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Effects of Fantasy and Fantasy Proneness on Learning and Engagement in a 3D Educational Game

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Effects of Fantasy and Fantasy Proneness on Learning and Engagement in a 3D Educational Game

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Dedication

I dedicated my dissertation to my wife, mother, and brother who have waited my graduation for a long time. Their love and unconditional support have been a source of the power for completing my doctoral study. As my best colleague, Sunsook Lee, my beautiful wife, deserves to be honored for my graduation. Her final touches on my dissertation always made it balanced and persuasive. I also appreciate my supportive children, my first son Eunseong Lee, second son Haeseong Lee, and third daughter Hae-eun Lee. I cannot forget their smiles on my way home and their warm welcoming every evening was a big amusement during my long-term study.

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Effects of Fantasy and Fantasy Proneness on Learning and Engagement in a 3D Educational Game

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Fantasies are defined as byproducts of human imagination and mental activities to internalize unusual external objective stimulus. In the literature, utilization of fantasy in educational settings promoted intellectual and emotional improvements. However, the research implications from these fantasy research studies are mostly limited to traditional game design and classroom teaching. There are two research purposes in this study. The first is to examine how different types of fantasy and student fantasy proneness influence science learning, factual information acquisition, and game engagement in a 3D educational game environment called "Alien Rescue." To accomplish this purpose, this research investigated the effects of fantasy type and fantasy proneness on science learning, factual information of alien characters, and game engagement. The second purpose of this study is to investigate student's perception of the varying types of fantasy. To accomplish the second purpose of the study, this research inquired how student identified each type of fantasy and related his or her past experience to the embodied characteristics in alien characters.

The participants of the study were 103 students who used Alien Rescue in four classes as their science curriculum for 10 days. The students in two classes were assigned to a treatment group using models with portrayal fantasy and the students in two classes were assigned to the other treatment group using models with creative fantasy. Employing mixed methods, this study analyzed both quantitative and qualitative data such as surveys and student interviews.

The results in the quantitative part of the study showed that portrayal fantasy was effective for science learning, alien information acquisition, and game engagement. Specifically, the students who used portrayal fantasy models showed higher improvement of science knowledge and scored better on both alien information acquisition and game engagement. High fantasy proneness group also showed better game engagement. The finding with qualitative data showed that the students pointed out eight elements in identifying 3D fantasy objects, and those elements were relevant to the design elements that the researcher included in the 3D modeling procedure. The students also showed a perception pattern that they understood 3D game characters based upon previous experience regardless of fantasy type.

The findings suggested that portrayal fantasy was effective in enhancing content learning, factual information acquisition, and engagement in educational games because the familiarity of the fantasy elements makes the identification of the fantasy characters easier and faster. However, too deep involvement in fantasy resulted in ineffective and inefficient learning outcomes. The findings also suggested that eight components of 3D models were essential elements in identifying fantasy game characters by learners as well as designing the 3D characters by game designers.

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Chapter 1: Introduction

> Typically, people use the terms imagination or fantasies to refer to something that is quite different from what they perceive in regards to science...But in actuality, imagination (or fantasy), as the basis of all creative activity, is an important component of absolutely all aspects of cultural life, enabling artistic, scientific, and technical creations alike. In this sense, absolutely everything around us that is created by the hands of human beings, the entirety of human culture, as distinct from the world of nature, is the product of human imagination and creations invoked through our imagination (Vygotsky, 2004, p. 9).

SIGNIFICANCE OF THE STUDY

Fantasy has been a common subject within movies, novels, and video games in our modern society, but it has been an unfamiliar topic in regards to education. Fantasy, as a term, can be traced back to Freud's psychoanalysis research (Figueira, Fonagy, & Person, 2013; Freud, 1908), and recent literature pertaining to fantasy can be more readily found in the fields of psychology and media research. In psychology, fantasy has been treated as a human characteristic, especially in correspondence with hypnosis research (Myers, 1983) and reality monitoring of individuals (Aleman, Bocker, & De Haan, 1999; Johnson & Raye, 1981) where it is defined as an environment that "evokes mental images of physical or social situations that are not actually presented" (Malone & Lepper, 1987, p. 240). In media design, Asgari and Kaufman (2010) defined it as "creations of the imaginative faculty and mental images which are unrealistic or improbable, and not actually present" (p. 95). Within the broader definitional views on fantasy, one could simply define it as "any departure from consensus reality[1]" (Hume, 1984, p. 21) including everything around us. Fantasy was created by human beings for

[1] *Consensus reality* is generally agreed to be reality, based on a consensus view. http://en.wikipedia.org/wiki/Consensus_reality

cultural development, where the forward expansions of knowledge and societal communities could be a product of human fantasy and imagination (Vygotsky, 2004).

Fantasy has different forms in accordance with various differing definitions. In literature, it can be an imaginative and thrilling story that an individual may conjure from his imagination, like a brave elf on a dragon as the main character of an ever-expanding fantasy world. Fantasia in music was originated from the term 'fantasy', and meant a product of a composer's inspiration from the mixture of different forms and styles of other genres. A piece of fantasy drawing can be a portrait of a legendary creature. In addition to the traditional utilization of fantasy, current advanced computer technology enables us to create new forms of fantasy through digital visual artworks and video games.

Today, video gaming and the utilization of fantasies through 3D technologies are popular phenomena in education. The artificial learning space, including experiential make-believe with visually vivid components, conveys authentic learning experiences that are atypical in an ordinary school curriculum. Research has reported that the use of fantasy have showed significant pedagogical benefits such as engaging the participants in a learning environment, improving learning outcomes, and facilitating creative thinking (Cordova & Lepper, 1996; K. A. Wilson et al., 2009). For example, the use of fantasy in content areas such as reading, math, and science created opportunities for contextualization during the learning process by invoking imaginative information to stimulate unification among fantastic stimulus and a preexisting knowledge base (Aleman & De Haan, 2004; Sharon & Woolley, 2004; Wadsworth, 2004).

Research indicated that utilization of fantasy in educational settings promoted intellectual and emotional improvements (Cook, 2002; Richert, Shawber, Hoffman, & Taylor, 2009; Richert & Smith, 2011; Richert, 2003). Research has shown that students

were more likely to engage in learning tasks when it was applied in a fantasy context, and students who learned the material in the fantasy context showed improvements in problem solving and had positive learning outcomes (Cook, 2002). Use of fantasy in educational contexts stimulates curiosity and imagination, and promotes creative thinking because fantasy is a medium that creates a novel condition that is inconceivable in real life (Cook, 2002; R. Garris, Ahlers, & Driskell, 2002; K. A. Wilson et al., 2009). Whereas cognitive tools and simulations were designed to support cognitive learning activities (Azevedo, 2005; Lajoie, 1993), fantasy learning environments facilitated active engagement in the learning processes by embellishing visual information and story itself in the learning contents.

However, the research implications from these fantasy research studies are mostly limited to traditional game design and classroom teaching. It is now necessary to expand the application of fantasy to current new media environments such as 3D educational games and virtual reality environments. Fantasy, as an ingredient of visual data representation in new media environments, there is not enough research to inform us how people interact with different types of designs of fantasy or which designs are effective in educational game design (Kim, 2009). In spite of the research that has investigated the effect of fantasy use in educational games and classroom teaching with designation of contextualization (Wiest, 2001), only a few researchers have investigated the relationship between fantasy type and personal preference (Habgood, Ainsworth, & Benford, 2005; Kim, 2009; Richert & Smith, 2011). Even the positive results on the use of fantasy in educational games and multimedia-based teaching in previous studies (Malone, 1980; K. A. Wilson et al., 2009) showed complicated research findings with research results from psychological research on fantasy (Aleman & De Haan, 2004; Richert & Smith, 2011). In other words, utilization of fantasy is generally beneficial for engagement and memory of

visual information, but it may cause a malfunction of cognitive processing due to deep involvement in fantasy. Extra deep involvement in fantasy can result in different, or even harmful, effects on cognitive processing according to the characteristics of the individual.

In psychometric studies, fantasy is an internal interpretation process on external objects or events, where the design of fantasy can be perceived differently according to the level of fantasy proneness (Merckelbach, Horselenberg, & Muris, 2001; Myers, 1983; S. C Wilson & Barber, 1983). Fantasy proneness is defined as the personal characteristics established from early childhood through exposure and engagement with imaginative activities (Merckelbach et al., 2001; Myers, 1983). Every individual has fantasy proneness, which is a concept that indicates "a range of experiences considered to be related to a deep involvement in fantasy" (Aleman & De Haan, 2004, p. 1). Previous research revealed that the memory of mental imagery of a high fantasy prone person was better than a lower fantasy prone person when they were exposed to fantasy (Aleman et al., 1999; Aleman & De Haan, 2004). The higher fantasy prone person showed impoverished reality monitoring, which is a malfunction of metacognitive processes to distinguish between internal imagination and external fantasy stimulus (Johnson, Hashtroudi, & Lindsay, 1993; Johnson, Raye, Wang, & Taylor, 1979; Johnson & Raye, 1981). This is a compounding effect of fantasy on memory and metacognitive processing. When people are exposed to a fantasy situation, highly fantasizing individuals show better vividness of imagery on the situation, but they do not perform effective separation of fantasy from reality. Higher memory performance in imagery and degrading performance in reality discrimination was derived from two theoretical reasons (Johnson et al., 1979; Johnson & Raye, 1981): (1) the images and perceptions are less distinctive from each other with regards to their sensory characteristics, and (2) images and perceptions are less distinctive from each other with regard to the metacognitive

processes associated with each. Kahan (1996) reported that increasing sensory similarities between perceived and imagined items increased source confusion. In human imagination through fantasy, fantasy visuals can be perceived in different ways in terms of individual experience and sometimes this distortion of perception can cause reality-fantasy distinction problems. Based on the amount of prior experience on the imaginative environments fantasy, high fantasy prone personality with better imagery performance can hinder reality differentiation performance.

In terms of fantasy design, research shows that individual students perceived certain types of fantasy in different ways. Richert and her colleagues (Richert et al., 2009; Richert & Smith, 2011; Richert, 2003) conducted a series of experiments to explore how young children transfer their knowledge from fantasy contexts to other situations. The results indicated that children were less likely to transfer fantasy stories than real stories to the targeted situation in general. However, as children get older, this general tendency seems to fade. When children were allowed to choose the type of story, younger participants who chose the fantasy story were more likely to transfer knowledge from the real story instead of the fantasy story. However, older participants who chose the fantasy story were more likely to transfer knowledge from the fantasy story than the real story. For the mediation effect of age, it has been speculated that older children who are more experienced with fantasy materials had an advantageous lead in utilizing fantasy sources, whereas younger children were not good at recognizing the fantasy characters as a possible source of information due to a lack of fantasy experience.

Richert and Smith (2011) also presented similar results in which the participants in the reality group were more likely to transfer solutions than the fantasy group to the applied context. This means that children were significantly less likely to transfer knowledge when they learned with fantasy-based media than with reality conditions and

settings. Participants in reality conditions were more likely to answer correctly to the general memory questions than the participants in the fantasy conditions. Based on a series of regression analysis, age, solution memory, and general memory were significant factors that affect knowledge transfer. According to their research results, as age, solution memory, and general memory increased, so did the transfer of knowledge in the realistic learning context.

In another analysis from Richert and her colleagues' studies, fantasy orientation and fantasy exposure were significant predictors for transfer of knowledge. As the participants' orientation to fantasy increased, transfer increased, and the participants in the one-on-one exposure condition were more likely to learn than the participants in the classroom exposure group. These results indicated that children could differentiate different types of information in fantasy contexts based on their fantasy experience. In general, children who had experienced fantasy from media in their childhood had a better grasp on problem-relevant information in the informative context. However, too deep engagement in fantasy can cause information differentiation problems in the informative context. The research results from the interaction effects between information transfer and fantasy experience showed that fantasy context could cause cognitive processing issues in learning, which was similar to reality monitoring problems (Aleman & De Haan, 2004; Johnson & Raye, 1981). In conclusion, utilization of fantasy is generally useful for learning and engagement, but being excessively involved in a fantasy context during the learning process can bring detrimental effects on learning.

These mixed research results indicate that fantasy cannot be simply judged as good or bad, especially as a design component for educational games. As Malone (1980) and Habgood, Ainsworth, and Benford (2005) suggested, fantasy can be embedded in different manners for a game, for example endogenously or exogenously, and needs to be

carefully designed for educational game development. Based on the lack of conclusive research findings on the use of fantasy for educational games, this study attempts to investigate how different types of fantasy and individual fantasy proneness affect learning outcomes and game engagement in an educational game environment. This research will provide insights into designing learning conditions that utilize fantasy components applied in diverse learning conditions, such as educational games, online contents, and classroom teaching where individualized teaching is essential.

PURPOSE OF THE STUDY

There are two overarching research purposes in this study. The first is to examine how different types of fantasy and student fantasy proneness influence the learning outcomes and engagement in an educational game environment called "Alien Rescue." To accomplish this purpose, this research investigated the effects of fantasy type and fantasy proneness on science learning, factual information of alien characters, and game engagement. The second purpose of this study is to investigate student's perception of the varying types of fantasy. To accomplish the second purpose of the study, this research inquired how student identified each type of fantasy visuals and related his or her past experience to the embodied characteristics in alien characters.

This research is informed by the literature on fantasy both in psychology and educational game design because the main focus is to examine the relationship between fantasy types in educational games and personal fantasy proneness in terms of learning performance. For the theoretical foundation of this study, cognitive constructivism learning theory was used to examine how students interpret fantasy and explain how previous experiences shape new schema on the subject of fantasy. Fantasy components,

as an embellishment of graphics in an educational game, are interpreted based on the previous experience in similar circumstances. Based on the cognitive constructivist theories (Collins, Greeno, & Resnick, 1992; Ertmer & Newby, 2008; Jonassen, 1991), previous experience on the topic of fantasy in a game gradually interacts with upcoming fantasy stimulus to shape new schema on the topic. If a student has enough knowledge and experience to sort out imaginative components and learning contents based on his metacognitive ability, the use of fantasy in the learning situation can be especially beneficial in learning and motivation. However, use of fantasy components in educational games may not simply enhance learning and engagement, but rather can deepen its interactions with the learner's propensity for fantasy experience through the usage of varying types of fantasy, for example realistic fantasy characters (Richert & Smith, 2011). Without metacognitive processing for distinction between reality and fanciful decoration of learning contents, excessive involvement of fantasy in educational game playing can cause reality monitoring problems or confusion between actual learning and imaginative information.

The fantasy examined in this study consist of two types: Portrayal and creative fantasy (Kim, 2009; Vygotsky, 2004). Based on the cognitive constructivist perspective on imagination (Piaget, 1952; Vygotsky, 2004) and artwork process in digital fantasy art (Robertson, 1992; Stoneham, 2010), two fantasy types (portrayal fantasy and creative fantasy) were used in the study. In the practice digital artworks, fantasy artists start to create a fantasy object based on their experience by tracing the memories of existing concepts and objects from the beginning of their jobs. This process is close to representing or portraying a concept by combining preexisting concepts. However, their artwork makes the portrayed concept more distinctive to the original ideas by creatively combining and changing the meaning and details of the fantasy object. These fantasy

design principles are consistent with the process of human imagination (Vygotsky, 2004) and the principles of fantasy design (Kim, 2009). Even though fantasy, by definition, denotes unreal and supernatural objects or events, fantasies arise from similarity and representative reality of preexisting concepts. These primitive forms of fantasy also go through an alteration process with dissimilarity and creative combination of unreality.

By definition, creative fantasy is a type of visual fantasy that includes imaginative components making the object completely different from pre-existing artifacts through combining heterogeneous elements. In educational games, learners identify that objects or events are quite different from existing conceptions and that the final product should be recognized as a new concept because of continuous combinations in the production process of the fantasy that completely changes the original meaning of the artifacts. On the other hand, portrayal fantasy is a type of fantasy that transforms components of the objects, such as shape or color, within possible variations, which learners are used to seeing. When learners encounter portrayal fantasy, they engage in an imaginative process since the components of the fantasy objects are manipulated so that the learner can perceive cognitive incongruence from his knowledge base. In this research, two types of fantasy were applied to the game characters, which were the main characters in Alien Rescue (AR), and the learners viewed these types of alien characters in the Alien Database during their problem solving process.

This study employs mixed methods, which is a research methodology using both quantitative and qualitative data. The current study employed both a confirmatory and explanatory approach in a single study. Quantitative data were used for empirical evaluation of research hypotheses and qualitative data were to substantiate the findings from quantitative analysis results as well as investigate individual perception on fantasy employed in the study. The implications from the qualitative inquiry will enhance the

understanding on fantasy designs for educators and game designers. The findings of this study will help inform the effects of fantasy as an educational game attribute and the interaction between the different types of fantasy and fantasy proneness on student learning and engagement.

RESEARCH QUESTIONS

1. What are the effects of fantasy type (portrayal and creative) and fantasy proneness (high and low) on student learning and engagement in a game-based new media environment for middle school science? Learning in this environment is measured by Space Unit Test (SUT) and Information Acquisition Test (IAT). SUT is related to the learning content of 6th grade science and IAT is related to the fantasy components of the aliens in the game environment.
    a) Is there an interaction effect between fantasy type and fantasy proneness on science learning?
    b) Does fantasy type predict science learning?
    c) Does fantasy proneness predict science learning?
    d) Is there an interaction effect between fantasy type and fantasy proneness on information acquisition and game engagement?
    e) Does fantasy type predict information acquisition and game engagement?
    f) Does fantasy proneness predict information acquisition and game engagement?

2. What are student's perceptions of fantasy characters in the game-based new media learning environment for middle school science?
    a) What elements make students identify fantasy as portrayal or creative?

b) Does student's prior experience relate to the identification of six alien species, and how does student's previous experience affect their understanding of six species of alien?

TERM IDENTIFICATION

Fantasy: Fantasies in this research are defined in two-ways, as an artifact and a human experience. As an object or environment, it is defined as an imaginative environment that "evokes mental images of physical or social situations that are not actually presented" (Malone & Lepper, 1987, p. 240). As an experience, fantasy is a mental activity that happens when one gets involved in imaginative thinking in fanciful environments. In this definition, fantasy is an interpretational process on fantastic objects or circumstances based on one's knowledge base.

Portrayal fantasy: Portrayal fantasy is conceptually defined as a type of multisensory information that includes imaginative components representing familiar pre-existing artifacts. Operationally, portrayal fantasy is defined in this research as a type of visual representation that has transformed components in shape or color. The transformation of the objects should take place within the notion that the target audiences are used to the originality of the main characteristics. The original sources are from current media and ordinary experiences such as fantasy novels, movies, fantasy arts, nature and travels.

Creative fantasy: Creative fantasy is a type of visual representation that includes imaginative components making an object completely different from the pre-existing artifacts by combining heterogeneous elements. In this research, the operational definition of creative fantasy is a type of imaginative graphics that is seen completely

different in shape or color from the original objects because of the continuous alteration of the components. In order to create a creative fantasy, the parts or concepts of the original objects are adapted and combined with other objects, however the final product of continuous recreation process is the product that is completely different from the original objects or concepts.

Fantasy proneness: A construct of human cognition. Fantasy proneness is one's tendency to be deeply involved in imaginative thinking and gratifying fanciful activities that one has experienced from childhood (Lynn & Rhue, 1986).

TERM ABBREVIATION

There are specific terms used with abbreviation in this study. The abbreviations were limited to the names of survey and program in order to avoid excessive use of the terms. The names of independent and dependent variables were not shortened intentionally in order for clear description. The list of the abbreviated terms is as follows.

AR: Alien Rescue, which is a game based new media environment employed as the experiment setting in this study.

SUT: Space Unit Test, which is the name of survey used to measure how much students have or learned science knowledge before or after their game play. SUT was administered twice in this study. Later, the science knowledge improvement score was calculated by subtracting SUT pretest score from the posttest, however SKI, the abbreviation of the term was used only a few times in chapter four to prevent confusion with SUT.

IAT: Information Acquisition Test, which is the name of survey used to measure how much students acquired the factual information on each alien throughout the game play.

CEQ: Creative Experience Questionnaire, which was the name of survey to measure student's fantasy proneness.

GEQ: Game Engagement Questionnaire, which is the name of survey to measure how much student engage in the game.

Chapter 2: Review of Literature

> Imagination is the beginning of creation. You imagine what you desire; you will what you imagine; and at last you create what you will (Shaw, 1921).

PURPOSE OF THE LITERATURE REVIEWS

The purpose of the literature review is to provide an overview of the research in utilization of fantasy in education. The relevant definitions of fantasy and fantasy proneness are discussed first. Then, the relevant research investigated the effect of fantasy and fantasy proneness in educational settings are analyzed. According to the analysis of the definitions of fantasy, the effects of fantasy and fantasy proneness were reviewed in terms of learning outcomes and motivation within diverse learning circumstances. In the later section, the theoretical perspectives of fantasy design for educational games are discussed. Learning theories and fantasy design models were reviewed to develop a hypothetical model to describe the process of fantasy development and users' interpretation toward the fantasy.

In the literature review, a comprehensive systematic search of the literature was used in order to elicit a better understanding of the research results on the use of fantasy in educational games (H. M. Cooper, 1982; H. Cooper, 2009; Harris Cooper, Hedges, & Valentine, 2009). In the following section, the focus of literature review and literature search methods is described first. In the review results section, fantasy research is reviewed historically and relevant definitions of fantasy are discussed. After the discussion about the definitions, the effects of fantasy and fantasy proneness in education are reviewed, and finally the researcher proposes a hypothetical model to visualize a

process of fantasizing in both phases of educational game design and play as well as their possible interaction and relationship between the two sides.

REVIEW FOCUS AND LITERATURE SEARCH METHOD

In order to find a more effective and efficient manner in searching for relevant literature, the researcher created a list of literature searching terms and major themes in reviewing the definitions and effects of fantasy. Considering the diversity of research orientations of fantasy, fantasy has been defined as a game design attribute and a propensity of human thinking. Different keywords and search points were employed for a comprehensive literature search. In order to examine the effects of fantasy as a game attribute, the researcher selected focuses and themes such as *definitions of fantasy, Educational use of fantasy, fantasy design in computer games, and fantasy use in multimedia development*. Also, in order to review the effects of fantasy proneness as a moderating variable in the process of fantasy interpretation, *fantasy proneness and cognition and fantasy-reality distinction* was chosen. After the determination of the research foci and study themes, the researcher searched for important seminal studies to further review and analyze in order to trace essential literature relevant to the current study.

The initial landmark studies were selected by the ancestry and descendancy approach (Cooper, 2009), which means chasing important articles and tracing references. After investigating the initial landmark studies (Aleman et al., 1999; Habgood et al., 2005; Kim, 2009; Malone, 1980; Richert & Smith, 2011), the following search terms were selected: *fantasy*, *game*, *learning*, and *fantasy proneness*. Utilizing these search terms, the researcher tested whether they elicited a manageable number of search results

on major databases. In the initial trials, the researcher entered *fantasy AND game AND learning* in EBSCO and ProQuest databases. The databases produced over 15,000 hits, where the majority of the search results were not of satisfactory level or were irrelevant articles. In the next search attempt, the most important search term, fantasy, was restricted to key terms in the advanced search settings. After setting a restriction on fantasy during the database searching, a combination of search terms, *KW*[2]*(fantasy) AND game AND learning* yielded a reasonable number of hits (total of 651) at the following databases: Academic Search Complete, Communication and Mass Media Complete, Computer Source, EdITLib (Education and Information Technology Library), ERIC, Information Science and Technology Abstracts, Internet and Personal Computing Abstracts, Library, Information Science, and Technology Abstracts, ProQuest Dissertations & Theses Full Text, PsychARTICLES, PsychINFO, Psychology and Behavioral Sciences Collection, Science and Technology Collection, Social Sciences Abstracts, and Web of Science.

DEFINITIONS OF FANTASY

The original terms for "fantasy" were *fantasie or fantsy*, which were derived from Old French and Middle English, *and phantasia* from Latin ("Fantasy," n.d.). The first known use of the term can be traced back to the 14th century, but varying meanings and terms such as phantom, imagination, image, illusion, preference, appearance, and make-believe have contributed in establishing the current meaning of fantasy from 16th to the 19th centuries ("Fantasy," 2013a). Simply getting to the point, fantasy is encyclopedically defined in two general manners: as the faculty or activity of imagining

[2] KW is a library database searching option that restricts the searching results to the author assigned keywords.

things that are impossible in reality, and the by-products of the psychological and intellectual processes of humans (“Fantasy,” 2013a, “Fantasy,” 2013b).

First, fantasy as the intellectual ability to create new things derived from humans’ unfulfilled needs and instinctive deficiencies to solve reality problems. According to Freud (1908), fantasy is a way of representing unsatisfied desires, and fantasizing occurs as a means of attempting to escape from their dissatisfactory situations, or getting vicarious gratification in imaginative ways. The mechanism of fantasizing in the human mind yields certain types of intellectual by-products. In several cultures, diverse concepts from the imaginative mental processing has been expressed by several synonyms of fantasy: imagination, fancy, invention, make-believe, creativity, vision, daydreaming, and reverie (“Fantasy,” 2013b; Perron, 2005; Sills, 1968; Valkenburg, 2008).

Vygotsky (2004) also defined fantasy as "the creative mental activity, which is based on the ability of our brain to combine elements” (p. 9). Vygotsky asserted that the elements constituting fantasy are rooted in human experience, and combining these elements is a basic way for people to create fantasies. Educational game researchers, Lepper and Malone (1987) defined fantasy as an environment that “evokes mental images of physical or social situations not actually presented” (p. 240). According to Asgari and Kaufmann (2010), fantasy was "the creations of the imaginative faculty and mental images which are unrealistic or improbable, and not actually present" (p. 95).

In an approach to understand fantasy as an innate intellectual ability, at the beginning, fantasy has been defined as a mental construct in the field of psychology. Due to the imaginative process of the human brain, researchers have compared daydreaming and fantasy to erecting a castle in the air in order to accomplish unsatisfied wishes (Freud, 1908; Person, Fonagy, & Figueira, 1995). In the International Encyclopedia of

the Social Sciences, fantasy is defined as one's ability to make a local habitation with airy nothing, or give a name to new objects (Sills, 1968).

In the definition of fantasy as an intellectual ability, it seems fantasy takes an important role in human thinking to develop new ideas and imaginative creatures. Fantasy is not simply copying or simulating existing objects, but taking on a holistic mental process utilizing cognitive knowledge and emotion to create different types of knowledge. A few relevant terms to fantasy such as daydreaming and hallucination add negative meanings to fantasy, inferring that fantasizing is a wasteful activity. However, even these uneconomical processes of thinking should be understood as a part of creative thinking.

Second, fantasy has represented by-products in the psychological process of daydreaming and imaginative thinking. In dictionaries, fantasy has been defined as a result or artifacts of being able to imagine impossible or improbable things, as well as an unusual mental image representing conscious or unconscious wishes ("Fantasy," 2013a, "Fantasy," n.d.). Fantasy also can be an imaginative story that includes fanciful objects and events that are developed by artists or talented people who have artistic creativity. Through all this, fantasy has been regarded as a genre of imaginative science fiction and novelty involving magic and adventures in an extra ordinary world, or a musical composition, called fantasia, which typically involves variations of existing works or imaginative representations of a story ("Fantasy," 2013a, "Fantasy," n.d.).

While worlds in fantasy novels and music are non-visually represented, those in video games or realistic virtual learning environments can be vicariously offered to users through the creation of imaginative objects. Since participants in new learning environments can directly interact with the visualized objects created through 3D software, the imaginative appearances and uniqueness of the environment are essential

elements in the meaning of the words to simulate the reality of the world in a detailed manner, where fantasy objects can affect the participants' existing knowledge in either a direct or indirect way. In the Encyclopedia Britannica, fantasy is described as an imaginative fiction depending upon the effects of oddity and strangeness of the setting ("Fantasy," 2013b). For example, game characters in medieval times could be combined with the battlefields of the 20th century. Strange combinations of game characters and settings create opportunities for the usages of new weapons and game stories. Matching these idiosyncratic components generates authentic supernatural or unnatural gaming experiences. Based on explanations from the Encyclopedia Britannica, fantasy can also be a series or combinations of objects within a video game, or on a broader scope, a genre of games and novels, a single work of masterpiece or just a simple imaginative story.

