The Role a Motivational Agent plays:

The Effects of a Co-learner Agent and an Expert Agent

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Abstract

Purpose: Expert-like agents and co-learner agents are two kinds of most commonly used pedagogical agents in a computer based learning environment. An experiment is conducted to find out whether there were differences in terms of learners' performance and their perceived motivation level when they used instructions with agents playing these two roles. Furthermore, participants' perceptions of the agents are investigated.

Method: An experiment was conducted to test the effect of co-learner and expert agent implementation. The dependent variables are users' perceptions of agents, task performance, motivation level and the user experience of the instructions. 60 Participants were divided randomly into three groups and were requested to perform a same task in Photoshop with a designed instructions containing the different agent. For group 1 and 2, the instructions only contained an expert-like agent or a co-learner agent separately while for group 3 the instructions contained both these two types of agent. Participants were asked to fill out an online questionnaire to indicate their opinions about the instructions after the initial task performance and then were requested to repeat the task without instructions.

Results: The results of this study show no differences between the three participant groups in initial and repeated task performance. The results show a difference in motivational level; compared to an expert-like agent, the implementation of a co-leaner agent lead to higher level of satisfaction among users. Furthermore, participants' perception of an agent differed due to the role they play. An expert-like agent is deemed to be more credible and knowledgeable while a co-learner agent is perceived as being more friendly and attractive.

Conclusion: Agent role serves as an important part of agent design that needs to be taken serious consideration since the implementation of different agents proved to have an impact on users.

Keywords: expert-like agent, co-learner agent, task performance, motivation, agent perception, user experience

1. Introduction

With the advance of technology, we now are capable of designing computer-based learning environments to support simulated social interactions between learners and computers. This great change has facilitated the development of agents, which is used as a metaphor, referring to characters, often human-like, which appear on screen (Erickson, 1997). Agents guiding users through learning environments are known as pedagogical agents: “animated life-like characters embedded in instructional applications” (Yanghee Kim & Baylor, 2006a). Pedagogical agents can be seen as an endeavor to simulate social contexts in which people typically achieve goals through collective efforts in their daily lives, thus contributing to create more realistic environments for users to acquire knowledge. For example, the implementation of a mentor-like agent will be helpful in creating a class-like learning environment in which students are instructed and encouraged by their teacher.

There are many researches that have investigated the effect of pedagogical agents. As a kind of motivational element, the implementation of pedagogical agents introduces more instructional support throughout the process of learning (Clark & Choi, 2005).According to Baylor, the advantages of implementing agents are quite obvious since “it is most convenient or timely for a learner”(Baylor, 2011). Furthermore, the application of a pedagogical agent may “facilitate learners to engage in the learning task and consequently to enhance learning in computer-based environment” (Yanghee Kim & Baylor, 2006a).

Researches in this field have also explored whether or not the factors influencing human to human communication are still effective when employed in agent based environment. As described in Kim and Baylor’s research (2006) of customizing agent-based social models, design constituents of pedagogical agents needed to be taken into consideration such as interaction type, appearance, affect, competency and so on. These features are strongly related with or influence the instructional role represented by agents.

Just classmates and teachers in students’ real lives, pedagogical agents can help to facilitate the process of learning of users by playing various roles in instructions, like expert (W. L. Johnson, Rickel, & Lester, 2000), tutor (Graesser, Chipman, Haynes, & Olney, 2005), mentor (Baylor & Kim, 2005a), learning companion or even trouble maker (Aimeur & Frasson, 1996). In a multimedia learning environment, agents can be classified into two categories on the basis of their mastery of relevant knowledge. The first type of agents could serve as “mastery model”; agents who are capable of playing the role as mentors or experts. They are usually highly competency, having acquired enough knowledge about the whole system, demonstrating the desired level of performance. The second type of agents have a lack of knowledge or experience about the task, sharing the same questions with learners and can be seen as the students’ avatars, playing the role of co-learners or peer in the system. This kind of agents serve as “coping model” with low competency (Baylor, 2011). Researches have shown differences between these two agent models. For example, according to Ebbers (Ebbers, 2007), a coping model agent enhanced great motivational outcomes as compared to a mastery model agent. Kim and Baylor (Yanghee Kim & Baylor, 2006b) also found in their research that low competency models are more influential in terms of “enhancing self-efficacy beliefs”. Since agents' mastery level of knowledge is strongly related with their role designing, these conclusions are also applicable when comparing the effects of agent role.

Arguably, expert-like and peer-like agents are most commonly implemented among all the roles(Baylor & Kim, 2005).The detailed effects of these two agent stereotypes are still to be discovered. The application of mentor agent conforms to a traditional learning environment, in which teachers serve as the medium for knowledge transfer. The deduction is easily made that with more enriched domain knowledge, expert-like agents are inclined to be more credible and persuasive. However, as the agent who shares similar problems with the user, co-learner agents may help arouse stronger emotions so that users may feel more motivated and confident; this finally leads to a higher level of satisfaction.

In the former two studies, it was found that distinctions did exist among participants working with a peer-like agent and those instructed by expert-like agent with respect to learners' task-related attitudes, performance and agent perceptions (Rosenberg-Kima, Baylor, Plant, & Doerr, 2008; Veletsianos, 2010). According to Veletsianos, participants working with a peer-like agent had better performance and tended to give higher ratings to the agent. Rosenberg-Kima's research, however, focused more on task-related attitudes of participants and the conclusion was drawn that peer-like agents can be more effective in terms of enhancing the learner's self-efficacy as well as raising their enthusiasm while expert-like agents had a greater influence on learners' beliefs in the subject domain. Baylor also conducted an experiment in which a comparison among three pedagogical agent roles was made. It was pointed out that compared to an expert agent that only provides information, the agents with motivation, namely motivator agent and mentor agent, were more engaging and facilitated learning better. However, the expert agent was found to be the most credible one and led to a significantly better performance on the transfer measure (Baylor, 2003). In another research led by Liew, Tan and Jayothisa (2012), the effects of peer-like and expert-like agents were studied. Nevertheless, expectations such as peer-like agent can enhance participants' self-efficacy, expert-like agent are perceived to be more knowledgeable are not supported. Thus, these two agent stereotypes' effects on users are still uncertain.

On the other hand, with the popularization of multiple agent implementations, the possibility raises for peer-like agents and expert-like agents to coexist in one instruction system. Since a comparison will be made between these two stereotypes, will learners' perceptions of each agent role alter? Will participants be more motivated? And will their learning achievement differ from single agent systems that include an only peer-like agent or expert-like agent?

The reason for choosing this topic is that despite the fact that agent stereotype serves as a very important part of agent designing, studies focusing on this field are still very limited, especially when it comes to a multi-agent system. In this study, an experiment will be conducted, aiming at confirmation and further extending of earlier research findings. This research may help to deepen understanding of pedagogical agent role, thus promote the agent designing.

The proposed research will firstly analyze the assumptions of earlier researches about pedagogical agents, the design of the agent and various agent roles implemented as well as their impact on users. The experimental part will investigate the specific effects of an instructional system with one agent playing the role of an expert or a co-learner as well as an instructional system in which the expert-like agent and peer-like agent coexist. By comparing and analyzing the results, the research aims to find the differences made by agent stereotype implementation.

2. Theoretical Framework and Research Questions

The framework is divided into two parts: In the first part, the basic theory of pedagogical agents including its definition and its theoretical foundation will be explained. In the second part, the focus will be on specific agent roles.

2.1Pedagogical agents and its theoretical basis

As a kind of motivational elements, pedagogical agents are widely applied to inspire users. The implementation of pedagogical agents has created a social simulated environment in which users are encouraged to have interactions with computers. The design of pedagogical agents involves numerous aspects with direct impact on user's perception of agents or attitudes toward tasks. Moreover, the pedagogical agent system also can be classified into the single-agent system and multi-agent system. According to research, the number of agents containing in a system serves as an important and influential factor.

2.1.1 Motivation and Motivational Elements

The definition of motivational elements is, as Loorbach stated, the "textual additions or modifications to user instructions aimed at motivating the reader to keep on reading and trying long enough to perform the desired procedure correctly"(Loorbach, Steehouder, & TAAL, 2006, pp. 10–15). A good instruction, should be in pursuit with a motivational sub-goal along with the main instructive goal so that users are ensured to be motivated to keep on working when they are confronted with setbacks(Karreman & Loorbach, 2013).

However, motivation is a complex concept hard to be defined. To better define the motivational design, the ARCS model is developed and widely applied as a measurement of motivation (Keller, 1987, pp.1-10). Based on the ARCS model, the motivational elements should be aimed at enhancing attention, relevance, confidence or satisfaction. The classification is somewhat artificial due to the reason that these categories are highly interrelated. Motivational elements aimed at one category are of great possibility to fall into other categories as well(Karreman & Loorbach, 2013).

As motivation plays a vital role in effective technical communication, introducing motivational elements in instructional documents is of great value (Goodwin, 1991). For example, Goodwin stated in his book that readers should be encouraged to continue reading a manual in spite of various obstacles (Goodwin, 1991, p.99). A similar view is advocated by Horton, who claimed documents enhanced by motivational elements as "seductive documents". He pointed out that technical writers should handle drawing readers' attention so that they can notice and act on the information by creating more seductive documents (Horton, 1997). Furthermore, the importance of motivation elements could be embodied through the fact that International Organization for Standardization (ISO) defines usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.” Satisfaction, which supports users to have a continuing desire to learn and thus maintain high motivation, are included as an essential element in usability along with effectiveness and efficiency(Karreman & Loorbach, 2013; Van Der Meij, Karreman, & Steehouder, 2009). It serves as an important proof against those who attaches all the value of a manual to its correctness only.

Based on the assumption that users usually experience a lack of patience when dealing with complex and tedious instructions and easily get frustrated when in face of setbacks, motivational elements are applied to raise users’ interest, inspire them as well as boost their confidence. With the aim of facilitating positive experiences during the process of performing tasks, motivational information mainly focuses on users’ attention, their feelings about the relevant tasks and their level of confidence(Loorbach, Karreman, & Steehouder, 2007). Instructions inducing motivation should provide not only insightful instructions but also pursue an impression of concise and entertaining.

Several studies have been made to prove the positive effects of motivational elements have on users. It is demonstrated that users do appreciate motivational elements. By implementing motivational elements and information, there’s a possibility to enhance participants’ performance and help them to become more persistent when facing challenging tasks(Loorbach et al., 2007).

There are various types of motivational elements with different targets based on the ARCS model, aiming at attracting attention, increasing the feeling of relevance or booming confidence(Karreman & Loorbach, 2013). For example, motivational elements like distinct colors or pictogram are mainly used to improve attention level of users while the implementation ofanecdotes aim at improving relevance level. Furthermore, to satisfy users’ desire for social interaction, the strategies of influencing users’ affect and showing sympathy can be applied, such as the implementation of pedagogical agents (Van de Meij, 2008).

