in English on the scores of the three types of cognitive load.</td>
<td>Not supported</td>
</tr>
<tr>
<td>H4: ESL students who interact with an APA in a peer role will show significantly higher motivation scores than ESL students who interact with an APA in an expert role.</td>
<td>Supported</td>
</tr>
<tr>
<td>H5: ESL students with low prior knowledge in English will show significantly higher motivation scores than ESL students with high prior knowledge in English.</td>
<td>Not supported</td>
</tr>
<tr>
<td>H6: There will be an interaction effect between the role of APA and the students’ level of prior knowledge in English on the motivation scores.</td>
<td>Not supported</td>
</tr>
<tr>
<td>H7: ESL students who interact with an APA in an expert role will show significantly higher vocabulary acquisition scores than ESL students who interact with an APA in a peer role.</td>
<td>Not supported</td>
</tr>
</tbody>
</table>
H8: ESL students with high prior knowledge in English will show significantly higher vocabulary acquisition scores than ESL students with low prior knowledge in English. Supported

H9: There will be an interaction effect between the role of APA and the students’ level of prior knowledge in English on the vocabulary acquisition scores. Not supported

Summary

The three research questions identified through the data analysis process are about the influence of APA’s roles and ESL learners’ prior knowledge on learners’ cognitive load, motivation, and vocabulary acquisition. Each research question has several hypotheses, some of which are supported by the collected data of this study while some are not.

For the first question regarding the influence of APA’s roles and ESL learners’ prior knowledge on learners’ cognitive load, no statistical significance was found for APA’s roles, nor was it for ESL learners’ prior knowledge. There was also no statistical significance for the interaction between them on the cognitive load scores. However, a higher mean of the cognitive load scores was reported by (PL) group, peer agent with ESL learners who classified as LPK, with caution that this higher mean was not statically significant. Another approach for identifying the effects on the ESL learners’ cognitive load was measuring the three components: Intrinsic Load (IL), Extraneous Load (EL), and Germane Load (GL) separately. The only statistical significance was found for the effect of ESL learners’ prior knowledge on the IL and EL. That is, English proficiency has an influence on the ESL learners’ intrinsic and extraneous cognitive load where ESL learners with LPK reported higher scores in their IL and EL. That means the ESL learners with LPK encountered higher cognitive load related to the content complexity and the learning instructions along with APA assistance. Since there was no
significant effect of agent’s roles on ESL learners’ IL, EL, or GL, the design of the presented
agents in this study were valid and checked from the pre-study and the pilot study for their
effectiveness on ESL learners’ cognitive load. Upon examining these statistical results by
groups, they revealed that higher means of IL and EL were reported by (PL) group. This comes
along with the higher mean of the cognitive load scores reported by (PL) group; however, this
higher mean of cognitive load, IL, and EL scores by (PL) group was not significant.

Regarding the second question about the influence of APA’s roles and ESL learners’
prior knowledge on learners’ motivation, no statistical significant effect of the interaction
between APA’s roles and ESL learners’ prior knowledge on the motivation scores was found.
However, there was a statistical significant effect of APA’s roles on the motivation scores with
5.5% of improving in the score when a peer agent presented. There was also a statistical
significant effect of ESL learners’ prior knowledge for the motivation scores with 15% of change
in the score when students had high prior knowledge. Another approach used to identify the
effects on the ESL learners’ motivation was to measure the motivation’s four components:
Attention (A), Relevance (R), Confidence (C), and Satisfaction (S) separately. The results
indicated a statistical significant effect of the agent’s roles on the ESL learners’ satisfaction
specifically when the peer agent presented. Another statistical significant effect of prior
knowledge was found for A, C, and S but not for R. Remarkably, all these components’ scores
had higher means with PH group, while lower means were reported by EL group. This finding
aligns with the higher mean of motivation scores reported by PH group and the lower mean by
EL group. The “Descriptive Table” indicates that the PH group had a higher mean of the
motivation score among the four groups ($M=148.36$), while the EL group had a lower mean
score ($M=122.55$). Thus, when ESL students with HPK encounter the peer agent, they are likely
to be more motivated. They devoted more attention, experienced more confidence, and were more satisfied with the learning contexts.

For the third question about the influence of APA’s roles and ESL learners’ prior knowledge on learners’ vocabulary acquisition, no statistical significance had been found in the agent’s roles as a main effect as well as in the interaction effect between APA’s roles and ESL learners’ prior knowledge for the posttest scores. However, a statistical significant main effect of ESL learners’ prior knowledge was revealed. As expected, ESL learners with high prior knowledge performed better than learners with low prior knowledge in the posttest, $M=5.43$ and $M=4.33$ respectively. Despite that there was no statistical significant effect of the interaction between agent’s roles and ESL learners’ PK, there was a pattern between the groups’ estimated means. Examining the means of the posttest scores for each group show that the EH group had a higher mean score than PH group, $M=5.77$ vs. $M=5.08$. Additionally, EL group had a higher mean score than PL group, $M=4.40$ vs. $M=4.25$. Meaning that EH group outperformed PH group and EL group performed better in the posttest than PL group. These pattern and difference in the sample means could be caused by sampling error. However, it is possible to suppose that encountering the expert agent caused better posttest score than encountering the peer agent when the ESL learners had the same level of prior knowledge. Furthermore, students’ sensitization from the pretest and posttest may affect the outcomes of this research (Gall et al., 2007).
CHAPTER FIVE:
DISCUSSION

This chapter presents a summary of the study and important conclusions drawn from the collected data that are reported in Chapter Four. First, an overview of the study’s purpose, research questions, and methodology are presented briefly. Next, the major findings are summarized and related to the existing literature. Implications for actions, limitations and recommendations for further research follow. Finally, a conclusion brings the chapter to a close.

Overview of The Problem

Purpose Statement and Research Questions

This study examined the effects of two APA’s roles (expert/teacher agent and peer agent) with two levels of prior knowledge in the English proficiency (high level and low level) on the ESL learners’ cognitive load, motivation, and vocabulary acquisition. This study utilized different instruments to measure variables under this investigation and to answer these following three research questions:

(1) What is the effect of the role of Animated Pedagogical Agent (Expert vs. Peer) and the ESL students’ level of prior knowledge (High vs. Low) on students’ cognitive load (intrinsic, extraneous, and germane cognitive load)?

(2) What is the effect of the role of Animated Pedagogical Agent (Expert vs. Peer) and the ESL students’ level of prior knowledge (High vs. Low) on students’ motivation?
What is the effect of the role of Animated Pedagogical Agent (Expert vs. Peer) and the ESL students’ level of prior knowledge (High vs. Low) on students’ vocabulary acquisition?

Methodology Review

This is a quantitative research using a 2x2 factorial experimental design. This design formulates four treatment groups with a different combination of the two factors: APA’s roles and ESL students’ prior knowledge. These four treatment groups are: expert agent x ESL students with HPK (EH), expert agent x ESL students with LPK (EL), peer agent x ESL students with HPK (PH), and peer agent x ESL students with LPK (PL). The dependent variables of this study are: student’s cognitive load, motivation, and vocabulary acquisition. Before conducting the main study, a pre-study and a pilot test was completed with college level ESL students. The pre-study helped determine the visual appearance of the two agents, expert and peer. The pilot test validated those applied animated agents and tested the tutorial in its online platform. Then the main research was conducted to collect the data of this study. For data analysis, two-way ANOVAs were performed.

Major Findings

Cognitive load: by examining the cognitive load score as one whole indicator, there was no statistically significant effect of agent’s roles, students’ prior knowledge, and no interaction effect between agent’s roles and level of PK for cognitive load score. However, investigating the three components of cognitive load revealed a statistical significant effect of ESL learners’ prior knowledge on IL and EL scores. That means, the group of ESL learners with low prior knowledge encountered higher cognitive load related to content complexity and learning
instructions along with APA facilitation. These learners had cognitive load that did not contribute to learning and required working memory resources to process the presented material. Their low posttest scores indicated that the high extraneous load hampered knowledge acquisition (Jong, 2010).

In contrast, the group of ESL learners with high prior knowledge encountered lower IL and EL. Therefore, prior knowledge influenced ESL learners’ cognitive load, in specific intrinsic and extraneous load. Generally, cognitive load depends on the learner’s initial familiarity with the content. When ESL learner has high entry knowledge about the topic, the cognitive load of the lesson will be lightened and vice versa (Meyer, 2000). Additionally, IL related to the difficulty of the subject matter and EL related to the instructional design, they both align with prior knowledge and experience of the learner (Jong, 2010). Further, according to the expertise reversal effect, the optimal instructional techniques and procedures for novice learner may become suboptimal for expert learner (Kalyuga, Ayres, Chandler, & Sweller, 2003; Sweller et al., 2011). Therefore, students with low prior knowledge, who has no experience or familiarity with a topic, would receive intrinsic cognitive load of the presented material through the agent. While students with high prior knowledge, who are familiar with a topic, would encounter extraneous cognitive load because of presenting redundant materials. This redundancy affects the cognitive load by demanding cognitive resources to process unnecessary extraneous cognitive load (Kalyuga et al, 2003; Sweller et al, 2011). Based on this study’s findings, IL was significantly higher with LPK students. It confirms what previous researchers suggested that these students lack familiarity with the presented topic, thus student received IL. The findings also denote that students with HPK reported low EL, which is inconsistent with what previous researchers suggested. Hence, this low EL with HPK students can attribute to the newness of the
presented topic to these students. The dearth of significant effect of agent’s roles on ESL learners’ IL, EL, or GL indicates the validity of the presented agents in this study. The two agents were checked from the pre-study and the pilot study and were examined for their effectiveness on ESL learners’ cognitive load.

**Motivation:** regarding APA roles, there was a significant effect of agent roles on motivation scores. The peer agent had advantage over the expert agent by 5.5% more in the motivation score reported by ESL learners. For more explanation, univariate tests for the motivation’s four components (A, R, C, and S) were conducted. These tests show that there was a statistical significant effect of agent roles for ESL learners’ satisfaction scores. That is, the peer agent raised the ESL learners’ feelings of being satisfied with the material by 7.4%. From the SLA perspective, Krashen’s hypothesis of the affective filter assumes that language learners with low-anxiety are highly motivated and self-confident. This affective filter defines the effective language teacher as a someone who can provide input and help make it understandable in a low anxiety situation (Krashen, 1982). ESL learners during this study’s tutorial were working individually with a peer agent who was perceived to be helpful more than a judgmental agent. This helps reduce the anxiety by creating a supportive environment, hence, ESL learners become more motivated and satisfied with the peer agent.

The ESL learners’ prior knowledge also significantly influenced the ESL learners’ motivation score. As anticipated, ESL learners with HPK outperformed their counterparts with LPK by 15% more in the motivation score. The ESL learners’ prior knowledge significantly influenced ESL learners’ attention, confidence, and satisfaction. When ESL learners had HPK, they were more motivated, paid more attention and were interested to learn, felt more confident in learning requirements and responsibilities, and were more satisfied with their accomplished
goals. In comparison, ESL learners with LPK were less motivated and reported lower scores in attention, confidence, and satisfaction. It seems that the content was suited to the advanced learners. Participants with HPK reported their experience as significantly satisfying, which refers to state of learning concentration called “flow” (Csikszentmihalyi, 1990). Experience satisfying learners when it provides activities with enough challenge to motivate the person and not so much to produce anxiety. The content in the tutorial was a goal-directed and bounded by activities requiring a psychic energy (attention) that could not be done without skills (Csikszentmihalyi, 1990). This explains why participants with HPK invested more attention and felt more confidence and satisfaction.

Posttest (vocabulary acquisition): ESL learners’ prior knowledge also significantly influenced the posttest scores in the vocabulary acquisition test. As anticipated, ESL learners with HPK outperformed their counterparts with LPK by 4% more in the posttest score. It is to be noted that the score change in the posttest refers to having more prior knowledge in English would make a small progress in this vocabulary posttest. According to second language acquisition order, the beginners in ESL will not have acquired some “late-acquired” morphemes and structure. While advanced ESL tend to get more complex input and are able to utilize the comprehensible input (Krashen, 1982). It can explain why ESL learners with HPK outperformed their counterparts with LPK. Here, ESL learners with HPK were more ready to acquire new information. This language acquisition is fairly occurred once receiving comprehensible input (Krashen, 1982).