According to a broader categorization of the relevant definitions, fantasy could be defined as mental activities to internalize unusual external objective stimulus, and byproducts of human imagination such as narratives, learning environments, environmental objects, or even sound effects within an educational game.

In addition, recognizing the definitional differences between the two, a mental activity to internalize unusual stimulus and a byproduct of imagination, is very important for educational game designers because the design goal of educational games is to create an engaging learning environment in consideration with individual differences. An educational game refers to a new approach of making authentic learning environments through the utilization of computer games that possesses educational values as well as generating realistic problem situations in a supportive learning environment (Tang, Hanneghan, & El Rhalibi, 2007; Zyda, 2005). While commercial games mainly focus on entertaining and engaging elements within the gameplay itself, educational games utilize educationally beneficial features from game fantasies by pursuing specific educational

purposes. Successful game designers are able to create inquiry-learning environments within fantasy play, where game players should perform specific roles in order to accomplish their given tasks using real data and tools. The purposeful design practice does not educate the players, but intentionally embellishes traditional teaching practice with imaginative gaming experience so that the players can smoothly transfer their knowledge in the outside world.

DEFINITION OF FANTASY PRONENESS

According to early studies on fantasy (Myers, 1983; S. C Wilson & Barber, 1978, 1983), fantasy is a psychological construct that denotes one's propensity to engage in imaginative circumstances that is formulated from life-long experiences. In delineating the construct of fantasy proneness, Wilson and Barber (1983) noted that their excellent hypnotic subjects reported similar experiences with greater frequencies than other subjects in a) fantasizing much of their waking life, b) the ability to hallucinate objects and experience what they fantasize as real, c) out-of-body experiences, d) occasional difficulty in differentiating fantasized events and the real world, e) belief in their ability to heal, and f) having secret fantasy lives. Based on Wilson and Barber's notion, fantasizing is a perceptual moment when people imagine unusual occasions in their own world by talking to unreal objects or experiencing hallucination in ordinary life.

According to Lynn and Rhue (1988), fantasy proneness is derived from the construct of imaginative involvement that was stated in the studies by Josephine R. Hilgard (1970, 1974). Imaginative involvement is an adult's deep involvement in imaginative thinking and gratifying fanciful activities that one has experienced from childhood. Conceptually, imaginative involvement is quite similar to fantasy proneness

that Lynn and Rhue (1988) mentioned. In addition to the conceptual similarity among the definitions, she stated that fantasy proneness and imaginative involvement is not truly discriminative to absorption, which is defined as the capacity in absorbing and self-altering attention, because those abilities bridges hypnotic and non-hypnotic contexts in their research contexts. In other words, fantasy proneness, imaginative involvement, and absorption share commonality in defining human's ability to link between real life and imaginative thinking. Research revealed that these abilities formulated from continuous early-childhood experiences, and fantasy proneness can psychometrically be related to daydreaming, reality monitoring, creativity, hallucination, and schizophrenia (Aleman & De Haan, 2004; Dunn, Corn, & Morelock, 2004; Johnson et al., 1979; Johnson & Raye, 1981; Merckelbach et al., 2001). In conclusion, as a construct of human cognition, fantasy proneness can be defined as one's propensity to be deeply involved in imaginative thinking and gratifying fanciful activities that one has experienced from childhood (Lynn & Rhue, 1986).

OVERVIEW OF FANTASY RESEARCH FOR EDUCATIONAL GAME DESIGN

In the literature, educational research using fantasy has been conducted in general teaching context and media design. Regarding human imagination and adolescents' creativity, fantasy has been used for contextualization of learning processes and a number of research studies investigated the effect of fantasy in terms of knowledge transition and perception (Cordova & Lepper, 1996; Richert, 2003). In addition, education media research employed computer technology to visualize fantasy in diverse learning contexts, and educational researchers dealt with fantasy as an important agent for engaging in the learning process by making learning fun (Malone & Lepper, 1987; Malone, 1980; K. A.

Wilson et al., 2009). However, educational research about fantasy has been critiqued by a few researchers for a lack of research on fantasy design guidelines for specific educational purposes (Habgood et al., 2005; Kim, 2009). Most of the research using fantasy for teaching and learning did not report how they designed their fantasy materials in detail and how the research participants perceived the fantasy in different contexts. Even in educational game research, few researchers specified the factors and principles for designing fantasy components in educational multimedia design even though they agreed fantasy elements are essential elements making learning immersive (Malone & Lepper, 1987; S. C Wilson & Barber, 1983).

Fantasy research emerged during the early 1980s in the fields of educational media design (Lepper, 1985; Malone, 1980; Myers, 1983). Malone (1980) developed a design framework for educational games by addressing game design elements making education games interesting. His theory is based on the research findings from intrinsic motivation (Deci, 1975), which denotes a type of motivation that drives human behaviors by internal rewards. Later, Malone and Lepper defined fantasy in their publication as "an environment that evokes mental images of physical or social situations not actually presented" (Malone & Lepper, 1987, p. 241). In their theoretical framework, major components that make educational game-playing fun are challenges, curiosity, fantasy, and control. Specifically, Malone suggested two types of intrinsic and extrinsic fantasy, which differentiates from one another in their embedment of fantasy in game content. Intrinsic fantasy makes a learning activity structured directly into fantasy whereas extrinsic fantasy is not directly related to the learning contents even though it stimulates engagement in game-playing.

In addition to the field of educational game design, fantasy has emerged as a research topic in regards to psychiatry after a serendipitous finding of fantasy proneness

(Myers, 1983; S. C Wilson & Barber, 1983). According to Myers (1983), the characteristics of fantasy prone individuals were accidentally found when they were studying hypnosis of individuals. The persons who are highly hypnotic showed similar characteristics in high fantasy prone individuals. After the finding, fantasy proneness is defined as a human's propensity on the fantasizing behaviors created by the likelihood of being involved in the unreal contexts or imaginative mental processes (Myers, 1983; S. C Wilson & Barber, 1983). Researchers who are interested in the relationship between fantasy proneness and psychiatric health reported that individuals who suffer severe fantasizing were more likely to have mental illnesses such as schizophrenia, dissociation issues, and reality distinction problems (Lynn & Rhue, 1986; Merckelbach et al., 2001; Myers, 1983). However, other researchers who attempted to find non-psychiatric implications from the research, in terms of fantasy proneness, revealed proper levels of fantasy proneness positively related to human imagination, creativity, and cognitive imagery processing (Lynn & Rhue, 1988; Merckelbach et al., 2001; Myers, 1983).

Since the early studies and theories about fantasy in games and fantasy proneness, several researchers who attempted to investigate the effects of fantasy in various settings reported that the integration of fantasy in diverse learning environments showed positive effects on motivation and engagement as well as cognitive learning outcomes. For example, math word problems contextualized in a fantasy environment enhanced knowledge transfer and engagement in classrooms in regards to problem solving and processes (Cook, 2002; Richert et al., 2009; Richert & Smith, 2011; Richert, 2003). As a method for the contextualization of learning content using fantasy components in game based learning environment, the gamification of mathematics concepts also improved learning and motivation levels of the students in a substantial manner (Cordova & Lepper, 1996; Lepper, 1985; Malone & Lepper, 1987). R. Garris et al (2002) and K. A.

Wilson (2009) conducted a review literature and synthesized the results on the effect of game design attributes and revealed that fantasy is an essential game attribute in promoting cognitive and motivational aspects of learning.

In summary, fantasy as a game design attribute is an essential component in designing educational games and fantasy proneness as an individual propensity toward an imaginative thinking environment is another factor affecting the learning process in the imaginative gaming environment. These two different concepts on fantasy have been rarely considered together in the game design literature, and the mechanism that explains how individual game users who have different experiences on the topic of fantasy perceive the game design elements has not been investigated effectively. Fantasy research in educational media attempted to investigate the effects of fantasy elements in a learning system, where it would compare whether or not the inclusion of fantasy itself is enhancing the fun and engaging aspects of the material. On the other hand, psychological studies on the topic of fantasy have emphasized how to measure individual traits generated by fantastic experiences and the relationships with other psychological constructs. These independent research strand reflect that there has been a lack of research about which types of design of fantasy as a game element is effective for learning and how these elements are interpreted by individuals who have different experiences with fantasy during game-playing.

GAME DESIGN CHARACTERISTICS AND FANTASY

In designing an educational game, combining appropriate game attributes with learning contents are the main interests of educational game designers in supporting optimal learning outcomes. There has been a long discussion on the essential game

attributes along with the changes of game development technologies and design methodologies, however fantasy has been one of the most important components throughout the entirety of this discourse.

Lepper (1985) reviewed categories of approaches and determinants in intrinsic motivations for game design and suggested four categories in which the last category called fantasy engagement is newly added. In the first category, he suggested that challenge, competence, effectance, and mastery of motivation are important determinants for intrinsic motivation of students. In this view, as problem solvers, students are actively involved in attractive tasks and activities that engage them in problem solving and its process. In this view, critical variables affecting intrinsic motivation are the goal structure of the activity (e.g., the clarity, multiplicity, and hierarchy of the goal), the difficulty of accomplishing the goals (e.g., optimal level of difficulty), and the relevance of the goals to personal abilities (e.g., a dependence of skill).

In the second category, curiosity, incongruity, complexity, or discrepancy are important factors in enhancing intrinsic motivation. The nature of humans in this view is that of an information processor. Humans are pleased with the settlement of surprise, incongruity, complexity, or discrepancy in a problematic situation. Carefully designed tasks and events including appropriate levels of surprise, incongruity, complexity, or discrepancy stimulates expectations in learning relevant skills needed by accomplishing the given tasks. By this account, crucial elements of intrinsic motivation are novelty, complexity, variability, figurality, and uncertainty.

In the third category, perceived control and self-determination are considered as essential determinants. In this view, humans are autonomous agents who are likely to control the external environment and activities that stimulate the sense of control, which in turn enhances intrinsic motivation. Therefore variables such as levels of choice,

control, feedback from the environment, and contingencies between behaviors and learning outcomes are important research topics.

Finally, fantasy engagement is included in another category as a determinant of intrinsic motivation in correlation with educational games. Fantasy is a medium that creates significant changes in motivation and emotion when it is integrated in the learning process, but it is a somewhat confusing construct that has not been categorized in previous research categories. In this view, humans, as *Homo Ludicus* (Liu, Horton, Kang, Kimmons, & Lee, 2013; Ortoleva, 2012), are active participants in the imaginative environment, and they interpret new objects and fanciful stories to play around with. Factors that strengthen fantasy are the use of imaginative graphics, characters, story plots, sound effects, and all other technical devices playable during game-playing sessions. Even if these factors have not been investigated enough to suggest explicit implication for game design in terms of fantasy in literature, researchers provided evidences that the fantasy elements promote intrinsic motivation, offering unique experiences of learning by a creative gaming narrative through interactive audio-visual effects and manipulative animations in a realistic environment (Kim, 2009; Parker & Lepper, 1992; Richert et al., 2009).

Up until Lepper and Malone (Lepper, 1985; T. W Malone, 1980) found fantasy engagement as an important determinant in intrinsic motivation, the former three constructs of intrinsic motivation were fairly prevalent. Fantasy engagement is a unique construct that cannot be classified in former definitions of intrinsic motivation. Nonetheless, Malone (1980) considered that computer games could still be an effective environment that engages users in knowledge development through game playing, where it brings out the users' fantasy-like experiences by utilizing various sets of imaginative graphics and stories. Therefore, fantasy used in the multimedia learning environments

could be another viable approach in enhancing intrinsic motivation due to motivational and cognitive advantages.

After Malone and Lepper's seminal research on fantasy in terms of intrinsic motivation, a number of researchers attempted to identify the determinants of fantasy engagement for imaginative game design. Malone (1981) conceptualized the essential game elements as (a) challenges, (b) fantasy, (c) complexity, and (d) control. After Malone's conceptualization, Malone and Lepper (1987) changed a component, complexity, with curiosity in their theory. Thornton and Cleveland (1990) noted that a critical element of a game is interactivity, while de Felix and Johnson (1994) suggested that (a) dynamic visuals, (b) interactivity, (c) rules, and (d) a goal are the essential game components. Gredler (1996) suggested that (a) a complex task, (b) the learner's role, (c) multiple paths to the goal, and (d) learner's control are the major design components for a game, where as Baranauskas, Neto, and Borges (2001) stated that the essential components of a game are challenges and risks. Thiagarajan (1999) also insisted that (a) conflict, (b) control, (c) closure, and (d) contrivance are the four essential attributes for game design.

In the 2000's, Garris and Ahlers (2001) cited 39 game descriptors that increase the game-like senses that are felt in simulation games. One year later, Garris and his colleagues (2002) reviewed game articles and suggested six key gaming features: (a) fantasy, (b) rules/goals, (c) sensory stimuli, (d) challenges, (e) mystery, and (f) control. Most recently, Wilson and her colleagues (2009) extracted 18 game attributes from relevant literature and narrowed the attributes to seven key components: (a) fantasy, (b) representation, (c) sensory stimuli, (d) challenge, (e) mystery, (f) assessment, and (g) control.

The trend above shows that game attributes have steadily included multimedia related components. For example, game attributes such as representation, sensory stimulus, and mystery are design elements where audio-visual techniques and animation could be applied. This possibility to adapt technological advantages indicates that the use of multimedia such as visual representation and 3D fantasy are becoming popular in current game design theories. According to Kim (2009), fantasy in literature started as a sub-creative art, but it has advanced to a core genre in recent culture along with the development of computer technology. Within these innovative computer technologies, various game attributes were incorporated into diverse educational media, and so imaginative visuals become a critical component for virtual learning environment designs (Dalgarno & Lee, 2010).

EFFECTS OF FANTASY ON LEARNING AND ENGAGEMENT

There have been a number of studies examining the benefits of the educational use of fantasy after the inception of Malone's game design framework for learning generating fun (Malone, 1980). His theory was based on his teacher, Mark Lepper's work. Mark Lepper's learning motivation theory denotes four major factors (challenge, curiosity, control, and fantasy) that create a learning environment that is intrinsically motivating and engaging. His framework has offered important design implications in educational game design as well as general teaching situations (Lepper, 1985; Malone & Lepper, 1987).

In addition to general design research such as educational games and multimedia, a number of researchers insisted that fantasy is a vital ingredient in designing a fascinating educational environment. Fantasy research showed diverse evidences that

imaginative components in designing learning environments resulted in the student's overall growth of performance in cognitive and motivational areas (Cook, 2002; Cordova & Lepper, 1996; Malone, 1980; Parker & Lepper, 1992; Richert et al., 2009; Richert & Smith, 2011; Richert, 2003; Wiest, 2001, 2001; K. A. Wilson et al., 2009, 2009).

Parker and Lepper (1992) examined two related topics of fantasy: 1) the impacts of fantasy on student interest on learning, 2) the effect of different kinds of fantasy in the learning environment. In order to examine the effect of fantasy, the researchers developed three different versions of fantasy (detective, pirate, space version) based on computer applications in a LOGO environment. No-fantasy group was also assigned as a control group. Research participants were 3rd and 4th graders consisting of 24 males and 23 females during the first experiment, and 19 males and 13 females during the second experiment. As a result, all groups of students who were assigned three different types of fantasy scored better in comparison to those with no-fantasy groups. When given a chance, the participants were more likely to choose any of the different types of fantasy rather than the no-fantasy materials. In addition to the preference for choosing fantasy materials, the fantasy groups showed significantly higher learning performance in understanding general geometric concepts relevant to graphics programming in LOGO in the delayed post-test as well as greater interest and learning task involvement than no-fantasy did.

Cordova and Lepper (1996) conducted a series of experiments on the effects of fantasy in an elementary school setting using a mathematics game. A total of 72 children were assigned to one of five conditions: a) generic fantasy-no choice, b) generic fantasy-choice, c) personalized fantasy-no choice, d) personalized fantasy-choice, and e) an additional no-fantasy control condition. Fantasies, as a context of fantasy activities such

as graphics, text, and sound effects, were embedded as motivational adornments in HyperCard environments within Apple computers.

As a result, adding fantasy components positively influenced motivation and math learning in comparison to no-fantasy, and personalized fantasy tended to be a better choice than generic fantasy. In terms of the direct enjoyment score, students scored significantly better in liking rating on fantasy rather than the no-fantasy one ($p < .0001$), and students liked personalized fantasy better than general fantasy ($p < .0001$). Also, students reported better scores on stringent motivation, which meant how they would be to stay during recess or after school, in generic fantasy environments than no-fantasy ones, ($p < .01$), and in personalized fantasies than generic fantasies ($p < .05$). In addition, students reported more likeable responses on relative enjoyment in fantasy conditions than no-fantasy conditions, ($p < .01$), and students were more likely to choose personalized fantasy than generic fantasy ($p < .0005$). Lastly, regarding the effects on mathematics learning, students showed significantly better performance on mathematics in fantasy environments than no-fantasy environments ($p < .0001$), and students also scored better in personalized fantasies than generic fantasies ($p < .0001$).

Wiest (2001) compared fantasy word problems with real-world problems in mathematics in order to verify the role of fantasy in children's problem solving performance and preferences. The research participants were 4th and 6th graders and total 273 participants (138 females and 135 males) were sampled from six classrooms. The research team compared different types of fantasies and real-world stories: low fantasy, high fantasy, children's fantasy, and adults' real-world.

As a result, 4th grade students outperformed everyone else in low fantasy setting, which contained an abnormal world that included unexpected non-rational episodes even though it did not show statistical significance. Sixth grade students solved problems

significantly better than everyone else on real-world and high fantasy problems. More specifically, they performed better on children's real world problems than on low fantasy ($p < .05$) or adults' real-world problems ($p < .001$). They also scored better on high fantasy problems, which contained an imaginary, but internally consistent secondary world including myth or unreal creatures that were not present in adults' real world problems, than adults' real world problems ($p < .05$). Also, there were significant differences ($p < .0001$) between grade levels for problem solving performance. Combined scores, including grade 4 and 6, in children's real-world problems, where ordinary situations were supposed to be experienced by most 4th and 6th graders, were significantly better than adults' real-world situational problems, where the common problem situations could be experienced by most adults ($p < .05$). In addition, students reported that different stories accompanying the same mathematical questions affected the way they solved the problems and their perceptions on the level of problem difficulties, and they felt stronger interests, engagement, or distraction in fantasy contexts than real-world contexts. The research participants also reported that the different interests within each problem affected their desire to take on the problems, conduct effective problem solving processes, and raise their attentiveness.

Cook (2002) conducted an experimental research study on the effects of fantasy use in a university teaching environment. In her research, based on the research assumption that imagination is constrained by reality (Seelau, Seelau, Wells, & Windschitl, 1995; Taylor, Pham, Rivkin, & Armor, 1998), she set the hypothesis that perspective-taking, which is the ability to find the possibilities for solutions of the problem in the situation where there is no specific answer, would enhance learning performance in imaginative situations. To accomplish the purpose of the research, the university instructors read a fanciful story in which a protagonist faced impossible events

during a boat trip for an experimental condition, whereas the other instructor read a realistic story of the boat trip in as a control condition. As for the results, the students who participated in the fancifully decorated story solved more word problems than the realistically decorated story. Also, students who were exposed to fanciful words scored higher on a measure of mental set breaking. Increased scores of mental set breaking indicates that the students who received the fanciful words showed a greater tendency to change their ways of problem solving than they were used to in the past.

Wilson and her colleagues (2009) conducted a systematic review on educational game attributes and their learning outcomes using a comprehensive taxonomy of learning outcomes. The effects of fantasy were categorized into three domains: cognitive, skill-based, and affective (see Table 1 below).

In cognitive domain, Gopher, Weil, and Bareket (1994) reported that the use of game including fantasy components significantly impacted the application of aircraft maneuvering skills. In their study, participants who accomplished maneuvering a spacecraft to destroy a space fortress in a war game outperformed those who did not receive the training. Van Eck (2006) showed that games were effective in applying HIV/AIDS knowledge and Thomas, Cahill, & Stantilli (1997) showed results indicating that digital games with fantasy components are beneficial in teaching various tasks such as matching concepts, manipulating numbers, and recognizing patterns.

For cognitive strategies, Bowers and Jentsch (2001) reported that the inclusion of fantasy elements in games contributed to an increase in the usage of cognitive strategies as well as overall performance. In Wilson and her colleague's review (2009), a number of research showed that the use of fantasy components in educational systems facilitated the use of cognitive strategies such as facilitative learning activities, and understanding the

meanings, and judgment of ideas (Gopher et al., 1994; Habgood et al., 2005; McFarlane, Sparrowhawk, & Heald, 2002).

Researchers	Cognitive	Skill-Based	Affective
Belanich, Sibley, and Orvis (2004)	D		
Bowers & Jentsch (2001)	C		Og
Day, Arthur, & Gettman (2001)	Ap, K	Or, P	
Driskel & Dwyer (1984)		Or	M
Garris & Ahlers (2001)			M
Gopher, Weil, & Bareket (1994)	Ap, C	P	
Habgood (2005)	C		M
Habgood, Ainsworth, & Benford (2005)			M
Lepper (1985)	Ap, C, D, K		M
Lepper & Chabay (1985)	Ap, D		M
Malone (1981)			
Marks (2000)	Ap	Cp	
McFarlane, Sparrowhawk, Heald (2002)	C, D, K	Or, P	M, Rp
Merzenich et al (1996)			Rp
Parker & Lepper (1992)			M
Proctor, Panko, & Donovan (2004)	C		
Rieber (1996)	C, K		M
Rosas et al (2003)	D, K		M, Rp
Thomas, Cahill, & Santilli (1997)	Ap, D		
Van Eck (2006)	Ap, C, D	Ad, Au, Or, P	Rp
Virou, Katsionis, & Manos (2005)	D		M
Westrom & Shaban (1992)			M

Note. Cognitive domain: Application (Ap), Cognitive Strategies (C), Declarative Knowledge (D), Knowledge Organization (K); Skill-based domain: Adaption (Ad), Automaticity Set(Au), Compilation (Cp), Origination (Or), Psychomotor (P); Affective domain: Motivation (M), Organization(Og), Receiving and Responding Phenomena (Rp)

Table 1: Research Linking Fantasy and Learning Outcomes

Games with fantasy components also showed the benefits of declarative knowledge and knowledge organization. Belanich, Sibley, and Orvis (2004) concluded that the use of military games had impacts on procedural knowledge and declarative knowledge as well as more relevant information recall. The research participants answered with more accuracy when they were in the graphic images category than text/audio-based information. Lepper (1985) also said that general game attributes such as challenge, control, fantasy, surprise, and sensory stimuli were correlated with declarative knowledge, cognitive strategies, knowledge organization, and application. Lepper and Chabay (1985), however, stressed careful use of sensory information such as graphic images and audio effects because too much sensory stimuli could be detrimental to learning in general. Thomas, Cahill, and Santilli (1997) reported significant increases in knowledge awareness about HIV/AIDS and Van Eck (2006) stated that games were effective tools in matching concepts, numbering, and pattern recognition. Finally, Virvou, Katsionis, and Manos (2005) concluded that the use of games with fantasy elements was good in improving geographic knowledge. By exploring in a virtual world to find missing pages of a book, the poor performers improved more than the good performers in general.

In Wilson and her colleagues' review, the authors also investigated if fantasy components influenced skill-based domains. Van Eck (2006) stated that games with fantasy were good tools for the automaticity of skill sets and adaptation. Computer games were the ideal training environments that created automatic repetitions without burdens, and the obtained skills sets were modified as needed in different situations. According to several researchers (Driskell & Dwyer, 1984; McFarlane et al., 2002; Van Eck, 2006), fantasy elements in the game contributed in creating new thinking patterns in order to fit unique situations creatively. Other researchers concluded that fantasies in games were

related with psychomotor skill improvements (Gopher et al., 1994; McFarlane et al., 2002; Van Eck, 2006).

Finally, the use of fantasy showed positive impacts on affective domains in various research results. Most of all, the majority of researches concluded that fantasy in games had impact on motivation (Driskell & Dwyer, 1984; Rosemary Garris & Ahlers, 2001; Habgood et al., 2005; Lepper & Chabay, 1985; Parker & Lepper, 1992; Rieber, 1996; Westrom, 1992). In game based learning environments utilizing fantasy, mastery oriented participants had an increase of expertise at a specific task. Also, performance-oriented participants showed their intention to succeed more and the intention resulted in receiving more positive feedback from other people. Moreover, fantasy components stimulated awareness to events, gathering selective attention to specific phenomena, participating in learning processes in active ways, and evaluating different values to resolve conflicts (Bowers & Jentsch, 2001; Merzenich et al., 1996; Rosas et al., 2003).

Richert et al (2009) conducted a series of experiments to explore how young children transfer their knowledge to other settings. In the first experiment, 64 children with ages ranging from 3.5 to 5.7 were assigned to two groups. In fantasy source condition, students received the source story embellished with the fantasy character and the target story about the children's real teacher. Contrary to the fantasy source group, students in reality source conditions received the source story about their real teacher and the target story about fantasy characters. In the first experiment, the result indicated that children in younger age groups ranged from ages 3.5 to 4.6 were less likely to transfer the fantasy source story than the reality source story. This meant that younger children were more likely to transfer solutions from the stories about real characters than fantasy characters.

In the second experiment in the study (Richert et al., 2009), Richert and her colleagues expanded the research question to explore whether different types of performance tasks intermediated transfers of knowledge. In the second experiment, 37 children were randomly assigned to different source-target settings: fantasy-to-fantasy, fantasy-to-reality, reality-to-fantasy, and reality-to-reality. In addition, the transfer context was changed to social or physical related, and problem types were also added as either fantasy or reality. Character type was also separated by younger and novel characters. For the results, problem type (physical vs. social) was not a significant factor, and only the main effect of source condition was detected. In other words, research participants in the reality source conditions were significantly better on knowledge transfer than those in the fantasy source conditions, regardless of transfer conditions or problem type.

In the third experiment, the authors changed the research procedure so that children would solve a problem by themselves in a game situation instead of doing specific activities in a target story about a character with a problem to solve. As a result, there were significant interaction effects between story type and story preference. The participants who preferred the fantasy source story responded more correctly to the targets in the real source story than the fantasy source story. Also, there was a three-way interaction among story type, age group, and story preference. In particular, younger participants who preferred the fantasy story were more likely to transfer from real story than fantasy, but older participants who chose fantasy story were more likely to transfer from the fantasy story. For the interpretation of the mediation effect of age, the authors speculated that older children who have more experience with fantasy media and materials were more advantageous to utilize fantasy source, whereas younger children were not good at recognizing the fantasy characters as a possible source of information.

In recent research, Richert and Smith (2011) again investigated the effects of fantasy by conducting two experimental studies examining relevant factors that mediate children's information transfer about characters from fantasy worlds and the real world in classroom learning settings. For the purpose of the research, the authors hypothesized that children who read the fantasy story would not transfer well compared with the children who read the real story, since children over 4 years could differentiate the information for actual problems in the imaginative situation (Richert et al, 2009). In addition, those who read the fantasy story would receive the same amount of information about the problem structure and solution from the fantasy story, but those fantasy story readers would face a lack of direct relevance to the transfer situation, in turn resulting in inefficient transfers.

As a result, a univariate effect was detected between the groups for general memory and solution memory questions in the first experiment in which 16 girls and 17 boys aged from 3.5 to 5.5, totaling 33 students. Also, there was a significant difference between the groups in regards to the number of correct responses of the transfer questions ($p < .05$). The participants in the reality group were more likely to transfer solutions than the ones in the fantasy condition. This means that children were significantly less likely to transfer knowledge when they learn with fantasy-based media than reality-based ones.