2.1.2 Pedagogical agents

According to the social cognitive perspective on teaching and learning, social interaction is of great importance in terms of motivational outcomes (Vygotsky, Cole, John-Steiner, Scribner, & Souberman, 1978). The implementation of pedagogical agents has satisfied users by providing them a simulated social environment in which communications, as well as interactions, are greatly encouraged, thus can be seen as an endeavor to introduce more instructional support. As a kind of motivational elements(Clark & Choi, 2005), pedagogical agents are defined as animated life-like “designed to enhance learning and motivation by simulating social interaction with a learner”(W. L. Johnson et al., 2000; Y. Kim et al., 2007). Learners can get information and knowledge through interacting with PALs (Pedagogical Agents as Learning Companions), who may provide an indication, encouragement or collaboration.

However, arguments always exist in terms of the specific effects of pedagogical agent implementation. On the one hand, compared to conventional courseware, pedagogical agents included in instructional application can provide social interactions with learners and are proved to be heAlpful to overcome some constraints on computer-based learning(Yanghee Kim & Baylor, 2006b). Since researches have demonstrated that social interaction serves as a key point of influencing learners' cognitive and affective characteristics, pedagogical agents may help users to become more engaged in learning tasks by simulating human instructional roles and providing consistent interaction(Skinner & Belmont, n.d.). The advantage of implementing agent can also be proved by Moreno's research, in which learners exposed to an environment with a pedagogical agent demonstrated better learning achievement and higher motivation level than learners without an agent(Moreno, Mayer, Spires, & Lester, 2001). While on the other hand, there are concerns that the presence of pedagogical agents can distract leaners from the learning content (Dehn & van Mulken, 2000).Just as Heidig and Clarebout stated in their studies, the majority of researches on pedagogical agents' effect of facilitating learning yielded no difference(Heidig & Clarebout, 2011). To give a clear explanation of this phenonmenon, it is vital to find out under what conditions can pedagogical agents facilitate learning. It was pointed out in their study that despite the uncertainty, factors such as learning environment, learner characteristics, and the pedagogical agent's function might influence the final outcomes of agent application. While in most studies, only the designing of pedagogical agents are concerned to be of great importance.

To create a social context for learning, pedagogical agents are designed to possess human-like personae under normal circumstances(H. Johnson, Nigay, & Roast, 1998). As for the detailed design of agent, it is never an easy task because many factors, as well as their mutual influence, need to be taken into consideration. In general, factors frequently concerned in pedagogical agent design include gender, ethnicity, multiplicity, visual image, verbal and nonverbal communication. In some specific cases, for example, when a peer agent acts as a co-learner in a system, the competency of agents serves as an important factor (Yanghee Kim & Baylor, 2006a). There are plenty of researches focusing on each detailed factor of agent designing, and many conclusions have been drawn to refine the design for different groups of users. Just as Baylor pointed out in her research (2011), users are more inclined to be influenced by agents with same gender and ethnicity. Furthermore, the "appearance and message delivery together with the dialogue are key design considerations" for an agent(Baylor, 2011). Appearance, which serves as the most important aspect of designing, plays a major role in the effectiveness of agents. As a complex factor, appearance is influenced by many factors such as the gender of the agent, its visual image, the level of realism and even the gender of users. For example, it is proved that the most effective agent among female undergraduate should be equipped with following features such as being a young, attractive and cool female(Baylor, 2011). On the other hand, message delivery through a human-like voice with appropriate emotional expressions is also vital in terms of design feature because emotion is proved as a part of human intellectual and cognitive functioning (Kort, Reilly, & Picard, 2001). Meanwhile, body movements like gestures, the facial expression can convey enriched information and draw learners' attention(Baylor & Kim, 2000). In general, "the credibility of these agents build trust relies on the visual quality of the agent and the behaviors that emulate humans"(Mora-Torres, Laureano-Cruces, Gamboa-Rodríguez, Ramírez-Rodríguez, & Sánchez-Guerrero, 2014).

The design of agents remains to be the possibly most complex issue. Many factors still need to be further studied with respect to the agent's voice, the role of nonverbal communication such as deictic gestures. Based on previous studies, Heidig and Clarebout have put forward a subordinate model which enable a systematic review of formal studies: Pedagogical Agents-Levels of Design (PALD) in their research(Heidig & Clarebout, 2011). They organize the different design features on three levels, including global design level as the lowest level, medium design level and detail design level as the highest level. They also mentioned that in this model, "decisions on a higher level presuppose decisions on a lower level". As the figure shows, agent roles, together with determining features, directly determines the most detailed factors like agent age, gender and so on.

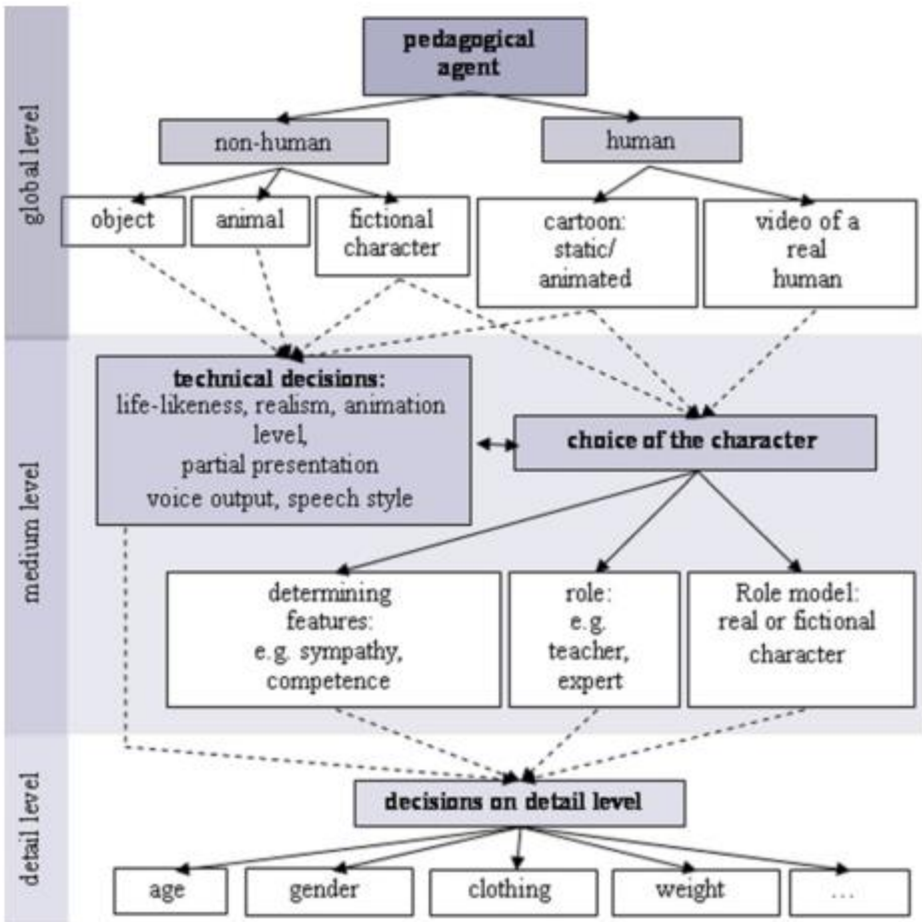


Figure 1 Pedagogical Agents- Levels of Design model (PALD)

2.1.3 The multiplicity of agents

A promising possibility in terms of regulating pedagogical interventions is the instantiation of multiple pedagogical agents in a learning environment(Baylor, 2002).The introduction of multiple agents has been widely applied since it is proved in researches that the use of multiple anthropomorphic agents can improve learning achievement (Xiao, Zhong, & Yuhui, 2004)

Bandura pointed out that learners may develop stronger beliefs in their ability to learn when they are exposed to multiple social models (Bandura, 1977). To apply this principle, an instructional environment may include multiple agents with varying perspectives or domain-specific skills, representing distinct agent. By separating agents functionally, it would be easier for students to compartmentalize the agent information when it is delivered by different sources. Baylor and Ebbers have also proved in their research that splitting agent roles into two distinct agents is preferable to combing those roles into one agent (Baylor & Ebbers, 2003).

Hietala and Niemirepo (1998) point out in their study that the same social factors occurring in learning communities with human beings are also influential in a learning community consisting of multiple artificial teaching and learning agents. They suggest that by providing alternatives to the learner via an "extended family of intelligent agents", the learning process can be effectively simplified. According to Baylor, "by designing a cle ar delineation of roles in the two-agent condition, learners' cognitive load requirements were reduced, deriving a more efficient learning situation(Baylor & Ebbers, 2003).

Schunk, Hanson and Cox (1987) tried to investigate how peer models influenced achievement behavior among children. They pointed out that compared to children who observe a single mastery model, those with single copying model, multiple coping model, and multiple mastery models demonstrated higher self-efficacy and better performance. This finding further proves that the effects of pedagogical agents can never be completely decided by a single factor. It is always the comprehensive function of all factors working together and influencing each other.

2.1.4 User Experience and Pedagogical Agent

Although user experience is a concept that has been widely disseminated and accepted in the field of Human-Computer Interaction, it is still not clearly defined (Law, Roto, Hassenzahl, Vermeeren& Kort, 2009). This is mainly because of the wide gap between practitioners and academics in their understanding of what user experience is. Though, in industry field, the user experience is treated mainly as a synonym of usability, its differences from usability is emphasized academically (Hassenzahl, 2008). However, the close connection between usability and user experience can never be denied. According to Herzum (2010), user experience includes peoples' behaviors, attitudes, and emotions about using a particular product, device or software. In general, user experience includes both usefulness and usability, which was measured according to ISO 9241-11 by the effectiveness, efficiency, and satisfaction of use. On the other hand, as a kind of motivational elements, pedagogical agents are proved to be effective in terms of improving satisfaction level. Therefore, despite the fact that researches focusing on the relationship between the implementation of agent and user experience are very limited, the deduction can still be made that user experience is possible to be improved by introducing agents since pedagogical agents areproved to effective in terms of enhancing learning performance and improving motivation.

2.2 The Instructional Role of Pedagogical Agent

Since pedagogical agents serve as an endeavor to simulate the social environment, the agent's persona and associated role is of great importance. Since people tend to apply the same social rules and expectations from human-human interaction to computer-human interaction, the agent roles are mostly from real-life learning environment and the effect of agent roles can also be explained by theories developed in terms of human instruction (Ericsson, Krampe, & Tesch-Romer, 1993). Given their function for supporting learning, pedagogical agents can be designed to represent different instructional roles such as expert, instructor, mentor, learning companion. To design effective pedagogical agents more vividly, different types of human metaphors have been adopted. Traditionally, the expert tutor is the most widely used role in giving instructions. Many agents are developed as expert-like image such as the agent AutoTutor which plays the role of tutor (Graesser, Person, Harter& Group,2001) as well as the Steve and Adele agents which represent experts in the domains of military trainings (Johnson et al., 2000). Meanwhile, there are increasing studies designed to focus on learning companion agent role by adopting a peer metaphor, which is also applied in former tutoring systems (Goodman, Soller, Linton, &Gaimari, 1998; Kapoor& Picard, 2005). The implementation of expert-like tutor agent and the co-learner agent has perfectly simulated the most common learning environment in which each leaner is tutored by tutors with rich knowledge and simultaneously surrounded by the peer with similar levels of ability. As the two kinds of most typical agent role in the instructional system, expert-like agent and co-learner agent would be the focus of this study.