In fact, language acquisition is “a fluid process of constant linguistic growth and stretching, and not a static condition where simplified language forms are always required” (Meyer, 2000, p. 233). Vocabulary acquisition is basically a knowledge acquisition that requires
an individual’s working memory resources to process and understand the presented rules and guidelines. Then comes the stage of constructing and subsequent automating of schemas. Vocabulary learning strategies demand diverse contexts, repeated language patterns, and directed expressions to achieve them. In this study, ESL learners encountered vocabulary strategy guided by APA, practiced the roots and prefixes activities, then completed the posttest during a short period of time (as minimum as 20 minutes). Thus, the agent’s tutorial in this study could not reach the participants to the stage of engaging in schema construction and automation, which is a way to increase the germane load (Jong, 2010). This explains why agent’s roles did not significantly influence vocabulary acquisition. It also demonstrates why GL had not been affected significantly, while IL and EL were. However, researchers claim that the essential process for understanding material and processing learning associates with GL (Mayer & Moreno, 2003). While others argue that this essential process seems to be related to making sense of the material and not engaging in the schema construction, which is IL. Therefore, the difference between IL and GL is hard to distinguish and possibly does not exist due to their similar ontology, namely “cognitive processes” (Jong, 2010).

Finally, there was no significant interaction effects of agent’s roles and ESL learners’ PK on the cognitive load, motivation, and vocabulary acquisition. Several limitations may hinder the process of reaching other outcomes, thus, requiring future studies on this matter. The limitations and suggested future research are discussed later in this chapter. Noticeably, 62% of the participants’ native language was Arabic. This refers to a sample lacking culturally diverse. Having a cross-culture sample gives a general overview and an approximate understanding of cultural differences because what might be considered totally acceptable and natural in one country, could be confounding or offensive in another (Hofstede, Hofstede, & Minkov, 2010).
Therefore, dominating a specific culture could lead to inconclusive outcomes and inability to distinguish between the possibility of no effect and the possibility of sample error. Sample error here indicates to having unrepresentative sample of the general population of English language learners worldwide.

**Findings Related to The Literature**

There are several differences between this study and previous studies. Firstly, this study examined two roles in which agents mimic real classroom resource providers: teacher/expert and peer. These two usual resource providers can develop students’ academic and social competencies as well as create a safe environment for students (Wentzel et al., 2010). Furthermore, these resource providers, teacher/expert and peer, have been employed as cognitive and motivational scaffoldings in the educational and multimedia setting. Both agents have been designed to portray their intended roles through their image, voice, animation, and script.

Secondly, the presented research considered the prior knowledge of ESL students as an independent variable to control any results related to the participants’ English proficiency. Thirdly, this study offered an online tutorial for teaching English Language Learners an important strategy for vocabulary acquisition. It was designed for a specific audience, adult ESL learners, on specific subject matter, the English language. Lastly, this study scrutinized the ESL learners’ cognitive load and motivation not only by looking at them as whole outcomes, but also considered their components. Two ways of data analyses were applied for each outcome, cognitive load and motivation, to reveal more detailed findings.

The findings of this study compared with those in the literature have revealed some agreements as well as contradictions. As mentioned in the literature review, presenting a peer or
motivator agent has been highly rated in terms of motivating college students (Baylor & Kim, 2009). This finding agrees with what this study observed and concluded. Furthermore, when APA makes learning more interesting/motivating through its internal or external properties, learners tend to invest more effort in processing the presented materials. This is called the “interest hypothesis” for APA design (Moreno, 2005) and has been proved in this study with ESL learners. When the peer agent with motivating internal and external properties was in the tutorial, ESL learners significantly reported high motivation scores than learners with the expert agent. ESL learners who had the peer agent reported as being more satisfied with their achievement and the learning experience.

Another agreement relates to the significant effect of students’ prior knowledge on the posttest score. Prior knowledge has been shown to be the most important factor that influences learning (Kalyuga, 2013). Previous research has also found that students with HPK significantly outperformed the LPK students in the posttest when animated agent had hand gestures to the relevant information. The agent’s hand gestures help students to effectively organize the verbal and visual information and integrate that information with their prior knowledge (Johnson et al., 2015). It is consistent with the findings of this study that ESL learners with HPK significantly outperformed the LPK students in the posttest. Yet, the presented study replaced the agent hand gestures with the synchronous narration and on-screen text. Both, agent hand gestures and synchronous on-screen text, displayed as signaling effects. Moreover, modeling the academic language and focusing attention on the language and its patterns while teacher talking are effective strategies for SLA in classrooms (Meyer, 2000).

Further, the findings of this study show that the means of IL and EL scores were low with ESL learners who had HPK. This is corresponding to Sweller’s cognitive load. Sweller assumes
that when learners devote more working memory resources to deal with the intrinsic cognitive load that is defined as germane cognitive load. As this GL decreases, the extraneous cognitive load increases (Sweller, 2010). In other words, when IL goes down, it is assumed that sufficient working memory resources are available to handle higher EL, hence, no EL can be demonstrated (Sweller, 2010).

In addition to the previous agreements, this study found a statistical significant effect of the students’ level of prior knowledge on the motivation score. Students with HPK reported higher motivation scores than students with LPK. Thus, students with HPK were more motivated to learn. Being motivated can increase a learner’s generative process and enhance understanding of the presented material. ESL learners with HPK also reported significantly less in their IL and EL scores. Considering the model of interest-knowledge relationship, learners in the low-interest and low-knowledge category have limited contact with the subject and are likely to have limited acquired knowledge (Tobias, 1994). By comparing the means of the motivation, A, R, C, S, and posttest scores, it was found that the ESL learners with HPK had higher scores in all of the above, while ESL learners with LPK rated lower scores. This is consistent with the low-interest and low-knowledge learner category. Moreover, the higher mean score among ESL learners with HPK was for attention \( M=49.56 \) out of 60 points for A category). Attention in ARCS model is defined as “capturing the interest of learners; stimulating the curiosity to learn” (Keller, 2010). In other words, capturing learners’ attention would refer to capturing their interest and curiosity to learn. Therefore, the attention of ESL learners with HPK was mostly captured by the agent tutorial, and along with their prior knowledge; they outperformed the posttest. In contrast, ESL learners with LPK had lower A, R, C, and S scores captured by the agent tutorial and had lower posttest scores.
How the study contradicts the reviewed literature can be explored in several points. First, previous researchers found that students with high prior knowledge, who are familiar with a topic, would encounter extraneous cognitive load because of dealing with redundant material. This redundancy affects the cognitive load by demanding cognitive resources to process unnecessary and additional information (Sweller et al., 2011). Based on the presented study’s findings, no statistical significance was found of ESL learners’ prior knowledge on the cognitive scores. However, despite the two cognitive load components (IL and EL) were significantly affected by ESL learners’ prior knowledge, ESL learners with LPK reported higher scores of IL and EL than ESL learners with HPK. It may explain that the presented content included new information, thus, they were not redundant for students with HPK and required effort from students with LPK to understand. Second, a research study found that undergraduate students who interacted with an agent as an expert or mentor outperformed the other group who interacted with an agent of lesser expertise such as a motivator on the transfer test (Baylor, 2003). Using an expert agent led to increased information acquisition and the agent was rated as more facilitative teacher (Baylor & Kim, 2005). However, the findings of this study indicated that there was no statistical significant effect of agent’s roles on ESL learners’ vocabulary acquisition. In addition, the means of the posttest score for ESL learners with HPK were very close in both agents’ groups (the mean of EH= 5.77 and PH= 5.08). A similar situation appeared with the posttest means of ESL learners with LPK (the mean of EL= 4.40 and PL= 4.25). This means that ESL learners with similar English proficiency performed similarly with both agents (expert and peer).

This study contributes to the current knowledge base of cognitive load and multimedia design principles. Regarding cognitive load in multimedia learning environments, employing the Gagne’s Nine Events of Instruction on the whole tutorial design besides APAs models as
cognitive and motivational scaffoldings proved their claims. The Nine Instructional Events as well as scaffolding by APAs as guiding models correspond to ESL learners’ cognitive processes. Based on this study’s results, no effect for agent roles had significantly influenced ESL learners’ cognitive scores, neither the three subgroups IL, EL, and GL. Since working memory is divided into partially visual and auditory channels, overloading either one of these two sub-processors may also increase EL (van Merriënboer & Ayres, 2005). However, presenting redundant information (narrated text by animated agents and on-screen text) through two modalities (visual and audio) did not overload ESL learners’ cognitive capacity, especially learners with HPK. This also extended the claim that modality and redundancy design principles are not applicable for ESL learners. In terms of motivation in multimedia learning environments, designing a peer agent with motivated external and internal features through adopting Keller’s ARCS model shows its intended outcomes. Events for promoting learner’s attention, relevance, confidence, and satisfaction were applied to the peer agent. Based on the study results, the peer agent significantly and positively influenced ESL learners’ motivation. Moreover, the findings of the pilot test extended the powerful of agent’s persona effect as suggested by Lester et al. (1997). The pilot test’s results show that both agents (the expert and peer) have been perceived by ESL learners as a person-like with ability to facilitate learning, being credible, human-like, and engaging agent. That was assessed by using the validated instrument (Agent Persona Instrument-API).
Implications

Results from the current study suggest theoretical and practical implications. Furthermore, this study provides inferences regarding cognitive load and motivation as they relate to a multimedia learning environment.

Theoretical Implications

Former researchers argue that the redundancy design principle is not applicable for ESL learners. Presenting redundant information to learners in two different forms of media (narrated text and on-screen text) by APAs did not overload learners’ cognitive capacity. In this study, ESL learners’ cognitive load score was not statistically affected by agent’s roles. Previous studies show that vocabulary acquisition was improved when audio or written input was augmented by verbal and visual annotation (Plass & Jones, 2005). Moreover, presenting the peer agent with adopted ARCS model on the voice and script of its version significantly influenced and promoted ESL learner’s motivation scores.

Practical Implications

Regarding implications for instructional design relative to APAs in computer-based environment, this study examined whether different roles of APA and different levels of ESL learners’ prior knowledge have effects on ESL learners’ cognitive load, motivation, and vocabulary acquisition. The findings indicate that the group of ESL learners with peer agent encountered higher motivation scores. This can be applied regarding APA design in which peer agent role is presented in an agent-based environment designed when ESL learners’ motivation is the main goal.

The limited interaction between agents and ESL learners in this study during a short-period of time demonstrates new research implications and APA design approaches. Therefore,
more interactional and responsive agents through long-period sessions would be highly beneficial for ESL learners. This new aspect of designing agent-based environments would reveal new outcomes related to cognitive load, motivation, and learning effects. In addition, since agent roles have no significant effect for vocabulary acquisition, considering other language skills such as listening or speaking would also be a possible research implication with APA’s roles.

**Limitations and Further Research**

The first limitation to this study was the sample size. It was small sample size to provide adequate power to detect a significant difference in the intervention effect. Prior estimation of the statistical power was suggested in my proposal, which shows how to interpret the study results. Statistical power is heavily dependent on the sample size. Therefore, it was better to estimate how many subjects were needed per group for a specified power at some \( \alpha \) level (Stevens, 2007). In my case, I estimated a minimum number of participants to attain enough power for detecting Type II error (\( \beta \))—the probability of accepting the null hypothesis when it is false. Regarding this study, power analysis for ANOVA with two levels of independent variables and three dependent variables was conducted in G*Power to determine a sufficient sample size using an alpha of 0.05, a power of 0.80, a small effect size (\( f = 0.10 \)) (Faul, Erdfelder, Buchner, & Lang, 2013). Based on the aforementioned assumptions, the desired sample size is 274, but only 91 subjects were recruited. Therefore, the results from this study are not conclusive; the agent’s role has no effect on ESL students’ cognitive load or that there is no interaction effect between agent’s role and ESL students’ prior knowledge on students ‘cognitive load, motivation, and vocabulary acquisition. Again, these inconclusive results are due to the inability to distinguish
between the possibility of no effect and the possibility of a type-II error that may have resulted partially from the low sample size. Thus, future research should be planned to avoid this constraint by recruiting the desired sample size in order to attain enough power for better understanding and for finding the effects that may have gone undetected.