The second study with 51 children aged 3.5 to 5.5, 20 boys and 31 girls, revealed that children's age, cognitive ability, and story condition were significant factors, which were related to solution memory. Based on regression analysis, it was confirmed that as children’s age increased, so did the number of correct responses to the solution memory questions. In terms of general memory, as cognitive ability increased, so did the number of right answers on general memory questions. Story type was also a significant factor in which participants in the reality condition were more likely to answer more correct answers to the general memory questions than the participants in the fantasy condition.

For the number of correct answer on transfer questions, participants in the fantasy group were less likely to answer better than the participants in the reality group.

In the combined analysis of each reality and fantasy groups, a simple linear regression analysis confirmed that age, solution memory, and general memory were significant factors, which affected knowledge transfer. As age, solution memory, and general memory increased, so did transfer of knowledge in the realistic learning context. Contrary to the reality condition, another simple linear regression analysis indicated that fantasy orientation and fantasy exposure condition were significant predictors for the transfer of knowledge. As the participant's fantasy orientation increased, transfer decreased, and the participants in the one-on one exposure condition were more likely to transfer than the participants in the classroom exposure group. As a result of regression analysis, age and solution memory were the primary factors that had significant impact on the transfers from real stories. In the fantasy condition, however, children were less likely to transfer if they scored high in the fantasy orientation, and they were more likely to transfer if they read the story in a one-on-one condition.

In other studies, the use of fantasy in games and traditional classroom teaching facilitated cognitive development, learning motivation, knowledge transfer, and problem solving. Students who studied in a learning environment designed by fantasy showed better cognitive learning outcomes on geometric concepts in computer based learning environments (Parker & Lepper, 1992). Students who studied mathematics in fantasy environments showed better performance than no-fantasy environments and scored better in personalized fantasies than generic fantasies (Cordova & Lepper, 1996).

Wilson and her colleagues (2009) also showed that effects of fantasy were categorized into three domains: cognitive, skill-based, and affective. In the cognitive domain, fantasy promoted cognitive strategies, declarative knowledge, and knowledge

organization. In the skill-based domain, adaption, automaticity set, compilation, origination, and psychomotor skills were enhanced, and in the affective domain, motivation, organization, receiving and responding phenomena were improved. Especially, literature showed relatively consistent evidence that the use of fantasy components in game and multimedia learning is effective in engaging students in relevant learning activities and learning motivating (Cook, 2002; Malone & Lepper, 1987; Richert & Smith, 2011; Wiest, 2001).

Fantasy showed a positive impact on problem-solving in mathematics. Wiest (2001) compared fantasy word problems with real-world problems in mathematics in order to verify the role of fantasy. 4th grade students outperformed everyone else in a low fantasy setting, which contained an abnormal world that included unexpected non-rational episodes even though it did not show statistical significance. 6th grade students solved problems in real-world problem significantly better than low fantasy problems and adults' real-world problems. Students also scored better in high fantasy problems, which contained an internally consistent secondary world including myth or unreal creatures that were not present in adults' real world problems. Cook (2002) also found that the use of fantasy had a positive impact on word problem solving in a university teaching environment. The students who participated in the fancifully embellished story solved more word problems than the realistically described story. Students who were exposed to fanciful words scored higher on a measure of mental set breaking due to the increased possibility to accept a new perspective when students read a fantasy story.

Malone's framework is quite close to a general theory in regards to designing motivational components within educational games. He thought there had been a lack of research in finding any consensus on how to apply his framework in designing fantasy components in teaching for the classroom. In addition, the lack of research on how to

design different types of fantasy has lead to inconsistent research results regarding the effect of the fantasy components depending on the setting where the fantasies are implemented. Richert and her colleagues (2009; 2011; 2003) showed children in younger age groups, for example, pre-kindergartners were more likely to transfer the fantasy reality source story than fantasy source story. This meant that younger children were more likely to transfer solutions from the stories about real characters than fantasy characters due to the similarity of transfer condition. Fantasy experience and personal preference by maturation of individuals are important factors that should be considered in the design of fantasy in the game design process.

In addition, research about fantasy design strategies and different types of fantasy was not investigated to show enough experimental evidences in diverse learning situations (Habgood et al., 2005; Kim, 2009). Studies have shown that variables such as age and personal experiences on fantasy played a critical role in the conceptualization of fantasy and in the eventual transfer of knowledge learned, even in retained for later usage (Richert et al., 2009; Richert & Smith, 2011; Richert, 2003).

APPROACHES AND PRINCIPLES FOR FANTASY DESIGN

Human beings create new things through imagination and creativity based on knowledge. Through their creative abilities to create physical objects or abstract concepts, humans have attempted to pursue the life of convenience by devising new tools and leave drawings and songs as products of mental activity by crystallizing the image and feeling of everyday realities (Piaget, 1952; Vygotsky, 2004). Even humans understand abstract concepts by generating hypothetical constructs and combining the imaginative concepts to create unrealistic objects under the name of fantasy art. These

creative acts have contributed to the development of fields within arts, new technologies, and even new cultures within different areas and aspects of human lives (Vygotsky, 2004).

As important components for educational games, various fantasy elements are developed by the developers' imagination and creativity based on the game story. Fantasies in educational games are carefully designed with cooperation among game design experts such as concept artists, 3D modelers, animators, and game engine programmers (Robertson, 1992; Stoneham, 2010). Especially, the visual fantasy, that is the main interest of this research, is the masterpieces of concept artists and 3D modeling experts. In other words, all the game characters, weapons, and other environmental objects used in the game are the by-product of the creativity and imagination as well as the experience of the experts.

In the following section, the types of psychological processes that may be applied in developing fantasies and the kind of design principles that can be applied in developing visual element of fantasy for educational games are discussed. To discuss the psychological process of human imagination, Vygotsky (2004)'s idea about human imagination is introduced and fantasy design approaches are compared. Finally, Vygotsky's approaches are integrated into the Kim (2009)'s principles of fantasy design, and the categories of source of fantasy with their examples are discussed in a way to show how the aforementioned fantasy principles are applied in the actual developmental process of fantastic visuals for educational games.

Basic Approaches: Reproduction and Combinative Recreation

Vygotsky understood this unique process of human creation as imagination and the process of fantasy (Vygotsky, 2004). He elucidated imagination and fantasy as a core

element of cultural and technological change within a society and his conceptualization of human imagination is critical in understanding what human creativity is and how individuals create fantasies. He theorized the process of the creative change with two concepts called reproduction of memory and combinative creation (Vygotsky, 2004).

Reproduction is a process to create something through mental or physical activities by using the human memory. At the very beginning of the learning process, humans imitate their environmental stimuli in order to understand a specific concept or event. Humans first learn from environmental elements by emulating the objects so as to create initial knowledge where the knowledge is registered in another form of memory for environmental adaptation. In the process of reproduction, which is regarded as an initial knowledge building process prior to creative modification of knowledge, Vygotsky (2004) explicated that *plasticity* and *trace of memory* are the organic basis of human reproductive activities. Plasticity here is defined as the property of the human mind that makes changes in the experiences of individuals' brains so that one could register what they are observed and perceived into their memory. During the adaption of the environment, this extreme flexibility of memory works to generate informational traces from environmental stimuli for a more efficient understanding of nature. Mental plasticity makes it easy to generate memory traces, but only when learning stimuli are offered enough in number and strength.

Let's take an example in children's play. A neat display of completed Lego[3] models in a fanciful showcase entices children to buying one in toyshops. Children who are eager to create the model just like the one in the showcase follow the instructions provided in the kit after buying one. Then, the model might be crashed soon or taken

[3] Lego is a trademark of a toy company. See the website (http://en.wikipedia.or/ wiki/Lego).

apart to be stored in containers. A few days later, the children try to make the Lego model again, but this time they are able to remember and memorize some parts and processes of assembly in the instructions. They might feel at relative ease to build the same model without referring to each instruction thoroughly like they had to for their first trial. These repetitions engrave memory traces in the plastic neural system so that the kids can effectively memorize how to build the Lego model on their own through enough trials.

When a fantasy as a visual object is created in a game design project, fantasy experts should follow the memory traces to reproduce a fantastic image at the beginning of fantasy creation. As a final product of the artwork of the fantasy experts, the fantasy object is decorated with heterogeneous elements in shapes, colors, and functions, but the core aspects of the unusual image in general is derived from the concepts in reality around us. Since game players perceive the message contained in a fantasy object in a game based on their knowledge and experience, similar concepts adapted from reality become essential components eliciting common sense among fantasy developers and game users. Likely, Kim (2009) and Robertson (1992) suggested similarity to existing concepts and vividness in representation as the fundamental characteristics that consist of fantasy. Borrowing common features from real objects or concepts to create an unreal creature in function and concept attains similarity, and these artworks may generate vivid representations of real objects even if they are unreal. The visually vivid representations of unreal object also have visual accuracy, and the fidelity of realism is another way to describe imaginative visuals in better ways. In this sense, reproduction is not simply copying an entire shape or color of a real object, but borrowing initial ideas and concepts as a starting point of the fantasy artwork with visual accuracy. In the reproductive process, clear images and meanings are enhanced with visual fidelity.

As the procedures of reproduction are repeated, another types of production begin to occur. People perceive concepts and events around the world all the time. These fractional conceptualizations and mental images are learned by repetitive attempts. In the series of reproductions, the memory traces are engraved in our memory and the efficiency of reproduction is increased. However, if our mental activity was limited to reproduction utilizing the old concepts, then we would not be able to create a new future that goes beyond the reproduced past (Vygotsky, 2004). Combinative recreation is a process to make something different from existing resources by combining heterogeneous elements acquired through previous experiences.

The byproduct of this creative process can be a physical object, abstract idea, or emotional construct. Humans receive diverse stimuli in the environment, and they mimic the images or behaviors in the beginning stages of learning when they first try to understand a certain object. Even though Vygotsky (2004) defined reproductive creation as a pattern of human intelligence, he emphasized that human creativity does not limit our consequences of learning for reproduction. According to him, it rather expands our knowledge by various forms of combination and alteration of existing information assets.

As the reproductions are repeated, humans begin to combine related concepts, and start to find new concepts and behavioral patterns. After starting to create new concepts, we can see the concepts and patterns gradually evolving from simple combinational forms into complex products, and finally a completely new and different invention appears. Even though the new idea resulted from existing ideas or resources, the final product by combinative creation is pretty far from the original one. The originality of the source is completely altered in the final product by combinative creation.

Dissimilarity and variation are core characteristics that are accompanied by creative combination to create fantasy. Kim (2009) found that a combination of concepts

and ideas as an intellectual process of imagination generates dissimilarity, creativity, and affectivity on the new creature. In the process of fantasy creation in a game, visual artists generate authentic gaming environments where imaginative fantasy visuals are integrated by distortion and variation of the original images. Even if the fantasy experts incorporate meaningful elements that were produced by mimicking and adapting the surroundings, the creative variation and alteration of the sources are inevitable when they are attuned to the authentic environment of the games. Personal value and affectivity are also included in the process of alteration of the original image. According to Freud (1908), fantasy is generated due to the unresolved desire in ordinary life. The audience of fantasy in computer games and mass media can share the emotional deficiency through the creatures of fantasy artworks. In other words, the purpose of alteration and differentiation of fantasy resources is to embed any intention in the artistic visuals to generate affective coordination with the entire process of game-playing.

To summarize, Vygotsky's notion that human imagination enables reproduction using memory and invents something new through combinative creation offers the basic approaches to fantasy development methods. Humans are adaptive organisms and need to understand and learn environmental resources unceasingly. As a human learning process for environmental adaptation, fantasy creation is started by reproduction and the imitational concepts and images are essential for combinative creations of ideas. In addition, the creatures of combinative creations constitute another forms of fantasy as a form of human knowledge, and the new creature carries different emotion and affectivity in an authentic learning environment. Therefore, both reproductions and creative combinations can be considered as essential methods for fantasy development in imaginative artworks of fantasy developments.

Principles of Fantasy Design

Vygotsky's idea about human imagination is informative for fantasy design. He suggested two fundamental approaches to understand how people imagine and what we should consider when we create imaginative objects. He also believed that the foundational understanding about those imaginative thinking processes is important in investigating the fundamental mechanism of the creative thinking process. However, Vygotsky's conceptualization does not elicit enough practical guidelines for the specific areas of multimedia and audio-visual design of fantasy within game development because these two dichotomous approaches of imagination are generic. Even though his generic approaches on fantasy development are closely linked to the evidence of how creative kids work on their jobs in drawing and writing (Kim, 2009; Vygotsky, 2004), they still need to be expanded to the specific areas of fantasy and multimedia design using graphics and sounds for educational games. Especially, since current research focuses on the effect of different types of fantasy that are used in an educational game design context, more specific principles or design guidelines need to be addressed in terms of visual design. To fill the gap, the researcher discusses essential principles of fantasy design as an important guideline for this study from Vygotsky (2004)'s theory.

Kim (2009) conducted research examining the potential of fantasy in education and factors and principles for fantasy design. In her dissertation research, she reviewed an extensive amount of literature on how fantasy has been investigated and understood in various fields of research including psychology and education. Her research included a series of interviews of 7 experts who were working with learning design in commercial games and fantasy novels. The data was analyzed by grounded theory. As a result of the analysis, she found four major categories and twelve principles of fantasy design. In the

following section, the categories and principles are described pertaining to the visual design of fantasy in educational games (see Table 2).

Category	Description	Principles	Relevance to Vygotsky (2009)
Portrayal representation of fantasy	Portrayal fantasy being described like real object by adapting parts or mimicking experience.	Descriptive realism	Reproduction
		Experiential realism	
Creative representation of fantasy	Fantasy having intentionally changed elements by distorting the original concepts. The original meaning of the elements is completely transformed.	Distortion of being	Combinative Recreation
		Distortion of time and space	
		Adaption and transformation of other materials	
		Distortion of ordinary sense	
Combinative representation of fantasy	Creating new image of fantasy by combining other elements or hiding the original meanings	Hidden meaning	
		Including new narrative and own story	
		Coordination and relevance among reality and fantasy	
		Adding personal desire and wish	
Envisioned representation of fantasy	Visualizing abstract values and metaphysical concepts	Spatialization of abstract concept	n/a
		Visualization of intangible concept	

Table 2: Categories and Principles for Fantasy Design (Kim, 2009)

According to Kim (2009), the first category of fantasy design principles is portrayal representation of fantasy. Portrayal fantasy strives to make the fantasy reasonable, logical, and believable to people who have ordinary senses of fantasy through interactions with public media. The most important feature of portrayal fantasy is the similarity of a new image to preexisting subjects. Portrayal fantasy is the representation

of fictional subjects when they have components similar in function and concept (Hume, 1984) so that the representation decreases the perceptual gap between the generated fantasy from reality.

Vygotsky (2004) pointed out the importance of reproduction of one's knowledge as part of a creative idea. Therefore, the imaginative objects realistically represented by accurate reproduction create vivid images and do not pass over the limitations of reality in shape, color, function and concept. For example, adding two more arms to a human body to create an alien is believable and common in public media (See an example of a movie called John Carter at http://en.wikipedia.org/wiki/John_Carter _%28film%29) because it could plausibly happen through genetic changes. The two additional arms have similarities in function and appearance with ordinary human body parts even though they would not be regarded as real arms in a general sense.

In the first category of portrayal fantasy, Kim (2009) suggested two different principles to make vivid and pictorial images in fantasy.

1) *Describe objects with accuracy and detail in shape and color (Descriptive realism)*. Adapting real components in fantasy and seamless integration of the components enhance vividness and accuracy of imagination. With this descriptive realism, fantasy objects, or visuals, make fake objects preexisting objects genuine.
2) *Include manipulative or participatory components in the fantasy (Experiential realism)*. Inclusion of participatory activities also creates realistic experiences in the fantastic story. Adding activities in fantasy-based learning situations and embedding controllable functions on fantasy characters promote a sense of fantasy in the game playing.

The second category of fantasy design principles is creative representation of fantasy. Creative fantasy is an elaborated product of the existing concepts. That is transformed from an original concept/object where it makes the viewers perceive it as an entirely new object. Compared with the previous realistic fantasy, the basic idea of creative fantasy is to change the original functions and characteristics of the reality. Creative fantasy is also based on previous experiences and images from a given situation in the past just like realistic fantasy. However, these experiences are stored in one's knowledge base and later combined for the reproductive purposes of a previous image. Finally, continuous efforts for distortion and countless combinations between the relational components from past images generate creativity and independence from existing concepts, which can be seen as the creative reproduction process of imagination (Vygotsky, 2004).

As an example from the aforementioned movie, John Carter, the four-armed alien would be recreated by combining several concepts and components and later the artist would make a few subtle differences through his creative processing. Compared with the realistic alien, the creative alien may have a different shape that is not consistent with ordinary creatures on earth. Examples may include a different skin texture like a reptile's skin, and a mechanic component to link the left arm to the torso. The final result may be an extraordinary object that has a novel shape. Several combinations and distortions make the object far more creative and distant from reality, and at the same time it generates a creative reality within the fantasy. In regards to the creative fantasy category, four principles were found in Kim (2009)'s study: distortion of being, distortion of time and space, adaption and adjustment of materials, and distortion of ordinary sense (Kim, 2009).

3) *Alter the shape, color, or meaning of being (Distortion of being)*. Changing the original meaning and physical properties of existing creatures generate authenticity and difference from an ordinary sense. In the visual design of fantasy objects, modification of color and shape in characters and objects sometimes result in alterations of the role of the subjects.
4) *Change the background of events in time and space (Distortion of time and space)*. An event has historical narrative, and the historical background in a certain place can be changed to create a new image of game elements. Alteration of the background information in the design of a game's visuals creates a unique atmosphere promoting imaginative thinking.
5) *Utilize different materials from idiosyncratic objects and transform the shape, color, and meaning (Adaption and transformation of other materials)*. Transformative adaption of other components in shape, color, and meaning helps to create a new object or concept. Beyond changing something in itself, borrowing parts from the original resources such as legend, myth, movie, and TV adds a different mood and creative functionality in the subject.
6) *Deform natural law and twist ordinary sense (Distortion of ordinary sense)*. In order to create supernatural creatures, natural laws and scientific logic can be distorted. Environmental objects and behaviors of fantasy characters can change an ordinary sense of the real world to enhance a sense of creativity.

The third category is combinative representation of fantasy that intentionally hides or camouflages the internal story of the fantasy by integrating other elements, which is an important category of fantasy principles. The intention is to conceal the underlined purpose of the fantasy so that the audience does not become aware of the main purposes/goals in a straightforward or direct manner. When elements are combined to

create a new concept, the original meaning disappears or is replaced with another. The relevant components also can be integrated into a new object to create a new imaginative concept, but the new narrative can be generated during the process according to the imagination of fantasy designers.

For example, a game character in an educational game is designed to deliver target curricular knowledge; however, the knowledge is delivered with concealment so that the gamer is not aware of its purpose. The role of the learner in Alien Rescue is to save endangered aliens by investigating the planets and moons in our solar system. In the game narrative, students were invited as young scientists, and a director from NASA sends informative messages to solve the problem. However, nobody explains that the information learned from the Solar System Database, which is related to the science curriculum in school, and the information of the aliens become important clues to find proper planets in the Solar System Database throughout the gamplay. These details are so concealed, or altered components, that they make the game player become more engaged in the game. Also the details of hidden elements make game players feel personal presence within the creative space of the game (McMahan, 2003). According to Kim (2009)'s analysis, there are four principles within combinative fantasy: hidden meaning, including new narrative and different story, relevance to reality, and adding personal desire and wish.

7) *Conceal the original meaning of objects or events to be used (Hidden meaning)*. Substituting and concealing the original meaning are essential processes to create a new creature and story. In order to create a supernatural event and an imaginative creature, combining other characteristics by substituting parts, shape, and color elements may conceal and replace the

original form of the object. Sometimes, the original meaning should be hidden and a new one has to replace it by combining different elements.

8) *Include new narrative and apply different story (Inclusion of new narrative).* Creating new concepts and meaning breathes new narrative into objects. Fantasies as artifacts in games have specific stories in each background. Text information, descriptive visual, and audio effect can be used for the element of fantasy.

9) *Coordinating detailed information and relevance among reality and fantasy (Relevance to reality).* When a main concept of a fantasy object is set, the following details need to be attuned to the main concept. The detailed information such as historical background, organic functions, and aesthetical decoration should be relevant to reality.

10) *Apply human desire and wish to the new creature (Personal desire and wish).* Unfulfilled human wishes are a motive of imaginative thinking. Human desire and wishes embedded in a fantasy promote imagination by creating a story improbable in reality to the audiences in games.

The last category is envisioned representation of fantasy, which is the visualization of visually impossible objects. This type of visualization creates a fantasy in itself because the visualized concepts do not exist in real life, but are recognized as abstract concepts. The subcategories of envisioned fantasy are personification, materialization of abstraction, and visualization of space. These techniques are now common due to new technologies such as 3D modeling tools and digital artworks. For example, the air from characters' breath can be made by using the particle effect in 3D game engines such as Unity 3D (Creighton, 2010). The particle represents the abstract concept of invisible air or airflows. This representation conveys a similar concept of the

actual object, but human imagination can create huge variations in the shape and function of the original concept as diverse forms of fantasy. According to Kim (2009), there are two principles within the category of envisioned fantasy: spatialization of abstract concepts and visualization of intangible concepts.

11) *Convert abstract concepts and values into a visually represented space (Spatialization of abstract concept)* Abstract concepts can be spatially visualized alternative measures such as color, coordinates on axes, or an amount of sound.
12) *Visualize invisible concepts (Visualization of intangible concept)* Abstract concepts can be visualized by metaphors and utilizing controllable components of relevant concepts.

A HYPOTHETICAL MODEL OF FANTASY FOR EDUCATIONAL GAMES

Educational game designers develop fantasy in games and individual learners interpret fantasy during game playing. Throughout the discussion on the definitions of fantasy and fantasy design principles, the dual aspects of fantasy are represented to capture the importance of both perspectives. Game researchers need to understand both aspects so as to understand the implications for more effective educational game design and better academic achievement. This means, on one hand, fantasy is an artifact that can be separately defined in the developer's perspective in an imaginative learning environment. Fantasy can be an object, or story, that is rooted in the artistic experience of the developers, where the final artifacts of the experts are carefully integrated into the games or learning system. On the other hand, from the perspective of learners, fantasy is

the subject of perception through the action of game playing, and this personal interpretation is another process to understand developers' intents that are embedded in game stories and objects. When learners play the games, the gaming experience must be different from each other based on one's imagination. The meaning of fantasies varies from each learner because individual learners have different perspectives and knowledge on the topic of fantasy.

The dual aspects of fantasy aforementioned are essential to understand the intent of qualitative investigation on the student's perception on fantasy. The main purpose of this research is to examine how individual learners perceive different types of fantasy in an educational game and to extend the scope of the research to include the dual aspects of fantasy, as a design artifact and human propensity of fantasy perception. However, literature review results indicate that fantasy as a design artifact in educational games has focused on examining whether inclusion of fantasy components in teaching and learning was beneficial or not. Even though only a few researchers are interested in design principles and comparing applications of different fantasy types, little research has been conducted to examine the relationship between fantasy types and personal perception of fantasy in literature. This means that few research frameworks, including the two aspects of fantasy, were examined, and there have been a lack of research to fill the gap in understanding the relationship between fantasy as a design component and internal perception during an educational gameplay.

As a developer of an educational game, the media designers and 3D modelers need to understand the perspective of the learner by asking questions as following: if students like the characters, what traits they like or dislike: if the game can enhance students' educational achievements as intended, how they can improve the characters based on the learners' reflections, and so on. As a way of understanding the process of

fantasy creation and perception at a glance, a hypothetical model called Procedural Model of Fantasy for Educational Games (PROMFT) was created based on the overall literature review (see Figure 1). It addresses two essential agents that account for developmental and interpretational processes of fantasy.

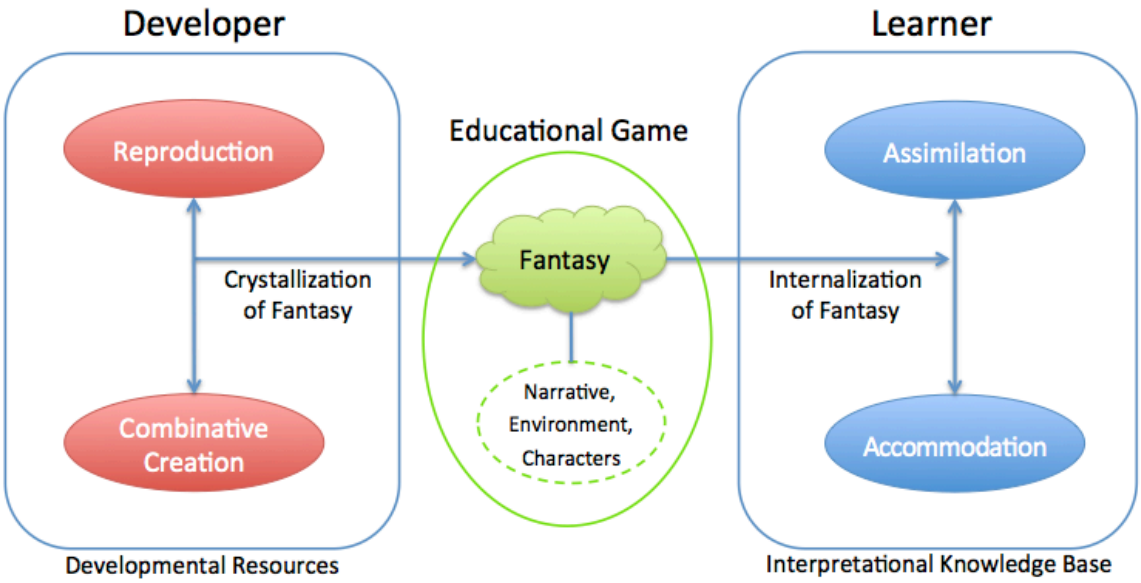

Figure 1: Procedural Model of Fantasy for Educational Games (PROMFT)

Developer's Perspective

In a game development process, collaborative work among professionals to develop fantasies and imaginative visuals is common because those fantasy visuals and graphics are generated within the story and conceptualization for designing coherent gaming experiences. According to Kim (2009), game narrative is the foundational element for game development and other components such as visual graphics, characters, and interactivities should be systematically aligned with the narrative. During the development process, fantasies are crystallized into the game structure by merging

personal resources of each artist, which should match the game's plot structure. This is the first step of fantasy creation by reproduction of memory (Kim, 2009; Vygotsky, 2004). For example, game narrative writers work on and imagine the game story in their minds while concept artists draw game characters with their inspiration. To do these, the game narrative writer needs to search for classical fantasy movies, or the concept artist may need to visit European countries to get inspiration on medieval architecture. These efforts to gather existing data for their works enable them to reprocess the images and experience of their creations, and the reproductive process crystallizes new images of fantasy.

Professionals continuously have to revise the reproduced images through combinative creation in order to get different products (Kim, 2009; Vygotsky, 2004). Fantasy is usually adapted in order to create a unique experience, which helps to expand our imagination beyond common world problems around us. Therefore, realistic experiences that only simulate preexisting experiences through reproduction alone are not enough. Since fantasy is a byproduct for accomplishing unresolved human wishes, there is plenty of flexibility for fantasy creators to recreate the fantasy in different ways. Countless concepts or ideas can be combined for the enhanced authenticity in the fantasy.

In a game development project, there is usually a set of clear intents and directions as a structural guideline. Game design professionals follow these guidelines to create different types of fantasy. However, the individual product of creative fantasy is mostly derived from the inspiration and experience of the artists. Depending on their creativity, the product of imagination can represent far more realistic and invoking images by reproduction, or very exclusive images by combinative recreation. Once various types of fantasy, that is, characters and idiosyncratic objects, are created within game development, they need to be organized in a game design structure.