2.2.1 Coping model vs. Mastery model

The main character strongly related to agent role is its mastery level of knowledge. Agents with strong professional background usually play the role of expert, mentor, taking responsibility of giving instructions, or sometimes as a highly competitive co-leaner who serves as a challenge for users. While agents with limited experience of relevant field are more frequently designed as peer or co-learner with low competency. Ebbers has put forward two types of an anthropomorphic interface agent model: mastery model and coping model (Ebbers, 2007). This is based on the formal studies on therapeutic contexts in which modeling is used to reduce avoidance behaviors in fearful clients (Thelen, Fry, Fehrenbach, & Frautschi, 1979; Schunk, Hanson& Cox,1987). Mastery model agents demonstrate positive attitudes towards the task and the desired levels of performance. This type of agent model "cheerfully and easily learns the information, demonstrating high self-efficacy in the process" (Ebbers, 2007) The copying model is an endeavor to model for the learners how to cope with a situation as a novice, demonstrating the typical fears and deficiencies of observers initially but gradually gain self-confidence and improve performances (Kazdin, 1978) . It "initially struggles with the material but is capable of building mastery gradually through the expressed use of coping and learning strategies" (Ebbers, 2007).

When being exposed to a mastery agent, learners should perceive it as dissimilar to them since it can learn the materials effortlessly and enthusiastically. With a dissimilar social comparison to the mastery model agent, learners would be expected to seek to disaffiliate with that model. A mastery agent can help learners to achieve more positive learning performance outcomes. However, the implementation of mastery model agent can also cause the anxiety in the form of negative mood in learners. It is also possible that mastery model agent is of great effects in terms of helping users to get greater cognitive dissonance and finally lead to lower regulation (Festinger, 1962).

Conversely, the results indicate that when in a computerized human-agent learning environment, the coping agent can lead to more positive social learning outcomes among users. Learners with coping model agents are more likely to see them as "true partners" for the reason that coping model agents share the same struggles with them. Therefore, users' anxiety tends to be more easily diminished and thus it will lead to more positive affect, motivation, attitudes and behaviors (Festinger, 1962). Ebbers found out that working with coping model can help to enhance motivational outcomes as compared to be with mastery agents. Baylor also pointed out in her research that if the agent is caring and acts as a coping model, motivational and affective outcomes maybe enhanced(Baylor, 2011).

Similarly, PALs can be designed to achieve different levels of competency depending on the theoretical perspective. When with high-competency agents, learners can grow intellectually beyond the limits of their present capabilities. Since high-competency agents have already acquired rich knowledge in the relative domain, learners can take advantage of their knowledge and experience. However, the high competency PALs might decrease a learner's self-efficacy beliefs in the task. It has been proved by Aimeur and Frasson (1996) that learners' affective characteristics including self-esteem, sense of responsibility and confidence were significantly enhanced when they work with peers who were academically weaker than themselves in computer-based environments.

2.2.2 Expert-like agent

Expert-like agents are agents with the feature of an expert, with higher than average mastery level of knowledge in one domain. Expert agents mainly take the responsibility of providing instructions, serving as an instructive role rather than a supportive role in a system(Baylor & Kim, 2005b). It has been pointed out in Van de Pol and her colleagues' research that the evaluation criteria of a qualified human teacher comes down to two factors: the expertise and personality (Van de Pol, Volman, & Beishuizen, 2011). As Veletsianos (2010) put forward in his book, agents playing an expert role may positively influence learners' stereotypic perceptions and expectations of the agent. With a high mastery level of knowledge, pedagogical agents resembling experts are usually perceived as intelligent and competent (Kim, Baylor, & Reed, 2003). Being an expert is firmly related to exhibiting extensive knowledge or better as well as a more stable performance within a domain (Gonzales, Burdenski, Stough, & Palmer, 2001). It is known that for a human being who wants to develop expertise in a certain domain, several years of deliberate practice is required (Ericsson, Krampe, & Tesch-Romer, 1993). By implementing an expert-like agent in a system, learners tend to assign higher confidences and trust to instructions. Since pedagogical agent role is based on realistic social stereotype, expert-like agents are usually designed as a role with confidence and will "not swayed emotionally by instant internal or external stimulation"(Baylor & Kim, 2000). In consideration of these features attached to this role, expert agents are usually designed with the visual image of professors dressed in a suit. Furthermore, the expert-like agent must speak in a formal and professional manner, with very few exaggerate non-verbal communications to make sure it is emotionally detached form leaners.

Despite the shortage of being less supportive, it is believed that expert agents are perceived to be more credible and more helpful when it comes to transfer of learning(Baylor, 2003).

2.2.3 Co-learner agent

Co-learner agents, or pedagogical agents as learning companions (PALS), are defined as "peer-like characters simulating peer interaction in computer-based learning"(Yanghee Kim & Baylor, 2006b). As implied by its name, a learning companion is set as a role keeping company of learners during the process of study. Just as the role a classmate plays in real life, co-learner agenta share the same information resource with leaners and can be designed to collaborate with or compete against users. Many researches in the field of psychology have proved the benefits of peer-to-peer interaction over teacher-to-learner interaction theoretically and empirically (Matusov& Hayes, 2000; Yarrow & Topping, 2001) for the reason that having social interaction or cooperation with equally able peers is believed to have benefit on intellectual development, thinking, affect as well as cognitive growth (Matusov& Hayes, 2000). As Bandura stated, attribute similarity between the learner and social model can have significant impact on learner's self-efficacy belief, which serves as a critical component of learner motivation (Bandura, 1997).The implementation of the co-learner agent is an attempt to simulate the beneficial interaction in tutoring systems, thus achieve the effect of motivating users.

As for the relationship between learning companion and leaner, three types of protocols are presented by Chan and Baskin (1990) including competition, suggestion, and collaboration. According to the theory, for learner and learning companion who work independently and then comparing work, their relationship is defined as competition; for those who work collaboratively with one's working and the other one's watching, their relationship is defined as suggestion and for those working collaboratively and sharing responsibility, the relationship between them is defined as collaboration. Earlier use of learning companions was mainly focused on the systems' learning along with the learners (Yanghee Kim, 2007). While nowadays, with the development of interface technology, the three relationship goals between learner and learning companion mentioned above can all be achieved.

When designing a co-leaner agent, besides factors which always needed to be taken into consideration such as gender, affect, ethnicity, multiplicity and so on, a very unique factor, namely competency, along with relevant interaction type, is of great value and needs to be resolved. For example, when a PAL is equipped with instructor-like competency, it will lose its peer-likeness because "the PAL should be perceived as peer-like and believable"(Yanghee Kim & Baylor, 2006b). PALs are supposed to be helpful in learning and proving motivation. However, as Baylor and Kim (2006) pointed out, the high competency of a PAL might decrease a learner's motivation. On the contrary, a co-learner agent with appropriate levels of competency can achieve the better effect of simulating human peer interaction thus further facilitate learning. This conclusion is also in line with the former research of mastery model agent and copying model agent.

Another factor that has been studied on co-learner agent is whether being caring will lead to different feelings of users. To address this issue, Lee and colleagues (2007) conducted an experiment that employed three conditions: a caring co-learner agent; a non-caring co-learner agent and a control. They finally demonstrated that students working with caring co-learner agent had significantly greater feelings of social support and trust. Thus, a conclusion can be drawn that learners are most motivated when working with a caring co-learner agent with the appropriate level of competency.

2.2.4 Multi-agent System of Expert Agent and Co-learner Agent

The multi-agent system provides a platform that allow each pedagogical agent "to specialize on the behaviors for which they are responsible"(Campbell & Wu, 2010). Since different types of information can be delivered by distinct sources in multi-agent system, it might be easier for learners to compartmentalize the information. Baylor and Ebbers (2003) conducted an experiment in which they used two split agents, a motivator agent and an expert agent, to replace the mentor, agent. The results showed that compared to a single mentor agent, the combination of these two agents facilitated learning more effectively by providing learners with both motivation from the motivational agent and learning support from the expert agent. They pointed out that by attributing certain types of comments to a certain agent, the cognitive load of users is largely reduced. It was found in their research that the implementation of these two agents in one system has great impacts on helping users to recall information in the process of learning. However, compared to mentor agent, the two-agent system didn't help much in terms of users' motivation level.

2.3 Hypotheses

Since there are limited researches focusing on pedagogical agent's role and its effect on users, this study aims to further investigate and confirm existing research results. To better investigate the persona effects of the pedagogical agent, the research question raised as: What's the pedagogical agent role's effect on users?

Task performance

- 1a). Participants with a co-learner agent will have a higher level of effectiveness compared to participants with an expert agent or two kinds of agents simultaneously in the task completion phase.
- 1b). Participants with both a co-learner agent and an expert agent will have a higher level of effectiveness compared to participants with an expert agent or participants with a co-learner agent in the task repetition phase.
- 1c). Participants with both an expert-like agent and a co-learner agent will spend longer time on finishing the task compared to participants with only an expert agent or a co-learner agent in the task completion phase.

Motivation

- 2a). Participants with a co-learner agent and with both a co-learner agent and an expert agent will have a higher level of motivation compared to participants with an expert agent only.
- 2b). Participants with a co-learner agent will have a higher level of confidence than participants with an expert agent and participants with both a co-learner agent and an expert-agent.
- 2c). Participants with a co-learner agent will have a stronger feeling of relevance than participants with an expert agent and participants with both a co-learner agent and an expert-agent.
- 2d). Participants with a co-learner agent will have a higher level of satisfaction than participants with an expert agent and participants with both a co-learner agent and an expert-agent. .
- 2e). Participants in multi-agent groups will have a lower level of attention then participants with a co-learner agent and participant with an expert agent.

Agent perception

- 3a). Participants will give higher ratings to the co-learner agent when co-learner agent and expert agent coexist in a system.
- 3b). Participants with only a co-learner agent will have a different perception of this agent than participants with a co-learner agent and an expert agent.
- 3c). Participants with only an expert agent will have a different perception of this agent than participants with a co-learner agent and an expert agent.

User experience

- 4). The participants with a co-learner agent will report better user experience compared to participants with an expert agent and participants with both a co-learner and an expert agent.