Another limitation in this study is related to the content area and its intent skills. This study’s aim was to discover whether the two APAs’ roles (expert/teacher vs. peer) and the two levels of ESL learners’ prior knowledge in the English proficiency (high level vs. low level) have effects on the ESL learners’ vocabulary acquisition. This vocabulary outcome was measured after presenting one strategy called analyzing word parts (prefixes and roots). This was a very specific content area with particular type of knowledge and skills. To utilize English prefixes and roots, ESL learners need time to study, review, be exposed to more words, and practice the words for eliciting the meanings while they read or write. Despite the effectiveness of direct vocabulary instructions applied in this research, vocabulary development demands other strategies to be incorporated with these direct instructions such as extensive reading, student-directed review and reinforcement activates, and expanding vocabulary knowledge in its breadth (number of words known) and depth (meaning of words) (Wallace, 2007). Therefore, future research should investigate APAs in online tutorials for ESL learners focusing on different skills, such as listening or communication skills, or different topics, such as idioms and phrases. Measuring another educational benefit such as far transfer learning is recommended. APAs with voice indicated their positive influence on the participants’ far transfer test in studies of Atkinson (2002) and Moreno et al. (2001).

English language learners are faced linguistic and cultural challenges with English materials. They may react in ways that are new, creative, destructive, or unexpected based on
their differences in cognitive abilities, institutional differences in the societies from which they have come, and their differences in the capacity to absorb electronic information. For example, Chinese people are raised on the script nature that develops children’s ability at pattern recognition and imposes a need for rote learning (Hofstede et al., 2010). Based on this experiment’s sample, the participants were predominantly middle-eastern and Asian learners. Thus, the lack of diversity would lead to inconclusive outcomes and inability to distinguish between the possibility of no effect and the possibility of sample error. The sample error indicates to having unrepresentative sample of the general population of English language learners worldwide.

Previous studies have short APA sessions, at times as brief as two minutes. The study of Craig, Gholson, & Driscoll (2002) is a good example. In contrast, other studies had APA sessions with ESL learners as long as one hour, as in Carlotto and Jaques’s study (2016). In the later study by Carlotto and Jaques, the fully embodied agent condition significantly outperformed the no agent condition measured by the ESL learners’ gain scores (the difference between the pretest and posttest scores). It is noticeable that the longer period of time in which ESL learners were exposed to a fully embodied APA, the more knowledge they gained. This presented study, and despite the whole tutorial took at least 20 minutes, ESL learners were exposed to the spoken expert agent for only 12 minutes and the peer agent for 14 minutes. Being exposing to APA that explains, points, and speaks the target language would influence ESL learners more effectively when it lasts longer than several minutes. Thus, longer APA sessions should be considered in future research.

The final limitation this study had was providing an active interaction between APA and learners. Enhancing the virtual interaction between APA and learners would promote learners’
engagement with learning tasks and experiences. To accomplish this, a three-tier framework of 15 research-based guidelines has been proposed by Veletsianos, Miller, and Doering (2009) and called “EnALI framework_ Enhancing Agent Learner Interactions.” They claim that this framework fosters effective factors and provides a well-rounded approach to integrate virtual interactions between agents and humans without marginalizing peripheral issues such as the role of the instructor (Veletsianos, Miller, & Doering, 2009). This “EnALI framework” focuses on three aspects: user interaction by providing attentive and sensitive agents, messages that have appropriate intricacies, and agent characteristics that display appropriate demeanor and posture.

Future APA research should follow this holistic framework for designing and development pedagogical agents within interactional educational settings, or follow this framework for evaluating other virtual agents in electronic learning contexts. In addition, considering “expertise reversal effect” with real-time assessment of a learner’s expertise level in adapted e-learning is absolutely necessary (van Merriënboer & Ayres, 2005).

This study investigated agent-based environment for ESL learners within an area where English is spoken and students were seeking academic English for continuing their higher education. Different learning and teaching environment where English is not spoken, which is considered English as a Foreign Language (EFL), would reveal other findings and issues related to APA design and ESL learners. In addition, ESL learners in English-for-academic-purpose programs are more likely to prefer learning English in formal settings. ESL learners in different programs, English-for-specific-purpose such as business or occupation, would be more likely to learn the language in informal or interactive ways with APA. Further studies are also needed to examine different ages of participants such as k-12 grades ESL learners. Teaching ESL learners through agent-based environment showed that this environment influenced their cognitive load,
motivation, and vocabulary acquisition when ESL learners’ prior knowledge is considered. Therefore, taking into account other learner characteristics such as spatial abilities and preferred learning style is necessary (Plass, Kalyuga, & Leutner, 2010; Horwitz, 2013). The difference between learners and their spatial abilities may cause different levels of English learning as well as different SLA outcomes (Plass et al., 2010). Individual’s learning style such as visual, auditory, kinesthetic learners is an instinctive and persistent way to process information in any learning situation. Therefore, offering a variety of activity types and language experiences should help ESL learners with different sensory preferences (Horwitz, 2013). Anxiety-level in learning a language is another aspect that future research may look at. ESL learners’ anxiety-level is an important variable in language learning influencing achievement (Horwitz, 2001). Learning independently within online tutoring has been found as a low-anxiety space for practicing and developing language skills (Ibarz & Weeb, 2007). Thus, different roles of APA may impact the anxiety-level of language learners differently. Learners’ gender can also affect the influence of the agent due to gender stereotypes. ESL learners’ gender could be a confounding variable and may cause different outcomes because of the different or preferred agent’s roles. Future research may consider the ESL learners’ gender as an independent variable to explore whether learners of different genders prefer different roles of APA. Future researchers may also scrutinize different levels of the second language motivation. Second language motivation is a multifaceted construct that has three different aspects and levels: social dimension/language level, personal dimension/learner level, and educational subject matter dimension/learning situation level (Dörnyei, 1994). The presented study was concentrated on the learning situation level including modeling and task presentation as teacher-specific motivational components and enhancing ARCS features as course-specific motivational components (Dörnyei, 1994). Briefly,
investigating SLA with APA regarding other aspects/levels of second language motivation could also be a possible focus for future research.

**Conclusion**

The presented study contributes to APA design, learners’ prior knowledge, and SLA. First, this study replicates an existing peer agent effect on motivation. According to oral feedback after completion of the tutorial, it was found that APA had a positive impression on ESL learners who participated in this study. Based on the data analysis, the findings provide one significant effect of agent roles in which the peer agent significantly influenced ESL learners’ motivation, especially ESL learners with HPK. Second, it provides further evidence of prior knowledge effects on cognitive load, motivation, as well as learning (i.e. vocabulary acquisition in this presented study). Third, ESL learners need time to understand, practice, and then construct knowledge relative to the second language content and skills. Vocabulary instruction should actively involve and engage learners in processing words with a variety of contexts. Thus, this study produced several considerations for designing an effective APA to teach English language for adult ESL learners, specifically for teaching vocabulary strategies. Future studies should concentrate on agent’s capacity to interact with and respond to ESL learners’ inquiries (intelligent tutoring system_ ITS). Longer online sessions embedding (ITS) with ongoing practice and assessment would lead ESL learners up from processing the presented material to constructing and automating schema in their long-term memory within adapted and personalized learning environment.

Despite a general lack of statistically significant findings related to agent roles and related to the interaction effects of the agent roles and prior knowledge for ESL learners,
avoiding this study’s limitations and considering other learner characteristics provide directions for future research. Since learning English language is continuously demanded around the world, studies about designing online environments with effective and interactive APAs for ESL learners are needed. Building agent-based environments within multimedia and online settings requires a great deal of time and effort to be carefully designed. However, it is worth it when such products are being utilized in educational institutions, language learning centers, and teaching online programs.
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Appendix A: Demographic Survey

1- Gender:
○ Male ○ Female

2- Age:
○ 18-23 years old
○ 24-29 years old
○ 30-35 years old
○ 36-40 years old
○ 41-46 years old

3- Your native language:
○ Arabic
○ Bengali, Hindi
○ Malay, Javanese
○ Mandarin
○ Vietnamese
○ Korean
○ Japanese
○ Spanish, French, Portuguese
○ Russian
○ Other

4- Current English level in the institution
○ Level 1
○ Level 2
○ Level 3
○ Level 4
○ Level 5
○ Level 6

5- How long have you been studying English at English learning Institution/s?
○ less than 6 months
○ less than one year
○ more than one year

6- Preferred learning style (visual, auditory, or kinesthetic)
○ visual learning/ prefer graphs, maps, charts to learn
○ auditory learning/ prefer listening and speaking to learn
○ kinesthetic learning/ prefer physical and body activities to learn
○ nothing specific/ you prefer more than one style to learn

7- The latest scores of English skill tests TOEFL (Test of English as a Foreign Language):
○ 0-31
8- The latest scores of English skill tests IELTS (International English Language Testing System):
  ○ 0-4
  ○ 4.5-5.5
  ○ 6-6.5
  ○ 7-9
  ○ Not applicable
Appendix B: Measuring the Cognitive Load

All the following questions refer to the activity (lecture, class, discussion session, skills training or study session) that just finished. Please respond to each of the questions on the following scale (‘0’ meaning not at all the case and ‘10’ meaning completely the case):

0 1 2 3 4 5 6 7 8 9 10

1. The topic/topics covered in the activity was/were very complex. (Intrinsic Load - IL)
2. The activity covered formulas that I perceived as very complex. (IL)
3. The activity covered concepts and definitions that I perceived as very complex. (IL)
4. The instructions and/or explanations during the activity were very unclear. (Extraneous Load - EL)
5. The instructions and/or explanations were, in terms of learning, very ineffective. (EL)
6. The instructions and/or explanations were full of unclear language. (EL)
7. The activity really enhanced my understanding of the topic(s) covered. (Germaine Load- GL)
8. The activity really enhanced my knowledge and understanding of vocabulary. (GL)
9. The activity really enhanced my understanding of the formulas covered. (GL)
10. The activity really enhanced my understanding of concepts and definitions. (GL)
Appendix C: Instructional Materials Motivational Survey (IMMS)

The four components of motivation will be examined: attention, relevance, confidence, and satisfaction. 36 items will be included in the survey (Keller, 2006).

1 (or A) = not true
2 (or B) = slightly true
3 (or C) = moderately true
4 (or D) = mostly true
5 (or E) = very true

1. When I first looked at this lesson, I had the impression that it would be easy for me.
2. There was something interesting at the beginning of this lesson that got my attention.
3. This material was more difficult to understand than I would like for it to be.
4. After reading the introductory information, I felt confident that I knew what I was supposed to learn from this lesson.
5. Completing the exercises in this lesson gave me a satisfying feeling of accomplishment.
6. It is clear to me how the content of this material is related to things I already know.
7. Many of the pages had so much information that it was hard to pick out and remember the important points.
8. These materials are eye-catching.
9. There were stories, pictures, or examples that showed me how this material could be important to some people.
10. Completing this lesson successfully was important to me.
11. The quality of the writing helped to hold my attention.
12. This lesson is so abstract that it was hard to keep my attention on it.
13. As I worked on this lesson, I was confident that I could learn the content.
14. I enjoyed this lesson so much that I would like to know more about this topic.
15. The pages of this lesson look dry and unappealing.
16. The content of this material is relevant to my interests.
17. The way the information is arranged on the pages helped keep my attention.
18. There are explanations or examples of how people use the knowledge in this lesson.
19. The exercises in this lesson were too difficult.
20. This lesson has things that stimulated my curiosity.
21. I really enjoyed studying this lesson.
22. The amount of repetition in this lesson caused me to get bored sometimes.
23. The content and style of writing in this lesson convey the impression that its content is worth knowing.
24. I learned some things that were surprising or unexpected.
25. After working on this lesson for a while, I was confident that I would be able to pass a test on it.
26. This lesson was not relevant to my needs because I already knew most of it.
27. The wording of feedback after the exercises, or of other comments in this lesson, helped me feel rewarded for my effort.
28. The variety of reading passages, exercises, illustrations, etc., helped keep my attention on the lesson.
29. The style of writing is boring.
30. I could relate the content of this lesson to things I have seen, done, or thought about in my own life.
31. There are so many words on each page that it is irritating.
32. It felt good to successfully complete this lesson.
33. The content of this lesson will be useful to me.
34. I could not really understand quite a bit of the material in this lesson.
35. The good organization of the content helped me be confident that I would learn this material.
36. It was a pleasure to work on such a well-designed lesson.