Learner's Perspective

In an educational game, fantasies exist in forms of information such as text, visual images, audio clips, and animated interactions. From the perspective of cognitive constructivism on learning (Collins et al., 1992; Ertmer & Newby, 2008; Jonassen, 1991), individuals should interpret the various forms of fantasy information in relations with their own experiences. Once a learner faces fantastic stimuli while playing the game, he interprets the information based on his previous experiences. He may compare the fantastic objects with real artifacts found within the surrounding world, or try to identify the role of certain fantasy characters in terms of problem solving. Detained data within fantasy characters are linked to the game narrative and the learner may identify the information in a problem-solving framework.

When the visual information of fantasy is tuned into one's schema, it internalizes incoming information in an existing knowledge base through the process of assimilation. Assimilation is a cognitive process through which a person combines new information into an existing schemata in order to achieve a better understanding of the events or stimuli (Piaget, 1952; Wadsworth, 2004). Assimilation is a process that does not increase the number of schema, but enriches the details of knowledge within it. Assimilation of schema within a topic can result in qualitative change rather than quantitative increase of schema. Therefore, the interpretation of fantasy is more likely to occur when an object of fantasy is close to an existing concept generated by realistic or reproductive representation of fantasy (see Table 1).

For example, when a student sees a game character in an educational game, he immediately compares the game character from the game with other images of characters that he already knows from other media. The uniqueness of the new character's shape, color, and costume is compared with the characters in different games or movies. If the

main features in the game character do not go beyond one's experience and knowledge base, the visual information is integrated into current schema enhancing the variety of that kind of knowledge.

Fantasy interpretation by assimilation has several characteristics (Wadsworth, 1979, Schunk, 2004). First, assimilation is the ongoing internal process that occurs in cognitive processing. It is the very first cognitive and evaluative process that occurs until the existing schema is not enough to explain the incoming event. If the fantasy information in a game can be assimilated in the existing knowledge on that kind of fantasy, the fantasy information improves one's knowledge by incorporating new information of fantasy into an existing structure. Second, assimilation enhances the density of informational structure in schemata. Even though it does not result in the numeral increase of schemata, assimilation definitely intensifies the semantic relationships among informational elements within a schema as well as inter-relational connections between relevant schemata.

Based on basic characteristics of the concept, assimilation is a part of cognitive adaptation to a learning environment. The process of assimilation creates a growth of schema, but it does not account for significant changes of the existing schemata. Piaget (1952) accounted for the changes of schemata with the process of accommodation. Here, we need another concept of accommodation to understand and explain the changes and process of schemata introduced by Piaget (Piaget, 1952; Wadsworth, 2004).

Accommodation is a mental process in which new schema is created or significant modification of existing schemata occurs in order to internalize new stimuli or events (Wadsworth, 1979, Schunk, 2004). Accommodation is a perceptional process to create semantic bases in knowledge structure or to change existing bases in different ways for intellectual adaption of a person.

Let's look at an example. A little boy is watching a fantasy movie drawing a small world of insects. He has a schema about ants including an understanding of the difference between pavement ant and fire ant based on a book he read. However, he might face a cognitive deficiency when he sees another insect, that is, a small roach looking very similar to ants. In the scene of talking among ants and roaches in the fantasy movie, he noticed that they have a similarity in appearance, however biological properties and habitat are different in many ways. Roaches are usually larger than ants and have a pair of bigger antennas on the head. Most importantly, they seem not to have three body sections and live with less friends in number than ants. He noticed that the insect is not an ant, and might ask his mom saying, "What is that ant?" Then, the mom realizes that the insect is a small roach rather than an ant. She could teach her son that it is a different insect called a roach.

Internally, accommodation elicits assimilation during this process. Rather than understanding the relationship between assimilation and accommodation as independents, we should pair them as interdependent processes. At first, the boy tried to understand the roach through his ant schema based on assimilation process, but he realized there was a big discrepancy between his schema and the new stimulus. The boy had to create a new schema about the different insects, where he would separate it from his ant schema. Additionally, he assimilates his schema through his mom's explanation about roaches. Accommodation and assimilation are interdependent cognitive processes and we can expect that one happen right after another and vice versa.

In terms of interpreting visual information of fantasy, accommodation and assimilation have comparative characteristics in regards to the scope and details of the knowledge building process in comparison with assimilation (Wadsworth, 1979). First, accommodation is a creative, but forceful process. Whereas assimilation is an imposed

process where one applies it to an existing schema in order for an incoming stimulus to be understood, accommodation is an inventive process that develops knowledge structures in quantitative ways. Second, accommodation results in the enhancement of intellectual acceptability out of existing knowledge bases, whereas assimilation brings intellectual growth within existing knowledge structures of fantasy topics. In other words, assimilation adds appropriate cases in a similar topic of fantasy so that it can deepen the meaning of the schema or its semantic relationship among schemata. Accommodation expands the schematic structure or adds the schema itself to already existing schemata in order to enhance the acceptability of the environmental information. Third, accommodation and assimilation are interdependent elements of the various processes and purposes of the two cognitive processes. These two elements account for the occurrence of intellectual understanding of fantasy during the same time. The depth of schema from the assimilative process enriches the quality of knowledge in a domain, and the variety of schema from the accommodative process expands the amount of knowledge. In the perspective of human intellect, the quality and quantity are equally important and interdependent.

To summarize the literature review presented earlier, two arguments were raised in the review of literature. First, even though the evidence showed that the use of fantasy components is beneficial in learning and motivation in educational settings, educational game design theory and research have not provided appropriate guidelines about how to design fantasy components in those circumstances due to the lack of research on the different designs of fantasy. Second, the new types of fantasy elements as environmental components in educational games can interact with the personal propensity of fantasy proneness. The literature indicated that humans build a personal schema and attitude on a topic of fantasy, and this personal knowledge and preference can mediate the process of

perception of fantasy inducing different results on learning and engagement in educational games.

Based on these arguments, this study attempted to examine the potential of visual fantasy design on learning and engagement according to fantasy proneness in a middle school with science curriculum. Specifically, the researcher analyzed the effects of different types of fantasies and fantasy proneness on science learning outcomes and engagement in an educational game environment called Alien Rescue. In addition to the investigation of the effects, the researcher investigated student's perception of the varying types of fantasy by analyzing how student identified each type of fantasy and related his or her past experience to the embodied characteristics in alien characters.

Chapter 3: Methodology

Imagination is more important than knowledge (Einstein, 1931, p. 97).

This chapter explains the methodology and procedures that were used in the current research study. In this study, mixed methods were used to accomplish the research purposes. Mixed methods is a research method combining quantitative and qualitative approaches during different phases of the study in order to pursue the purposes of research (Creswell & Clark, 2007; Tashakkori & Teddlie, 2003). The philosophical and methodological foundation that guides this research is pragmatism. Pragmatism is a research paradigm utilizes multiple methods of data collection and analysis for research purposes. In this paradigm, any method that works in practice can be combined (Creswell & Clark, 2007; Creswell, 2013). The quantitative analysis is based on a quasi-experimental study of four middle school classrooms, and the qualitative framework relies on interviews with students and classroom observations to examine the effect of fantasy in an educational gaming context. Quantitative analysis received priority in mixing the methods (Creswell & Clark, 2007), and qualitative data analysis was used to supplement the result of quantitative findings to understand the perceptional process of 3D fantasy. The temporal relationship between quantitative and qualitative strand is *sequential* (Creswell & Clark, 2007) since qualitative data gathering was initiated by analyzing the results of a pretest for *maximum variation sampling* (Merriam, 2009). Quantitative data sources included the survey tests and qualitative data sources included interviews with students as well as classroom observations. In the following section, the researcher describes research questions, research environment, fantasy design rationale, measurement tools, research analysis, and procedure in detail.

RESEARCH QUESTIONS

1. What are the effects of fantasy type (portrayal and creative) and fantasy proneness (high and low) on student learning and engagement in a game-based new media environment for middle school science? Learning in this environment is measured by Space Unit Test (SUT) and Information Acquisition Test (IAT). SUT is related to the learning content of 6th grade science and IAT is related to the fantasy components of the aliens in the game environment.
   a) Is there an interaction effect between fantasy type and fantasy proneness on science learning?
   b) Does fantasy type predict science learning?
   c) Does fantasy proneness predict science learning?
   d) Is there an interaction effect between fantasy type and fantasy proneness on information acquisition and game engagement?
   e) Does fantasy type predict information acquisition and game engagement?
   f) Does fantasy proneness predict information acquisition and game engagement?

2. What are student's perceptions of fantasy characters in the game-based new media learning environment for middle school science?
   a) What elements make students identify fantasy as portrayal or creative?
   b) Does student's prior experience relate to the identification of six alien species, and how does student's previous experience affect their understanding of six species of alien?

RESEARCH PARTICIPANTS

The participants in this study were 103 6th grade students who attended in Alien Rescue session in four classes as their science curriculum for 10 days. The target audience of the AR program was from a suburban middle school in the southwestern area in the United States and four classes were sampled for this study. The students in two classes were assigned to a treatment group using portrayal fantasy and the other students in two classes were assigned to the other treatment group using creative fantasy. In this research, it was not possible to randomly assign the students to the treatment and control groups because the classes were intact classes. Because the researcher was working in this natural school setting, he chose to follow a quasi-experimental design (Campbell, Stanley, & Gage, 1963; Shadish, Cook, & Campbell, 2002).

ALIEN RESCUE AS A GAME ENVIRONMENT

Alien Rescue (AR) is a 3D based new media environment for six grade space science. AR is designed to engage students in solving a complex problem that requires them to use scientific inquiry tools, experimentation procedures, and knowledge of space science as exploring a realistic 3D learning space (Liu et al., 2013). Over the course of a decade, AR has evolved from a multimedia-supported problem based learning system to a 3D ludic simulation and educational game (M. Liu, Horton, Kang, Kimmons, & Lee, 2013; M. Liu, Horton, Olmanson, & Toprac, 2011).

AR was designed as a unit in the sixth grade science curriculum to be covered within fifteen-class sessions lasting 45-50 minutes each. It also aligns with the National Science Education Standards and Texas Essential Knowledge and Skills (TEKS).

AR focuses on a complex problem solving process that creates an inquiry-based science research environment, which is embedded in an immersive 3D game environment

based on an imaginative game narrative. The role of the students within the game is the character of a young scientist whose goal is to find appropriate planets or moons in our solar system that serve as new homes for six endangered alien species. To accomplish this goal, they need to be able to operate the *International Space Station Paloma*, which functions as a 3D virtual environment. In the 3D virtual environment, students meet fantasy aliens, learn about their provisions and habitats, and use learning tools and experimental simulations to verify that the environmental characteristics of the planets are appropriate for the rescued aliens.

When learning Alien Rescue, the problem solving process begins as multi-media footage showing an imaginative story about endangered aliens that are waiting for assistance in finding new residential planets. As science researchers facing a problematic situation, young students have to understand the authentic situation and manage the data in the creative 3D learning environments for complex problem solving with the given resources and budget in order to make effective decisions. Students need to go through the Alien and Solar System Databases in order to gather factual resources in understanding the critical elements that are needed for the aliens' survival. The game environment and aliens' resources are supplied in 3D, which are based on fantasy design principles (Kim, 2009; Vygotsky, 2004). The learning process is promoted by the imaginative 3D spaces and the authentic learning context that relates to real-life problem solving processes. At the end of the scientific inquiry process in the spaceship, student researchers submit appropriate solutions for the aliens' relocations based on rationale and justifications.

FANTASY COMPONENTS IN ALIEN RESCUE

Alien Rescue is a scientific inquiry environment in which fantasy components and a wide variety of cognitive tools are integrated into the gaming environment for effective scientific problem solving (Liu et al., 2013). There are 14 cognitive support tools in Alien Rescue, and they are categorized into three groups, which are labeled as Imaginative Game Narrative, Scientific Inquiry Environment, and Self-Regulated Learning Tools. The structure and relationship among the tools are described in Figure 2.

Imaginative Game Narrative, seen in Figure 2, is an essential element in Alien Rescue that makes the gaming experience engaging and motivating (Asgari & Kaufman, 2010; M. Liu et al., 2013). An imaginative narrative that enriches the story of the game should be integrated into the game design structure in order to maximize the authenticity of the experience. As a science learning game, Alien Rescue utilizes a fantasy game narrative. Young scientists aboard a spaceship called Paloma need to rescue the endangered aliens. This creative game story stimulates the imagination and creativity of the students by allowing them to meet and interact with living creatures that are outside of the Earth. Also, the game story is embellished with fantasy components and includes embedded clues that can be used as resources for problem solving during game play.

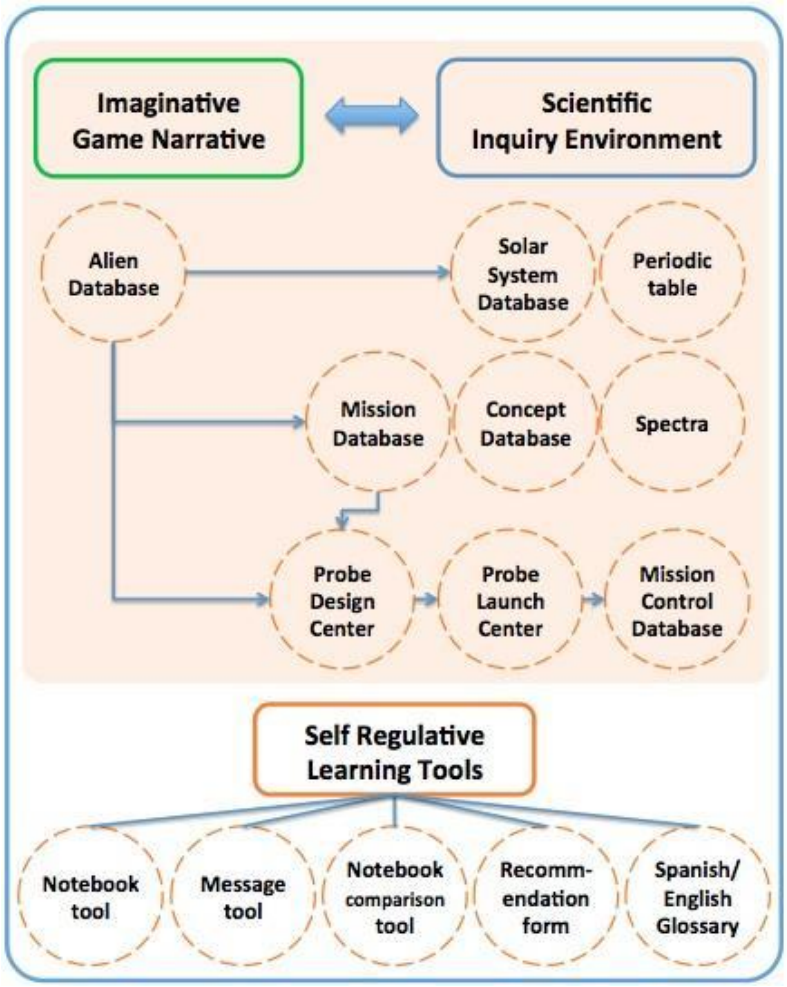

Figure 2: Game Design Structure and Components in Alien Rescue

The Alien Database is a core fantasy element that links *Imaginative Game Narrative* and the elements in *Scientific Inquiry Environment*. The Alien Database provides a rich source of information about the home planets of aliens, their journey, characteristics, appearance and habitat requirements through fantastic 3D graphics and text. Each game player finds useful evidence in this resource center where the research findings are smoothly transferred to the next activities in the solar system database and probe design. Therefore, studying the Alien Database and understanding essential

components for the survival of the alien species is the most important prerequisite activity in utilizing the wide variety of scientific tools in the game-play.

Diverse scientific knowledge resources and tools are employed as the elements of the Scientific Inquiry Environment in order to solve a mission to rescue the endangered alien species. Most importantly, students have to study scientific facts in the Solar System Database in order to find possible planets or their moons by doing scientific investigations. The Solar System Database provides detailed information on selected planet and moons with informative text and realistic photographic images. Students use the Solar System Database in conjunction with the periodic table and a spectra chart to compare several critical chemical elements and characteristics. The spectra chart display graphical representations of the essential elements found on planets and moons, such as the nitrogen and carbon, and students use it to compare and identify elements found in the Alien Database. The periodic table provides a reference to the elements found during the investigation of the environmental factors of the alien species. The Concept Database provides instructional modules about important scientific concepts. For each concept, interactive animations and simulations are imbedded in the instruction.

Imaginative simulation tools are embedded in the Scientific Inquiry Environment to support the scientific inquiry within the game. Alien Rescue employs Probe Design and Launching Center to support an authentic space investigation processes through the management of probes. Student design their own probes by studying the types of probes and their missions in the Mission Database, which provides information on NASA missions and actual probes that were used in missions with descriptions and images. Then, students move to the Probe Design Center where they create their own probes for appropriate planet investigation. Student scientists create probes by selecting a probe type, communication device, power source, and instruments within the given budget.

Once designed, the probes are sent to the Probe Launching Center, which supports an interface to launch them. Students can confirm the probes generated in the design center and choose which probe(s) they want to launch as a final product according to the budget limitations. Finally, the investigation results from the probes will be confirmed in the Mission Control Center, which provides student scientists with data collected by the probes, such as seismograph and thermometer readings. Game players try to get useful information from the data by interpreting them, which can later be used in developing a plausible solution. Malfunctions of equipment may result from inappropriate probe design. Faulty probe design and launching may lead to mission failure and a waste of budget.

A range of self-regulative learning tools is integrated into the game structure in order to reduce the cognitive load on the learner. The notebook tool enables the players to write and save notes on the results after their science research activities. Notebook Comparison tool also helps in comparing information from multiple notebook entries so that students can detect similarities and differences between entries. The message tool allows users to send and receive text messages from the IRC (Interstellar Relocation Commission) Director and other aliens during a particular problem solving procedure. Recommendation Forms provide solutions and rationales for the alien habitat. Teachers can review and critique the submitted solutions and rationales later. Finally, the Spanish/English Glossary allows users to refer to Spanish translations of English words encountered within the program.

FANTASY DESIGN: TWO SETS OF FANTASY CHARACTERS

For the purposes of this study, the researcher constructed 2 sets of alien characters based on the definitions of fantasy, which are portrayal and creative versions of fantasy. For creating the two different sets of alien models, the researcher reviewed the design resources for two versions of fantasy aliens in the fields of fantasy art and visual graphics. The two types of fantasy models are incorporated in the different game settings and compared by asking how students think and perceive the different types of alien models in a pilot study. In the following section, those designs and the validation process of the designs are described.

Design Sources for Fantasy Characters

The origins of fantasy are inside of our memories and our memories are shaped by our cultural experiences. A fantasy artist, Robertson (1988) summarized the subjects of fantasy as unseen, odd, new, dream, and productive worlds surrounding the author of the fantasy. Fantasy as an artwork is an extraordinary or bizarre vision that could not be seen in regular artworks. However, the original ideas of the unusual artworks are mostly based on one's socio-cultural experiences. Ironically, it is believed that fantasy artwork is unreal, but mostly it is generated and painted with careful consideration of realism. That is, the fantasy artists intentionally decide how much of realism is changed to create a reasonably unreal creature and they should go through the reproduction and creative combination process, which is conceptualized by Vygotsky (2004). It is about how people create new things by imagination.

Considering the diversity of origins of fantasy from diverse cultures and personal experiences, the fantasy drawing artists consider all the possible sources of fantasy. According to Robertson (1988), the categories of fantasy origins are as follows.

1. Picture sources: Fantasy artists are inspired by previous artwork, technical sources, and photography. They sometimes take a trip to gather idiosyncratic sceneries or explore a new place for inspiration. On the trip, they use photographs or sketches to save ideas. Many images online are sometimes useful as references and many of these are edited to convey a meaning for fantasy artworks.
2. Natural objects: The shapes of plants and the surface texture are good examples of the artwork.
3. Reality: Everyday objects also inspire fantasy artists, and individual inspiration in ordinary life is a good source of fantasy.
4. Manufactured Objects: The manufactured objects have a unique design that represents a concurrent period and fashion. Each have authentic features even though their functions are similar. Some industrial products change in shape and color over time due to friction and decaying. Those characteristic changes can make an unusual form of texture or shape.
5. Unseen worlds: Evolving worlds, past worlds, microscopic worlds, mathematical worlds, invisible worlds, and abstract worlds are possible references for fantasy artworks. Also, the battle scenes of World War I and II in comic books or real history are good references of fantastic moments and actual plastic models can be resources.
6. Using other cultures: Old customs and traditions in other cultures are good sources of fantasy. Cultural elements such as exotic ornaments, facial decoration, and colorful garments are the components that create an authentic image of the culture. Those cultural differences are good sources of fantasy.
7. Past Masters: Considering the prevalence of commercial fantasy visuals in the industry, the artworks from the previous masters in movie and advertisement are

good examples to access online. In addition to the online assets from other masters, the companies that are developing 3D modeling software are managing the 3D asset store. Various 3D assets registered in the stores are good references for fantasy modeling.

Following Robertson's (1988) suggestions, the researcher draws inspirations from the reference sources including current fantasy art, old-fashioned fantasy movie posters, traditional mask art, and fantasy drawings (Barlowe & Duskis, 1996; Carroll, 2007; Dean, 1984; Gregor, 2001; Haber, 2011; Jude, 1999; Korshak, 2009; Lukacs, 2010; Robertson, 1992), according to Robertson (1988)'s suggestions. Images from Google (http://www.google.com/imghp) and Flickr (http://www.flickr.com/) were also used as a part of an alien.

Character Design Procedure and Examples

In the research questions for investigating the effect of fantasy type on learning outcomes and engagement, two types of fantasy design (portrayal vs. creative) are applied to 3D character models in Alien Rescue. These two types of design are derived from the perspective of a fantasy developer in the discussion of PROMFT (see Figure 2), and the two designs denote the two dichotomous modeling approaches (reproduction vs. creative combination), which are naturalistic in fantasy artwork and imagination research (Kim, 2009; Robertson, 1992; Vygotsky, 2004). These two approaches are applied to the 3D modeling techniques (portrayal vs. creative) in this research, and the researcher developed a total of 12 alien models.

Portrayal fantasy includes imaginative components representing familiar pre-existing artifacts. It makes the audience feel that the fantasy has a familiar feeling with their present experience. When the entrants encounter these types of fantasies, they get involved in the imaginative situation due to inside components of the fantasies being tweaked and manipulated so that the viewers would experience cognitive inconsistency from their knowledge base. However, those changes are only accomplished within the consensus, or common sense of ordinary people, so the audience of the fantasies experience objects and situations as being realistically portrayed simulations and events that they had experienced before but in varying ways.

Given the aforementioned "conceptual definition" (Cooper, 2009, p. 24), an "operational definition" (Cooper, 2009, p. 25) is determined in terms of visual fantasy perspective. In portrayal fantasy, components in shape or color have been transformed within the possible variations that the target audiences are used to. The original resource for these designs can be stemmed from current media and ordinary daily experiences from such as fantasy novels, popular movies, popular 3D visual arts, nature, and travels. For example, the researcher utilized basic shapes and concepts that are already exposed in the entertainment media such as movies and fantasy novels. It is very common for aliens to have thin green bodies and big eyes (see Figure 3). They are humanoid in form, but sometimes they have different facial characteristics, or different head proportions. The accepted variations take place within the range of common characteristics because these alterations can bring cognitive discrepancy between the fantasy object and one's own knowledge base. However, these variations should not be significantly different from the common sense that ordinary people have about aliens. However, these variations should not be significantly different from the common sense that ordinary people have about aliens.

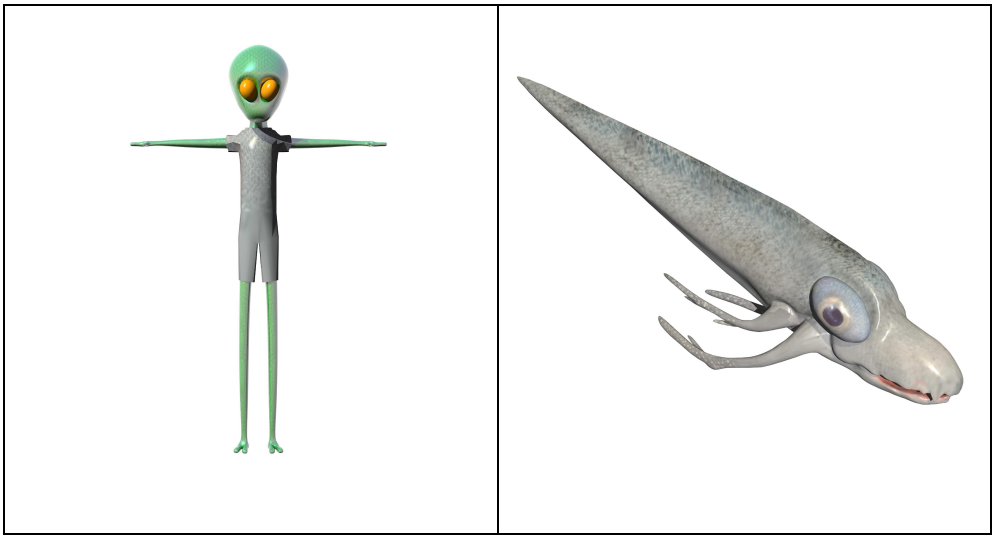

Figure 3: Examples of Portrayal Fantasy

Creative fantasy is a type of fantasy that includes imaginative components making the object completely different from pre-existing artifacts. The audience feels that the fantasy is quite different from existing conceptions because of the continuous combination and integration of heterogeneous components from various creatures. It completely changes the original meanings of the objects, so in the end, the final creature will be recognized as qualitatively different object. In the production stage of creative fantasy, continual changes add up, and the concept of the final product crosses the boundary of the shared understanding of ordinary people. The audience of the fantasies may recognize the objects as representations of completely imaginary or unusual products and totally new artifacts. When the viewers encounter these types of fantasies, they experience accommodative knowledge creation (Piaget, 1952; Wadsworth, 2004) on the types of fantasies and undergo structural changes of their own knowledge.

Given the conceptual definition of creative fantasy, an operational definition was determined in terms of visual designs of fantasies. Parts or concepts of these fantasies are from continuous changing or combining existing objects. However, the final product of the creative process is completely different from the original objects or concepts.

For example, the researcher mixed mechanical components of the alien's body to make a humanoid alien. The alien's torso was replaced with mechanical components, and the design for the alien's head came from an African mask. Also, different forms of popular aliens in traditional movies and TV programs in the US (Marcovitz, 2012) were combined in designing new aliens. The torso of an alien has two pairs of thin arms, a pair of 6 fingers, and the other with tentacles (see Figure 4). The head shape is adapted from an African traditional mask (Gregor, 2001). To create this alien, the researcher had to trim each part and modified the intersections of the components. The final product became a humanoid alien, but it had very exceptional shapes and color in the body and face.

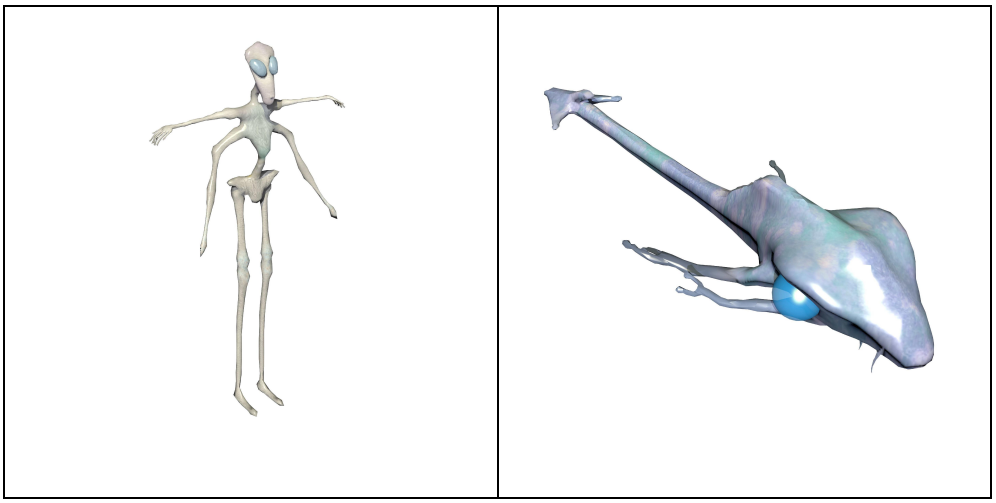

Figure 4: Examples of Creative Fantasy

Validation Process of Fantasy Designs Through Pilot Study

In order to validate the designs of the fantasy characters based on the two definitions of fantasy mentioned above, the researcher showed the new design of fantasy characters to two graduate students who were enrolled in the learning technologies program. After the researcher explained the definitions of two types of fantasy, they validated the designs and provided feedbacks on each design (Merriam, 2009).