3. Methodology

3.1 Experimental Design

Based on pedagogical agent design and the effect of different agent role found by prior researches, an experiment was conducted to test expert-like agent and co-learner agent's impact on users.

During the research study, participants were asked to perform a task in Photoshop, which included four sub-tasks with the help of printed instructions. Participants were divided into three groups with each group containing 10 female and 10 male. There were pedagogical agents presented in the instructions for each group. While for group 1, it was an expert-like agent giving instruction and reminding participants of some complex steps. For group 2, the pedagogical agent was designed as a caring co-learner who gives encouragement at an exactly same place where the expert-like agent gives remind. In the manual prepared for group 3, the expert-like agent and co-learner agent coexisted.

3.2 Material

According to former studies, learners are more inclined to be influences by agents with same gender as them(Baylor, 2011), which means participants should be matched with agents with their gender in an ideal case. However, since agents' gender is not a dependent variable in this research, the decision had to be made in the selection of agents' gender. Since it is widely recognized that female agents are acceptable both for male and female students, the agents in this study were designed as female. For the expert-like agent, the visual appearance resembled a female lecture while the co-learner agent was designed as a female college student in her 20s. Additionally, both agents were designed to give an introduction at the beginning of the instructions so that users could get an overall impression on them. The expert agent, named Kate, introduced herself as an expert with abundant experience in using Photoshop. The peer agent, Kelly, however, introduced herself as a novice of using Photoshop. The following figures show the visual images design of expert agent and co-learner agent.

Figure 2 expert-like agent

Figure 3 co-learner agent

The instructions were based on a tutorial from an online blog that instructed users to change the background of an image by using channel method in Photoshop. To ensure the instructional effect of the manual, the level of complexity of the task was controlled within the normal range. Because of the limitation that agents applied in this experiment were in the static state, all information provided by agents were through their verbal communication and visual image only to make sure that no other factors influenced the experiment. Participants' completion status of tasks and the time each participant spent on tasks were all recorded.

After performing tasks, participants were asked to fill out a questionnaire using ranking methods in which they evaluated the quantified levels of their motivation, satisfaction with the system and gave opinions or some additional comments on the motivational agents.

In the instructions, the expert-like agent was designed with typical features of an expert, that is, knowledgeable, having confidence and mainly provide information only. While the co-learner agent is designed as a learning companion with same mastery level of knowledge. Despite the lack of experience, the co-learner agent tended to be very caring and tried to motivate participant by giving encouragement all the time.

The comparison of these two types of agents can be seen as the following example, which was excerpted from the instructions in which the expert-like agent and co-learner agent coexist.

Refining edge of the selected subject is very helpful to improve the quality of final outcome. As you can see, you have removed the background of original image perfectly with the help of edge refinement.

Now we have finished 75% of whole task and we are about to finish the task successfully!
Let's work on the final subtask.

3.3 Measurements

The dependent variables included participants' performance, their motivation level, their perceptions of agents they are working with and the user experience of instructions.

For each construct, the Cronbach's Alpha value was calculated to ensure the reliability of the collected data.

Learners' agent perceptions

Four items, each scaled from 1 (strongly agree) to 5 (strongly disagree) measured learners' perceptions of agent's attractiveness (I like Kate/Kelly), agent's friendliness (Kate/Kelly is friendly), agent's knowledge (Kate/Kelly is knowledgeable) and agent's lesson credibility (I can trust the lesson that is presented Kate/Kelly). (Liew et al., 2013)

The Cronbach's Alpha of co-learner agent and expert agent were calculated to measure the reliability of agent perception data.The value of Cronbach's Alpha of co-learner agent perception and expert agent perception was shown in the following table:

Table 1 Cronbach's Alpha value of agent perception

	Co-learner	**Expert**
Cronbach's Alpha	.863	.881

The high value of Cronbach's Alpha value of these two constructs shows that the data was reliable.

Learners' motivation level: Attention, Relevance, Confidence, and Satisfaction

The self-report measure RIMMS (Reduced Instructional Materials Motivation Survey), a 12-item version of the instructional materials motivation survey (Keller, 2009; Loorbach et al., 2006), was conducted to measure the four constructs of Keller's ARCS model of motivation design, which are attention, relevance, confidence and satisfaction. Each item scaled from 1(strongly agree) to 5(strongly disagree).

The Cronbach's Alpha value of these four constructs was calculated. The result was shown in the following table.

Table 2 Cronbach's Alpha value of ARCS model

	Relevance	**Attention**	**Confidence**	**Satisfaction**	**Overall**
Cronbach's Alpha	.581	.724	.664	.810	.832

According to the results, the values of attention, confidence and satisfaction constructs are all greater than 0.6, which meant the data of these three constructs was of high reliability. Although the result of Relevance construct was not high enough, it was very close to the standard of being reliable. For this reason, the decision was made to take it as valid data.

User experience

Four items measured learners' overall experience were conducted, including the level of positiveness, satisfaction, effectiveness and efficiency. Each item scaled from 1(most negative) to 5(most positive) (Yang, 2015).

The Cronbach's Alpha value of user experience was as high as 0.845. Therefore, it's convincible that the data of user experience is reliable and can be used for further research

Learners' task performance

The analysis of learners' learning achievement mainly depends on two factors, namely effectiveness and efficiency. By recording whether participants can finish the task successfully with or without instructions, the time they spent on tasks and which subtasks they stopped under the condition that they didn't finish the task successfully, the learning achievement can be measured. To be noticed, leaners were requested to perform the task twice. They were asked to perform the task with instructions in phase 1 and repeat the task without instructions in phase 3. The completion status of both two phases was recorded while the time spent was only recorded in phase 1.

3.4 Participants

The participants of the research were mainly students from the University of Twente. The sample consisted of the same number of male and female participants in total and in each group so that the result of the experiment was ensured not to be influenced by gender or education level. In this study, 60 participants, 30 males, and 30 females, were divided equally into three groups, with 10 males and 10 females in each group. All the participants joint the experiment out of their willing and were requested to finish the task without searching for help. The education level and average age of participants are listed in the following table:

Table 3 The education level and average age

Group	**Expert**				**Co-learner**				**Expert and Co-learner**			
	Bachelor	**Master**	**Phd**	**Average age**	**Bachelor**	**Master**	**Phd**	**Average age**	**Bachelor**	**Master**	**Phd**	**Average age**
Female	3	6	1	23.2	2	7	1	23.4	3	7	0	21.3
Male	3	6	1	22.8	3	5	2	23.2	3	4	3	23.3

All participants were required to have no experience or very limited experience in using Photoshop to eliminate the possible influence on experiment's credibility.

3.5 Pre-study

Before the formal experiment started, eight participants were asked to perform the task step by step according to the instruction and give suggestions on how to improve the quality of instructions. In addition to this, these participants also gave their opinions on the visual image of pedagogical agents applied in the instructions. Thus, it was ensured that the instructions were understandable; the task was doable, and the agents were acceptable before the formal experiment was conducted.

Meanwhile, to enhance the validity, the online questionnaire was tested beforehand carefully to avoid errors. Clear instructions and simple wording were used to ensure that the results are valid.

3.6 Procedure

Each participant was asked to finish all the tasks on his or her own in the uninterrupted environment. He or she was firstly given an introduction of the experiment and asked to sign a consent form to make sure of the anonymous processing of recorded data. Then the participant would start to work on the task with the help of instructions. During the process of experiment, the participant was not allowed to ask any questions about how to perform tasks, but he or she could choose to stop whenever they felt that they were not capable of continuing the experiment anymore. Participant's operation was screen recorded. After finishing the tasks, the time he or she spent on the tasks was recorded. Whether the participant had finished the tasks or not, the participant was asked to fill out the questionnaire after performing tasks. Finally, the participant was asked to perform the whole task again without instructions. Whether he or she had successfully repeated the task and in which subtask did he or she stuck was taken noted. In this way, an analysis of the task performance and opinions of the multi-agent system can be conducted.

4. Results

This section presents the experiment's results. Differences in users' task performance, their motivation level, the perception of the pedagogical agent they worked with, and the user experience of the instructions.

4.1 Differences in task performance

Learners' task performance was measured by two sub-constructs, which were effectiveness and efficiency. Since participants were required to perform the task firstly with instructions in phase 1 and then repeat it without instructions in phase 3, the data of effectiveness were collected both in these two phases. While the data of efficiency were only collected during phase 1.

4.1.1 Differences in effectiveness

In each group, there were participants who failed in finishing the task with instructions and in repeating the task without instructions.

11 participants failed to finish the first step of the experiment, which was performing the task with the help of instructions. Group 1 (participants with instructions containing expert-like agent only) was with the highest failure rate, 5 participants out of 20 were unable to finish the

task successfully. While in group 2 (participants with instructions containing co-learner agent only) and group 3 (participants with instructions containing both co-learner agent and expert-like agent), the occurrence number tied up, with 3 participants failed in each group.

The number of participants who failed to repeat the task without instructions, however, soared up to 31, with 12 in both group 1 and group 3, and 7 people in group 2. By analyzing the data mentioned above, it seemed that participants working with a co-learner agent performed best in terms of effectiveness.

Since the whole task was divided into four subtasks, for those who have failed in step 1 or step 3, data was collected as in which subtask the participant end. Table 4 and Table 5 show the detailed results for each group in the phase of task completion and task repletion separately.

Table 4 Performance in phase 1

		Group			Total
		expert	**co-learner**	**Expert and co-learner**	
Which part did the participant end	**Subtask 1**	1	0	0	1
	Subtask 2	1	0	2	3
	Subtask 3	0	1	0	1
	Subtask 4	3	2	1	6
Participants who finished all task		15	17	17	49

Table 5 Performance in phase 3

		Group			Total
		expert	**co-learner**	**expert and co-learner**	
Which part did the participant end	**Subtask 1**	5	3	4	12
	Subtask 2	4	3	5	12
	Subtask 3	0	1	2	3
	Subtask 4	3	0	1	4
Participants who finished all task		18	23	18	29

To better measure the agents' impact on effectiveness in phase 1, the mean score was calculated as shown in Table 6.

Table 6 Mean score of effectiveness in Phase 1

	Expert		**Co-learner**		**Expert and Co-learner**	
Total task performance	M	SD	M	SD	M	SD
Number of tasks performed correctly	3.50	1.41	3.80	0.58	3.65	1.16

As hypothesis 1a stated, participants with a co-learner agent will have a higher level of effectiveness compared to participants with an expert agent or two kinds of agents simultaneously in the task completion phase.The results of an ANOVA showed that this hypothesis was not confirmed (F=0.556, p=0.594). The conclusion can drowns that agent didn't have an effect on effectiveness.

Table 7 shows the mean score of effectiveness in Phase 3.