### Table A 1. IMMS scoring guide

<table>
<thead>
<tr>
<th>Attention</th>
<th>Relevance</th>
<th>Confidence</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>6</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>3 (reverse)</td>
<td>14</td>
</tr>
<tr>
<td>11</td>
<td>10</td>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td>12 (reverse)</td>
<td>16</td>
<td>7 (reverse)</td>
<td>27</td>
</tr>
<tr>
<td>15 (reverse)</td>
<td>18</td>
<td>13</td>
<td>32</td>
</tr>
<tr>
<td>17</td>
<td>23</td>
<td>19 (reverse)</td>
<td>36</td>
</tr>
<tr>
<td>20</td>
<td>26 (reverse)</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>22 (reverse)</td>
<td>30</td>
<td>34 (reverse)</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>33</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29 (reverse)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31 (reverse)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix D: Agent Persona Instrument (API)

In order to validate the two presented personas that are applied in this study, the Agent Persona Instrument (API) is utilized. This validated instrument for assessing pedagogical agent persona consists of four key factors for agents to be perceived as person-like: facilitating learning, credible, human-like, and engaging (Baylor & Ryu, 2003b).

Table A 2. Agent Persona Instrument (API)

<table>
<thead>
<tr>
<th>Key factors</th>
<th>(1) strongly disagree</th>
<th>(2) disagree</th>
<th>(3) neutral</th>
<th>(4) Agree</th>
<th>(5) Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Facilitating Learning</strong></td>
<td></td>
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</tr>
<tr>
<td>1. The agent led me to think more deeply about the presentation.</td>
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<tr>
<td>2. The agent made the instruction interesting.</td>
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<tr>
<td>3. The agent encouraged me to reflect what I was learning.</td>
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<tr>
<td>4. The agent kept my attention.</td>
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<tr>
<td>5. The agent presented the material effectively.</td>
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<tr>
<td>6. The agent helped me to concentrate on the presentation.</td>
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<tr>
<td>7. The agent focused me on the relevant information.</td>
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<tr>
<td>8. The agent improved my knowledge of the content.</td>
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<tr>
<td>9. The agent was interesting.</td>
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<tr>
<td>10. The agent was enjoyable</td>
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<tr>
<td><strong>Credible</strong></td>
<td></td>
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</tr>
<tr>
<td>1. The agent was knowledgeable.</td>
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<tr>
<td>2. The agent was intelligent.</td>
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<tr>
<td>3. The agent was useful.</td>
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<tr>
<td>4. The agent was helpful.</td>
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<tr>
<td>5. The agent was instructor-like.</td>
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<tr>
<td><strong>Human-like</strong></td>
<td></td>
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</tr>
<tr>
<td>1. The agent has a personality</td>
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</tr>
<tr>
<td>2. The agent's emotion was natural.</td>
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<tr>
<td>3. The agent was human-like.</td>
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</tr>
<tr>
<td>4. The agent's movement was natural.</td>
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<tr>
<td>5. The agent showed emotion.</td>
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<tr>
<td><strong>Engaging</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1. The agent was expressive.</td>
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<td></td>
</tr>
<tr>
<td>2. The agent was enthusiastic.</td>
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<tr>
<td>3. The agent was entertaining.</td>
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<tr>
<td>4. The agent was motivating.</td>
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<tr>
<td>5. The agent was friendly.</td>
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</tr>
</tbody>
</table>
Appendix E: Vocabulary Pretest and Posttest

Pretest
(10 items, 3 prefixes, 3 roots, 4 combinations of both root and prefix)

1. If a creature is described as “extraterrestrial”, it most likely comes from  ________________.
   a. the mountains
   b. the space  (1 point)
   c. the underground
   d. the ocean

2. The researcher needed to collect demographic data to examine:
   a. Statistic characterizing the research place
   b. Statistic characterizing the research time
   c. Statistic characterizing the research results
   d. Statistic characterizing the human population  (1 point)

3. The biannual meetings are likely to be occurred ________________.
   a. twice a month
   b. twice a year  (1 point)
   c. each month during the year
   d. each two month during the year

4. Insecticide is used to ________________ insects.
   a. kill  (1 point)
   b. feed
   c. catch
   d. attract

5. A bouquet of monochromatic flowers will include ________________.
   a. no blossoming flowers
   b. flowers of different shapes
   c. flowers of the same color  (1 point)
   d. flowers of similar smell

6. If a patient was diagnosed premortem, his disease was identified ________________.
   a. after he died
   b. before his death  (1 point)
   c. by a doctor
   d. accidentally

7. If a woman is announced to have had quadruplets, it means she has had _____________ children at once.
   a. Two
b. Three 
c. Four       (1 point) 
d. Five 

8. The science of recording events by period and by date is called ________________.
   a. omniology  
b. chronology     (1 point) 
c. geology 
d. triology 

9. **Postnatal** depression can occur ________________ childbirth.
   a. after   (1 point) 
b. before 
c. during 
d. all of the above 

10. If a person is described as **antisocial**, he/she ________________________.
    a. does not like to eat vegan food 
b. does not like to communicate with people      (1 point) 
c. seeks communication with people 
d. studies communication 

**Post-test**
(10 items, 3 prefixes, 3 roots, 4 combinations of both root and prefix) 

1. An animal is called “**subterranean**” if it spends most of its life ____________.
   a. underwater  
b. outside the earth`s surface 
c. below the earth`s surface     (1 point) 
d. in an open field 

2. If a student is called “**omniscient**” about a subject matter, he/she most likely ____________.
   a. knows little about the subject  
b. does not know anything about the subject 
c. is still learning about the subject 
d. has complete knowledge about the subject     (1 point) 

3. A man is called **monogamous** if he has ________________________.
   a. one child 
b. one job 
c. one wife     (1 point) 
d. two wives 

4. If the discovery of a wound occurred **post-mortem**, it happened ____________.
   a. immediately after the accident
b. after the death (1 point)
c. during the examination
d. before the incident

5. If a rug is described as **polychromatic**, it __________________________.
   a. displays a number of colors (1 point)
   b. costs a lot of money
   c. feels soft
   d. is of a bright color

6. If Mr. Jackson is described as a **pro-war** politician, he ____________ war.
   a. is against
   b. has no opinion about
   c. in favor of (1 point)
   d. has just returned from

7. If an article states that “Secretary of State Johnson was a **predecessor** of Secretary of State Jackson”, it means __________________________.
   a. Jackson was the person who held the position first
   b. Johnson was the person who held the position first (1 point)
   c. Both had the position at the same time
   d. Both were fired from the position

8. If Mr. Holmes was convicted of **homicide**, he was found guilty of ____________.
   a. stealing money
   b. kidnapping a child
   c. falsifying documents
   d. killing a person (1 point)

9. If an animal is a **herbivore**, it __________________________.
   a. feeds on plants (1 point)
   b. uses plants to build its shelter
   c. hides among plants
   d. raises its offspring in plants

10. A **chronometer** is used to measure ________________.
    a. distance
    b. time (1 point)
    c. color
    d. temperature
Appendix F: Tutorial Activities

Roots Activity:
(5 items, 1 point each)

1. The science of **chromatography** studies ___________.
   a) humans
   b) colors (1 point)
   c) sounds

2. A **mortician** most likely works with ___________.
   a) taxes
   b) music
   c) dead bodies (1 point)

3. **Terra Cotta** is a color that is mostly close to the shade of _________.
   a) brown (1 point)
   b) white
   c) purple

4. In a **chronicle**, events will be arranged based on their ___________.
   a) Importance order
   b) time order (1 point)
   c) alphabetical order

5. **Herbicide** is used to ___________ plants.
   a) destroy (1 point)
   b) water
   c) grow
The feedback of roots activity:

Table A 3. The feedback for roots activity

<table>
<thead>
<tr>
<th>Correct answer</th>
<th>Wrong answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct! You choose “color”. The word includes the root “chrom” that means color.</td>
<td>It was a good try. The word “chromatology” refers to a science of study colors because it includes the root “chrom” that means color.</td>
</tr>
<tr>
<td>Correct! You choose “dead bodies”. The word includes the root “mort” that means death.</td>
<td>It was a good try. The word “mortician” refers to a person who works with dead bodies because it includes the root “mort” that means death.</td>
</tr>
<tr>
<td>Correct! You choose “brown”. The word includes the root “terra” that means earth or soil.</td>
<td>It was a good try. The word “terra cotta” refers to a color that is closed to the color of soil because it includes the root “terra” that means earth or soil.</td>
</tr>
<tr>
<td>Correct! You choose “time order”. The word includes the root “chron” that means time.</td>
<td>It was a good try. The word “chronicle” refers to records sorted based on the time because it includes the root “chron” that means time.</td>
</tr>
<tr>
<td>Correct! You choose “destroy”. The word includes the root “cide” that means kill or cut.</td>
<td>It was a good try. The word “herbicide” refers to something is used to kill the herb because it includes the root “cide” that means kill or cut.</td>
</tr>
</tbody>
</table>
Prefixes Activity:
(5 items, 1 point each)

1. The object on the picture below is called ___________.
   a) bicycle
   b) monocycle
   c) tricycle  (1 point)

2. Each of the 2 shapes on the picture is called a_____________.
   a) polysphere
   b) biosphere
   c) hemisphere  (1 point)

3. If an item was misplaced, it means it was ________________.
   a) incorrectly positioned  (1 point)
   b) positioned outside
   c) quickly found

4. If an object is submerged in the water, it is ________ water.
   a) filled with
   b) covered by  (1 point)
   c) on the surface of

5. If something is considered omnipresent, it ____________.
   a) cannot be found anywhere
   b) can be found everywhere  (1 point)
   c) has very limited presence
The feedback of prefixes activity:

Table A 4. The feedback for prefixes activity

<table>
<thead>
<tr>
<th>Correct answer</th>
<th>Wrong answer</th>
</tr>
</thead>
</table>
| Correct! You choose “tricycle”  
This option includes the prefix “tri” that means three and the picture presented a vehicle with three wheels. | It was a good try.  
The picture presented a vehicle with three wheels, so you should choose a word includes the prefix “tri” that means three. |
| Correct! You choose “hemisphere”  
This option includes the prefix “hemi” that means half and the picture presented a sphere figure that is cut into two halves. | It was a good try.  
The picture presented a sphere figure that is cut into two halves, so you should choose a word includes the prefix “hemi” that means half. |
| Correct! You choose “incorrectly positioned”.  
The word includes the prefix “mis” that means wrong. | It was a good try.  
The word “misplace” means put an item in the wrong place because it includes the prefix “mis” that means wrong. |
| Correct! You choose “covered by”.  
The word includes the prefix “sub” that means under. | It was a good try.  
The word “submerged” means an object is placed under something (in this sentence: under the water) because it includes the prefix “sub” that means under. |
| Correct! You choose “found everywhere”.  
The word includes the prefix “omni” that means all. | It was a good try.  
The word “omnipresent” means something presenting everywhere because it includes the prefix “omni” that means all. |
Appendix G: The Script of Applied Agents

Both agents script is based upon Gagne’s events of instruction. That is, the whole tutorial followed the nine Events of Instruction. For the peer agent script, the ARCS model was incorporated with the Events of Instruction. The two table below illustrates how Events of Instruction is employed to design the expert agent script, and both Events of Instructions and ARCS model are applied through the peer agent.

Table A 5. Tutorial script for expert agent

<table>
<thead>
<tr>
<th>The Nine Events of Instructions</th>
<th>Roots of English words</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Gain Attention</td>
<td>Provide a hook that quickly draws the learner into the lesson, excites learner with shock factor to motivate.</td>
</tr>
</tbody>
</table>

Hello, my name is Professor. Smith, and I’m your instructor during this tutorial. I’ll demonstrate for you a vocabulary strategy called analyzing word parts. Analyzing word parts is an important strategy that helps understand the meaning of new words in academic texts. This tutorial will commence shortly, so please click the (start) button to start our lesson.

2- Inform Learner of Objectives

Objectives must be measurable and observable, provide overview of lesson.

In this tutorial, you will learn some common word parts called roots and prefixes. Knowing that will help you to: (synchronous text onscreen)

- Break new words into parts called roots and prefixes
- Analyze the meaning of each part
- And Determine the meaning of the word as a whole

3- Stimulate Recall of Prior Learning

Present a scenario

Suppose that you come across the following sentence while you’re reading:

“He was a nonconformist in college.”

How could you determine the meaning of nonconformist if you don’t know it?