After modifying the designs of 3D models, a pilot study was conducted to examine how middle school students perceive different types of aliens; this served as the site where the researcher conducted this study. The pilot study data was consisted of student interviews, and a total of 31 students participated in the interviews during the AR gaming session. 14 were male and 17 were female students in the same middle school. All the participants received only one type of fantasy design from Alien Rescue. The researcher prepared the printed material of both types of alien characters and showed the other set to each group for their comparison during the interview.

As a result of the pilot study, students indicated that all alien characters in both portrayal and creative design matched up with each definition of fantasy. Students also distinguished the different types of the alien species clearly according to the definition when the researcher showed another type of 3D fantasy aliens. As the researcher asked the questions about first impressions or feelings on the portrayal aliens, students connected the characters with objects they already knew from popular movies and culture. However, students did not clearly identify existing objects that they were familiar with when they were asked about their first expressions on the creative aliens. They told they had never seen aliens like them in popular culture and even thought some aliens did not look like aliens. In perceiving creative fantasy characters of aliens, students reported that the heterogeneous components of shapes and colors in different alien characters took

an important role on differentiating them from portrayal fantasy characters of aliens. In addition, students were more likely to see the details of an alien's body in bright lighting conditions to watch the details of the 3D models.

DATA SOURCES

In this study, the researcher employed mixed methods collecting both quantitative and qualitative data for the purpose of triangulation (Creswell, 2009). In the data analysis procedure, the quantitative and qualitative data were compared and integrated in order to answer the research questions. Throughout the experiment, all the tests responses were scored, and the quantitative measures (fantasy type, fantasy proneness score, science knowledge improvement score, information acquisition score, and game engagement score) were coded for statistical analysis. Two students in each class, a total of eight students, were interviewed twice, and classes were observed a total of 12 times. The interviews with students and class observation were transcribed. And then the transcribed data was coded using a qualitative data analysis tool called NVIVO. The mixed data of different perspectives was analyzed in order to validate the research findings. In the following section, the quantitative and qualitative data sources will be described in detail.

Quantitative Data Sources

Quantitative data sources consisted of four instruments: (1) Creative Experience Questionnaire for fantasy proneness, (2) Space Unit Test, (3) Alien Information Test, and (4) Game Engagement Questionnaire. The Creative Experience Questionnaire was used to measure the level of fantasy proneness of individual students as an independent

variable, and the other three measures were used to measure student learning performance and engagement as dependent variables.

Creative Experience Questionnaire (CEQ)

Creative Experience Questionnaire (CEQ) measures the individual propensity of fantasy proneness. CEQ consisted of 25 items with the scores ranging from zero to 25. It is a self-reported survey with a dichotomous (yes/no) scale where each "yes" answer adds a point for a total of 25. The 25 items ask about the intense elaboration of imaginative thinking, strong involvement in fantasy, daydreaming, and consequences of fantasizing.

A fantasy proneness survey was first developed by Wilson and Barber (1981) entitled the Inventory of Childhood Memories and Imaginings (ICMI). The original scale consisted of 103 items with a dichotomous (yes/no) answer as a form of a self-reported scale. A few years later, Myers (1983) revised the Wilson-Barber Inventory of Childhood Memories and Imaginings to make it more appropriate for use with children. Later, she changed the previous survey appropriate for children (ICMIC) including 48 items. Five years later, Lynn and Rhue (1988) developed a shorter version of the ICMIC by reducing the number of items. However, these surveys were too lengthy in items and specifically aimed at children and adolescents (Lynn & Rhue, 1988). To alleviate the limitations of the measurement tools in fantasy research, Merkelbach et al (2001) developed a brief survey instrument called the Creative Experience Questionnaire to measure fantasy proneness. In order to avoid negative connotations on the term “fantasy,” the researchers adapted a neutral name for the title of the survey.

The researcher used this brief survey developed by Merkelbach et al (2001) in this study, but the instrument was created for adult subjects and some of the items include

terms difficult for children to comprehend. Therefore, researcher made modifications with words that are familiar with 6th graders: “When I was little” instead of “As a child,” “spent” instead of “devoted,” removal of the term “intensity” and so on. Examples of the test questions are as following:

Intense involvement on fantasy: When I was little, I thought that the dolls, teddy bears, and stuffed animals that I played with were living creatures.

___Yes

___No

Results and concomitants of fantasizing: Many of my friends and/or relatives do not know that I have such detailed fantasies.

___Yes

___No

Two graduate students who have teaching experience in English as a second language validated the contents of the items. The revised instrument is attached in Appendix A. The reliability of CEQ was .95 for test-retest correlation and the internal reliability (Cronbach’s alpha) was 0.72 (Merckelbach et al., 2001).

Space Unit Test

Space Unit Test (SUT) was used to measure science knowledge acquired by students while playing AR. Science teachers in the school district where this research was conducted developed it. The assessment had 26 items and was used to measure the status

of students' science knowledge before and after the gaming. Science teachers and content experts in the school district developed the survey items and validated the content of the test. The incorrect answers were scored as zero and correct answers were scored as one. A total range of the scores for the test was between zero and 26. Each question has four answer choices. Examples of the questions are as following:

4. Most planets have an atmosphere. Which of the following does an atmosphere NOT do for a planet?

A. an atmosphere helps protect a planet's surface from harsh radiation from the Sun

B. an atmosphere breaks up meteors as they are pulled toward the planet

C. an atmosphere allows plants and animals to exist on every planet in the solar system

D. an atmosphere helps lessen the amount of energy lost to space from the planet's interior

16. Suppose the Sun suddenly shrank in size but its mass remained the same so that is was compacted much more densely. What would happen to the size of the Earth's orbit around the Sun?

A. Earth's orbit would shrink in size.

B. Earth's orbit would expand in size.

C. Earth would fly out of the solar system.

D. Earth's orbit would be unaffected.

Since teacher instruction and direct teaching of the learning content were not included in the session of AR, students who gained a high score on the SUT were regarded as successful learners who have a good understanding of the scientific topics included in the program. The reliability of the SUT was .96 (Cronbach's alpha). Because SUT is a unit test to be used in the school district, the researcher intentionally excluded in the appendix.

Information Acquisition Test

The focus of Information Acquisition Test (IAT) is designed to measure retained information about six alien species while playing the game Alien Rescue. It is especially designed for measuring fantasy information learned by students and the researcher developed the test items. First, the researcher developed four to five questions on each alien, and a total of 28 questions were developed on six components of descriptions for each alien species: body, food, dwelling, habitat, communication, and technology. All the questions measure the cognitive domain of remembering and understanding in accordance to Bloom's taxonomy (Bloom, 1956). After the first validation process by two middle school teachers in English language arts with more than five years of teaching experience, 18 questions out of 28, three questions for six alien species, were finally chosen (See the Appendix B). Another two graduate students who have teaching experience in English and science reviewed the final questionnaire in terms of face validity. Examples of the items are as follows:

Remembering Information: How does the Akona pass on the information they know?

1) By saving the information in a computer

2) By breaking their body into other pieces

3) By shaking the blue core of the body of the Akona

4) By communicating with the Eolani

Understanding Information: Why don't the Kaylid spend much time on the surface?

1) Because they like to stay underground.

2) Because the food they like to eat is not growing on the surface.

3) Because they like the cold temperatures in their caves underground.

4) Because there is not very much atmosphere for them to breathe.

Game Engagement Questionnaire

Game Engagement Questionnaire (GEQ) was used to measure students' engagement during game playing in the study. *Game engagement* is a term used to describe the subjective involvement experiences of individuals during active video game playing. A total of 19 items with three response choices ("No", "Sort of", "Yes") are included in the original survey of GEQ to measure relevant subjective experiences. Five items measure absorption experience, nine items are for flow, four items are for presence, and one item is for immersion experience (Brockmyer et al., 2009).

Presence is defined as a personal experience of being inside a virtual environment (Mania & Chalmers, 2001; Mikropoulos & Strouboulis, 2004). The methods for measuring presence have been continuously changing as researchers started actively trying to create a solid method. Ryan, Rigby, and Przybylski (2006) developed a nine-itemed Player Experience of Need Satisfaction survey that includes physical, emotional, and narrative experience during immersive game playing. Witmer and Singer (1998)

developed the Presence Questionnaire with a 19-item Likert-scale and the Immersive Tendencies Questionnaire with an 18-items with Likert-scale to measure the sense of presence in a game environment and the personal differences in the preference of individuals to experience presence. As Table 3 indicates, four of the questions that ask about the sense of presence were adapted from the aforementioned questionnaires in the Game Engagement Questionnaire.

Flow is a term that denotes the feelings of enjoyment that occur when one's skill level and received challenge is balanced in order to perform a task that is intrinsically motivating (Choi & Kim, 2004; Csikszentmihalyi, 1992). Also, having a clear goal and immediate performance feedback should improve the flow experience. 9 items are included to measure the feeling of being in control, being one with the activity, and experiencing time distortions.

Psychological absorption is the term used to describe complete engagement in the present experience (Irwin, 1999). Unlike the sense of presence and immersion, if one is in the state of psychological absorption, he/she experiences an altered state of consciousness. In this status, a separation of thoughts, feelings, and experiences can be elicited as well as malfunction of affect (Glicksohn & Avnon, 1997). Five items measuring engagement in the present experience were added to develop the Game Engagement Questionnaire.

Immersion is a technical term that describes one's experience where one engages in the game-play experience while maintaining conscious awareness of one's surroundings (Wirth et al., 2007). An item for measuring immersion is added in the survey.

GEQ Items	Construct
1. I don't answer when someone talks.*	Flow
2. I can't tell I'm getting tired.*	
3. If someone talks to me I don't hear.	
4. I feel like I can't stop playing.	
5. The game feels real.	
6. I would get up.*	
7. Playing seems automatic.*	
8. I play without thinking how to play.	
9. Playing makes me feel calm.	
10. Things seem to happen automatically.*	Presence
11. My thoughts go fast.	
12. I play longer than I mean to.	
13. I lose track of time.	
14. I feel scared.*	Absorption
15. I lose track of where I am.*	
16. I feel different.	
17. Time seems to stand still or stop.	
18. I feel spaced out.*	
19. I really get into the game.	Immersion

Table 3: Items and categories of Game Engagement Questionnaire

The researcher reviewed the 19 items in the original survey, and eight items (* cited) were eliminated because of the irrelevance to the student's learning process in the game. Finally, 11 items were used to measure the student's engagement during the game playing (See the Appendix C).

The reliability of GEQ with 19 items was .85 (Cronbach's alpha) and Rasch analog to Cronbach's alpha also indicated that the Rasch estimate of person reliability was 0.83 and item reliability was .96 (Brockmyer et al., 2009).

Qualitative Data Sources

Qualitative data consists of interviews with students, classroom observations, and the researcher's field notes. To gather qualitative data, the researcher participated in the research context as a participant-observer with a realist ethnographic perspective (Creswell, 2012). The realist ethnography approach is a way of gathering qualitative data with keeping objective stance on the research situation, minimizing personal bias, political goals, and intentional judgments by adapting a third-person point of view. In addition, the role of the researcher in class participation was to assist the teacher with the Alien Rescue game technology in class as well as to collect research data.

Interviews with Students

The sampling strategy for the selection of interviewees was the maximum variation method in a purposeful sampling method (Denzin & Lincoln, 2005; Merriam, 2009; Schwandt, 2001). The maximum variation method selects samples that directly reflect the purpose of the study with rich information. Two out of four classes included in this research were assigned to the portrayal fantasy groups and the other two to the

creative fantasy groups. The researcher chose two students from each to include in the qualitative analysis. One was from those identified as having high fantasy proneness and one from those identified as having low fantasy proneness in the CEQ test. Thus, the purposive sample included a total of eight students.

In order to select the participants, two students per group in the research design were selected using the pretest results of fantasy proneness and science knowledge test. A student who scored low and a student who scored high in the fantasy proneness test were chosen in each class. Two students in each experiment condition, a total of eight students in four experimental conditions were chosen for the interview (see Table 4).

Class	Treatment Condition	Interviewees		Total
		Male	Female	
1	Portrayal	1	1	2
2	Portrayal	1	1	2
3	Creative	1	1	2
4	Creative	1	1	2

Table 4: Number of Interviewees

Interviews were semi-structured with open-ended questions (Denzin & Lincoln, 2005; Schwandt, 2001; Silverman, 2010). To address the first qualitative research question, students were asked about their perception of the new design of aliens:

- When you first saw the aliens, what did you think?
- Could you tell me what did you think about each alien when you first saw?
- Which parts or elements of the alien realistic (or fantastic)?

For the second qualitative research sub question about the relationship between past experience and the fantasy elements of models, students were asked:

- Did you remind any objects or characters from other movies or games when you saw the aliens of AR?
- What are they and how are they related to the AR aliens?
- If they did not remind any objects or characters, which elements of the alien species are different from the aliens you are familiar with?"

Classroom Observations

The purpose of classroom observation was designed to monitor how students engage in the game-play of Alien Rescue and how students interact with other contextual elements including peers, teachers, and the game components. Classroom observations were conducted to attempt to collect data on the implementation of the fantasy elements in the game to enhance the understanding of the study. Specifically, since the current research was conducted in a *naturalistic* setting (Schwandt, 2001), the research participants were allowed to interact with other cohorts and teachers as well as the game components itself during gameplay. Especially, students should access the alien database where the main fantasy components are located, and the alien data affects the learning trajectory of the individual students during their game play as each student determines which alien they should rescue and how, based on their own decisions. With these reasons, the researcher observed how long and often students access alien databases, and

why they chose specific aliens to help for their survival. The researcher's field notes and reflective memos were used as supplemental information, and data from participant's observation, called emic data, was gathered (Merriam, 2009). Contrary to etic data, emic data contains descriptions of human behavior or thoughts of individuals in a local situation. That is, an emic account produces a personal interpretation of a phenomenon within a specific culture. Based on the personalized interpretation, the researcher investigated which students have varying fantasy proneness, how they perceive each type of fantasy, and how it affects their learning process.

RESEARCH ANALYSIS

This research employed both quantitative and qualitative methods in a frame of mixed methods research so that each dataset takes on roles of mutual supplementation (Creswell & Clark, 2007; Creswell, 2013). Data collection from quantitative and qualitative parts occurred at the same time, and all the data were utilized to triangulate and provide better results and understanding on the investigation. In the following section, quantitative and qualitative analyses are explained in detail.

Quantitative Analysis

The overarching purpose of the quantitative investigation was to examine the effects of fantasy type and the level of individual fantasy proneness on science learning, information acquisition, and game engagement. In order to address the purpose, two research questions were asked including two independent variables and three dependent variables in the analysis. Two independent variables are two types of fantasy and individual level of fantasy proneness. Three dependent variables are science learning,

information acquisition and game engagement. 2*2 factorial ANCOVA was employed for the research question one to three, and 2*2 factorial MANOVA was employed for the research question four to six.

More specifically, for the first research question "Is there an interaction effect between fantasy type and fantasy proneness on science learning," two-way ANCOVA was conducted with the between subject independent variables of fantasy type (portrayal vs. creative) and fantasy proneness (high vs. low) and a dependent variable of science knowledge improvement. The improvement score was calculated by subtracting SKT pretest score from the posttest. Also, the pretest score was used as the covariate. Based on the result of two-way ANCOVA, a series of post-hoc tests and graphical analysis were conducted as well as the Cronbach's internal consistency reliabilities for the Creative Experience Questionnaire and Science Knowledge Test.

For the fourth research question, "Is there an interaction effect between fantasy type and fantasy proneness on information acquisition and game engagement," two-way MANOVA was conducted with between subject independent variables of fantasy type and fantasy proneness. Dependent variables for the MANOVA analysis are information acquisition and game engagement. Based on the result of overall test of MANOVA, a series of univariate AVONA post hoc tests were conducted to examine the effect of each dependent variable if any interaction effect is found. In addition, the Cronbach's internal consistency reliabilities for the Information Acquisition Test and the Game Engagement Questionnaire were analyzed.

Qualitative Analysis

The focus of the qualitative inquiry in this research was to examine the student perception toward fantasy characters in Alien Rescue so that the intention of the researcher to develop two types of fantasy can be validated or not on both positions of game developer (the researcher) and the user (students). Data was analyzed by each research question. To address the research questions in the qualitative part about the students' perception toward fantasy characters and how the perception affects their game playing, interviews with students, classroom observations, and field notes were used.

More specifically, for the first two research questions, "what elements do students identify fantasy as portrayal or creative" and "Does student's prior experience relate to the identification of six alien species, and how does student's previous experience affect their understanding of six species of alien?," interviews with students were conducted. All the interview contents and observations with field notes were transcribed and coded.

The researcher read, reformatted, and reorganized all the coded data for the two qualitative research questions to develop themes using NVIVO. At first, open codes were created by the researcher from a line-by-line analysis of the interview data from students, and these codes were mapped and grouped axially before the further analysis (Denzin & Lincoln, 2005; Merriam, 2009; Silverman, 2010). Then, common themes and shared relationships were extracted and organized according to the three research questions as a guide. One more researcher was included independently in the coding process, and the agreement rate between the two researchers about categories, subcategories, themes, and interpretations were discussed to obtain 100% inter-rater reliability (Merriam, 2009; Silverman, 2010).

RESEARCH PROCEDURE

Mixed methods were used to accomplish the research purposes in this study. Priority in mixing research methods is on the quantitative strand and qualitative data was analyzed for triangulation (Creswell & Clark, 2007). Both quantitative and quantitative data gathering began at the same time, however interview participant sampling was initiated by analyzing the result of a pretest. In the following section, IRB procedures and each data gathering procedure are discussed in detail.

Approval Process

To conduct the research, the researcher obtained approvals from the research site, the parents of the participants, the participants, and the University of Texas at Austin's Institutional Review Board. Principal of the middle school confirmed the approval of the research site. Based on the principal's approval, the researcher submitted the letter to the Institutional Review Board.

An IRB application was submitted to the Review Board after completing the application consisting of a research proposal, consent letter, assent letter, site approval, and all the surveys to be used in the study. The approval for all the research participants and selected interviewees were obtained based upon the IRB regulations.

Quantitative and Qualitative Data Gathering Procedures

This study was conducted during regular science class time periods within a middle school. Students participated in the AR session for 12 class periods, 45 minutes per class, with additional instruction for research activities, data collection, and interview session.

Each student in a class worked at his/her computer. Students in the class were assigned by the teacher to work individually, but encouraged to share information they discovered. The researcher served as the assistant teacher during the study. During the session he supported the classroom teacher for encouraging students, answering students' questions, and resolving technical problems.

On the first day of the study, assent forms were completed and the Creative Experience Questionnaire (CEQ) and the Space Unit Test (SUT) were administered as pretests to measure initial scores of learner's relevant characteristics. The CEQ was administered before the beginning of the experiment session because the researcher used the result of the questionnaire to select the interviewees according to their levels of fantasy proneness. The fantasy proneness data gathered from students was used for the assignment of the treatment to each group according to the experimental design as well as investigating whether the student's level of fantasy affects learning performance and game engagement or not. In addition, it was utilized to select interviewees for qualitative investigation on the gaming experience with fantasy characters. Two interviewees were selected from each class, one at a low level of fantasy proneness and the other at a high level, where a specific type of fantasy was assigned. A total of four classes were included in the research. Out of four classes, two classes were assigned to portrayal fantasy and the other two to creative fantasy. The total of eight students participated in the interview. The fantasy proneness was administered in online and took about 10-20 minutes. SKT was administered before the Alien Rescue session as a pretest to measure how much science knowledge the students already have, and to make a comparison with the posttest survey results at the end of the session. The survey took 20-30 minutes and was also administered online.

According to the analysis of CEQ results, eight students were sampled and interviewed, beginning on the second day of Alien Rescue session. Each interview with the students took 10-20 minutes, and one or two students were interviewed within a class session.

Classroom observation started at the beginning of the entire research procedure. Because the researcher participated in the implementation of Alien Rescue sessions as a participant-observer (Creswell, 2012), the researcher could collect diverse information about the game from students in the actual implementation context. Qualitative data from student interviews and field notes were collected throughout the classroom observation.

In the middle of AR session, the Game Engagement Questionnaire (GEQ) was administered to measure how much students were immersed in the game play and took 15-20 minutes to administer online.

At the end of AR session, the Information Acquisition Test (IAT) was administered to measure how much information was obtained through the game play. A question on whether the student has played AR before was added in IAT, and if a student answered that he/she already have played AR before in the posttest, the case was removed from the data analysis process. The survey took 10-20 minutes and was given online.

Last, the posttest survey was administered to measure how much students have learned science knowledge by playing Alien Rescue. To prevent the memory effect of the test, the survey items were presented in a randomized sequence every time. It took 20-30 minutes and the survey also presented online.

For the overall procedure of this research, see Table 5.

Activities Within Study	Days of Study																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Administration of pre tests:																	
CEQ and SKT (Pretests)	0	0															
Implementation of Alien Rescue in class		0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Administration of post tests:																	
GEQ (Post test)						0	0										
SKT and IAT (Post test)														0	0	0	0
Conduct of Interviews with students and teacher			0	0	0	0	0	0	0	0	0	0					
Classroom observation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

Table 5: Timeline of Research Activities During Alien Rescue Session

Chapter 4: Results

> Every great advance in science has issued from a new audacity of imagination (Dewey, 1929).

This chapter reports the process of examination and analysis results on the effects of fantasy type and fantasy proneness in terms of learning and engagement as they were measured in an educational game called Alien Rescue. There are two overarching research questions in this study. The analysis using quantitative data includes six questions and the analysis using qualitative data includes two research questions. First of all, this chapter starts with the descriptive statistics on the sample. Then, six quantitative research questions are discussed with statistical techniques such as ANCOVA and MANOVA. In the analysis using qualitative analysis, two research questions are discussed with the analysis results using student interviews.

DEMOGRAPHIC INFORMATION

A total of 103 students in 4 classes used Alien Rescue as their science curriculum. Out of the total students, 78 students with parental permission were participated in the study. Two classes used portrayal version of the program and the other two did creative version. Among 78 students, the researcher eliminated eight cases for reasons of incompletion of survey and suspicious extreme responding with single value. Finally, 70 students were sampled for the analysis.

In Table 6, the researcher categorized research participants by class, gender, ethnicity, and fantasy type. More female students were included in class 1, 2 and 4

whereas more male students were in class 3. Considering total number of male and female students (N_{male} = 30 and N_{female} = 40), 15% of difference between the two groups was reported.

In the ethnicity of the groups, 60% of participants were white, 28.6% were Hispanic, 5.7% were Black/African American, and the rest were less than 5%. In general, the white ethnicity was over 50% in each class, however Class 3 and 4 had more Hispanic students than white students. In addition, Class 3 did not include Black / African American students at all.

Class	Gender		Total	Ethnicity					Total
	Male	Female		White	Hispanic	Black/African American	Two or More Races	American Indian/Alaskan Native	
1 (Portrayal)	7 (41.2%)	10 (58.8%)	17 (100.0%)	11 (64.7%)	3 (17.6%)	2 (11.8%)	1 (5.9%)	0 (0.0%)	17 (100.0%)
2 (Portrayal)	6 (35.2%)	11 (64.7%)	17 (100.0%)	12 (70.6%)	4 (23.5%)	1 (5.9%)	0 (0.0%)	0 (0.0%)	17 (100.0%)
3 (Creative)	10 (62.5%)	6 (37.5%)	16 (100.0%)	8 (50.0%)	6 (37.5%)	0 (0.0%)	1 (6.3%)	1 (6.3%)	16 (100.0%)
4 (Creative)	7 (35.0%)	13 (65.0%)	20 (100.0%)	11 (55.0%)	7 (35.0%)	1 (5.0%)	1 (5.0%)	0 (0.0%)	20 (100.0%)
Total	30 (42.9%)	40 (57.1%)	70 (100.0%)	42 (60.0%)	20 (28.6%)	4 (5.7%)	3 (4.3%)	1 (1.4%)	70 (100.0%)

Table 6: Demographic Information

RELIABILITY OF MEASUREMENT TOOLS

Table 7 presents the internal consistency for the Space Unit Test (SUT), the Creative Experience Questionnaire (CEQ), and Game Engagement Questionnaire (GEQ). Cronbach's alpha of the SUT was .96. The CEQ's alpha was .83, and the GEQ's alpha was .85. These were over the rule of thumb for the acceptability in educational research.

	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
SUT	.96	.96	26
CEQ	.83	.83	12
GEQ	.85	.85	11

Table 7: Reliability of the Measurement Tools

The researcher employed the Unit Test for Science Knowledge developed by the school district where this research was conducted. Since the researcher only received individual scores on pretest and posttest scores by the test, the reliability of the SUT was based on the scores given by the school.

In addition, the Information Acquisition Test (IAT) was validated properly, however the statistical reliability of the measure was not acquired due to the complexity of the altered testing procedure. The purpose of IAT was to measure how much information learned about each of six aliens. However, student's gaming progress was relatively slow until the end of AR use period, and most of students solved problems only

for 1 or 2 aliens out of 6. Therefore, the understanding of the other aliens was excluded and measuring the reliability of the measure was not available due to the individualized survey response.

RESEARCH QUESTION USING QUANTITATIVE DATA: EFFECTS OF FANTASY TYPE AND FANTASY PRONENESS ON SCIENCE LEARNING

a) Is there an interaction effect between fantasy type and fantasy proneness on science?
b) Does fantasy type predict science learning?
c) Does fantasy proneness predict science learning?

The research question one to three addresses whether fantasy embedded in Alien Rescue and fantasy proneness of individuals affect the process of science learning or not. Based on the statement of research question, the researcher incorporated two independent variables (fantasy type and level of fantasy proneness by CEQ) and a dependent variable (science knowledge improvement between pretest and posttest score of SKT).

In the data analysis with quantitative data, the researcher also included a confounding variable, pretest score, which affects science knowledge enhancement in educational gaming (Asgari & Kaufman, 2010; Liu, Horton, Toprac, & Yuen, 2012). A high pretest score on science knowledge generally represents higher interest and readiness to the subject itself in educational gaming environments. Considering the types and relationships of variables, the researcher decided to use ANCOVA to investigate the effect of fantasy type and fantasy proneness on science knowledge improvement

controlling for previous science knowledge. Before conducting the main body of the analysis, a descriptive analysis was performed.

Descriptive Statistics

In a descriptive analysis on science knowledge improvement (SKI) on each group, the mean score of students who received portrayal fantasy (M = 4.32) was higher than that of students who received creative fantasy (M = 2.69) in general. In portrayal group, the group of students with low fantasy proneness showed a higher mean score on science knowledge with less standard deviation (M = 4.07, SD = 3.67) than the other (M = 4.07, SD = 3.67). In the creative fantasy group, students who showed low fantasy proneness scored higher in science knowledge improvement (M = 3.33, SD = 4.15) compared to high fantasy proneness (M = 1.80, SD = 4.07).