Table 7 Mean score of effectiveness in Phase 3

	Expert		**Co-learner**		**Expert and Co-learner**	
Total task performance	M	SD	M	SD	M	SD
Number of tasks performed correctly	2.25	1.24	2.85	0.75	2.20	0.95

The expectation of effectiveness in the repetition phase was participants with both a co-learner agent and an expert agent will have higher level of effectiveness compared to participants with an expert agent or participants with a co-learner agent (hypothesis 1b). The results of ANOVA test showed no significant differences between three groups (F=0.287, p=0.753). Thus, Hypothesis 1b was not confirmed.

4.1.2 Differences in efficiency

Efficiency was measured by making a comparison between the time participants consumed in each group. Participants who did not finish the task were excluded. The ANOVA test was conducted to measure the difference between the three groups.

Table 8 shows the mean score of effectiveness in Phase 3.

Table 8 Mean score of efficiency

	Expert		**Co-learner**		**Expert and Co-learner**	
Total task performance	M	SD	M	SD	M	SD
Number of tasks performed correctly	19.60	8.70	17.00	5.87	20.65	8.44

Expectation was made that participants with both an expert-like agent and a co-learner agent will spend longer time on finishing the task compared to participants with only an expert agent or a co-learner agent in the task completion phase (hypothesis 1c). While the mean score did show some tendencies of the hypothesis, the ANOVA test (F=1.168, p=0.318) showed no significant differences between each group. Thus, hypothesis 1c was not confirmed. Agents didn’t have a significant influence on efficiency.

4.2 Differences in motivation level

The motivation design level was measured through the four constructs of Keller's ARCS model. Thus, the results of the experiment were analyzed through a univariate ANOVA, with each construct, namely attention, relevance, confidence and satisfaction, as dependent variables. The independent variables in the analysis were pedagogical agents.

A univariate ANOVA test was taken to measure the difference among three groups in attention, confidence and satisfaction constructs separately.

Table 9 shows the mean score of each construct in each group. Group 1 represents the condition in which participants are instructed by expert agent; group 2 represents the condition in which participants are encouraged by co-leaner agent; group 3 represents the condition in which participants are exposed to expert-like agent and co-learner agent simultaneously.

Table 9 The Mean Score of RIMMS

Construct		Expert	Co-learner	Expert and Co-learner
confidence	Mean	1.9	2.16	2.26
	SD	0.53	0.77	0.63
satisfaction	Mean	2.53	1.98	2.5
	SD	0.81	0.68	0.71
Attention	Mean	2.3	2.2	2.33
	SD	0.73	0.63	0.7
Relevance	Mean	2.12	2.28	2.32
	SD	0.71	0.66	0.57
Overall	Mean	2.21	2.17	2.35
	SD	0.59	0.51	0.42

Motivation: It was expected that participants with a co-learner agent and with both a co-learner agent and an expert agent will have a higher level of motivation compared to participants with an expert agent only (hypothesis 2a). Since ANOVA showed no statistically differences existed ($F=0.720$, $p=0.491$). The hypothesis was not confirmed. The implementation of different agents didn't affect the overall motivation level of users.

Confidence: It was expected that participants with a co-learner agent will have a higher level of confidence than participants with an expert agent and participants with both a co-learner agent and an expert-agent (hypothesis 2b) because a co-learner agent persistently encourages the users, which would boost their level of confidence. However, a statistical test (ANOVA) showed no differences between the co-learner agent group and expert group agent group, nor did it exist between these two groups and the multi-agent group ($F= 1.89$, $p=0.160$). Thus, the hypothesis was not confirmed. The implementation of different agents didn't affect the users' confidence level.

Relevance: It was expected that the co-learner agent group would show a higher level of relevance compared to the other two groups (hypothesis 2c). According to the results of the ANOVA test, no significant difference was found between the co-learner group participants and the other two groups (F= 0.545, p=0.583). The implementation of different agents didn't affect the users' relevance level.

Satisfaction: As hypothesis 2d stated, participants in co-learner agent group would be the most satisfactory group. Multi-agent group came to the second, followed by expert agent group. As it shown in table 4, a significant difference was found between three groups (F=3.551, p=0.035). A Bonferroni post hoc test showed that this was due to a tendency (p=0.089, d=0.23) toward a difference between group 1 and group 2. Thus hypothesis 2c was confirmed.

Attention: Hypothesis 2e stated that compared to other two groups, multi-agent group users would show the lowest level of attention because it was possible that they were distracted by the presentation of two agents. However the hypothesis was turned down as the test showed no differences among three groups (F= 0.205, p=0.813).

4.3 Differences in Agent Perception

The agent perception was measured through four aspects, namely agent's attractiveness, agent's friendliness, agent's mastery level of knowledge and agent's credibility. The mean score of these four aspects was calculated as the overall perception of the agent. The results of the experiment were analyzed through a univariate ANOVA.

To measure the differences of agent perception between each group, the ANOVA test was conducted.

Table 10 shows the mean score of co-leaner agent perception and expert agent perception.

Table 10 Mean score of co-leaner agent perception and expert agent

		Expert	Co-learner	Expert and Co-learner
Expert	Mean	2.25		2.46
	SD	0.81		0.77
Co-learner	Mean		2.26	2.75
	SD		0.66	0.69

Hypothesis 3a stated, participants will give higher ratings to co-learner agent when co-learner agent and expert agent coexist in a system.. While as the ANOVA test showed, there was indeed a significant difference between the two agents perception under the condition that both agents coexist in the instructions (F=3.973, p=0.026). However, it was expert agent who earned higher ratings. Thus the hypothesis 3 was turned down. Generally, participants deemed the expert agent to be better than the co-learner agent.

As for the expectation that participants with only a co-learner agent will have a different perception of this agent than participants with a co-learner agent and an expert agent (hypothesis 3b), it was approved by a T-test (F=5.180, p=0.029) which showed that participants’ ratings of co-learner agent decrease when it was presented together with expert agent.

Expectation was made that participants with only an expert agent will have a different perception of this agent than participants with a co-learner agent and an expert agent. (hypothesis 3c). However, it was not confirmed by a T-test (F=0.714, p=0.403) which showed that participants’ ratings of co-learner agent did not change much when it was presented together with expert agent.

4.4 Differences in user experience

User experience consists of four aspects, namely the level of positiveness, satisfaction, effectiveness and efficiency. The mean score of these four aspects was calculated the results of the experiment were analyzed through a univariate ANOVA.

Table 11 shows the mean score of user experience in each group.

Table 11 The Mean Score of user experience

	Expert	Co-learner	Expert and Co-learner
Mean	2.51	2.31	2.4
SD	0.73	0.92	0.79

The expectation was that the participants with a co-learner agent will report better user experience compared to participants with an expert agent and participants with both a co-learner and an expert agent. (hypothesis 4). However, by taking the ANOVA test, no general effects of agent on user experience was found (F=0.299, p=0.743). Hypothesis 4 was not confirmed.

5. Discussion

This study focused on finding out the possible effects of different types of pedagogical agent. Aiming to examine the possible impact made by an expert-like agent and a co-learner agent, twelve hypotheses were put forward as assumptions based on the results of former studies. By analyzing data collected in experiment, results of these hypotheses were revealed, as shown in the following table.

Table 12 Conclusion

Hypotheses		Results
Task Performance	Participants with a co-learner agent will have higher level of effectiveness compared to participants with an expert agent or two kinds of agents simultaneously in the task completion phase.	Not supported
	Participants with both a co-learner agent and an expert agent will have higher level of effectiveness compared to participants with an expert agent or	Not supported

	participants with a co-learner agent in the task repetition phase.	
	Participants with both an expert-like agent and a co-learner agent will spend longer time on finishing the task compared to participants with only an expert agent or a co-learner agent in the task completion phase.	Supported
Motivation	Participants with a co-learner agent and with both a co-learner agent and an expert agent will have a higher level of motivation compared to participants with an expert agent only.	Not supported
	Participants with a co-learner agent will have a higher level of confidence than participants with an expert agent and participants with both a co-learner agent and an expert-agent.	Not supported
	Participants with a co-learner agent will have a stronger feeling of relevance than participants with an expert agent and participants with both a co-learner agent and an expert-agent.	Not supported
	Participants with a co-learner agent will have a higher level of satisfaction than participants with an expert agent and participants with both a co-learner agent and an expert-agent.	Supported
	Participants in multi-agent groups will have a lower level of attention then participants with a co-learner agent and participant with an expert agent.	Not supported
Agent Perception	Participants will give higher ratings to co-learner agent when co-learner agent and expert agent coexist in a system.	Not supported
	Participants with only a co-learner agent will have a different perception of this agent than participants with a co-learner agent and an expert agent.	Supported
	Participants with only an expert agent will have a different perception of this agent than participants with a co-learner agent and an expert agent.	Not supported
User Experience	The participants with a co-learner agent will report better user experience compared to participants with an expert agent and participants with both a co-learner and an expert agent.	Not supported

5.1 Implications

The study showed the effects of co-learner agent and expert-agent on users in terms of following four constructs: task performance, motivation, agent perception, user experience.

In this study, no differences were found in terms of effectiveness and efficiency by implementing different types of pedagogical agent. Although in some studies, agent-based instruction is proved to result in better learning performance(Eiriksdottir & Catrambone, 2011), the result of this study is basically in line with the results of some other former researches on motivational elements(Karreman & Loorbach, 2013; Loorbach et al., 2006). Besides motivational elements' limited influence on effectiveness and efficiency, another possible cause for this phenomenon could be attributed to the task itself. As stated in former research(Lester, Converse, Stone, & Kahler, 1997), the magnitude of animated pedagogical agents' effects on students' problem-solving performance increase with the level of problem difficulty. Since the task was limited to be within a certain level of difficulty and was controlled to contain reasonable amount of information, the possibility of causing a significant difference in effectiveness and efficiency is relatively small, especially when participants were all well-educated college students who have had easy access to computer as well as various applications from very young age. A relatively new finding of this study is that agent has no great effect on the effectiveness in task repetition phase. No matter they were given useful instructions by expert agent or encouragement by co-learner agent, or instructions together with encouragement, participants' completion status of task repetition didn't differ much. Perhaps it was too much cognitive load for participants to memorize the complete operating steps when they were introduced to use Photoshop for the first time and the implementation of agents is of very minor effect on it.

Hypotheses that participants working with instructions with a co-learner agent will a have higher level of motivation compared to participants with expert agent only was partly proved. This conclusion further confirmed the co-learner agent's effect in terms of motivating users. Despite the fact that co-learner agent is clearly not equivalent to human peer, its effect on simulating social interaction in computer-based learning environment has been proved (Yanghee Kim & Baylor, 2006a). Since peer-peer interaction has been verified to be of great benefits in terms of learners' affective attainments(Bandura, 1977), the introduction of co-learner agents, especially caring ones, can contribute to the improvement of leaner's motivation level. The hypothesis that the implementation of co-learner agent can lead to higher ratings of satisfaction is verified in the study. As the agent simulating human-peer interaction, co-learner agent is perceived to be more friendly(Y. Kim et al., 2007; Yanghee Kim & Baylor, 2006b).