There is a fast way to guess its meaning, which is analyzing word parts. English words are made up of word parts called: prefixes, roots, and suffixes. Each part has specific meaning. Once you know the meaning of these parts, you can determine the meaning of the whole word.

These word parts can come together in one word as in our example “nonconformist” and they come in order as the following:

Prefix, root, and then suffix.

By breaking our word based on that order, we got: non-, conform, -ist.
If you notice that the difference between these word parts is their position within a word. The prefix is a letter or group of letters that is added before a word to change its meaning such as “non” in the word “nonconformist”.

The root can come in the beginning of the word, in the middle, or at the end of the word and has the basic meaning. In our word “nonconformist”, the root “conform” comes in the middle. The suffix is a letter or group of letters that is added to the end of a word such as “ist” in the word “nonconformist”. It forms new words or show the function of a word.

After breaking the word part, we will analyze the meaning of each part, and we’ll find that: non means not, conform means go along, the suffix “ist” at the end of the word means one who does something. So, the whole new word “nonconformist” means someone who does not go along with others.

Because this tutorial focuses on prefixes and roots only, I’ll present for you some common roots and prefixes along with their meanings. And I’ll show you how to break a new word into parts and analyze their meanings to finally determine the meaning of the whole new word. After that, you will have a chance to practice some word parts activities.

| 4- Present Stimulus Material | Display the content/multimedia, and break the material into small “chunks”. Printed on-screen, the root, the meaning, the root in a word, and then the sentence will be printed out |

Starting with the roots, some roots are words themselves like the word “zoo”. Zoo originally is a Greek root that means animal.

Other roots are combined with other word elements to form other words. For example the word “frugivore”. “frug” is a prefix that means “fruit” and “vor” is a root and means “to eat”. By combining both prefix first followed by the root as in “frugivore”, we got a word means fruit eater.

Another example of common Greek roots is the root “chron”. “chron” means time. “The documents are arranged in chronological order from the earliest date to most recent” means the documents are arranged in order of time, from the oldest one to the newest one.

English words have also borrowed a lot of roots from Latin. For example, a Latin root as “cide” means “kill or cut”. “Her family found that she wrote a suicide note” because sui means self, so the sentence indicates that she wrote a note about killing herself.

If you notice that, knowing the meaning of the root, regardless if the roots are Greek or Latin, allows you to guess the meaning of the unknown word.

| 5- Provide Learner Guidance | Assist learners to encode information for long-term storage or guidance strategies (case studies, examples, mnemonics) |
So, when you come upon an unfamiliar word, you first check to see if that word has any recognizable root. Then, try to figure out its meaning which in turn helps you to guess the meaning of the whole word. To be exposed to other roots, a table of common roots will be presented for you along with their meanings before starting the activity. The table will be presented for you for only 5 minutes. You’re required to study them. If you finished studying them in less than 5 minutes, you can click the “next” button to move on to the practice activity and skip the determined time.

The root table will be printed on screen (See Table A 7).

6- Elicit Performance  
Practice (new skills or behavior) to confirm correct understanding

After presenting some common roots, you need to practice them through the next “multiple choice” activity. This activity will not record your score. It’s for you to practice roots and get feedback once you complete it. Please, click the “start” button when you’re ready.

“Multiple choice” activity will be printed on the screen (See Appendix F).

7- Provide Feedback  
Immediate feedback on learner’s performance and error correction

Immediate feedback will be presented after submitting the answers. The feedback is a writing text. No presence of the spoken agent in this stage.

“Multiple choice” activity feedback will be printed on the screen (See Table A 3 in Appendix F).

End of the “Root instructions”
After practicing the “Root’s multiple-choice activity”, the agent will begin the “Prefixes instructions”:

The Prefixes Script

<table>
<thead>
<tr>
<th>4- Present Stimulus Material</th>
<th>Display the content/multimedia, and break the material into small “chunks”.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On the screen, the root, the meaning, the root in a word, and then part of the sentence will be printed out</td>
</tr>
</tbody>
</table>

After completing the Roots activity, we’re moving to the prefixes, as another word parts. A prefix, as I mentioned before, is a letter or group of letters added in front of a word or word root to change its meaning. A common example is the prefix “re” that means do it again like saying reread or rewrite.

Another common prefix is “anti”. “anti” means against. The word “anti-aging” refers to a product or technique designed to prevent the appearance of wrinkles or of getting older.
“Poly” is also a common prefix means many. A polygon is a figure which has “many” sides and angles. For instance, the tringle is a polygon that has three sides and three angles.

<table>
<thead>
<tr>
<th>5- Provide Learner Guidance</th>
<th>Assist learners to encode information for long-term storage or guidance strategies (case studies, examples, mnemonics)</th>
</tr>
</thead>
</table>

There are more than fifty prefixes in English. So, familiarizing yourself with the most common prefixes will help you to gain knowledge about them. Two tables of common prefixes will be presented for you along with their meanings. Each table will be printed onscreen for 5 minutes and you’re required to study them. If you finished studying the first table in less than 5 minutes, you can click the “next” button to move on to the second table of the common prefixes and skip the determined time. After studying both tables, you’ll practice prefixes activity.

The two table will be printed on screen (See Table A 8 & Table A 9)

<table>
<thead>
<tr>
<th>6- Elicit Performance</th>
<th>Practice (new skills or behavior) to confirm correct understanding</th>
</tr>
</thead>
</table>

After studying some common prefixes, you need to practice them through the next “multiple choice” activity. This activity will not record your score. It’s for you to practice the prefixes and get feedback once you complete the activity. Please, click the “start” button when you’re ready.

“Multiple choice” activity will be printed on the screen (see Appendix F).

<table>
<thead>
<tr>
<th>7- Provide Feedback</th>
<th>Immediate feedback on learner’s performance and error correction</th>
</tr>
</thead>
</table>

Immediate feedback will be presented after submitting the answers. The feedback is a writing text. No presence of the spoken agent in this stage.

“Multiple choice” activity feedback will be printed on the screen (See Table A 4 in Appendix F).

<table>
<thead>
<tr>
<th>8- Assess Performance</th>
<th>Final assessment</th>
</tr>
</thead>
</table>

This stage has been delayed for the study’s purpose of measuring the learners’ cognitive load immediately after completing the tutorial and then follows the motivation survey IMMS. The final assessment as a post test is placed after both cognitive load questionnaire and IMMS.

| 9- Enhance Retention &Transfer | Make learning “stick” (e.g., review with additional examples, paraphrase content, use metaphors, generating examples, and create concept maps or outlines), Relate objectives to personal experiences, summarize content and apply to new situation. |
What I presented for you is a strategy to analyze unfamiliar words. Keep in your mind the meaning of common roots and prefixes. That will help you to determine or even guess the meaning of new words. Try to connect them to the familiar words that you already knew. Also, try to read and find other roots and prefixes from trusted resources. Remember, the more roots and prefixes you learn, the more words you can decode.

Table A 6. Tutorial script for peer agent

<table>
<thead>
<tr>
<th>The Nine Events of Instructions</th>
<th>Roots of English words</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Gain Attention</td>
<td><strong>Note: The italic parts indicate the implications of ARCS model in the peer agent’s script</strong></td>
</tr>
<tr>
<td></td>
<td>Provide a hook that quickly draws the learner into the lesson, excites learner with shock factor to motivate.</td>
</tr>
</tbody>
</table>

Hi, my name is John, and I’m a USF student majoring in teaching English. I’ve taught English learners before and now I’m here to introduce a vocabulary strategy called analyzing word parts for you. So, let’s get started and hit the (start) button.

*(ARCS-A1) Perceptual Arousal (concreteness):*
When the agent starts introducing himself, he shows the audience his expertise in teaching ESL students.

*(ARCS-A3) Variation in tone:*
A change in voice level while he is talking. High voice level to refer to the excitement when he introduces himself, and a little low volume when he shares his experience or rules/facts.

2- Inform Learner of Objectives
   Objectives must be measurable and observable, provide overview of lesson.

In this tutorial, you will learn some common word parts called roots and prefixes. Knowing word parts is an important strategy to get information about the word meaning. It helps you find out the meaning of some new words and remember them better, which in turn, increases the number of vocabulary that you know.

So, after this tutorial, I suppose that you will be able to: (synchronous text onscreen)
- Break new words into parts called roots and prefixes
- Analyze the meaning of each part
- And Determine the meaning of the word as a whole
**ARCS-R1) Goal Orientation:**
Relate the benefits of the course to improve the users’ performance by describing what the learner will be able to do after finishing this instructional material: “word parts is an important strategy to get information about the word meaning. It helps you find out..., remember…, increase…”

3- Stimulate Recall of Prior Learning

Present a scenario

Imagine that you come across the following sentence while you’re reading:
“He was a nonconformist in college.”
Is this the first time for you see the word “nonconformist” and you don’t know its meaning? If your answer is yes, let me tell you:
There is a fast way to guess its meaning by analyzing word parts. English words are made up of word parts called: prefixes, roots, and suffixes. Each part has specific meaning. Once you know the meaning of these parts, you can find out the meaning of the whole word.

These word parts can come together in one word as in our example “nonconformist” and they come in order as the following:
Prefix, root, and then suffix.
By breaking our word based on that order, we got: non-, conform, -ist.
If you notice that the difference between these word parts is their position within a word. The prefix is a letter or group of letters that is added before a word to change its meaning such as “non” in the word “nonconformist”.
The root can come in the beginning of the word, in the middle, or at the end of the word and has the basic meaning. In our word “nonconformist”, the root “conform” comes in the middle.
The suffix is a letter or group of letters that is added to the end of a word such as “ist” in the word “nonconformist”. It forms new words or show the function of a word.

After breaking the word part, we will analyze the meaning of each part, and we’ll find that: non means not, conform means go along, the suffix “ist” at the end of the word means one who does something. So, the whole new word “nonconf\(\text{ist}\)” means someone who does not go along with others.

Because this tutorial focuses on prefixes and roots only, I’ll show you some common roots and prefixes along with their meanings. I expect you to understand the meaning of each word part and remember it. It’s also helpful to connect the meanings of word parts into familiar words. For example, “non” means not as in the familiar word “non stop”. By this way, you’ll be able to keep both the word part and its meaning in your head for longer time.

**ARCS-C1) Building a Positive Learning Expectation:**
Define the criteria that would be used to determine the observed behaviors as evidence of successful learning by saying: “I expect you to understand… remember… connect…”.

4- Present Stimulus Material

Display the content-multimedia, and break the material into small “chunks”.

138
Printed on-screen, the root, the meaning, the root in a word, and then the sentence will be printed out

Now, starting with the roots as word parts, I’d ask you: Have you been in a zoo? (wait 5 seconds)
For me, I’ve been to the zoo many times; I love observing animals that I’d never get the chance to see like a giraffe or panda. Now do you know why a zoo called “zoo”? Because zoo originally is a root that means animal. Here the root is word by itself, no adding elements to it.

Other roots are combined with other word elements to form other words. For example the word “frugivore”. “frug” is a prefix that means “fruit” and “vor” is a root and means “to eat”. By combining both prefix first followed by the root as in “frugivore”, we got a word means fruit eater.

Now, look at this sentence: “The documents are arranged in chronological order from the earliest date to most recent”. Can you guess the meaning of the word “chronological”, if I told you that the root “chron” means time? (Wait for 5 seconds) Yes, it means the documents are arranged in order of time, from the oldest one to the newest one.

What about this sentence: “Her family found that she wrote a suicide note”? Can you guess the meaning of the word “suicide”, if I told you that the roots “sui” means “self” and “cide” means “kill or cut”? (Wait for 5 seconds) Yes, that means she wrote a note about killing herself.

(ARCS-A3) Variable Situations:
While the agent facilitates the content, he asks a question that requires students to think and guess before continuing the explanation when the peer agent asks, “Can you guess the meaning of the word… if I told you…”

(ARCS-R3) Familiarity:
Stimulate personal involvement through tie the instruction to the learner’s experience. The peer agent will ask: “Have you been in a zoo?”

| 5- Provide Learner Guidance | Assist learners to encode information for long-term storage or guidance strategies (case studies, examples, mnemonics) |

Here is a tip. When you face an unfamiliar word, you first check to see if that word has any recognizable root. Then, try to figure out its meaning which in turn helps you to guess the meaning of the whole word. To make you familiar with other roots, a table of common roots will be presented for you along with their meanings before starting the activity. The table will be presented for you for only 5 minutes. You’re required to study them. If you finished studying them in less than 5 minutes, you can click the “next” button to move on to the practice activity and skip the determined time.
The root table will be printed on screen (See Table A 3)

6- Elicit Performance    Practice (new skills or behavior) to confirm correct understanding

After presenting some common roots, you need to practice them in the next “multiple choice” activity. Don’t worry! This activity will not record your score. It’s for you to practice roots and get feedback once you finish it. So please, hit the “start” button when you’re ready.