There were fewer students with low fantasy proneness (N = 14) and more students with high fantasy proneness (N = 20) in portrayal treatment. On the other hand, there were more students with low fantasy proneness group (N = 21) treatment and fewer students with low fantasy proneness (N = 15) in creative fantasy. The collapsed total mean of science knowledge improvement is 3.49 (SD = 3.748) and total number is 70.

Fantasy Type	Fantasy Proneness	Mean	Standard Deviation	Case Number
Portrayal	Low	4.07	3.67	14
	High	4.50	2.80	20
	Total	4.32	3.14	34
Creative	Low	3.33	4.15	21
	High	1.80	4.07	15
	Total	2.69	4.13	36
Total	Low	3.63	3.93	35
	High	3.34	3.61	35
	Total	3.49	3.75	70

Table 8: Descriptive Statistics on SKI in Each Group

Preliminary Analysis and Assumptions Checking

Before running an ANCOVA to verify the effects of the variables, requirements and assumptions were confirmed. First, the two independent variables were categorical variables and the minimum number of the cases in each cell of the experiment design was over 5. Second, for the normality of the covariate and dependent variable, it was confirmed that the skewness and kurtosis of the variables are within -1 and +1 (see Table 7). The assumption of normality of the variables are not violated. Third, the analysis of linearity between covariate and dependent variable verified that the pretest scores has a statistically significant relationship to the scores of SKI ($F(1, 65) = 7.30$, $p < .01$, see Table 9). Fourth, a diagnostic test to assess the homogeneity of regression slopes verified that the probability associated with the interaction among relevant variables was

homogeneous ($F(3, 63) = 0.18$, $p = .91$). Therefore, the assumption of homogeneous regression slopes was satisfied. Fifth, in order to check the assumption of homogeneity of variance, Levene's test was utilized and the probability with Levene's test for equality of variance ($F(3, 63) = 1.91$, $p = .14$) was greater than the alpha ($p < .01$) for the diagnostics test. The assumption of equal variances was satisfied.

Overall, there was no significant violation of assumption to implement ANCOVA and the data was analyzed by the method in order to test the research hypothesis: there are significant differences between the effects of fantasy type and fantasy proneness when the pretest scores are controlled for.

Result of ANCOVA

A Two-Way Between Subjects ANCOVA was conducted on a dependent variable: Science Knowledge Improvement (SKI). The independent variables were fantasy type (portrayal and creative) and fantasy proneness of Individual (high and low).

First of all, the test statistics also indicated that there was no significant interaction between two independent variables on SKI ($F(1, 65) = 0.59$, $p = .45$, partial eta squared = .009). The researcher failed to reject the null hypothesis of no interaction effect. This result means that the relationship between fantasy type and gain of science knowledge is not contingent on the level of individual fantasy proneness.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	159.52	4	39.88	3.20	0.018	0.165
Intercept	282.01	1	282.01	22.63	1.132	0.258
Prescore	91.03	1	91.03	7.30	0.009*	0.101
Fantasy type	52.09	1	52.09	4.18	0.045*	0.060
Fantasy Proneness	2.37	1	2.37	0.19	0.664	0.003
Fantasy Type * Fantasy Proneness	7.30	1	7.30	0.59	0.447	0.009
Error	809.96	65	12.46			
Total	1820.00	70				
Corrected Total	969.49	69				

Note. Prescore = Pretest score of Science Knowledge Test. Fantasy Type * Fantasy Proneness = Interaction between fantasy type and fantasy proneness. R Squared = .165 (Adjusted R Squared = .113)
* $p < .05$

Table 9: Tests of Between-Subjects Effects on SKI

The profile plots showed a crossed line graph, however the statistical testing confirmed the non-existence of interactions among the independent variables.

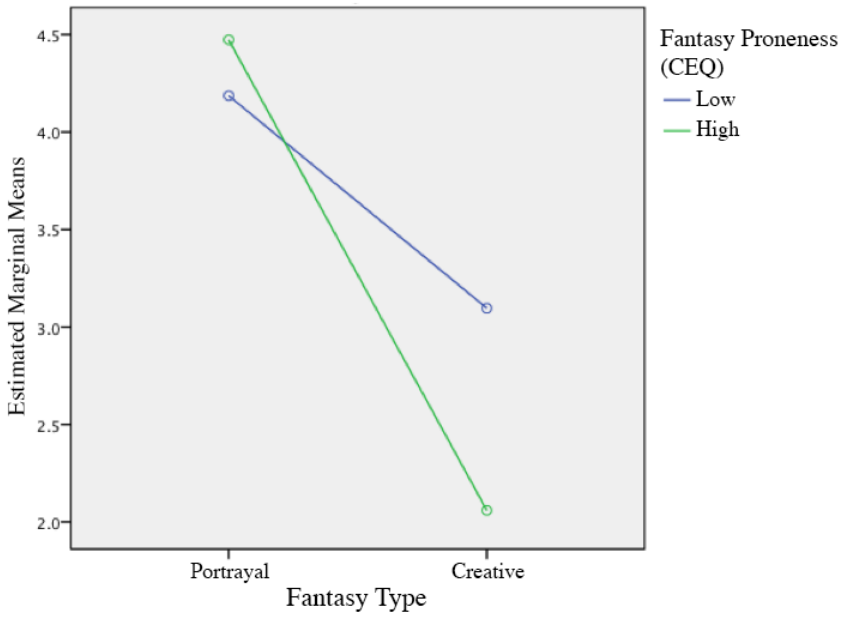

Figure 5: Profile Plot on SKI

Since the hypothesis testing on the interaction effect failed to reject the hull hypothesis, the following research hypothesis on the main effect on each independent variable in the experiment design were tested. 1) There are significant differences between the effects of fantasy type on the score of scientific knowledge improvement. 2) There are significant differences between the effects of fantasy proneness on the score of Scientific Knowledge Improvement. Because the interaction effect was not significant, another hypothesis testing was conducted without the interaction term.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	152.22	3	50.74	4.10	.010	.157
Intercept	308.00	1	308.00	24.87	.000	.274
Prescore	100.06	1	100.06	8.08	.006*	.109
Fantasy type	52.57	1	52.57	4.25	.043*	.060
Fantasy proneness	2.54	1	2.54	.21	.652	.003
Error	817.26	66	12.38			
Total	1820.00	70				
Corrected Total	969.49	69				

Note. Prescore = Pretest score of SUT. R Squared = .157 (Adjusted R Squared = .119)
* $p < .05$

Table 10: Tests of Between-Subjects Effects on SKI without Interaction Term

The main effect of level of individual fantasy proneness on SKI was not statistically significant (see Table 10), $F(1, 66) = 0.21$, $p = .65$, partial eta squared = .003. The hypothesis testing failed to reject null hypothesis, and the research hypothesis that "there are significant differences between the effects of fantasy proneness on the score of Scientific Knowledge Improvement" was not accepted.

The result indicated different levels of fantasy proneness did not have a relationship to the gain of science knowledge. That also means that individual fantasy proneness was distinct from the effect for fantasy type or preexisting knowledge about science measured by the pretest. Based on the mean total of SKI, research participants who had low fantasy proneness did not obtain significantly different scores on the gain of science knowledge (M= 3.64, SE = 0.61) compared to the participants who showed high

fantasy proneness (M= 3.27, SE = 0.60). The range of 95% of confidence interval of the two groups overlapped and the range of the lower group was completely included in the higher (see Table 11).

Independent Variable		Dependent Variable (Scientific Knowledge Improvement)		95% Confidence Interval	
		Mean	Std. Error	Lower Bound	Upper Bound
Fantasy Proneness	Low	3.64	0.61	2.42	4.86
	High	3.27	0.60	2.06	4.47

Table 11: SKI Estimates by Fantasy Proneness Level

The main effect for SKI by fantasy type was statistically significant (see Table 10), $F(1, 66) = 4.25$, $p < .05$, partial eta squared = .060. The null hypothesis that "the mean score of SKI is equal across the two fantasy types divided by portrayal and creative" was rejected. This means the treatment using different fantasy type has a relationship to Scientific Knowledge Improvement, which was distinct from the effect for fantasy proneness on the individual. The effect size of the variable (partial eta squared = .060) is slightly less than the moderate magnitude by rule of thumb (Cohen, 2013; MRC Cognition and Brain Sciences Unit, 2009).

Independent Variable		Dependent Variable (Scientific Knowledge Improvement)		95% Confidence Interval	
		Mean	Std. Error	Lower Bound	Upper Bound
Fantasy Type	Portrayal	4.33	0.62	3.10	5.56
	Creative	2.58	0.60	1.39	3.77

Table 12: SKI Estimates by Fantasy Type

Based on the mean total of SKI (See Table 12), research participants who received portrayal fantasy showed significantly different scores on the SKI ($M = 4.33$, $SE = 0.62$) compared to the participants who received creative fantasy ($M = 2.58$, $SE = 0.60$). The range of 95% of confidence interval of the two groups lightly overlapped.

RESEARCH QUESTION USING QUANTITATIVE DATA: EFFECTS OF FANTASY TYPE AND FANTASY PRONENESS ON INFORMATION ACQUISITION AND ENGAGEMENT

d) Is there an interaction effect between fantasy type and fantasy proneness on information acquisition and game engagement?
e) Does fantasy type predict information acquisition and game engagement?
f) Does fantasy proneness predict information acquisition and game engagement?

The research question four to six addressed whether different types of fantasy and fantasy proneness of individuals affect factual information acquisition and game

engagement during AR gaming. According to the research question, the researcher included two independent variables (fantasy type and fantasy proneness) as well as two dependent variables (alien information acquisition and game engagement) in the analysis. Contrary to the design of the aforementioned research question, the researcher excluded the covariate, which was the pretest score of the Science Knowledge Test, because alien information acquisition and game engagement were not relevant variables to the covariate. In addition, the two measures were not measured repeatedly as Science Knowledge Test (SKT) was done because all research participants had not played Alien Rescue before in school. The Game Engagement Questionnaire itself was specifically adapted in this study to measure the individual level of game involvement during game-play. It was assumed that the students would have no idea about what Alien Rescue was about and which aliens were included in the game.

Considering the types and relationships of variables, the researcher determined to use a Multivariate Analysis of Variance (MANOVA) to investigate the effects of fantasy type and fantasy proneness on information acquisition and game engagement during AR gaming.

Assumption checking

Before running a MANOVA, requirements and assumptions were confirmed. First, the two independent variables are categorical variables and the minimum number of the cases in each cell of the experiment design is over 5. Second, the researcher confirmed that the skewness and kurtosis of the variables were within -1 and +1 for the multivariate normality. The researcher also investigated the histograms for the univariate normality. The assumption of multivariate normality was not violated. Third, in order to

investigate the homogeneity of variance and covariance matrices, the researcher ran Box's M test ($F(9, 31837) = 0.73$, $p = .68$) as well as Leneve's test for alien information acquisition ($F(3, 66) = 1.23$, $p = .31$) and game engagement ($F(3, 66) = 2.26$, $p = .09$). The Box test is strongly affected by violations of normality and it may not be accurate if the numbers of each group are different. If the numbers of each group are approximately equal, then the Box M statistics could be ignored. However, the largest number ($N = 21$) of groups has 30% more than the smallest ($N = 14$), so the researcher looked at the score of Box's M and it was not significant ($p_{Alien.Information} = .68$; $p_{Game.Engagement} = .09$). Thus the assumption of homogeneity of covariances was not violated.

Overall, there was no significant violation of assumption to implement MANOVA and Wilks' Lambda was employed to test null hypothesis because of the following reasons. Pillai's trace is the best Multivariate statistics to employ when there is a violation of the homogeneity of covariance matrices assumption and group sizes are similar, which are not the case in this study. Under the condition where all assumptions are met, Wilks' Lambda provides a good test statistic and is commonly used. The research hypothesis on the second research question is as following: There are significant differences between the effects of interaction between fantasy type and fantasy proneness on a combination of dependent variables (alien information acquisition and game engagement).

Descriptive Statistics

In a descriptive analysis on alien information acquisition in each group, the mean score of the group in which the students showed high fantasy proneness ($M = 22.19$, $SD =$

10.67) was higher than that of the group whose students showed low Fantasy Proneness (M = 17.38, SD = 11.18) in general. In the high fantasy proneness group, the group of students who received creative fantasy scored slightly higher mean score on alien information acquisition with more standard deviation (M = 22.91, SD = 12.56) than portrayal fantasy groups (M = 21.65, SD = 9.32). In high fantasy proneness, the mean difference between the portrayal (M = 21.65, SD = 9.32) and the creative group (M = 22.91, SD = 12.56) was not large. The participants with low fantasy proneness in portrayal treatment were fewer (N = 14) and the participants with low fantasy proneness in creative treatment were more (N = 21) than the other. The collapsed total mean of alien information acquisition was 19.86 (SD = 11.12) and total number is 70.

Independent Variable		Fantasy Proneness					
		Low		High		Total	
		M (SD)	N	M (SD)	N	M (SD)	N
Fantasy Type	Portrayal	24.16 (11.66)	14	21.65 (9.32)	20	22.68 (10.25)	34
	Creative	12.87 (8.40)	21	22.91 (12.56)	15	17.05 (11.34)	36
	Total	17.38 (11.18)	35	22.19 (10.67)	35	19.79 (11.12)	70

Table 13: Mean scores and sample size on Alien Information Acquisition

In terms of game engagement as dependent variable, the mean score of the group in which the students showed high fantasy proneness (M = 9.83, SD = 5.50) scored higher than the low fantasy proneness group (M = 6.83, SD = 4.73). In the low fantasy

Proneness group, the group of students who received creative fantasy scored lower on game engagement with a smaller standard deviation (M = 6.10, SD = 4.73) than portrayal fantasy groups (M = 7.93, SD = 5.34). In high fantasy proneness, the group of students who received creative fantasy scored lower on game engagement with a higher standard deviation (M = 7.40, SD = 5.84) than portrayal fantasy groups (M = 11.65, SD = 4.57). The collapsed total mean of game engagement is 8.33 (SD = 5.31).

Independent Variables		Fantasy Proneness					
		Low		High		Total	
		M (SD)	N	M (SD)	N	M (SD)	N
Fantasy Type	Portrayal	7.93 (5.34)	14	11.65 (4.57)	20	10.12 (5.17)	34
	Creative	6.10 (4.25)	21	7.40 (5.84)	15	6.64 (4.94)	36
	Total	6.83 (4.73)	35	9.83 (5.50)	35	8.33 (5.31)	70

Table 14: Mean scores and sample size on Game Engagement

Result of MANOVA

First of all, the researcher conducted a MANOVA with two dependent variables and the analysis result provided four multivariate tests to examine whether two types of fantasy design and two levels of fantasy proneness differed on a linear combination of the dependent variables: information acquisition and game engagement.

The test results indicated that there was a significant interaction effect between fantasy type and fantasy proneness ($F(2, 65) = 3.68, p < .05$, partial eta squared = .031) as

well as the main effect of fantasy type ($F(2, 65) = 4.98$, $p < .05$, partial eta squared = .010) and fantasy proneness ($F(2, 65) = 3.18$, $p < .05$, partial eta squared = .048) independently. The effect size of the interaction was small, and two main effects were slightly less than medium by rule of thumb (Cohen, 2013; MRC Cognition and Brain Sciences Unit, 2009).

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	0.130	216.86	2	65	0.000	0.870
Fantasy Proneness	0.911	3.18	2	65	0.048*	0.089
Fantasy Type	0.867	4.98	2	65	0.010*	0.133
Fantasy Proneness * Fantasy Type	0.898	3.68	2	65	0.031*	0.102

Note. Design: Fantasy Proneness * Fantasy Type = Interaction between fantasy proneness and fantasy type. Only the scores of Wilks's Lamda were gathered from the analysis output in SPSS 22.
* $p < .05$

Table 15: Table of Multivariate Tests

Since all interaction and main effects were significant in the test of multivariate null hypothesis, further analysis on separate dependent variables was carefully conducted. In conducting the series of MANOVAs, the researcher performed univariate MANOVAs in order to analyze interaction on each dependent variable rather than simply interpreting the individual main effect. This analysis indicated that the interaction was specifically significant on alien information acquisition ($F(1, 66) = 6.26$, $p < .05$, partial eta squared = .087).

Source	Dependent Variables	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Alien Information	1488.49	3	496.16	4.65	0.005	0.175
	Game Engagement	340.56	3	113.52	4.66	0.005	0.175
Intercept	Alien Information	28234.92	1	28234.92	264.75	0.000	0.800
	Game Engagement	4640.69	1	4640.69	190.61	0.000	0.743
Fantasy Proneness	Alien Information	240.73	1	240.73	2.26	0.138	0.033
	Game Engagement	107.18	1	107.18	4.40	0.040*	0.063
Fantasy Type	Alien Information	427.12	1	427.12	4.01	0.049*	0.057
	Game Engagement	150.00	1	15.00	6.45	0.013*	0.089
Fantasy Proneness * Fantasy Type	Alien Information	667.89	1	667.89	6.26	0.015*	0.087
	Game Engagement	24.78	1	24.777	1.02	0.317	0.015
Error	Alien Information	7038.66	66	106.65			
	Game Engagement	1606.89	66	24.35			
Total	Alien Information	35930.36	70				
	Game Engagement	6803.00	70				
Corrected Total	Alien Information	8527.15	69				
	Game Engagement	1947.44	69				

Note. Design: Fantasy Proneness * Fantasy Type = Interaction between fantasy proneness and fantasy type. R Squared = .175 (Adjusted R Squared = .137)

* $p < .05$

Table 16: Tests of Between-Subjects Effects on Dependent Variables

In Table 16, Two-way between subjects ANOVA showed there was a statistical significance on the interaction between the two independent variables on Alien Information. The interaction was also analyzed further by separating out the means of fantasy type and fantasy proneness.

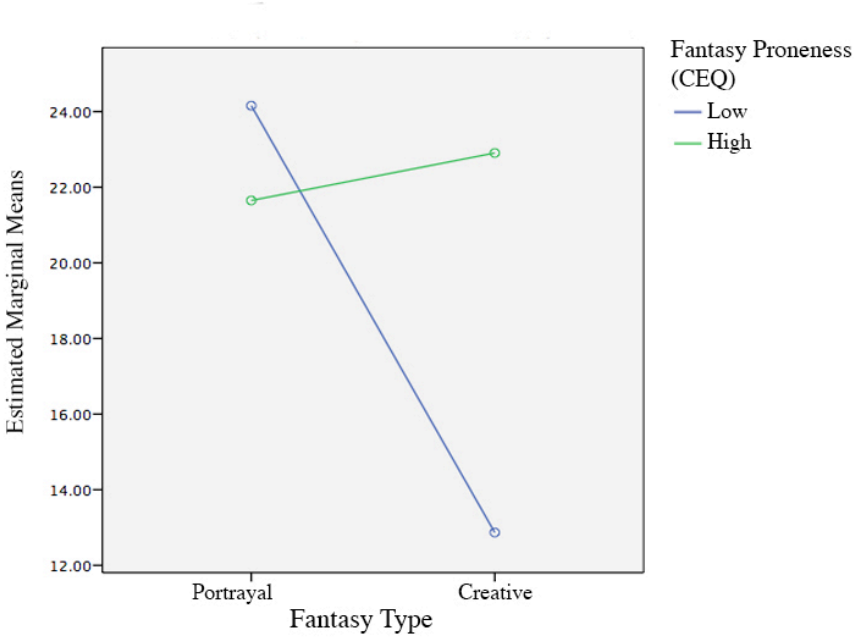

Figure 6: Profile Plot on Alien Information Acquisition

In the profile plot (see Figure 6), there is a slight gap between the two groups who received portrayal fantasy, however there is a significant gap between the two groups who received creative fantasy on Alien Information. The two line graphs are crossed and the score of each group is disordinal. The effects of interaction between fantasy type and

fantasy proneness on alien information acquisition are different in each group. The high fantasy proneness group showed a slightly better mean score in creative fantasy than portrayal, however the low fantasy proneness group showed a significantly lower mean score in creative fantasy compared to the portrayal group.

Independent Variables		Dependent Variable (Information Acquisition)		95% Confidence Interval	
Fantasy Type	Fantasy Proneness	Mean	Std. Error	Lower Bound	Upper Bound
Portrayal	Low	24.16	2.76	18.65	29.67
	High	21.65	2.31	17.04	26.26
Creative	Low	12.87	2.25	8.37	17.37
	High	22.91	2.67	17.58	28.23

Table 17: Confidence Intervals of Information Acquisition by Independent Variables

According to the mean comparison in the table above, three of the four treatment groups showed similar mean scores (above 21 point at least) of alien information acquisition and a low fantasy proneness group who received creative fantasy scored the lowest on the dependent variable. Even if there was a score difference among the four groups, the standard error of each group was similar and the 95% confidence interval of the 3 groups overlapped. Only the group of low fantasy proneness in creative type was far away.

Unlike the previous result on alien information acquisition, the two independent variables showed a significant main effect on game engagement. In the profile plot (Figure 7), there was a slight gap between the two groups who received creative fantasy

and a significant difference between the two groups who received portrayal fantasy. The two line graphs were not crossed and portrayal fantasy groups within the same level of fantasy proneness showed a higher mean score of the dependent variable than the creative fantasy groups. This meant the existence of main effect of fantasy type on game engagement ($F(1, 66) = 6.45, p < .05$, partial eta squared = .089).

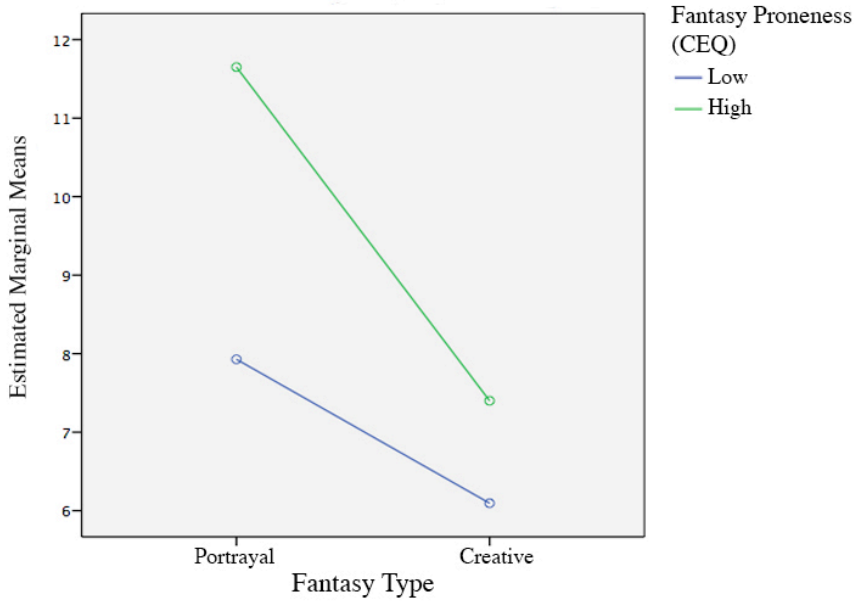

Figure 7: Profile Plot on Game Engagement

Additional univariate ANOVA confirmed a significance of the main effect of fantasy proneness on the dependent variable ($F(1, 66) = 4.40, p < .05$, partial eta squared = .063). The high fantasy proneness groups who received portrayal or creative fantasy showed relatively higher scores on game engagement. The high fantasy proneness group who received portrayal fantasy showed the highest mean score of game engagement (M =

11.65, *SE* = 1.10) and the low fantasy proneness group who received creative fantasy scored the lowest (*M* = 6.10, *SE* = 1.08). The other two groups showed similar mean scores. The low fantasy proneness group who received portrayal type scored a mean of 7.93 (*SE* = 1.32) and high fantasy proneness groups who received creative type scored 7.40 (*SE* = 1.27).

Due to the similar mean scores, the 95% of confidence level of the two groups with high and low fantasy proneness on game engagement overlapped each other (see Table 18). However, the 95% of confidence level of the two groups with portrayal and creative fantasy on game engagement did not overlap as much as on fantasy proneness.

Independent Variable	Level	Dependent Variable (Game Engagement)		95% Confidence Interval	
		Mean	Std. Error	Lower Bound	Upper Bound
Fantasy Proneness	Low	7.01	0.85	5.31	8.71
	High	9.53	0.84	7.84	11.21
Fantasy Type	Portrayal	9.79	0.86	8.07	11.51
	Creative	6.75	0.84	5.08	8.41

Table 18: Confidence Intervals of Game Engagement by Fantasy Proneness and Fantasy Type

To summarize, the researcher analyzed the data using MANOVA technique to examine the effects of fantasy type and fantasy proneness on alien information acquisition and game engagement. The research questions regarding the interaction and the main effect of the two independent variables on a combination of the two dependent variables were confirmed. This means that the interaction between fantasy type and fantasy proneness on the combination of dependent variables was statistically significant ($F(2, 65) = 3.68, p < .05$, partial eta squared = .031) as well as the main effect of fantasy type ($F(2, 65) = 4.98, p < .05$, partial eta squared = .010) and fantasy proneness ($F(2, 65) = 3.18, p < .05$, partial eta squared = .048). The following univariate MANOVA tests also showed that the interaction between the two independent variables on Alien information acquisition was statistically significant ($F(1, 66) = 6.26, p < .05$, partial eta squared = .087). The relationship on the two independent variables toward alien information acquisition was disordinal, which showed a distinguishable difference in a specific relation of the variables, and the low fantasy proneness group who received creative fantasy scored lower scores significantly. Finally, each main effect on the two independent variables was significant. In other words, the students who received portrayal fantasy or the students with high fantasy proneness scored statistically higher scores on game engagement.

SUMMARY OF QUANTITATIVE ANALYSES

The purpose of data analysis using the quantitative methods was to investigate how different types of fantasy and student fantasy proneness influence the learning outcomes and engagement in an educational game environment.

In the first analysis for the effects of fantasy type and fantasy proneness using Two-Way ANCOVA, the effect of fantasy type on science knowledge improvement was significant. The extra comparison on the means of each group indicated that using portrayal fantasy was effective in improving scientific knowledge. Research participants who received portrayal fantasy showed significantly higher improvement on science knowledge than the students with creative fantasy. However, the effect size of fantasy type is small (partial eta squared = .060) by rule of thumb (Cohen, 2013; MRC Cognition and Brain Sciences Unit, 2009).

In the second analysis, the researcher adapted MANOVA to examine the effects of fantasy type and fantasy proneness on alien information acquisition and game engagement and all relevant research questions were confirmed. The interaction between fantasy type and fantasy proneness on a combination of dependent variables was statistically significant as well as the main effect of fantasy type and fantasy proneness.

In addition to MANOVA analysis, the univariate analysis on alien information acquisition showed that the interaction effect between the two independent variables on alien information acquisition was statistically significant. Specifically, the relationship on the two independent variables toward alien information acquisition was "disordinal" (Hair, Anderson, Tatham, & Black, 1998, p. 344), which showed a distinguishable difference in a specific relation of the variables. The low fantasy proneness group who received creative fantasy showed the lowest scores on alien information acquisition than

the other groups. The main effects of fantasy type and fantasy proneness were significant on game engagement. Specifically, the students who received portrayal fantasy, or the students with high fantasy proneness scored statistically higher scores on game engagement.

RESEARCH QUESTION USING QUALITATIVE DATA: STUDENTS' PERCEPTION ON FANTASY TYPE

The purpose of the qualitative research questions in the study was to investigate how student identified each type of fantasy and related his or her past experience to the embodied characteristics in alien characters. To accomplish the research purpose, the researcher analyzed qualitative data based upon the following research questions.

a) What elements make students identify fantasy as portrayal or creative?

b) Does student's prior experience relate to the identification of six alien species, and how does student's previous experience affect their understanding of six species of alien?

Based on the overarching purpose to examine student perception on fantasy, the researcher aimed at the specific visual elements that make each type of fantasy more unique and distinguishable. With the analysis of student interviews, the researcher categorized these elements and then tried to make relations to the process of 3D modeling in order to capture how students had imagined when they used AlienDB, which includes all alien models and relevant information.