In this study, the co-learner agent was designed to give motivation and praise frequently, thus its perceived level of friendliness might be further improved. However, the presentation of co-learner agent is not helpful for the improvement of confidence in this study. The most possible reason for it might lie in the participants. As it mentioned before, participants in this study are all college students who have accepted at least undergraduate education. The average age of these participants is quite young, which means that most of them are raised in environment with various technology products, including computer. Compared to senior users who are more easily encouraged by motivational elements, young people are less afraid when they are exposed to new technology. Thus it would be harder to improve their level of confidence, which is already very high.

The other interesting finding in this research is that participants with multiple agents are proved to be no less attentive than participants in other groups. According to Moreno and Flowerday's finding (2006), participants who are more attracted by the agents are more likely to focus on the social characteristics of the agents, which will lead to interference in the learning process. Due to the fact that no differences of attention level were found in three groups and relative high mean score of attention, the most possible explanation is that participants are not very attracted by pedagogical agents here. It could be caused by the design of pedagogical agent or by the background of participants. Since users are more inclined to be effected by agent with their own gender(Baylor & Kim, 2000; Baylor, 2011), it is of great possibility that male participants were less influenced by pedagogical agents presented in instructions. On the other hand, college students may be less attracted by pedagogical agents compared to children or senior users.

As for the perception of agent, expert-like agent was given higher ratings by users, which is completely opposite to hypothesis. According to the mean scores, the expert-like agent was of higher level of credibility and knowledge although it was rated with lower level of attractiveness and friendliness. Since expert agent was with higher overall rating, the conclusion can be drawn that in this study, the expert agent was deemed to be much more credible and knowledgeable than co-learner agent. The finding that expert-like agent was of higher level of credibility further confirms the conclusions of previous studies mentioned in the theoretical framework part. However, contrary to some previous studies (Y. Kim et al., 2007; Liew et al., 2013), it was found in this study that expert-like agent is deemed to be more knowledgeable. This phenomenon may owe to the multi-agent system in which both the expert agent and co-learner agent were presented. Unlike co-learner agent, expert agent focused on providing useful information and reminders, which might easily lead to higher ratings of its knowledge level among users. Due to the same reason, possibly, the ratings of co-learner agent go down when it was presented in one system together with expert-like agent. However, another interesting finding to be noticed is that participants' ratings on expert agents didn't change much when it was presented together with co-learner agent. The reason for this phenomenon is still to be discovered.

It was hypothesized that the instructions of co-learner agent group would result in better user experience compared to other two groups because co-learner was expected to be more enjoyable due to previous researches. However, contrary to the hypothesis, it was proved in this study that user experience is not much altered despite the implementation of different agents. Since there are very limited researches focusing on the relationship between agent implementation and user experience, further studies are needed to be conducted in this field.

5.2 Limitations

Some limitations of the design of this study may affect the results, of which, the fact that the pedagogical agents are just printed on manual as static images might serve as the biggest one. Without non-verbal communication like facial expressions or gestures, less information related to agent was conveyed. Since it is proved that both the visual and voice characteristics of expert-like agent and co-learner agent have certain effects of learners' psychological behaviors(Doswell, 2004), the absence of voice information might lead to different psychological condition of users.

The other limitation of this study is the lack of investigation into gender difference. According to previous researches, one essential factor which must be taken into consideration when investigating the effect of pedagogical is the participants' gender. With different gender, learners might have distinct reaction to a same variable. For example, according to Baylor (2005), female students performed significantly better when using a cartoon agent than male students, while male students have better perform when they are exposed to highly realistic pedagogical agent (Baylor, 2005; Sahimi et al., 2010). Moreover, female participants and male participants tend to have different levels of acceptance of pedagogical agent itself. Research has proved that female learners were more likely to give better ratings for agents compared to male learners(Baylor & Kim, 2000). For these reasons, participants' gender also do make an impact on their opinion of agents. However, because of the limited number of participants, it is not possible to classify participants by their gender in each group.

On the other hand, since there are still very limited researches on the measurement of user experience, the investigation of user experience in this article is not completely scientific. Further researches are needed in this field.

5.3 Suggestions for future research

Since the participants in this research were all college students, further research can be made on agent's effects in different age group such as children or the seniors. Generally,the seniors are more in awe of technology compared to young people and it will take them longer time to learn the usage of electronic products. For this reason, it is of great possibility that they will feel higher level of motivation with the companion of agents. As for children, they tend to be more attracted by agents compared to adults. Therefore, it is possible that agents' effects on children will also be stronger. Furthermore, agent's effects can be measured among female users and male users separately so that the possible influence of various agents on users with different gender can be discovered more clearly.

It is found that studies on agents' effects on task repetition and user experience are very limited. Further researches can be made in this field to investigate pedagogical agents' influences on cognitive load so that the findings in this research can be better explained.

5.4 Conclusion

As an important factor of agent design, the pedagogical agent role not only is strongly related to other features of agent such as tone of voice, non-verbal communication and visual image, but also has direct impact on users. Although both expert-like and peer-like pedagogical agents are considered to be motivational elements, their effects of motivation differ. Co-learner agents are perceived to be more motivating than expert-like agent in general and are proved to be more effective in terms of improving satisfaction level. On the other hand, learners' perception about agents might differ due to their stereotypes. An expert agent is given higher ratings due to the remarkable impressions it has made in terms of being credible and knowledgeable. Furthermore, no clear proof was found in terms of agents' impacts on effectiveness and efficiency. Although the effectiveness of agents are dependent on factors such as learning context and target learners, it is supported that basically the activation of stereotypic beliefs in learner's mind by implementing different agent roles can lead to difference in their psychological condition as well as learning behaviors.

References

Aimeur, E., & Frasson, C. (1996). Analyzing A New Learning Strategy According to Different Knowledge Levels. *Computers & Education*, *27*, 115–127.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Macmillan.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215.

Baylor, A. L. (2002). Agent-Based Learning Environments As a Research Tool for Investigating Teaching and Learning. *Journal of Educational Computing Research*, *26*(3), 227–248.

Baylor, A. L. (2003, July). The impact of three pedagogical agent roles. In*Proceedings of the second international joint conference on Autonomous agents and multiagent systems* (pp. 928-929). ACM.

Baylor, A. L. (2005, January). The impact of pedagogical agent image on affective outcomes. In *International Conference on Intelligent User Interfaces, San Diego, CA*.

Baylor, A. L. (2011). The design of motivational agents and avatars. *Educational Technology Research and Development*, *59*(2), 291–300. http://doi.org/10.1007/s11423-011-9196-3

Baylor, A. L., & Ebbers, S. J. (2001). The Pedagogical Agent Split-Persona Effect : When Two Agents are Better than One. In *World Conference on Educational Multimedia, Hypermedia and Telecommunications* (Vol. 2003, No. 1, pp. 459-462).

Baylor, A. L., & Kim, Y. (2000). Pedagogical Agent Design: The impact of Agent Realism, Gender, Ethnicity, and Instructional Role. In *Intelligent tutoring systems* (pp. 592-603). Springer Berlin Heidelberg.

Baylor, A. L., & Kim, Y. (2005a). Simulating Instructional Roles through Pedagogical Agents. *International Journal of Artificial Intelligence in Education*, *15*, 95–115. http://doi.org/10.1007/BF02504991

Baylor, A. L., & Kim, Y. (2005b). Simulating Instructional Roles through Pedagogical Agents. *Artificial Intelligence in Education*, *15*, 95–115.

Broackmann, R. J. (1993). Secrets of user-seductive documents: wooing and winning the reluctant reader [Book Review]. *Proceedings of the IEEE*, *81*(1), 152-153.

Clark, R. E., & Choi, S. (2005). Five Design Principles for Experiments on the Effects of Animated Pedagogical Agents. *Journal of Educational Computing Research*.

Chan, J., Alldredge, B. K., & Baskin, L. S. (1990). Perphenazine-induced priapism. *Annals of Pharmacotherapy*, *24*(3), 246-249.

Dehn, D. M., & Van Mulken, S. (2000). The impact of animated interface agents: a review of empirical research. *International journal of human-computer studies*, *52*(1), 1-22.

Ebbers, S. J. (2007). The impact of social model agent type (coping, mastery) and social interaction type (vicarious, direct) on learner motivation, attitudes, social comparisons, affect, and learning performance.

Eiriksdottir, E., & Catrambone, R. (2011). Procedural Instructions, Principles, and Examples: How to Structure Instructions for Procedural Tasks to Enhance Performance, Learning, and Transfer. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *53*, 749–770.

Erickson, T. (1997). Designing agents as if people mattered. *Software agents*, 79-96.

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological review*, *100*(3), 363.

Festinger, L. (1962). *A Theory of Cognitive Dissonance* (p. 291). Stanford University Press.

Fishbein, M., & Ajzen, I. (1974). Attitudes towards objects as predictors of single and multiple behavioral criteria. *Psychological review*, *81*(1), 59.

Goodwin, D. (1991). Emplotting the reader: Motivation and technical documentation. *Journal of technical writing and communication*, *21*(2), 99-115.

Graesser, a. C., Chipman, P., Haynes, B. C., & Olney, a. (2005). AutoTutor: An Intelligent Tutoring System With Mixed-Initiative Dialogue. *IEEE Transactions on Education*, *48*(4), 612–618.

Graesser, A. C., Person, N., Harter, D., & Tutoring Research Group. (2001). Teaching tactics and dialog in AutoTutor. *International Journal of Artificial Intelligence in Education*, *12*(3), 257-279.

Heidig, S., & Clarebout, G. (2011). Do pedagogical agents make a difference to student motivation and learning? *Educational Research Review*. http://doi.org/10.1016/j.edurev.2010.07.004

Johnson, H., Nigay, L., & Roast, C. (Eds.). (1998). *People and Computers XIII*. London: Springer London.

Johnson, W. L., Rickel, J. W., & Lester, J. C. (2000). Animated Pedagogical Agents : Face-to-Face Interaction in Interactive Learning Environments 1 Introduction and Background, (July 1999), 1–36.

Karreman, J., & Loorbach, N. (2013). Use and effect of motivational elements in user instructions: What we do and don't know. *IEEE International Professional Communication Conference*.

Kapoor, A., & Picard, R. W. (2005, November). Multimodal affect recognition in learning environments. In *Proceedings of the 13th annual ACM international conference on Multimedia* (pp. 677-682). ACM.

Kazdin, A. E. (1978). History of behavior modification: Experimental foundations of contemporary research. University Park Press.

Keller, J. M. (1987). Development and use of the ARCS model of instructional design. *Journal of instructional development*, *10*(3), 2-10.