“Multiple choice” activity will be printed on the screen (See Appendix F).

7- Provide Feedback    Immediate feedback on learner's performance and error correction

Immediate feedback will be presented after submitting the answers. The feedback is a writing text. No presence of the spoken agent in this stage.

“Multiple choice” activity feedback will be printed on the screen (See Table A 7 in Appendix F).

Congratulations! You just got a badge for completing roots activity.

\textit{(ARCS-S2) Positive consequences:} Extrinsic reward will be given. After completing the activity, a completion badge will be given and printed on the screen. There are two completion badges: Roots and Prefixes Badge.

End of the “Root instructions”
After practicing the “Root’s multiple-choice activity”, the agent will begin the “Prefixes instructions”:

The Prefixes Script

| 4- Present Stimulus Material | Display the content/multimedia, and break the material into small “chunks”. On the screen, the root, the meaning, the root in a word, and then part of the sentence will be printed out |

After completing the Roots activity, we’re moving to the prefixes. A prefix, if you remember, is a letter or group of letters added in front of a word or word root to change its meaning. A common example is the prefix “re” that means do it again like saying reread or rewrite.

Another common prefix is “anti”. “anti” means against. Now try to guess the meaning of “anti-aging product” (Wait for 5 seconds). Yes, it means this product is designed to prevent the appearance of getting older.

“Poly” is also a common prefix means many. A polygon is a figure which has “many” sides and angles. For instance, the triangle is a polygon that has three sides and three angles.
5- Provide Learner Guidance  Assist learners to encode information for long-term storage or guidance strategies (case studies, examples, mnemonics)

As you do with any unfamiliar word, you first check if that word has any recognizable prefix. Try to figure out its meaning and then guess the meaning of the whole word. To make you familiar with some prefixes, two tables of common prefixes will be presented for you along with their meanings. Each table will be printed onscreen for 5 minutes and you’re required to study them. If you finished studying the first table in less than 5 minutes, you can click the “next” button to move on to the second table of the common prefixes. After studying both tables, you’ll practice prefixes activity.

The two table will be printed on screen (See Table A 8 & Table A 9)

6- Elicit Performance  Practice (new skills or behavior) to confirm correct understanding

After studying some common prefixes, you need to practice them through the next “multiple choice” activity. Don’t worry! This activity will not record your score. It’s intended for you to practice prefixes and get feedback once you finish it. So please, hit the “start” button when you’re ready.

“Multiple choice” activity will be printed on the screen (see Appendix F).

7- Provide Feedback  Immediate feedback on learner's performance and error correction

Immediate feedback will be presented after submitting the answers. The feedback is a writing text. No presence of the spoken agent in this stage.

“Multiple choice” activity feedback will be printed on the screen (See Table A 4 in Appendix F).

Congratulations! You just got the second badge for completing prefixes activity.

(ARCS-S2) Positive consequences:
Extrinsic reward will be given. After completing the activity, a completion badge will be given and printed on the screen. There are two completion badges: Roots and Prefixes Badge.

8- Assess Performance  Final assessment

This stage has been delayed for the study’s purpose of measuring the learners’ cognitive load immediately after completing the tutorial and then follows the motivation survey IMMS. The final assessment as a post test is placed after both cognitive load questionnaire and IMMS.
You’ve learned a strategy to analyze unfamiliar words. Keep in your mind the meaning of common roots and prefixes. That will help you to determine or even guess the meaning of new words. Try to connect them to the familiar words that you already knew. Also, search for other roots and prefixes from trusted books or websites. Reading and listening into academic content will also be helpful. Remember, the more roots and prefixes you know, the more words you can translate and find out their meaning.

Common roots table:

Table A 7. Common roots table

<table>
<thead>
<tr>
<th>Root</th>
<th>Meaning</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>annu</td>
<td>Year</td>
<td>annual report</td>
</tr>
<tr>
<td>bio</td>
<td>Life</td>
<td>study biology</td>
</tr>
<tr>
<td>chrom</td>
<td>Color</td>
<td>chromogenesis</td>
</tr>
<tr>
<td>dem</td>
<td>People</td>
<td>democracy</td>
</tr>
<tr>
<td>gam</td>
<td>Marriage</td>
<td>polygamist</td>
</tr>
<tr>
<td>mort</td>
<td>Death</td>
<td>mortality</td>
</tr>
<tr>
<td>terra</td>
<td>Earth/soil</td>
<td>territory</td>
</tr>
</tbody>
</table>

Common prefixes table (1):

Table A 8. Common prefixes table (1)

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Meaning</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>mono</td>
<td>One</td>
<td>monograph</td>
</tr>
<tr>
<td>bi</td>
<td>Two</td>
<td>bicycle (has two wheels)</td>
</tr>
<tr>
<td>Prefix</td>
<td>Meaning</td>
<td>Example</td>
</tr>
<tr>
<td>--------</td>
<td>-----------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>pre</td>
<td>Before</td>
<td>pretest before the lesson</td>
</tr>
<tr>
<td>post</td>
<td>After</td>
<td>posttest after the lesson</td>
</tr>
<tr>
<td>pro</td>
<td>Forward/support</td>
<td>proceed</td>
</tr>
<tr>
<td>in</td>
<td>Inside</td>
<td>inhabit</td>
</tr>
<tr>
<td>ex</td>
<td>Outside</td>
<td>expand</td>
</tr>
<tr>
<td>sub</td>
<td>Under</td>
<td>subway</td>
</tr>
<tr>
<td>mis</td>
<td>Wrong</td>
<td>misunderstood</td>
</tr>
</tbody>
</table>

Common prefixes table (2):

**Table A 9. Common prefixes table (2)**

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Meaning</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>tri</td>
<td>Three</td>
<td>tringle (has three sides)</td>
</tr>
<tr>
<td>quad</td>
<td>Four</td>
<td>quadruped (has four feet)</td>
</tr>
<tr>
<td>multi</td>
<td>Many</td>
<td>multipurpose</td>
</tr>
<tr>
<td>omni</td>
<td>All</td>
<td>omnipotent</td>
</tr>
<tr>
<td>hemi</td>
<td>Half</td>
<td>hemiplegia</td>
</tr>
</tbody>
</table>
Appendix H: Tutorial’s Screen Captures

Screenshots of the tutorial with Expert Agent

The login screenshot when students entered their passwords to expert agent tutorial:

![Login Screenshot]

The demographic survey:

![Demographic Survey]

The pretest:

![Pretest Screenshot]

The transition page from the pretest to the tutorial:
Analyzing word parts
Helps understand the meaning of new words

Roots & Prefixes
- Break new words into parts called roots and prefixes
- Analyze the meaning of each part
- Determine the meaning of the word as a whole
He was a nonconformist in college.

Prefixes, Roots, and Suffixes

non- = not
conform = go along
ist = one who does something
nonconformist = someone who does not go along with others.

Starting the “Roots” part:

The Roots

zoo = animal
fragr = fragrant
vax = to kill

fragr = fruit eater
chron = time
The documents are arranged in chronological order from the earliest date to most recent
chronological = in order of time, from the oldest one to the newest one

suicide = killing oneself

unfamiliar word

any recognizable root?

a table of common roots will be presented for only 1 minute

Study them
The transition page to the root activity:

The root activity starts:

The root activity with feedback of previous questions:
End the root activity and starting the “Prefixes” part:

The Prefixes

- a- = do it again
- anti- = against
- anti- = product or technique designed to prevent the appearance of wrinkles or of getting older
- poly- = many

*Example: *Polygons is figure with many sides and angles

The triangle is a *polygon* that has three sides and three angles

Common Prefixes

Two tables of common prefixes
Each side will be presented on screen for 5 minutes

Study them
The transition page to the prefixes activity:

The prefixes activity starts:
The prefixes activity with feedback of previous questions:

The cognitive load survey:
The IMMS survey:

1. The topic covered in the tutorial was very complex/hard.
   
   0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 completely the case

The posttest:

1. When I first looked at this lesson, I had the impression that it would be easy for me.
   
   Not true | Slightly true | Moderately true | Mostly true | Very true

The ending/last page of the whole tutorial:
Screenshots of the tutorial with Peer Agent

The login screenshot when students entered their passwords to peer agent tutorial:

The demographic survey:

The pretest:
1. If a creature is described as "extraterrestrial", it most likely comes from _______.

   the mountains  the space  the underground  the ocean

The transition page from the pretest to the tutorial:

Please put on the headseat and then go to the next page.

The first/introduction page:

Analyzing word parts
Starting the “Roots” part:

Roots & Prefixes
- Break new words into parts called roots and prefixes
- Analyze the meaning of each part
- Determine the meaning of the word as a whole

He was a nonconformist in college
Prefixes, Roots, and Suffixes
- non- = not
- con= = go along
- form = form
- ist = end
- nonconformist = someone who does not go along with others

The Roots
- zoon = animal
- frang = break
- frug = fruit
- op = out
- ex = out
- chron = in order of time, from the oldest one to the newest one

Unfamiliar Word
- any recognizable root?
- a table of common roots will be presented for only 5 minutes
- study them
The transition page to the root activity:

The root activity starts:

The root activity with feedback of previous questions:
Extrinsic reward after completing the root activity:

End the root activity and starting the “Prefixes” part:
The transition page to the prefixes activity:
The prefixes activity starts:

The prefixes activity with feedback of previous questions:

Extrinsic reward after completing the prefixes activity:
The cognitive load survey:

1. The topic covered in the tutorial was very complex/hard.

The IMMS survey:
The posttest:

1. When I first looked at this lesson, I had the impression that it would be easy for me.
   - Not true
   - Slightly true
   - Moderately true
   - Mostly true
   - Very true

The ending/last page of the whole tutorial:

Thank you for your participation!
Appendix I: IRB Approval Letter

July 24, 2017

Fadwa Flemban
Educational and Psychological Studies
Tampa, FL  33612

RE:  Exempt Certification
IRB#: Pro00031169
Title: Animated Pedagogical Agent’s Roles and English Learners’ Prior Knowledge: The Influence on Cognitive Load, Motivation, and Vocabulary Acquisition

Dear Mrs. Flemban:

On 7/23/2017, the Institutional Review Board (IRB) determined that your research meets criteria for exemption from the federal regulations as outlined by 45CFR46.101(b):

(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

As the principal investigator for this study, it is your responsibility to ensure that this research is conducted as outlined in your application and consistent with the ethical principles outlined in the Belmont Report and with USF HRPP policies and procedures.

Please note, as per USF HRPP Policy, once the Exempt determination is made, the application is closed in ARC. Any proposed or anticipated changes to the study design that was previously declared exempt from IRB review must be submitted to the IRB as a new study prior to initiation of the change. However, administrative changes, including changes in research personnel, do not warrant an amendment or new application.