After highlighting the detailed elements of the alien models, the researcher investigated why and how students understood these specific types of 3D images. Throughout the interviews with students, the researcher found that the previous experience of students emerged as the most important reference source, and the imaginative sources from prior experience were used in understanding fantasy visuals regardless of the familiarity to the novel creatures. In the following section, the researcher describes the analysis results according to each of the research questions.

Perceived Elements of 3D Fantasy Objects

For the first research question in qualitative part, the researcher analyzed important visual elements that make each type of fantasy more unique and distinguishable. Based on the analysis of the interviews with students, the researcher identified eight elements that students recognized as the essential components to make each alien unique and different. The elements are body-shape, face (or head), size, eye, tail, texture, color, and details.

With the eight elements identified, the research grouped them using two categories called *body mesh* and *texture*. The researcher intentionally adapted the terms *body mesh* and *texture* in order to compare how the game developer designs them and how they were understood by game-players. Even though those elements were designed using fantasy design principles and verified through the pilot test (see Chapter 3), the researcher identified a perception pattern that students tend to understand 3D models as the way of 3D modeling.

In the category of body mesh, students indicated body-shape, face (or head), size, eye, and tail as the major characteristics, which make each 3D alien unique. In the category of texture, color and details were the main elements, which make the aliens different from each other. In the following section, the researcher describes how students perceive these elements on each alien and make imaginative connections to the 3D models of aliens.

Body shape: Body shape was the most frequently mentioned element in the characteristics of aliens. In the game, there are six species of aliens. They have unique shapes such as mineral, humanoid, insect, and wild animal. The shape of each alien is important not only for the subjective relationship of body components to an entire alien, but also for the formation of first impression of it. Even though the individual elements in an alien contribute to make an image of the alien, the image of the body shape was over the sum of those components in terms of imagination. Students spontaneously made a first impression on each alien based on their experience. The first image influenced cognitive and emotional process during the gaming of Alien Rescue. In the following section, student's responses in the interviews are analyzed in order to describe how they made the first impression based on their experience on each alien.

First, Akona's body shape was more likely to be mentioned as crystal and rock on a mountain because of the sharp edges and alignment of the edge meshes (See Figure-8, Left is portrayal Akona and right is creative Akona).

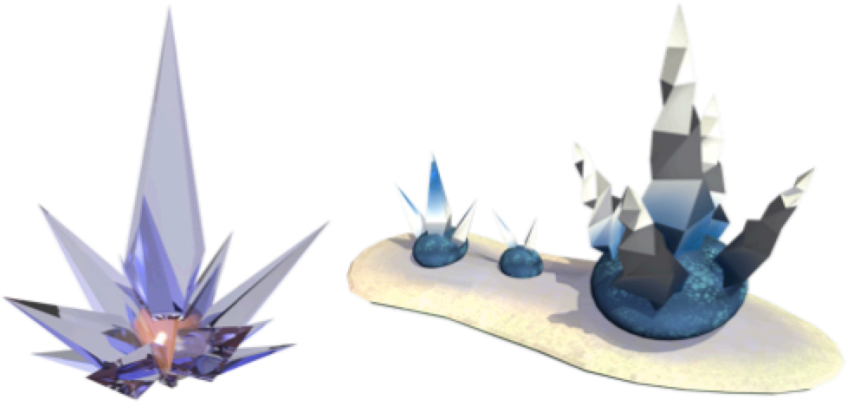

Figure 8: Two versions of Akona

Researcher: Lets go to the first. This is Akona. What did you think?

Helena: It reminds me a crystal and just looks it grows.

Researcher: That was Eolani. What did you think when you first saw Akona?

Hunter: I thought it is confusing how…wait...I could tell there is head whether anything like if there is front and back…just look like a giant crystal things.

When students talked about Akona in the second interview, they differentiated two versions of Akona using other attributes such as color and contextual information as the researcher showed another version of the alien to compare.

Researcher: "So, when you first saw my aliens, ok, let's go this first. When you first saw these aliens, what did you think? You can compare or you can just say your opinion on each alien. What did you think?"

Hunter: "Well, these five look more like children's toys and that one just looks like crystal you would find."

Second, students responded that Eolani looked like a human and compared it with other aliens' shapes, which have been familiar in previous experience (See Figure-9, Left is portrayal Eolani and right is creative Eolani). For students, the bigger head with large eyeballs were symbolic and thin body in both versions of alien was typical in the aliens.

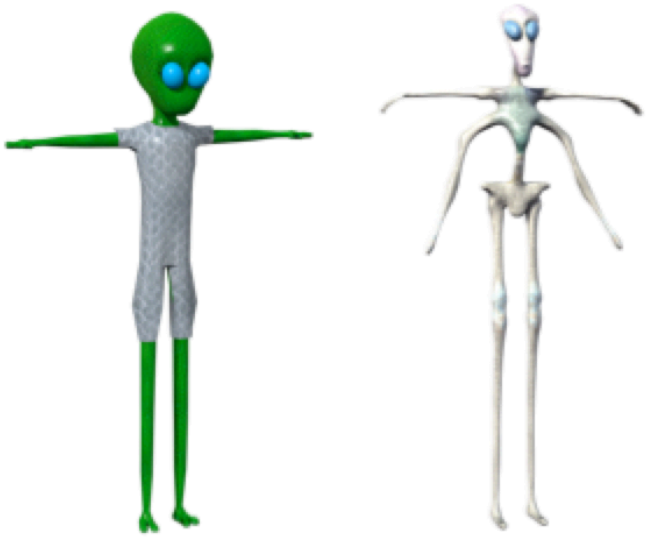

Figure 9: Two versions of Eolani

Researcher: And what about Eolani?

Joseph: Um…green, they looks like a human, so, just kind of knowing what they are like, sort of makes feel me like that make you want to help them, sort of find home, find away that they look like you know, when you put them in case something living there already like a planet an alien living there already, they can blend in and not be cut down.

Madelyn: What I think it look…yeah, I would like…If I saw alien, I would think it looks like a human, but that like it was not (indicating Akona).

Researcher: Ok. For example, these three (Researcher indicating Eolani, Kaylid, and Jakala-Tay) are humanoid.

Madelyn: Yes, that's what I've got an alien would look like something like that.

The shape that students were reminded of was the humanoid object that they have experienced in new media or popular cultures. Several students who talked about Eolani relating it certain humanoid creatures pointed out the thin limbs or typical color of aliens from previous experiences.

Researcher: Can you describe the 1960s' alien that you saw in other movies and popular culture?

Jackson: It looked like a guy who was green or gray, lived on mars, always hair like a ray on something with him, he was kind of tall, he had two to four arms and he got a big head, big black eyes like a big or regular head.

Researcher: So, let's take some examples. In the body shape, in terms of color, texture, the body shapes, eyeballs, hands and legs. What kind of components make you think it is realistic?"

Sammuel: Its color is green and its eyes are like really big and yellow. And he's really tall and skinny. And he like wears kind of I think it's like just one clothes were supposed to change. It's different and it has no hair.

Third, students described that the Jakala-Tay looked like a humanoid reptile such as a lizard due to the skin texture and tail (See Figure-10, Left is portrayal Jakala-Tay and right is creative Jakala-Tay). The students thought that portrayal Jakala-Tay looked like a

humanoid alien with a strong tail like a reptile and creative Jakala-tay looked like a muscular humanoid alien with reptile skins and tail.

Figure 10: Two versions of Jakala-Tay

Researcher: What you think about Jakala-Tay? Ya, it is not coming (Jakala-Tay was not loaded because of Internet speed).

Kevin: well, I think it is kind of looks like lizard, or like dinosaur looking. Yes, things kind of cool.

Researcher: What about Jakala-Tay? Which component helps you understand?

Joseph: The tail. The tail makes me feel like that it is very powerful that it will hunt and beat off living things and it can grab it with its tail. It makes it furious and stand out in front of all.

Fourth, students were reminded of humanoid insects when looking at the shape of Kaylid (See Figure-11, Left is portrayal Kaylid and right is creative Kaylid). Since portrayal Kaylid has a pair of fore arms that look like claw, several students reminded of a crab when viewing the Kalylid. However, other students who received creative Kaylid reminded of an insect such as a fly or praying mantis due to the unique head shape of the body.

Figure 11: Two versions of Kaylid

Researcher: Lets go, but wait for a second. Kaylid, what did you think?

Joseph: Um..I first saw, I thought maybe…paw…sort of you, I think you got the idea from Praying Mantis and…um…during that I think it looks very original, yellow fits on Mars or maybe Jupiter…but I don't know. I haven't gotten this one researching. I don't know.

Kevin: No, oh this is Power Rangers, interesting.

Researcher: A Kaylid?

Kevin: Ya, Kayli or Kaylid weird. It looks like a human crab (his friend said agreed).

Fifth, students were reminded of fish when the researcher asked about both types of Sylcari (See Figure-12, Left is portrayal Sylcari and right is creative Sylcari). A student who received portrayal Sylcari recalled an eel because of the tail whereas the other students who received creative Sylcari were reminded of catfish due to the tail and beard at the edge of Sylcari's mouse.

Figure 12: Two versions of Sylcari

Researcher: Mixing up all these 12 aliens, which are fantastic?

Madelyn: Um…your Sylcari, your Wroft, my Jakala-Tay.

Researcher: Could you explain why?

Madelyn: Because like that looks a lot more catfish, this looks even more, so I figured it more like realistic, and that looks like a jellyfish but it is like its eyes are different, those things are different, really cool, it looks like a transformer, it is cool.

Researcher: So, sylcari? What did you think?"

Sammuel: He's really cool. It looks like one of those sharks. I like this one in the water and there. Yeah I definitely knew some like this. Like in a fiction. And they are really cool. They look like one of those strong ones that keep controlled one. Like electric eels.

Finally, students reminded of other deep-sea animals such as jellyfish for the shape of Wroft (See Figure-13, Left is portrayal Wroft and right is creative Wroft). In the description in Alien Database, Wroft has an elastic dome with tentacles and the round dome reminded students of jellyfish. Several students also recalled mushrooms when viewing the shape of the dome, however the majority of responses on Sylcari's shape were comparing it to jellyfish.

Figure 13: Two versions of Wroft

Researcher: That is great. What about Wroft?

Joseph: Well, it was the first day alien that I saw, jellyfish? Um, I think this one goes with gas giant? And again, I haven't gotten this researching.

Face, eye and tail: Face (or head), eye, and tail were important elements that made each alien imaginative. Several students indicated that the face (or head) shape was one of the most distinctive components in differentiating aliens since face is closely related to developing first impressions of the aliens. Students also compared the shapes of the alien faces with other objects such as insects or animals. In addition, when students talked about aliens' faces, their eyes were critical components in characterizing aliens' faces. The Interviewed students indicated the shape and texture of the eyeball as important characteristics to make the alien unique.

Researcher: what about Kaylid? What kind of component?

Joseph: The head shape, it is interesting. The head shape has the holographic eyes and the claw thing, it stands out to me. I thought it is an alien again, I would extend this…I have never thought of this.

Researcher: Aha…Which component, here…The components are the head, color, hand shape, arm or legs, which components of aliens helped you understand the entire species of alien?

Jackson: Just about like their head, their arms and their legs just made me understand them whole lot more.

When discussing Jakala-Tay and Sylcari who have a tail, students pointed out that the tail was a critical element. They thought Jakala-Tay's tail was used for hunting or swimming.

Researcher: what about Jakala-Tay? Which component helped you understand?

Joseph: The tail. The tail makes me feel like that it is very powerful that it will hunt and beat off living thing and can grab it with its tail. It makes it feel voracious and stand out in front of all.

Texture and color: Color and texture in the alien models were the particular elements that make the aliens more realistic and imaginative. Alien bodies included multiple mesh components and the mesh textures were applied in the skin, hair, and clothes of the mesh. In their interviews, all students indicated color was the most critical element for making imaginative aliens, and several students pointed out their unique textures on their parts of the body such as skin or eyeballs.

Researcher: Why? Do you have any preference?

Aria: Um…I really like this one because it is unique (indicating green Eolani) and it reminds me a raw alien. This one (indicating Akona) looks like a crystal because I am a big fan of crystal and shiny everything. In this one, the arms are like a grasshopper.

Researcher: So, let's take some examples. In the body shape and in terms of color, texture, the body shapes, eyeballs, hands and legs. What kinds of components make you think it is realistic?

Samuel: Its color is green and its eyes are like really big and yellow. And he's really tall and skinny. And he like…wears kind of I think it's like just one clothes…were supposed to change, as it's different. And it has no hair.

Size and details: The size of the aliens was a relevant element to the shape of the model. Several students paid attention to the size of the aliens and compared the alien's size on the screen to the description on the Alien Database. Even if the sizes of aliens on the screen were similar because the developer assumed that the visual representation took place in the database on a computer at the spaceship called Paloma, students compared the imaginative size of aliens based on the visual on the screen and the description.

Researcher: What is different from the previous alien that you memorize?

Madelyn: Well…like the one you showed me first, that I don't see it in movies. That one?

Researcher: Eolani?

Madelyn: That one's like. A lot skinnier than normal. And its head is smaller.

In addition to the size of the model, students also pointed out the details of 3D models and placed more value on the realistic graphics in the 3D mesh. Students reported

they liked the detailed model such as Kaylid or Jakala-Tay more than Akona or Wroft because of the high-resolution graphic using more polygons in 3D modeling.

> Researcher: Let's go to the Jakala-Tay. What did you think?
>
> Joseph: When I saw this, I thought it is an alien. I was like…wow, that is really cool. I mean the detail on it. Everything is really cool. This alien is probably my favorite out of all of them. And green fits really well, black and white and…, I have no idea, I am supposed, but this one. I go researching it trying to figure out what is like and what is dislike, where it wants to live…but this is very original…um…like…very mind-blowing.

Cognitive Relationships between 3D Fantasy and Prior Experience

For the second sub research question, the researcher investigated why and how students understand these specific types of 3D images and found that gaming experience was formulated based on the students' previous experience. When students identify the fantastic visuals form aliens, they used stereotypical concepts to describe six aliens in Alien Rescue, and those stereotypes were similar to the design sources, which the developer employed in the 3D modeling process. Therefore those concepts were closely related to the core elements of 3D modeling and source of human imagination (Robertson, 1992). The students thought the creative aliens were quite different than the other aliens and portrayal design was more usual than the creative.

The researcher also found that students used various concepts relevant to each alien from their past experience, and those concepts were reprocessed by their imagination in order to understand the unfamiliar images of aliens. The students indicated the aliens in creative fantasy were more extraordinary compared with the portrayal aliens and hesitated in response when the researcher asked their thoughts.

According to the relationship between the concepts from students' experience and the core elements of alien modeling, the researcher analyzed 6 species of aliens by reference and characteristics in order to access how students imagined during the gameplay as following.

Alien Name	Design	References	Characteristics
Akona	Portrayal	Crystal, ice, rock, planet	Shining, Pointy, growing, sticking to planet, coming from the bottom of the ocean, sharp to attack, big, sand around
	Creative	Diamond, crystal, rock, mountain, plant	Looking like habitat itself, pointy and shinny, blue
Eolani	Portrayal	Human, person, fly, female, power rangers	Big-eyed, green-skinned, eye of fly, wearing clothe, requesting help from us (human), thin, seen in the movies or TV shows, seen in Sci-Fi movies, bulgy eyes
	Creative	Human	Bone, skinny, grey-skinned, wearing pajama
Jakala-Tay	Portrayal	Dinosaur, lizard, rock	Rocky texture
	Creative	Trex dinosaur, toy, muscular male, transformer	Having realistic skin, warm, larva colored, seen in the movie, looking like dinosaur (tyrannosaurus rex)
Kaylid	Portrayal	Human crab, praying mantis, mantis, grasshopper	Colorful, looking like a alien people imagine, praying arms, looking-like a LEGO block, shiny wood
	Creative	Fly, cockroach, beetle, bug, spider, cat, lizard	Insect-looking, big eye balls, fly's eye, alien saw in the movie, yellow fits to Mars or Jupiter
Sylcari	Portrayal	Fish, river monster, lizard	Fish in watery environment, swimming, flying, attacking people, spaceship-like
	Creative	Squid, catfish, praying mantis, toy, cockroach, eel, tadpole, lizard	Having big head and eyes, having beard, seen in Starwars, having shark's tail
Wroft	Portrayal	Jellyfish, plastic bag	Deep sea animal, swimming, jellyfish in the cartoon movie
	Creative	Jellyfish, deep sea animal, stingray, mushroom, fungi	Big, animal all do in the water, living under deep sea animal

Table 19: References and Characteristics of Each Alien

First of all, Akona was understood as a crystal or several pieces of mineral due to its shape in general. The students saw that portrayal Akona had a shiny and pointy form in body and it looked like growing from the bottom of planet whereas creative Akona looked like a diamond, or tiny mountain on a planet because of the plate at the bottom plate of the model (see Figure 8). The students imagined it looked threatening because of the sharp edge of portrayal Akona.

Eolani was understood as a humanoid creature. Due to the shape of the creature, students thought that both versions of Eolani were illustrated with various humanistic features such as clothing and gender. For portrayal Eolani, they thought it seemed like an old alien from old movies or SciFi movies due to its big eyes and green skin. The eyes were like a fly because they were protruded. On the other hand, they thought creative Eolani was a very skinny human with grey skin. Contrary to the portrayal Eolani, students were not able to recall any similar creatures like creative Eolani, however student mentioned it looked like a female who was requesting help from us due to the thin body and bony structure.

Jakala-Tay was a strong reptile-like creature to the students. Because of the strong tail on the back and muscular limbs, the students said that Jakala-Tay looked like a male alien invading the earth. They also thought portrayal Jakala-Tay's texture was obvious because it seemed like the scales of lizard or surface of a rock, and creative Jakala-Tay had more realistic skin with colors like larva. The mixture of yellow and red texture of the creative Jakala-Tay was unique for them. The students thought creative Jakala-tay was unique because of the extruded eyeballs and realistic skin texture.

Kaylid was also understood as an insect such as praying mantis or cockroach. Although several students mentioned it looked like a humanoid-insect because of the perpendicular shape of the model, the main characteristics they figured out were entomological features, such as claws and a hard shell. The images made by student's imagination for portrayal Kaylid were the praying mantis, grasshopper, and crab due to the shape of the eyeballs and big claws on arms. Based on these concepts, students thought portrayal Kaylid was a familiar form of alien people imagine. For creative Kaylid, students compared it to a fly, cockroach, beetle, bug, spider, cat, and lizard because of the extruded eyeballs and hard-shelled body.

Sylcari was a fish-looking creature swimming under water somewhere on a planet. Because of the streamlined shape, students compared it to several underwater animals like a catfish or tadpole and a few described it as a squid because it had four tentacles at the bottom of the body. With the realistic texture from a real fish and firm tale of portrayal Sylcari, students thought it lived in the water with aggressive behavior like attacking humans. Creative Sylcari seemed like a catfish or tadpole because of a pair of barbel around the mouse. The students thought creative Sylcari had more unique features from a toy or movie like Star Wars and portrayal Sylcari seemed like a real fish or river monster such as eel.

Wroft, with its gelatinous umbrella head, was often compared with jellyfish. Since the basic image of the reference was a deep-sea animal, the students thought that the relevant characteristics were relevant to the deep-sea environment. For portrayal Wroft, the students imagined the head would stretch out like a plastic bag and the alien swam using the elastic body under the deep sea. Contrary to it, creative Wroft seemed like a

jellyfish, but each element of the body came from other objects like a stingray and mushroom.

Throughout the conversation on the aliens, the student's previous experience was the most important reference source of identifying fantasy visuals. Students clearly differentiated two versions of aliens based on the familiarity and reality of the model. The portrayal aliens were more familiar to them, and recalled referable concepts easier than creative aliens. Those imaginative sources were used in understanding fantasy visuals regardless of the students' familiarity to the extraordinary creatures. They eventually combined the previous knowledge and experience into the new images in order to understand those unfamiliar aliens. Throughout the interviews, students showed a few patterns to make their own images of aliens based on their experience. In the following section, the patterns are described in detail.

Understanding aliens with familiar concepts: In identifying the imaginative, but familiar visual of the aliens in the beginning of the AR session, the students quickly found referable concepts throughout their experience to match the given design of the aliens regardless of the versions of alien design. The multiple references and relevant characteristics on each species were from the concepts around the living environment of students (see Table 19).

First, objects in nature consisted of a category of the references. The students understood creative Akona by making a connection to minerals due to the shape of it. Similarly, a student also mentioned a rocky texture in describing creative Eolani because of the mixture of the clothes color.

Researcher: Ok, could you explain why you chose two more aliens?

Joseph: Um…This one l like because it makes it feel more like…I really like to swim and stuff and this one like the jelly fish and it really brings me back to that water and the Akona.. I just like how it's shaped, having all the crystals thinking out of it. I just think that's really cool.

Researcher: What about second alien, Eolani?

Helena: um…it kind of looks like alien people imagines and stuff. The eyes remind me a fly. Uh…this one remind looks like lizard and stuff and it just like blend of rock (indicating clothes)

In describing creative Akona, students also pointed out plants because the image of Akona included a developmental characteristic, which meant the segments of Akona can be separated from the mother mesh. In the 3D graphic of creative Akona, two small Akona models were placed on a plate and the interviewee thought the small models looked like growing children of the big Akona.

Researcher: My first question. Oh, let's go to the alien. Can I close it? So, when you first saw the aliens, what did you think?"

Madelyn: When I first saw that one, it seems like I thought it was different. I've gotten think alien looks like that. It looks like a plant.

Students also understood several aliens using diverse concepts of animal: deep-sea animal, wild animal, and ancient animal. In describing Jakala-Tay, students compared it with a lizard and dinosaur because of the erect shape and texture of the alien. They also applied a concept of under-sea animal to Sylcari because of the streamlined body, and a jellyfish to Wroft due to the dome shape of the head.

Researcher: What do you think about Jakala-Tay? Ya…it is not coming (Waiting for Jakala-Tay image loaded).

Kevin: well, I think it is kind of…looks like lizard, or like dinosaur looking. Ya, things like of cool.

Researcher: What did you think?

Caroline: I forgot what it's called. But it's like fish movie and there like. Land, sea, and fish. They are just for attacking people and eating them. It's really funny, but not supposed to be. But its shape of it, it's like what the shape of the fish was.

Students also referred to movie characters or imaginative creatures to describe their aliens. The students, in describing portrayal Eolani, referred to old green aliens and showed the opinion that portrayal Eolani was close to those typical aliens shown in old media due to the color and thin body with the extruded eye. Even in describing creative Eolani, the students agreed that the thin body with multiple pairs of limbs was the distinctive characteristics that shape their first impression of creative Eolani.

Researcher: How about Eolani?

Hunter: Honestly, it looks sort of like little layered thing like pajamas or something.

Researcher: Pajama thing?

Hunter: Yeah, some little thing of that.

Researcher: Which is more traditional alien that you saw in the movies and...?

Hunter: Actually I think yours look more.

Researcher: Mine is more?

Hunter: Yes, because they're original green body ". Yeah like, they usually are in the movies.

Researcher: I see…the eyes are look like a fly's eyes. What about Sylcari?

Aria: That one looks like a squid. When I saw it has a big head, then goes down with circles and everything… I though it is really cool. When I saw it, it looks like kind of lizard kind, kind of monster.

Understanding non-stereotypical aliens using familiar references: Even though an alien itself is an unreal creature, students utilized familiar references and their experience to understand the different types of aliens. Compared with the students who received portrayal aliens made immediate relations to each alien using the existing concepts, the students who received creative aliens made new connections using existing concepts from their experience. When the researcher asked the opinion on creative version of the aliens, several students claimed that they had difficulties in comparing similar concepts or references on those aliens at first. However, they found the partial similarities to existing concepts helpful to understand new aliens and the mixture of the references created a unique image of understanding.

Students utilized daily life objects in understanding an alien. One of interviewees pointed out a plastic bag to explain the elasticity of the body when she described the head of the creative Wroft.

Researcher: What about Wroft?

Caroline: Like a jellyfish, like a plastic bag or something.

Researcher: Plastic bag?

Caroline:Ya...because it says it can expand to like ten feet and then when I read that...hey...ya...kind looks like a plastic bag...and so....except that just.

SUMMARY OF QUALITATIVE ANALYSES

The qualitative data study was to inquire the student's perception on the varying types of fantasy and how the perception affects their imagination and game playing for science learning.

For the first research question, the researcher identified eight elements that the students pointed out as the essential characteristics, which made each alien unique and different. The elements are body-shape, face (or head), size, eye, tail, texture, color, and details. The eight elements were organized in two groups named as body mesh and texture. The researcher intentionally adapted the two terms called body mesh and texture, in order to compare what researcher, as a game character designer, designed and how they were understood by game-players. Even though those elements were designed by each fantasy design principles (see Chapter 3), the researcher identified a perception pattern that students understood 3D models as the way of 3D modeling. Body mesh including body-shape, face, eyeball, tail, and details is created through polygon modeling process and texture and color is added on the model through texturing and painting. In the category of body mesh, students indicated body-shape, face (or head), size, eye, and tail were the major characteristics, which make each 3D alien unique and extraterritorial. In the category of texture, colors and details were the main elements, which make the aliens vivid and realistic.

In the second research question, the researcher investigated how students understand these specific types of 3D images. Based on the students' interviews, it is

found that gaming experience was formulated based on the interviewers' previous experience. The interviewees used typical concepts to describe six aliens in Alien Rescue from popular culture and media. Those concepts were closely related to the core elements discussed in the previous research question. It is also found that students first recalled familiar concepts to understand the unusual graphics of aliens, and then reprocessed those concepts in order to understand the unfamiliar images of aliens through imagination. The students who received creative fantasy showed the imaginative reprocessing more than the student those who received portrayal fantasy.

Chapter 5: Discussion

> For the imagination never operates in a vacuum. Its stuff is always fact of some order, somehow experienced: its product is that fact transmuted. I am not forgetting that fact may swamp imagination, and remain unassimilated and untransformed (Lowes, 2014, p. 290).

SUMMARY OF RESEARCH FINDINGS

There are two research purposes in this study. The first is to examine how different types of fantasy and student fantasy proneness influence the learning outcomes and engagement in an educational game environment called "Alien Rescue." To accomplish this purpose, this research investigated the effects of fantasy type and fantasy proneness on science learning, factual information of alien characters, and game engagement. The second purpose of this study is to investigate students' perception of the varying types of fantasy. To accomplish the second purpose of the study, this research inquired how student identified each type of fantasy visuals and related his or her past experience to the embodied characteristics in alien characters.

The findings of the study showed that portrayal fantasy was effective for science learning, alien information acquisition, and game engagement. Specifically, the students who used portrayal fantasy showed higher improvement of science knowledge and scored better on both alien information acquisition and game engagement. High fantasy proneness group also showed better game engagement.

In the qualitative part, the research findings showed that the students pointed out eight elements in identifying 3D fantasy objects and those elements were relevant to the design elements in a 3D modeling procedure. The students also showed a perception

pattern that they understood 3D game characters using previous experience regardless of fantasy type.

In the qualitative part, the research findings showed that the students pointed out eight elements in identifying 3D fantasy objects and those elements were relevant to the design elements in a 3D modeling procedure by the researcher as a 3D modeler in the AR project. The students' responses also showed a perception pattern that they understood 3D game characters based upon previous experience regardless of fantasy type.

In the following section, the findings of this research are discussed further in the context of the literature and the directions of future research are suggested along with the limitations of the current study.

POSITIVE EFFECT OF PORTRAYAL FANTASY ON LEARNING AND ENGAGEMENT

One of the important findings in this study was that portrayal fantasy was effective for learning as well as engagement in a new media 3D gaming environment. The students who received portrayal fantasy scored better on science learning, alien information, and game engagement, and those results can be explained by the familiarity and immediateness of the fantasy (Dillon, 2010).