Keller, J. M. (2009). *Motivational design for learning and performance: The ARCS model approach*. Springer Science & Business Media.

Kim, Y. (2007). Desirable Characteristics of Learning Companions. *Artificial Intelligence in Education*.

Kim, Y., & Baylor, A. L. (2006a). A Social-Cognitive Framework for Pedagogical Agents as Learning Companions. *Educational Technology Research and Development*, *54*(6), 569–596.

Kim, Y., & Baylor, A. L. (2006b). Pedagogical Agents as Learning Companions: The Role of Agent Competency and Type of Interaction. *Educational Technology Research and Development*, *54*(3), 223–243.

Kim, Y., Baylor, A., & Shen, E. (2007). Pedagogical agents as learning companions: The impact of agent emotion and gender. *Journal of Computer Assisted …*, *23*(3), 220–234.

Kort, B., Reilly, R., & Picard, R. W. (2001, August). An affective model of interplay between emotions and learning: Reengineering educational pedagogy-building a learning companion. In *icalt* (p. 0043). IEEE.

Law, E. L. C., Roto, V., Hassenzahl, M., Vermeeren, A. P., & Kort, J. (2009, April). Understanding, scoping and defining user experience: a survey approach. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 719-728). ACM.

Lester, J. C., Converse, S. A., Stone, B. A., & Kahler, S. E. (1997). *Artificial Intelligence in Education, 1997: Knowledge and Media in Learning Systems : Proceedings of AI-ED 97, World Conference on Artificial Intelligence in Education, Kobe, Japan* (pp. 23–30). IOS Press. Retrieved from

Liew, T. W., Tan, S.-M., & Jayothisa, C. (2013). The Effects of Peer-Like and Expert-Like Pedagogical Agents on Learners' Agent Perceptions, Task-Related Attitudes, and Learning Achievement. *Educational Technology& Society*, *16 (4)*, 275–286.

Loorbach, N., Karreman, J., & Steehouder, M. (2007). Adding Motivational Elements to an Instruction Manual for Seniors : Effects on Usability and Motivation. *Technical Communication*, *54*(3), 343–358.

Loorbach, N., Steehouder, M., & TAAL, E. (2006). The Effects of Motivational Elements in User Instructions. *Journal of Business and Technical Communication*, *20*(2), 177–199. http://doi.org/10.1177/1050651905284404

Matusov, E., & Hayes, R. (2000). Sociocultural critique of Piaget and Vygotsky. *New Ideas in Psychology*, *18*(2), 215-239.

Mora-Torres, M., Laureano-Cruces, A. L., Gamboa-Rodríguez, F., Ramírez-Rodríguez, J., & Sánchez-Guerrero, L. (2014). An Affective-Motivational Interface for a Pedagogical Agent. *International Journal of Intelligence Science*, *04*(01), 17–23.

Moreno, R., & Flowerday, T. (2006). Students' choice of animated pedagogical agents in science learning: A test of the similarity-attraction hypothesis on gender and ethnicity. *Contemporary educational psychology*, *31*(2), 186-207

Moreno, R., Mayer, R. E., Spires, H. A., & Lester, J. C. (2001). The Case for Social Agency in Computer-Based Teaching: Do Students Learn More Deeply When They Interact With Animated Pedagogical Agents? *Cognition and Instruction*, *19*(2), 177–213.

Palmer, D. J., Stough, L. M., Burdenski Jr, T. K., & Gonzales, M. (2001). Identifying Teacher Expertise: An Examination of Researchers' Decision-Making.

Rosenberg-Kima, R. B., Baylor, A. L., Plant, E. A., & Doerr, C. E. (2008). Interface agents as social models for female students: The effects of agent visual presence and appearance on female students' attitudes and beliefs. *Computers in Human Behavior*.

Roselyn Lee, J. E., Nass, C., Brave, S. B., Morishima, Y., Nakajima, H., & Yamada, R. (2007). The Case for Caring Colearners: The Effects of a Computer-Mediated Colearner Agent on Trust and Learning. *Journal of Communication*, *57*(2), 183-204.

Sahimi, S. M., Zain, F. M., Kamar, N. a. N., Rahman, N. S. Z. a., Majid, O., Atan, H., & Fook, F. S. (2010). The Pedagogical Agent in Online Learning : Effects of the Degree of Realism on Achievement in Terms of Gender. *Contemporary Educational Technology, 2010*.

Schunk, D. H., Hanson, A. R., & Cox, P. D. (1987). Peer-model attributes and children's achievement behaviors. *Journal of Educational Psychology*, *79*(1), 54.

Skinner, E. A., & Belmont, M. J. (n.d.). Motivation in the classroom: Reciprocal effects of teacher behavior and student engagement across the school year.

Soller, A., Goodman, B., Linton, F., & Gaimari, R. (1998, January). Promoting effective peer interaction in an intelligent collaborative learning system. In*Intelligent Tutoring Systems* (pp. 186-195). Springer Berlin Heidelberg.

Thelen, M. H., Fry, R. A., Fehrenbach, P. A., & Frautschi, N. M. (1979). Therapeutic videotape and film modeling: a review. *Psychological Bulletin*,*86*(4), 701.

Van Der Meij, H., Karreman, J., & Steehouder, M. (2009). Three decades of research and professional practice on printed software tutorials for novices. *Technical Communication*, *56*(3), 265–292.

Veletsianos, G. (2010). *Emerging Technologies in Distance Education* (Vol. 4, p. 335). Athabasca University Press.

Van der Meij, H. (2008). Designing for user cognition and affect in software instructions. *Learning and instruction*, *18*(1), 18-29.

Vygotsky, L. S. (1978). Mind in society (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.). *Cambridge, MA: Harvard UniversityPress. VygotskyMind in society1978*.

Veletsianos, G. (2010). *Emerging technologies in distance education*. Athabasca University Press.

Xiao, L. X. L., Zhong, X. Z. X., & Yuhui, Q. Y. Q. (2004). Adaptivity implementation based on multi-agent technology. *IEEE International Conference on Advanced Learning Technologies, 2004. Proceedings.*

Yang, B. (2015, January 1). Official manuals vs commercial manuals : effects on expectations and user experience. Retrieved from http://essay.utwente.nl/66749/1/Yang Bingying -s 1494856 scriptie.pdf

Yarrow, F., & Topping, K. J. (2001). Collaborative writing: The effects of metacognitive prompting and structured peer interaction. *British journal of educational psychology*, *71*(2), 261-282.

Appendix

Instructions with co-learner agent and expert agent

Hello, everyone. Welcome!
My name is Kate and I have several years of experience of using Photoshop. I will be your mentor in the following course in which you will learn how to change the background of an image by using channels, the grayscale images that store different types of information in Photoshop.
I will instruct you step by step and emphasize the key points for you.
Using Photoshop can be interesting. So, let's begin.

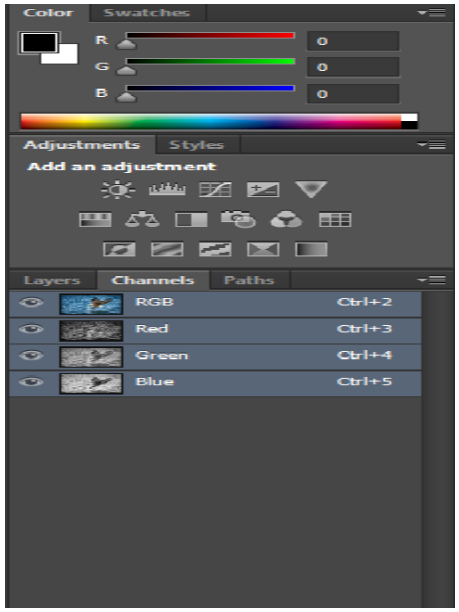
Hello, everyone.
My name is Kelly and I'm a novice of using Photoshop just like you. Now we are going to take the challenge to change the background of a image with the help of Photoshop. It would be nice to learn with you because we can remind each other of key points when we come across same kind of problems. I'm not sure whether we can finish the task, but I'm sure things will go better when we support each other.
So, let's not wait and start the task right now.

Subtask 1

Goal: Create a new channel in which the subject is covered by a dull surface.

1. Open the image in Photoshop (File> Open>Desktop>pic.jpg).

2. Select the Channels panel (Windows > Channels). The channels panel will then show in the right part of the interface as the following figure shows.



3. Choose Image > Calculations and make sure the Preview box in the right part of the tab is checked. Since the blue channel in this image shows the greatest difference between subject and background, it's now time to add one more channel to the blue channel to create a new channel based on the color.

It is all about the settings of calculations tab from step 4 to step 6. Please be careful about your choice and follow the instruction step by step. Remember, any minor mistake may lead to different outcomes.

It is all about settings of calculations tab from step 4 to step 6. It seems a little bit complicated. So, we should be attentive and I bet we can do it.

4. In the Source 1 area, set the Channel to Blue
5. In the Source 2 area, Choose Red from the Source 2 pop-up and click the Invert check box to reverse the details. This will help mask out the subject.
6. Use the Blending menu to combine the Blue and Red channels. Blending is used to control how two different images or channels blend together based on their color and luminance values. Different source images need different modes, so you'll need to click through many of the modes on the list. In this case, the Linear Burn mode works well to create a matte, which means a dull surface of the subject.

7. Click OK to create a new channel in the Channels panel. The channel, should be named Alpha 1 automatically and it becomes the active selection in the Channels panel (with the RGB channels turned off, for now). The following figure shows the result of step 7.

The first subtask is mainly about the settings of channels. It lays the foundation for upcoming subtasks. Be sure to take enough attention on channels panel because it will be used frequently in the whole task.

Congratulations! We have just finished the first part of the task. It's not that difficult, am I right?
Let's cheer up for the upcoming subtask.

Subtask 2

Goal: Remove the background of the newly created channel to select the subject.

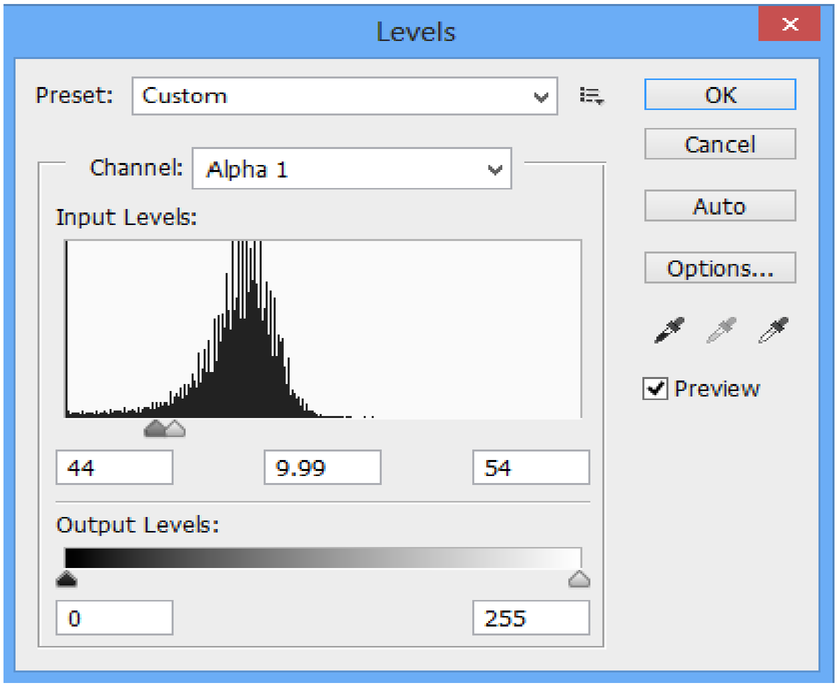
The quality of accomplishment of this part is strongly related to the accomplishment of the whole task. It's really important for you to correctly execute each step.