Given the determination of exemption, this application is being closed in ARC. This does not limit your ability to conduct your research project.
We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

[Signature]

John Schinka, Ph.D., Chairperson
USF Institutional Review Board
Appendix J: Tables of Normality, Homogeneity, and Between-Subjects Effects Tests

Pretest scores:
Tests of Normality

<table>
<thead>
<tr>
<th>Statistic</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>.951</td>
<td>.240</td>
</tr>
</tbody>
</table>

Agent Role = Expert agent, Prior Knowledge = High PK

<table>
<thead>
<tr>
<th>Statistic</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>.948</td>
<td>.342</td>
</tr>
</tbody>
</table>

Agent Role = Expert agent, Prior Knowledge = Low PK

<table>
<thead>
<tr>
<th>Statistic</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>.942</td>
<td>.164</td>
</tr>
</tbody>
</table>

Agent Role = Peer agent, Prior Knowledge = High PK

<table>
<thead>
<tr>
<th>Statistic</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>.936</td>
<td>.199</td>
</tr>
</tbody>
</table>

Agent Role = Peer agent, Prior Knowledge = Low PK

Levene's Test of Equality of Error Variances

Dependent Variable: Pretest Score

<table>
<thead>
<tr>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>.885</td>
<td>3</td>
<td>87</td>
<td>.452</td>
</tr>
</tbody>
</table>

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + IV1 + IV2 + IV1 * IV2

Tests of Between-Subjects Effects for Pretest score

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS *</th>
<th>F b</th>
<th>P c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agent role</td>
<td>1</td>
<td>6.885</td>
<td>1.546</td>
<td>.217</td>
</tr>
<tr>
<td>Prior knowledge</td>
<td>1</td>
<td>42.947</td>
<td>9.641</td>
<td>.003</td>
</tr>
<tr>
<td>Agent role * Prior knowledge</td>
<td>1</td>
<td>.000</td>
<td>.000</td>
<td>.992</td>
</tr>
</tbody>
</table>

Note. a MS: Mean Square. b F: F statistics. c P: Significance level.
Research Question 1: Cognitive load score

Tests of Normality

<table>
<thead>
<tr>
<th>Shapiro-Wilk Statistic</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Load score</td>
<td>.958</td>
<td>26</td>
</tr>
<tr>
<td>Agent Role = Expert agent, Prior Knowledge = High PK</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shapiro-Wilk Statistic</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Load score</td>
<td>.953</td>
<td>20</td>
</tr>
<tr>
<td>Agent Role = Expert agent, Prior Knowledge = Low PK</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shapiro-Wilk Statistic</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Load score</td>
<td>.885</td>
<td>25</td>
</tr>
<tr>
<td>Agent Role = Peer agent, Prior Knowledge = High PK</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shapiro-Wilk Statistic</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Load score</td>
<td>.963</td>
<td>20</td>
</tr>
<tr>
<td>Agent Role = Peer agent, Prior Knowledge = Low PK</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Levene's Test of Equality of Error Variances\(a\)

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.923</td>
<td>3</td>
<td>87</td>
<td>.433</td>
</tr>
</tbody>
</table>

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + IV1 + IV2 + IV1 * IV2

Tests of Between-Subjects Effects for Cognitive load

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agent role</td>
<td>1</td>
<td>794.017</td>
<td>1.884</td>
<td>.173</td>
</tr>
<tr>
<td>Prior knowledge</td>
<td>1</td>
<td>274.871</td>
<td>.652</td>
<td>.422</td>
</tr>
<tr>
<td>Agent role * Prior knowledge</td>
<td>1</td>
<td>1469.871</td>
<td>3.487</td>
<td>.065</td>
</tr>
</tbody>
</table>

Note. \(a\) MS: Mean Square. \(b\) F: F statistics. \(p\): Significance level.
Descriptive Statistics

Dependent Variable: Cognitive Load score

<table>
<thead>
<tr>
<th>Agent Role</th>
<th>Prior Knowledge</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert agent</td>
<td>High PK</td>
<td>54.35</td>
<td>24.54</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Low PK</td>
<td>49.75</td>
<td>18.48</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>52.35</td>
<td>22.00</td>
<td>46</td>
</tr>
<tr>
<td>Peer agent</td>
<td>High PK</td>
<td>52.20</td>
<td>17.20</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Low PK</td>
<td>63.80</td>
<td>20.55</td>
<td>20</td>
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<td>54.82</td>
<td>20.81</td>
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</table>

Intrinsic Load (IL), Extraneous Load (EL), and Germane Load (GL)

Tests of Normality

<table>
<thead>
<tr>
<th>Statistic</th>
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<tbody>
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<tr>
<td>EL</td>
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<td>.001</td>
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<tr>
<td>GL</td>
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Agent Role = Expert agent, Prior Knowledge = High PK

<table>
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</tr>
<tr>
<td>EL</td>
<td>20</td>
<td>.330</td>
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<td>.074</td>
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Agent Role = Expert agent, Prior Knowledge = Low PK

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Agent Role = Peer agent, Prior Knowledge = High PK
Levene's Test of Equality of Error Variances

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<tbody>
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<td>IL</td>
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<td>.547</td>
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Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + IV1 + IV2 + IV1 * IV2

Tests of Between-Subjects Effects for IL

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<td>.001</td>
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<td>Error</td>
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Note. a MS: Mean Square. b F: F statistics. c p: Significance level.

Tests of Between-Subjects Effects for EL

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<td>.000</td>
</tr>
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<td>Agent role * Prior knowledge</td>
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<td>.086</td>
<td>.770</td>
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<tr>
<td>Error</td>
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Note. a MS: Mean Square. b F: F statistics. c p: Significance level.

Tests of Between-Subjects Effects for GL

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<td>.166</td>
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<td>.144</td>
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<td>Error</td>
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</table>

Note. a MS: Mean Square. b F: F statistics. c p: Significance level.
## Descriptive Statistics

### Dependent Variable: EL

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<thead>
<tr>
<th>Agent Role</th>
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<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
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</thead>
<tbody>
<tr>
<td>Expert agent</td>
<td>High PK</td>
<td>6.23</td>
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<td>15.10</td>
<td>8.77</td>
<td>20</td>
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<tr>
<td>Expert agent</td>
<td>Total</td>
<td>10.09</td>
<td>8.91</td>
<td>46</td>
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<tr>
<td>Peer agent</td>
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<td>8.28</td>
<td>9.07</td>
<td>25</td>
</tr>
<tr>
<td>Peer agent</td>
<td>Low PK</td>
<td>16.10</td>
<td>9.07</td>
<td>20</td>
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<td>Peer agent</td>
<td>Total</td>
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<td>Total</td>
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<tr>
<td>Total</td>
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<td>40</td>
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<tr>
<td>Total</td>
<td>Total</td>
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<td>91</td>
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</table>

### Descriptive Statistics

### Dependent Variable: GL

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<th>Prior Knowledge</th>
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<th>Std. Deviation</th>
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<td>28.40</td>
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### Estimated Marginal Means

#### Prior Knowledge

### Dependent Variable: IL

#### 95% Confidence Interval

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<tr>
<th>Prior Knowledge</th>
<th>Mean</th>
<th>Std. Error</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
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</thead>
<tbody>
<tr>
<td>High PK</td>
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<td>Low PK</td>
<td>17.23</td>
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#### Prior Knowledge

### Dependent Variable: EL

#### 95% Confidence Interval

<table>
<thead>
<tr>
<th>Prior Knowledge</th>
<th>Mean</th>
<th>Std. Error</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
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</thead>
</table>
Prior Knowledge
Dependent Variable: GL

95% Confidence Interval

<table>
<thead>
<tr>
<th>Prior Knowledge</th>
<th>Mean</th>
<th>Std. Error</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
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</thead>
<tbody>
<tr>
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<td>Low PK</td>
<td>28.40</td>
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<td>25.123</td>
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</table>

Research Question 2: Motivation score
Tests of Normality

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</thead>
<tbody>
<tr>
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<td>.252</td>
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</tbody>
</table>

Agent Role = Expert agent, Prior Knowledge = High PK
<table>
<thead>
<tr>
<th>Shapiro-Wilk</th>
<th>Statistic</th>
<th>df</th>
<th>Sig.</th>
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</thead>
<tbody>
<tr>
<td>Motivation</td>
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<td>.007</td>
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<tr>
<td>Agent Role = Expert agent, Prior Knowledge = Low PK</td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shapiro-Wilk</th>
<th>Statistic</th>
<th>df</th>
<th>Sig.</th>
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</thead>
<tbody>
<tr>
<td>Motivation</td>
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<td>.050</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Shapiro-Wilk</th>
<th>Statistic</th>
<th>df</th>
<th>Sig.</th>
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</thead>
<tbody>
<tr>
<td>Motivation</td>
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<td>20</td>
<td>.177</td>
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<td>Agent Role = Peer agent, Prior Knowledge = Low PK</td>
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</table>

**Levene's Test of Equality of Error Variances**

Dependent Variable: Motivation score

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<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
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<tbody>
<tr>
<td>1.544</td>
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<td>87</td>
<td>.209</td>
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</table>

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + IV1 + IV2 + IV1 * IV2

**Tests of Between-Subjects Effects for Motivation score**

<table>
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<tr>
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<th>F b</th>
<th>P c</th>
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<td>.000</td>
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<tr>
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<td>.000</td>
<td>.983</td>
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</table>

*Note.* aMS: Mean Square. bF: F statistics. cP: Significance level.

**Estimated Marginal Means**

**Agent Role**
Dependent Variable: Motivation score

<table>
<thead>
<tr>
<th>Agent Role</th>
<th>Mean</th>
<th>Std. Error</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
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## Prior Knowledge

**Dependent Variable:** Motivation score

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<tr>
<th>Prior Knowledge</th>
<th>Mean</th>
<th>Std. Error</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
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<td>High PK</td>
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## Attention (A), Relevance (R), Confidence (C), and Satisfaction (S) scores

### Tests of Normality

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<tr>
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<th>Statistic</th>
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<th>Sig.</th>
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</thead>
<tbody>
<tr>
<td>A</td>
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<td>.024</td>
</tr>
<tr>
<td>R</td>
<td>.958</td>
<td>26</td>
<td>.359</td>
</tr>
<tr>
<td>C</td>
<td>.893</td>
<td>26</td>
<td>.011</td>
</tr>
<tr>
<td>S</td>
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<td>.118</td>
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Agent Role = Expert agent, Prior Knowledge = High PK

<table>
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<th>Sig.</th>
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</thead>
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<tr>
<td>A</td>
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<td>R</td>
<td>.928</td>
<td>20</td>
<td>.140</td>
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<tr>
<td>C</td>
<td>.830</td>
<td>20</td>
<td>.003</td>
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<td>.763</td>
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Agent Role = Expert agent, Prior Knowledge = Low PK

<table>
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<th>df</th>
<th>Sig.</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>.900</td>
<td>25</td>
<td>.018</td>
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<tr>
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<td>.413</td>
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<tr>
<td>S</td>
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<td>.005</td>
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Agent Role = Peer agent, Prior Knowledge = High PK

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<th>Statistic</th>
<th>df</th>
<th>Sig.</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>.920</td>
<td>20</td>
<td>.098</td>
</tr>
<tr>
<td>R</td>
<td>.966</td>
<td>20</td>
<td>.674</td>
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</table>
Levene's Test of Equality of Error Variances

<table>
<thead>
<tr>
<th></th>
<th>F</th>
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<th>Sig.</th>
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<tbody>
<tr>
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<td>.085</td>
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<tr>
<td>R</td>
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<td>87</td>
<td>.543</td>
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<tr>
<td>C</td>
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<td>87</td>
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<td>S</td>
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Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

Tests of Between-Subjects Effects for Attention

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<tbody>
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<td>.000</td>
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<td>Error</td>
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Tests of Between-Subjects Effects for Relevance

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<th>P</th>
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</thead>
<tbody>
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<td>.013</td>
</tr>
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<tr>
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<td>.001</td>
<td>.977</td>
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<tr>
<td>Error</td>
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</table>

Tests of Between-Subjects Effects for Confidence

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<th>P</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>Error</td>
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Tests of Between-Subjects Effects for Satisfaction

171
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<th>Source</th>
<th>df</th>
<th>MS ᵃ</th>
<th>F ᵇ</th>
<th>P ᶜ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agent role</td>
<td>1</td>
<td>147.731</td>
<td>6.991</td>
<td>.010</td>
</tr>
<tr>
<td>Prior knowledge</td>
<td>1</td>
<td>143.774</td>
<td>6.804</td>
<td>.011</td>
</tr>
<tr>
<td>Agent role * Prior knowledge</td>
<td>1</td>
<td>.007</td>
<td>.000</td>
<td>.986</td>
</tr>
<tr>
<td>Error</td>
<td>87</td>
<td>21.132</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* ᵃ MS: Mean Square. ᵇ F: F statistics. ᶜ p: Significance level.