Subtask seems to be the most important part of the whole task. Make sure that you are ready for this challenge and we can make it!

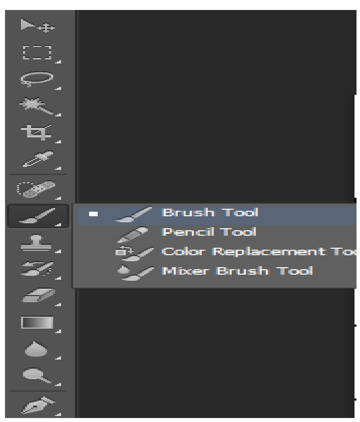
Step 1 may take a long time because we want to make contrast between subject and background as sharp as possible. Therefore, we need to be patient here.

The point of step 1 is to make the contrast between subject and background as sharp as possible. The settings of input level are not absolute here.

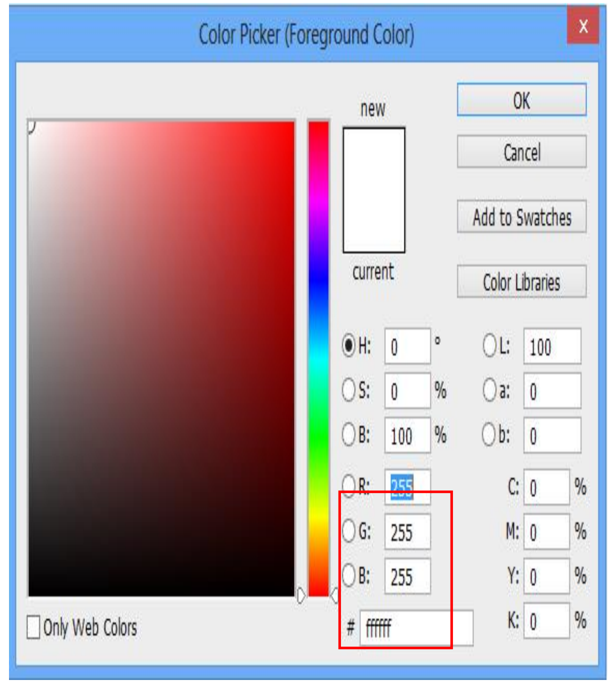
1. It’s now time to create a clean black and white mask for the new channel. Choose Image > Adjustments > Levels or press Ctrl+L. Move the White Input Levels slider to the left to lighten the gray areas to white. Move the Black and Gray Input Levels sliders to refine the matte and improve contrast between foreground and background. The following figure is an example of the final setting.



2. Choose the Brush tool in the toolbar at the left side of screen by clicking the right mouse button.



3. Click the Set foreground color button in the bottom of toolbar to enter the color picker window. Set the color of brush to white.



4. Paint over any areas that need to be removed from the matte as the following figure shows. You may find it easier to reduce the size of brush by pressing the key { [or improve the size by pressing the key }] when necessary.

5. Once the alpha channel has all holes filled in, Command-click (Ctrl-click) on the alpha channel thumbnail to load the selection. You'll see the dotted lines around the whole image as the following figure shows.

6. Choose Select > Inverse to reverse the selection so the subject is active. You'll see the dotted lines around the subject as the following figure shows.

7. Click the visibility icon next to the RGB composite channel to enable it and you'll see the following figure. Click on the RGB composite channel so it is the active channel as well.

Subtask 2 is about selecting the subject so that it can stand out. Now you need the upcoming subtask to refine the selection.

Now we have successfully finish subtask 2, the most complicated part of the whole task. I'm sure we can finish the rest parts.

Subtask 3

Goal: Refine the edge of selected subject and remove the background of the original image.

Subtask 3 focuses on the further refinement of our achievement from subtask 2. The settings of each parameter are related to the final outcome. Be sure to make your best choice.

Subtask 3 is relatively simpler than subtask 2. Since we are here, I don't think this subtask will be a problem for us.

1. Choose Select > Refine Edge to improve the selection.
2. Click the check box next to Smart Radius.
3. Set the value of radius as 1.4 px.
4. Click the Output pop-up menu in the Refine Edge dialog and choose New Layer with Layer Mask.
5. Click the check box next to Decontaminate Colors and click OK. The following figure is an example of the final settings.

6. In the Channels panel, disable the visibility of the Alpha 1 Channel to see the results.

Refining edge of the selected subject is very helpful to improve the quality of final outcome. As you can see, you have removed the background of original image perfectly with the help of edge refinement.

Now we have finished 75% of whole task and we are about to finish the task successfully!
Let's work on the final subtask.

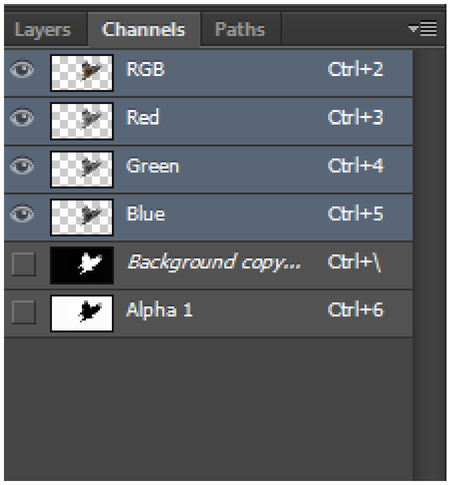
Subtask 4

Goal: Change the background.

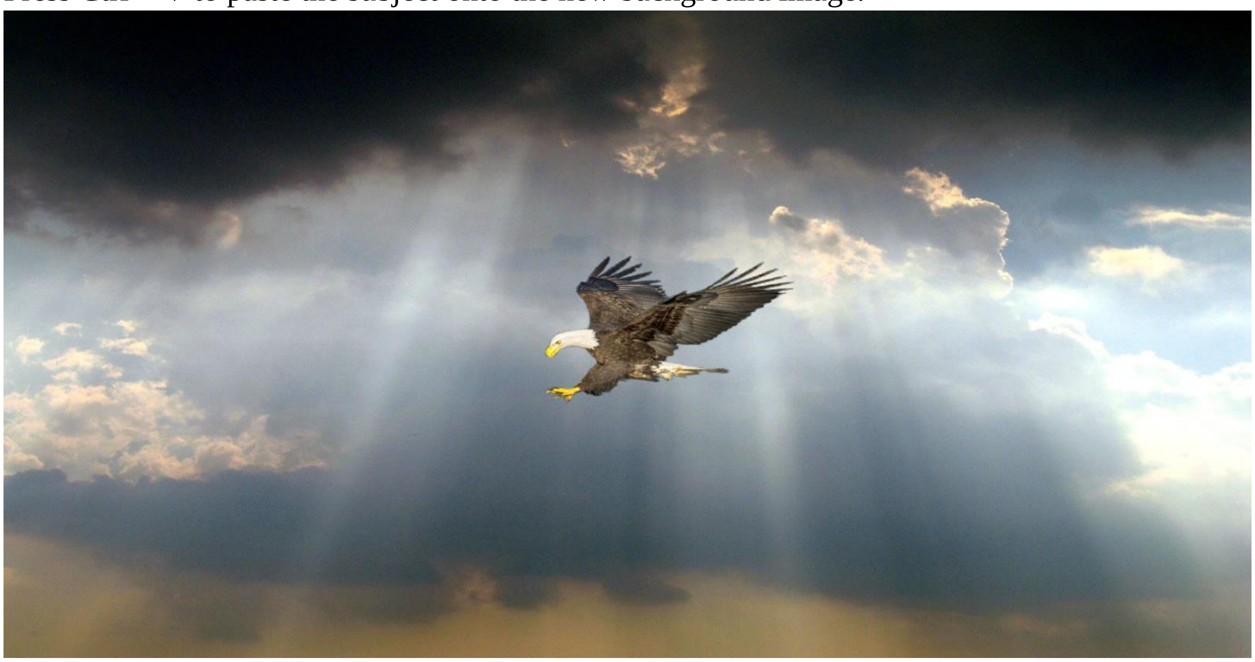
The final part only contains four steps. Come on, let's finish it.

The final part is about changing the background of the subject we have selected. Although it seems that there is not much work to do now, you still have to be cautious.

1. Click on the RGB composite channel as the following figure shows to make sure the RGB channel is selected.



2. Command-click (Ctrl-click) on the Background copy mask channel thumbnail to load the selection.
3. Press Ctrl + C to copy the selected image.
4. Open the new background image (File> Open>Desktop>pic2.jpg).
5. Press Ctrl + V to paste the subject onto the new background image.



Congratulations. Now you have successfully finished this task.

Congratulations. We have made it. Now it no longer will be a problem for us to change background of image in Photoshop.

Questionnarie

❖ Motivation

It is clear to me how the content of this instruction manual is related to things I already know.

The quality of the text helped to hold my attention.

As I worked with this instruction manual, I was confident that I could learn how to use Photoshop.

I enjoyed working with this instruction manual so much that I was stimulated to keep on working.

The way the information is arranged on the pages helped keep my attention.

I really enjoyed working with this instruction manual.

The content and style of writing in this instruction manual convey the impression that being able to work with Photoshop is worth it.

After working with this instruction manual for a while, I was confident that I would be able to complete exercises with Photoshop.

The variety of reading passages, exercises, illustrations, etc., helped keep my attention on the instruction manual.

The content of this instruction manual will be useful to me.

The good organization of the content helped me be confident that I would learn to use Photoshop.

It was a pleasure to work with such a well-designed instruction manual.

❖ Agent perception

I like Kate.
Kate is friendly.

Kate is knowledgeable.

I can trust instructions presented by Kate.

I like Kelly.

Kelly is friendly.

Kelly is knowledgeable.

I can trust instructions presented by Kelly.

❖ User experience

Very negative (1):Very positive(5)

Very satisfied(5): Very dissatisfied (1)

Very effective (5): Very ineffective (1)

Very efficient(5) :Very inefficient (1)