Estimated Marginal Means

**Agent Role**

Dependent Variable: Satisfaction (S)

<table>
<thead>
<tr>
<th>Agent Role</th>
<th>Mean</th>
<th>Std. Error</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert agent</td>
<td>22.36</td>
<td>.684</td>
<td>20.999</td>
<td>23.716</td>
</tr>
<tr>
<td>Peer agent</td>
<td>24.93</td>
<td>.690</td>
<td>23.554</td>
<td>26.296</td>
</tr>
</tbody>
</table>

**Prior Knowledge**

Dependent Variable: Attention (A)

<table>
<thead>
<tr>
<th>Prior Knowledge</th>
<th>Mean</th>
<th>Std. Error</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>High PK</td>
<td>47.93</td>
<td>1.032</td>
<td>45.882</td>
<td>49.985</td>
</tr>
<tr>
<td>Low PK</td>
<td>41.95</td>
<td>1.165</td>
<td>39.634</td>
<td>44.266</td>
</tr>
</tbody>
</table>

**Prior Knowledge**

Dependent Variable: Confidence (C)

<table>
<thead>
<tr>
<th>Prior Knowledge</th>
<th>Mean</th>
<th>Std. Error</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>High PK</td>
<td>35.56</td>
<td>.735</td>
<td>34.094</td>
<td>37.015</td>
</tr>
<tr>
<td>Low PK</td>
<td>30.33</td>
<td>.829</td>
<td>28.677</td>
<td>31.973</td>
</tr>
</tbody>
</table>

**Prior Knowledge**

Dependent Variable: Satisfaction (S)

<table>
<thead>
<tr>
<th>Prior Knowledge</th>
<th>Mean</th>
<th>Std. Error</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>High PK</td>
<td>24.91</td>
<td>.644</td>
<td>23.628</td>
<td>26.187</td>
</tr>
<tr>
<td>Low PK</td>
<td>22.38</td>
<td>.727</td>
<td>20.930</td>
<td>23.820</td>
</tr>
</tbody>
</table>
Research Question 3: Posttest score
Tests of Normality

<table>
<thead>
<tr>
<th>Shapiro-Wilk</th>
<th>Statistic</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posttest score</td>
<td>.870</td>
<td>26</td>
<td>.004</td>
</tr>
<tr>
<td>Agent Role = Expert agent, Prior Knowledge = High PK</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shapiro-Wilk</th>
<th>Statistic</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posttest score</td>
<td>.954</td>
<td>20</td>
<td>.440</td>
</tr>
<tr>
<td>Agent Role = Expert agent, Prior Knowledge = Low PK</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shapiro-Wilk</th>
<th>Statistic</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posttest score</td>
<td>.964</td>
<td>25</td>
<td>.509</td>
</tr>
<tr>
<td>Agent Role = Peer agent, Prior Knowledge = High PK</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Shapiro-Wilk

<table>
<thead>
<tr>
<th>Statistic</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posttest score</td>
<td>.951</td>
<td>20</td>
</tr>
</tbody>
</table>

Agent Role = Peer agent, Prior Knowledge = Low PK

Levene's Test of Equality of Error Variances

Dependent Variable: Posttest score

<table>
<thead>
<tr>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.697</td>
<td>3</td>
<td>87</td>
<td>.174</td>
</tr>
</tbody>
</table>

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + IV1 + IV2 + IV1 * IV2

Tests of Between-Subjects Effects for Posttest scores

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS *</th>
<th>F b</th>
<th>P c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agent role</td>
<td>1</td>
<td>3.947</td>
<td>.599</td>
<td>.441</td>
</tr>
<tr>
<td>Prior knowledge</td>
<td>1</td>
<td>27.102</td>
<td>4.115</td>
<td>.046</td>
</tr>
<tr>
<td>Agent role * Prior knowledge</td>
<td>1</td>
<td>1.629</td>
<td>.247</td>
<td>.620</td>
</tr>
</tbody>
</table>

Note. a MS: Mean Square. b F: F statistics. c P: Significance level.

Descriptive Statistics

Dependent Variable: Posttest score

<table>
<thead>
<tr>
<th>Agent Role</th>
<th>Prior Knowledge</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert agent</td>
<td>High PK</td>
<td>5.77</td>
<td>2.80</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Low PK</td>
<td>4.40</td>
<td>2.78</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>5.17</td>
<td>2.85</td>
<td>46</td>
</tr>
<tr>
<td>Peer agent</td>
<td>High PK</td>
<td>5.08</td>
<td>2.63</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Low PK</td>
<td>4.25</td>
<td>1.83</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4.71</td>
<td>2.32</td>
<td>45</td>
</tr>
<tr>
<td>Total</td>
<td>High PK</td>
<td>5.43</td>
<td>2.72</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Low PK</td>
<td>4.33</td>
<td>2.33</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>4.95</td>
<td>2.59</td>
<td>91</td>
</tr>
</tbody>
</table>

Estimated Marginal Means

Prior Knowledge

Dependent Variable: Posttest

<table>
<thead>
<tr>
<th>Prior Knowledge</th>
<th>Mean</th>
<th>Std. Error</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>High PK</td>
<td>5.425</td>
<td>.359</td>
<td>4.710</td>
<td>6.139</td>
</tr>
</tbody>
</table>
### Agent Role * Prior Knowledge
Dependent Variable: Posttest

<table>
<thead>
<tr>
<th>Agent Role</th>
<th>Prior Knowledge</th>
<th>Mean</th>
<th>Std. Error</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert agent</td>
<td>High PK</td>
<td>5.769</td>
<td>.503</td>
<td>4.769</td>
<td>6.770</td>
</tr>
<tr>
<td></td>
<td>Low PK</td>
<td>4.400</td>
<td>.574</td>
<td>3.259</td>
<td>5.541</td>
</tr>
<tr>
<td>Peer agent</td>
<td>High PK</td>
<td>5.080</td>
<td>.513</td>
<td>4.060</td>
<td>6.100</td>
</tr>
<tr>
<td></td>
<td>Low PK</td>
<td>4.250</td>
<td>.574</td>
<td>3.109</td>
<td>5.391</td>
</tr>
</tbody>
</table>
Appendix K: Informed Consent Form

Informed Consent to Participate in Research
Information to Consider Before Involving in This Research Study

Pro # Pro00031169

You are being asked to take part in a research study. Research studies include only people who choose to take part. This document is called an informed consent form. Please read this information carefully and take your time making your decision. Ask the researcher to discuss this consent form with you, please ask her to explain any words or information you do not clearly understand.

We are asking you to take part in a research study called: “Animated Pedagogical Agent’s Roles and English Learners’ Prior Knowledge: The Influence on Cognitive Load, Motivation, and Vocabulary Acquisition”. The person who is in charge of this research study is Fadwa Flemban. This person is called the Principal Investigator. The research will be conducted at INTO computer lab.

Purpose of the study
The purpose of this study is to examine the effects of animated character’s role on English learners’ cognitive load, motivation, and vocabulary acquisition.

Why are you being asked to take part?
We are asking you to take part in this research study because you are an adult English learner, and we are trying to create an effective animated character to teach vocabulary strategies.

Study Procedures:
If you take part in this study, you will be asked to set in a single computer, put on a headphone, and participate in an online tutorial including survey, activities, and tests. Your participation will take no more than your regular class’s time.

Alternatives / Voluntary Participation / Withdrawal
You have the alternative to choose not to participate in this research study. You should only take part in this study if you want to volunteer. You should not feel that there is any pressure to take part in the study. You are free to participate in this research or withdraw at any time. There will be no penalty or loss of benefits you are entitled to receive if you stop taking part in this study. Your decision to participate will not affect your student status or course grade.

Benefits
The potential benefits of participating in this research study include: learning a vocabulary strategy that helps you to guess the meanings of new words and increases your vocabulary knowledge.

**Risks or Discomfort**
This research is considered to be minimal risk. That means that the risks associated with this study are the same as what you face every day. There are no known additional risks to those who take part in this study.

**Compensation**
You will receive no payment or other compensation for taking part in this study.

**Privacy and Confidentiality**
We must keep your study records as confidential as possible. It is possible, although unlikely, that unauthorized individuals could gain access to your responses because you are responding online.

Certain people may need to see your study records. By law, anyone who looks at your records must keep them completely confidential. The only people who will be allowed to see these records are: the Principal Investigator, the advising professors, and The University of South Florida Institutional Review Board (IRB).
It is possible, although unlikely, that unauthorized individuals could gain access to your responses. Confidentiality will be maintained to the degree permitted by the technology used.

No guarantees can be made regarding the interception of data sent via the Internet. However, your participation in this online survey involves risks similar to a person's everyday use of the Internet. If you complete and submit an anonymous survey and later request your data be withdrawn, this may or may not be possible as the researcher may be unable to extract anonymous data from the database.

**You can get the answers to your questions, concerns, or complaints**
If you have any questions, concerns or complaints about this study, call the Principal Investigator at (813) 362-7464 or contact by email at fadwaf@mail.usf.edu

If you have questions about your rights as a participant in this study, or have complaints, concerns or issues you want to discuss with someone outside the research, call the USF IRB at (813) 974-5638 or contact by email at RSCH-IRB@usf.edu.

I freely give my consent to take part in this study. I am 18 years of age or older. I understand that by proceeding with this online tutorial and its survey and tests that I am agreeing to take part in this research.
Appendix L: Pilot Test Results

Table A 10. Pilot test demographic information

<table>
<thead>
<tr>
<th>Pilot test Group</th>
<th>Number of Participants *</th>
<th>Gender</th>
<th>Age</th>
<th>Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert agent group</td>
<td>7 (50%)</td>
<td>Male: 6 (85.7%) Female: 1 (14.3%)</td>
<td>18-23: 5 (71.4%) 24-29: 1 (14.3%) 30-35: 1 (14.3%)</td>
<td>Arabic: 3 (42.9%) Mandarin: 1 (14.3%) Japanese: 1 (14.3%) Other: 2 (28.6%)</td>
</tr>
<tr>
<td>Peer agent group</td>
<td>7 (50%)</td>
<td>Male: 4 (57.1%) Female: 3 (42.9%)</td>
<td>18-23: 7 (100%)</td>
<td>Malay, Javanese: 1 (14.3%) Mandarin: 2 (28.6%) Korean: 1 (14.3%) Spanish, French, Portuguese: 1 (14.3%) Other: 2 (28.6%)</td>
</tr>
</tbody>
</table>

*Total n=14

Table A 11. Descriptive statistics of expert agent based on API

<table>
<thead>
<tr>
<th>API factors</th>
<th>Mean *</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitating Learning</td>
<td>3.61</td>
<td>1.00</td>
<td>0.231</td>
<td>-0.924</td>
</tr>
<tr>
<td>Credible</td>
<td>3.63</td>
<td>1.04</td>
<td>0.642</td>
<td>-1.749</td>
</tr>
<tr>
<td>Human-like</td>
<td>3.23</td>
<td>0.94</td>
<td>-1.281</td>
<td>-1.445</td>
</tr>
<tr>
<td>Engaging</td>
<td>3.14</td>
<td>1.11</td>
<td>0.538</td>
<td>0.028</td>
</tr>
</tbody>
</table>

* Each factor score range: 1-5

Table A 12. Descriptive statistics of peer agent based on API

<table>
<thead>
<tr>
<th>API factors</th>
<th>Mean *</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitating Learning</td>
<td>4.11</td>
<td>0.58</td>
<td>0.165</td>
<td>-0.477</td>
</tr>
<tr>
<td>Credible</td>
<td>4.37</td>
<td>0.52</td>
<td>0.138</td>
<td>-1.958</td>
</tr>
<tr>
<td>Human-like</td>
<td>3.89</td>
<td>0.85</td>
<td>-1.281</td>
<td>2.058</td>
</tr>
<tr>
<td>Engaging</td>
<td>4.11</td>
<td>0.76</td>
<td>-0.494</td>
<td>0.638</td>
</tr>
</tbody>
</table>

* Each factor score range: 1-5
Appendix M: Notification from The Publisher

Email has been sent to obtain the publisher’s notification that permission is not needed:

From: Fadwa Flemban
To: Alexander Magill <magillalexander@gmail.com>,
West East Institute <staff@westeastinstitute.com>

Hello,
My name is Fadwa Flemban, and I had presented my proposal dissertation in your conference at Harvard Faculty club in Boston, July 2017. My dissertation's abstract also has been published in that conference's proceedings.

My question is, do I need to get your permission to write my abstract and publish it in my dissertation? I believe that I did not sign any release copyright in order to include it in your proceedings.

Thank you in advance for your assistance in this matter!

From: West East Institute
To: Fadwa Flemban

Dear Fadwa,
Thank you for your inquiries.
Please feel free to it since we don't have any copyrights with the proceedings publication as long as it is not published in the WEI Journals.

Kind regards,
Michael