According to Dillon (2010), game players have fun when they think the first look of the game is familiar. This enables the game players to identify the game environments immediately. By definition, portrayal fantasy, as imaginative graphics, carries visual information with familiar concepts and popular images. During the beginning of AR use, students were asked to research about aliens, and the research finding in this study indicated that the students identified the portrayal aliens easier and faster because of their

familiar shapes. The immediate identification was also advantageous in provoking the arousal of relevant emotion such as curiosity and exploration of the gaming environment (Dillon, 2010).

This finding is also consistent with the results from the other studies indicating fantasy is effective when students personalize learning experience through fantasy. Cordova and Lepper (1996) found that personalization of experience through fantasy was an important procedure in enhancing learning and motivation. Rather than using generic fantasy, which limits students' imagination, giving students flexibility of interpretation on fantasy by using personalized fantasy was effective for learning and motivation.

Similarly, Wiest (2001) also found that the relevant context of the fantasy is important in designing mathematical problems. In her study, sixth grade students performed better on children's real world problems than on low fantasy or adults' real-world problems. They also scored better on high fantasy problems, which contained an imaginary and internally consistent secondary world including myth or unreal creatures appropriate for children rather than adults. These results indicated that fantasy containing relevant information to those students' background is essential for enhancing learning and motivation.

To summarize, the findings of the studies discussed above indicates that the use of fantasy is positively related to the improvement of learning and motivation in the learning contexts when it triggers the personalization of experience based upon the relevance and sense of closeness of the fantasy.

Relationship between Imaginative Visual Information and Fantasy Proneness

For the successful completion of educational gaming, triggering positive emotion and provoking willingness to get involved in the gameplay is important. However, the finding showed that the students who had low fantasy proneness seemed to experience unfamiliarity on the creative visuals of alien in the beginning of Alien Rescue.

According to the definition of creative fantasy, the parts and components of creative fantasy are incorporated with continuous alterations of preexisting objects and the final product is completely different from the original objects or concepts. Over the 3D modeling process for creative aliens, the researcher as a 3D modeler incorporated various concepts and combined conceptual distortions. These alteration processes added extraordinary characteristics and generated obvious dissimilarity to existing concepts. When students encounter these aliens, they usually feel inconsistency between their knowledge base and the fantasy object. According to Dillon (2010), the unsuccessful experience in immediate identification of game leads to failure to trigger curiosity and joy for active game engagement with fun.

The research finding that a lack of relevance on fantasy visuals leads to an issue in the identification and recognition of the educational gaming environments is consistent with the literature. In the literature (Lynn & Rhue, 1988; S. C Wilson & Barber, 1978), high fantasy prone individuals show frequent fantasizing in daily life and occasional difficulty in differentiating fantasized events. Typically, high fantasy prone individuals are more likely to engage in those unrealistic situations. In other words, low fantasy prone individual has less experience on the fanciful situations and he or she is less likely to spend more time in identifying and fantasizing unusual aliens. Because creative aliens

carry unfamiliar concepts and extraordinary visuals, the cognitive structure of low fantasy prone student is less prepared for understanding new types of fantasy. In this sense, it is speculated that the unfamiliar information leads cognitive load in personalizing creative fantasy for those who have low fantasy proneness.

Regarding the importance of relevant images and the cognitive load on understanding fantsy, the research finding showed a consistent result with the principles of multimedia design that the unfamiliar visuals, especially creative fantasy, increase cognitive load in understanding and identifying new fantasy concepts. According to the multimedia design theory (Mayer, 2001), the principles suggest that student's learning outcome is limited when irrelevant words or graphics are added in the multimedia. Considering the fact that the interviewed students showed the disparity between their media experience and creative aliens, the new visual information of the creative aliens may cause more cognitive load in identifying the new concepts of fantasy than the familiar designs of aliens (Mayer, 2001). The extra information irrelevant to science learning itself in AR may lead to the overuse of cognitive resources in the beginning of AR gaming, and it may lead to ineffective learning and engagement.

The unsuccessful initialization of the game play can also be explained by a delayed accommodation of visual information. The unfamiliarity of creative aliens cause the issue in recognizing new graphical information from existing knowledge and the cognitive inconsistency between the new graphical information and their existing knowledge delayed perception of 3D aliens (Aleman & De Haan, 2004; Johnson & Raye, 1981; Richert & Smith, 2011). Also, the issue of visual identification may lead to another issue in building the relationships between the graphical information and the textual

information of the aliens in the game play. During the classroom observations, students tried to identify the aliens using the 3D visuals first and then comparing them with the textual information in the Alien Database. In terms of the definition of creative fantasy, the final form of creative fantasy can be a fuzzy concept in understanding and includes excessive visual information since the creative objects were made of countless combinations of different concepts and interaction.

Student interview results also supported that they were not familiar with creative aliens and the fuzzy shapes of the aliens required additional imaginative thinking to make relationships from the unique 3D visuals to the existing knowledge. Whereas the students who received the portrayal aliens found an approximate concept to understand their aliens quite quickly and even showed a sense of closeness to them, the other students who received creative aliens had difficulties or showed hesitation in searching for the referential images. These hesitations can be understood as a delay of knowledge creation through accommodation (Dillon, 2010; Piaget, 1952). The low fantasy proneness students showed similar difficulties in the identification process of the aliens especially when they were exposed to creative aliens. They required more time to process the unfamiliar graphical information.

GAME ENGAGEMENT IN 3D GAME PLAYING

Student's engagement experience from imagination through fantasy needs to be understood carefully because there was no empirical evidence verifying the student's engagement directly related to learning performances. Based on the ANCOVA and MANOVA analyses in this study, the findings indicated that fantasy proneness was a

positively related factor only on game engagement. Additionally, the researcher analyzed correlations between fantasy proneness and other variables[4]. The results showed same results with ANCOVA and MANOVA. The relationship between fantasy proneness and game engagement was positive ($r = .38$, $p < .05$) in spite of the fact that the other correlations between fantasy proneness and alien information, and fantasy proneness and science knowledge improvement were not significant. This means more time spent through deep engagement in the game does not necessarily result in better problem solving in the educational gaming although fantasy proneness as a personal trait is an important factor to explain how students engage in the game through fantasy.

Several researchers reported that employing games for teaching in various situations made users engage in the games due to the fantasy of the games (Hainey, Connolly, Stansfield, & Boyle, 2011; Prensky, 2006; Rieber, 1996; Whitton, 2011) and the engagement was due to the intrinsic integration of fantasy into the contents of the games (Malone, 1981). However, the findings in this research suggested that students built subjective knowledge through educational gaming, and prior experience relevant to the objects and gaming activities changed the pattern for effective use of an educational game. The previous experience relevant to 3D fantasy characters mediated the identification of those elements, and the sense of closeness on the extraordinary creatures created the positive emotions on the game itself. The personally relevant visual effects of

[4] In this research, the author intentionally employed Analysis of Variance (ANOVA) techniques including ANCOVA and MANOVA because fantasy type was a categorical variable and fantasy proneness was differentiable by two levels according to the frequency distribution. However, the score of fantasy proneness was a continuous variable, and the additional correlations between fantasy proneness and other dependent variables were conducted in order to investigate the magnitude of the relationships between those variables.

the fantasy game characters took an important role in developing curiosity in the beginning of the game play.

Beyond Malone (1980)'s discussion on the intrinsic design of fantasy, this study suggested that the motivational benefits from fantasy in educational games depended on the individual interpretation of fantasy in regards to the learning contents. It means the utilization of fantasy itself may lead to non-existence of the effect on engagement. Rather, fantasy itself is a medium to carry the context of game or learning content and the fantasy should be designed more in terms of learner's perspective. Game design theorists need to pay attention to personal characteristics and prior media experience in regards to the design of fantasy in the educational games.

ELEMENTS OF 3D FANTASY AND FANTASY PERCEPTION PATTERN

Eight major elements of 3D models were found and they are categorized in two groups according to the process of 3D modeling. In the body mesh elements, students pointed out that body shape, face (or head), size, eye, and tail were the major components they noticed when they first saw the aliens in Alien Rescue. In the texture elements, color and details were the major components.

The results indicated that students showed a tendency to recall each alien with a single reference concept rather than specific concepts that the designer was used in the designing process. The researcher had searched a wide variety of design sources and applied them to designing aliens. In general, these sources were used more in designing creative aliens, and students had described each alien using a few major concepts rather than mentioning the elements of body or texture. For example, students described Akona

using crystal, Eolani with popular aliens in movies, Jakala-Tay with reptiles, Kaylid with crabs, Sylcari with fish, and Wroft with jellyfish.

The difference between design intents by developer and responses by students comes from the difference of the amount of experience between adolescents and adults. Adults who are the game designers and developers have relatively deeper and larger experience on fantasy than young students. Given the age of the students in this study, students are between concrete operational and formal operation state (Ginsburg & Opper, 1988; Wadsworth, 2004), and their cognitive structure about fantasy should be incomplete unless they have enough experience on fantasy. Under the incomplete readiness in cognitive structure, children learn merely superficial information or do not understand the original intention of information (Ginsburg & Opper, 1988). In this research, creative aliens included extra ordinary information, which makes bigger disparity to student's current level of cognitive understanding on fantasy. Some students who first saw creative aliens showed hesitation in answering the interview questions. This means they faced cognitive conflicts in understanding new types of alien concepts. In addition, the disparity between their existing knowledge and new information leads to incomplete understanding or identification of the aliens, which cannot be generalized or will soon disappear.

Given the cognitive conflict of a certain age on fantasy, adult game designers need to consider the level of imagination and cognitive acceptability of the target audience especially when they are young students, and the PROMPT model (Procedural model of Fantasy for Educational Games, see Figure-1) can be useful when game designers or 3D modelers ask how their imaginative product would be perceived and

affect student's imagination in educational games. Considering the result that portrayal fantasy was effective in all dependent variables (science learning improvement, alien information, and game engagement), incorporating relevant and feasible elements in designing 3D fantasy would be better in attracting students because of the relevance and sense of closeness that lead the targeted audience to foster identification of game environment and involvement in gaming. In designing 3D objects in educational games, the portrayal elements can be created by reproducing preexisting concepts or reprocessing common objects around us. The reproduction process infuses familiarity and feasibility to the aliens, and the audience may perceive the sense of closeness as a psychological scaffold in helping to identify fantasy immediately, or lessen cognitive load to recognize them.

ROLE OF CLASSROOM CONTEXT

One of the characteristics of AR is problem-based learning (PBL), which encourages collaborative use of the program. Even though this study showed that different types of fantasy could play an essential role in individualized game play in educational gaming, peers and classroom context were also important factors affecting the student's experience with fantasy. In the actual implementation of AR in the school, the students were allowed to collaborate and discuss what they are doing. After the first day for introduction to Alien Rescue, the students were asked to use the game in their own way. From the beginning of the game play, students shared their preference and opinions on the game and talked about the detailed information on the visuals and

characteristics of the aliens. These interactions among peers influenced on formulating a preference on the aliens at the beginning of AR gaming.

In this study, students chose two or three aliens to rescue out of six aliens throughout the entire gaming session, and their preference was formulated by the alien's appearance. Among six aliens, Akona, Jakala-Tay, and Wroft were the most popular aliens and they were chosen because their shapes and graphical designs are usual. Many female students liked Akona because it looked like a crystal they actually like in real life. Jakala-Tay was chosen because they looked like an aggressive reptile, which was shown in the movies or video games.

Collaboration with peers also impacted individual imagination through fantasy in educational gaming. In the process of collaboration for data gathering on aliens, students shared their personal interpretation on the alien's visual at anytime and anywhere. Individual reaction on the unique design of the fantasy object is combined to the peer's reactions, and eventually collaborative game play forms an agreed experience on the gaming. Some students were curious about the other design of 3D aliens and asked to watch them, or the selection of which alien to save is decided based on the agreement of a couple of students working.

CONCLUSION

In this study, the effect of fantasy was examined in a 3D educational game environment. Unlike most studies that have examined the effect of fantasy as a major medium of learning contents in the traditional teaching environments, this study implemented the fantasy theory into the 3D character design and examined the effects of

the new types of fantasy considering the levels of student fantasy proneness in addition to the student perceptions on the fantasy characters.

The findings of the study showed that portrayal fantasy was effective for science learning, alien information acquisition, and game engagement. Specifically, the students who received portrayal fantasy showed higher improvement of science knowledge and scored better on both alien information acquisition and game engagement. High fantasy proneness group also showed better game engagement. Qualitative findings showed that the students pointed out eight elements in identifying 3D fantasy objects and those elements were relevant to the design elements in a 3D modeling procedure. The students' responses also showed a perception pattern that they understood 3D game characters using previous experience regardless of fantasy type.

Taken together, the researcher concluded that portrayal fantasy was effective in enhancing content learning, factual information acquisition, and engagement in educational games because the familiarity of the fantasy elements assisted the identification of the fantasy characters easier and faster. The sense of closeness also triggers curiosity and motivation to continue game play. However, including too much fantasy in educational games may lead to ineffective and inefficient result on learning because too extensive involvement in fantasy can lead to a problem in object identification and perception. The researcher also concluded that eight essential components of 3D model design took an important role in identifying fantasy game characters, and students utilized various concepts from their previous experience in understating the fantasy objects regardless of fantasy type. These findings suggested that

student's perspective and background knowledge is an essential guideline for optimal 3D character design for educational games.

IMPLICATIONS FOR RESEARCHERS AND EDUCATORS

This study contributes to expanding the applicable area of fantasy theory. In the literature, the studies related to fantasy were situated in more traditional settings such as classroom teaching, and the formation of fantasy was from traditional media (Richert et al., 2009; Richert & Smith, 2011; K. A. Wilson et al., 2009). However, this research was conducted in a new media learning environment, and the research findings contribute to expanding fantasy design theory into educational game design as well as educational media design. Particularly, only a few fantasy theories for educational media design can be found in the literature (Kim, 2009; Malone, 1981; Parker & Lepper, 1992) and there is not enough empirical evidence in the literature on their theory for the design practice of educational games. Although the findings of this research were situated in a specific classroom-based PBL game, they are valuable for game design practice and future research in the field of educational game design.

Even though the implementation of fantasy was focused on a visual element in a complex educational game system, the effects of fantasy on learning and engagement were noteworthy. The examination of the study verified that the utilization of a certain type of fantasy could bring educational benefit to educational gaming in classroom situation. This research had focused on a component in designing a different type of fantasy in a game called Alien Rescue, and portrayal type of fantasy characters was effective for improving scientific knowledge. Comparatively different from the previous

research in which the learning contents were solely designed by a single type of fantasy or the contents were for traditional classroom teaching (Cordova & Lepper, 1996; Wiest, 2001), this research considered the use of fantasy in a specific gaming situation and provided direct empirical evidence that utilization of fantasy only for game characters could change the dynamics of knowledge creation and information acquisition.

Application of 3D technology in developing fantasy is also a valuable contribution to educational game design. In the literature, it has been reported that the use of fantasy was effective in improving learning in various problem solving situations and cognitive tasks (Cordova & Lepper, 1996; Parker & Lepper, 1992; K. A. Wilson et al., 2009). However, the research findings from those studies were different situations such traditional teaching using 2D technology. The domains where the fantasies were applied were reading for early-childhood children, math using word problems, and college lectures in adult teachings. Also, the research interests in the previous studies were focused on whether the use of fantasy itself was effective or not (reference), or fantasy designs were focused only on out of school age (reference). As Malone (1981) theorized, fantasy is one of the most important design elements in the educational game design projects, and the research finding indicates that the specific type of 3D fantasy design is more efficient for improvement not only in science learning, but also for game engagement.

In order to apply fantasy theory for designing the 3D game characters, the researcher defined new types of fantasy and followed a rigorous pilot study in the same gaming environment, which was a public school setting. As an essential component in designing a 3D game, fantasy design principles were applied to the game characters, and

the evidences from the experimentation indicated that the graphical enhancement lead to the improvement of science learning and engagement through educational gaming. This study sampled the students from four classes in a school, and the experimentation was placed in a naturalistic research setting. As a result, students not only used the Alien Database more for their science problem solving, but also engaged in the gaming in different ways as a result of interacting with 3D fantasy aliens. This in turn led students to gain more knowledge about the aliens from the database. This means the 3D aliens take an important role in transferring the basic information for problem solving in the game. A specific type of fantasy, portrayal fantasy in this study, is better in delivering the relevant information for science learning through educational gaming.

IMPLICATIONS FOR EDUCATIONAL GAME DESIGNERS

Eight elements of 3D fantasy would give practical inspiration for character design in educational game design projects. Even if there have been several researchers who tried to establish a theory of fantasy for educational games, only general principles have existed and it has not elicited practical design evidences for actual 3D modeling in the area of education. Considering the scholarly and practical limitation in the field, current qualitative research results can produce practical guidelines for 3D game character design in educational game and enhance efficiency in game production. The 3D modeling for game production is one of the most time intensive jobs in design, and it requires interdisciplinary experience (Hall & Novak, 2008; Thompson, Berbank-Green, & Cusworth, 2007). Considering the reality of the educational game design project in universities and institutions, the design examples and the anatomy of the 3D models by

eight elements can be a evidence-based example of 3D fantasy modeling in the field of educational game and media development.

LIMITATIONS OF THE STUDY

There are some limitations on this research in terms of research methodology and generalizability of the findings.

First, this research was conducted as a part of middle school science curriculum, and the class assignment was based on school logistics, which was characterized as the naturallistic approach of the research in the methodology section. There were several factors that could not be controlled because of constrains in conducting the research in actual classroom settings, and this research was conducted as a quasi-experiment. The purpose of the naturalistic experiment is to take the context of experiment site into account, and this research maximized the advantage of the naturalistic approach to link between quantitative analysis findings and vivid contextual meanings on fantasy students experienced. However, the audience of this study needs to consider the context of experimentation, and future research needs to secure more cases and empirical evidences for generalization of the findings.

Second, the context of this research was an ongoing project, and the descriptions and reference images of the aliens were pre-existing. The aliens in the Alien Database were redesigned for the research purpose and the application of fantasy theory in the study was limited to Alien Rescue. The fantasy type discussed here can be applied in other areas such as traditional 2D media or sound design, and the principles can be adapted in a single project without considering the bigger system such as games or online

instructional systems. More evidences in different situations should be collected to produce general guidelines for fantasy design.

Third, readers need to be cautious about how to interpret the findings in this study and how the research findings could be generalized to other populations given the low effect sizes and marginal *p*-values. Diverse statistical techniques such as ANCOVA and MANOVA were employed in this research, however several statistics did not show large effect size with marginal *p*-value. Based on the classroom observations, it might come from the less controlled variables from the actual classroom context such as technological difficulties or authentic classroom cultures. The statistical results should be carefully understood in generalizing the research findings.

Finally, this research was conducted throughout an AR session over two and half weeks long, and the period of time was enough in capturing the longitudinal change of knowledge and motivation within the time period. However this research was not fully aimed to change the mind or attitude of a student on fantasy and game playing. GEQ was used only for measuring the magnitude of game involvement in the middle of AR gaming, and more studies need to be conducted to understand how students behave in educational gaming over time and how fantasy is related to their behavior with extended observations in various gaming circumstances.

FUTURE RESEARCH

In order to focus on the research purpose, 3D fantasy aliens are developed and used in the actual gaming environment. Further research is necessary to examine how those imaginative components affect other learning activities. Since fantasy design

principles and design approaches can be applied to other media as well as traditional classroom activities, more investigations on the use of fantasy in different subject area with different age groups need to be conducted.

More developmental examples of fantasy are necessary for game design practice. Fantasy is a byproduct of human imagination. There are fundamental principles for fantasy design found from the literature, however actual production of fantasy is dependent upon the form of media and personal experience of the developer. Based on the targeted media, fantasy can be developed in various forms such as visual representations, sound effects, or game narrative. According to the characteristics of media, each design principle should be projected in different forms and developer's artistic experience should be transmitted into fantasy in different ways. It is necessary to apply fantasy theory to diverse media and more examples are essential to acknowledge common forms of fantasy in different media.

In-depth qualitative analysis on fantasy during educational gaming is necessary. Even thought current research adapted mixed methods to employ diverse qualitative methods to describe how students perceive fantasy over educational game playing, the research finding explains only the effect of 3D characters in perceiving 3D visual element and how their understanding affected learning progress. Individual fantasy as a propensity of thinking is created by life long experience and the personal fantasy proneness interacts with other factors such as game interfaces and game environment itself within the dynamics of the classroom. Personal imagination through fantasy in educational gaming can be expanded or limited in different circumstance where the student plays the game.

Appendices

Appendix A: Creative Experience Questionnaire (CEQ)

The major purpose of this questionnaire is to find out to what extent people remember how they played and imagined during childhood and how their present interests relate to their childhood interests.

Please place a check Yes or No on each item below that applies to you. Please answer as honestly as possible and do not be concerned if you find that you are either checking almost all the items or almost none.

Items	Yes	No
1. When I was little, I thought that the dolls, teddy bears, and stuffed animals that I played with were living creatures.		
2. When I was little, I strongly believed in unicorns, dwarfs, elves, and other fairy tale.		
3. When I was little, I had my own make believe friend or animal.		
4. When I was little, I could very easily find the main character of a story and/or movie.		
5. When I was little, I sometimes had the feeling that I was someone else (e.g., a princess, an orphan, etc.).		
6. When I was little, my parents (or other adults, grandparents, brothers, sisters) encouraged me to play fantasy or allowed me to daydream.		
7. When I was little, I often felt lonely.		
8. When I was little, I spent my time playing a musical instrument, dancing, acting, and/or drawing.		
9. I spend more than half the day (daytime) fantasizing or daydreaming.		
10. Many of my friends and/or relatives do not know that I have such detailed fantasies.		
11. Many of my fantasies are realistic.		
12. Many of my fantasies are often just as lively as a good movie.		
13. I often confuse fantasies with real memories.		

14. I am never bored because I start fantasizing when things get boring.		
15. Sometimes I act as if I am somebody else and I completely identify myself with that role.		
16. When I look back on my childhood, I have very vivid and lively memories.		
17. I can recall many moments before the age of three.		
18. When I perceive violence on television, I get so lost into it that I get really upset.		
19. When I think of something cold, I actually get cold.		
20. When I imagine I have eaten rotten food, I really get nauseous.		
21. I often have the feeling that I can predict things that are bound to happen in the future.		
22. I often have the experience of thinking of someone and soon afterwards that particular person calls or shows up.		
23. I sometimes feel that I have had an out of body experience.		
24. When I sing or write something, I sometimes have the feeling that someone or something outside myself directs me.		
25. During my life, I have had strong religious experiences that influenced me very much.		

Appendix B: Information Acquisition Questionnaire (IAQ)

Re: Remembering, Un: Understanding, Ap: Applying,
An: Analyzing, Ev: Evaluating, Cr: Creating
(Revised Bloom's Taxonomy)

Questions						
Akona Questions	Re	Un	Ap	An	Ev	Cr
1. How does the Akona pass the information they know? 1) By saving the information in computer **2) By breaking their body into other piece** 3) By shaking the blue core of the body of the Akona 4) By communication with the Eolani	0					
2. Please choose the correct answer to explain the Akona. 1) The Akona eat water to move. 2) The Akona look like crystal, therefore their edges of body are transparent. 3) The Akona break off to grow into another alien species. **4) The Akona live on the rocks in the cold mountains.**	0					
3. Which circumstance is the Akona the most likely to live? **1) A cold moon that has mountains without earthquake** 2) A warm moon like earth 3) A moon that has enough greens 4) The place to live with the Eolani and Kaylid		0				
4. Please choose true or false on following statements. 1) The Akona is an intelligent alien that communicates with computer. (**True**/False) 2) The Akona gave computers to the Eolani and Kaylid. (True/**False**) 3) The Akona travel with the Eolani for the space missions. (**True**/False) 4) The Akona can move by shaking their body. (True/**False**)	0					
Eolani Questions						
1. Which is true to describe the appearances of Eolani? 1) The Eolani have 4 arms and 2 tails. **2) The Eolani's limbs are all covered with short white hairs.** 3) The Eolani's every limb has five fingers like human limbs. 4) The Eolani are mostly 2 feet tall when they fully grow up.	0					
2. Choose the wrong answer to explain the ability of Eolani. 1) The Eolani are able to build things like robots and computers. **2) The Eolani are able to communicate with other species with their oral language.** 3) The Eolani are able to make water by gathering heat from the sun and		0				

melting the ice with a plant. 4) The Eolani are able to make atmospheres and control the temperatures of the places where they live.						
3. Choose the one correctly matched about Eolani. 1) Body – Having two large eyes of red and yellow 2) Communication – Being able to read other species' mind 3) Dwellings – Living in buildings made of metals and strong for earthquakes **4) Food – Cooking their bread with grasses which they grow on their land**	0					
4. How can the Eolani change the other worlds in their need? **1) The Eolani can release the gases from rocks to make the atmosphere.** 2) The Eolani can take minerals from rocks and water to make their food. 3) The Eolani can control the gravity of the world by using their computers. 4) The Eolani can travel in a spaceship and make many colonies even out of our solar system.	0					
Jakala-Tay Questions						
1. Choose the correct answer matched to the each blank. The Jakala-Tay built homes on the 1) _____ of their world and right below it. They make red, orange, yellow and brown tricks to use for their buildings. Every building has a 2)_____ below it. It is very important because on the home world, Tay, there were big 3)_____ all the time. If it exploded, the Jakala-Tay could escape through them. They make them very strong with the 4)_____ they take from the ground. All of them connected to make a very large network underground. The Jakala-Tay made ships to carry them around through the places. 1) seasides **2) tunnel** 3) earthquakes 4) crystals	0					
2. Choose the correct answer to describe Jakala-Tay's physical abilities. 1) The Jakala-Tay can jump far and run fast because of their scales of the skin. 2) The Jakala-Tay can see a long way with their many large eyes on the head. **3) The Jakala-Tay can carry heavy things because they have two strong arms.** 4) The Jakala-Tay can catch small insects because they have six fingers on each hand.	0					
3. How do Jakala-Tay communicate? 1) The Jakala-Tay can write to Kaylid. 2) All the Jakala-Tay can speak to Eolani. 3) The Jakala-Tay can only speak to each other. **4) The Jakala-Tay can communicate in a written language with each other.**	0					
4. For Jakala-Tay, which is not required to live on a planet? 1) Many types of very small plants to eat 2) The gas in the atmosphere to grow their food **3) A common gas to breathe in an atmosphere** 4) The gases as fuels gathered to make ships move		0				

5. Choose True or False on the following statements. 1) Jakala-Tay make tools with metals and crystals from the ground. (**True**/False) 2) Jakala-Tay taught Kaylid about the machines to dig in the ground and make tools. (True/**False**) 3) Jakala-Tay build computers and many other machines like Eolani. (True/**False**) 4) Jakala-Tay learned how to build strong buildings underground from Eolani. (True/**False**) 5) Jakala-Tay are good at growing small insects and reptiles for their food. (**True**/False)	0					
Kaylid Questions						
1. Please choose the one with all correct descriptions about Kaylid among the following statements. ========== a) The Kaylid have a mouth with sharp teeth. b) The kaylid have bones on the inside of their bodies. c) The Kaylid have a strong shell on the outside of the body. d) The kaylid have their ears on the front of the head. e) The Kaylid run on their two legs. f) The Kaylid can hold things with their sharp strong claws of the legs. g) The Kaylid are around nine feet tall. ========== 1) a, b, e **2) a, c, f** 3) b, d, g 4) d, e, f	0					
2. Which is not the way in which the Kaylid communicate? **1) Using much sound** 2) Using a sign language 3) Through writing 4) Using computers which they built on their own	0					
3. Which is the most properly and commonly fitted to the both of blanks in the following statement about the Kaylid's Dwellings? The Kaylid build their homes and buildings by cutting into the _____. They cut long, thin tunnels through the _____ to the surface to let the light from the sun come in, and they build larger tunnels to the surface. 1) ground **2) rock** 3) metal 4) earth	0					
4. Why do the Kaylid not spend much time on the surface? 1) Because they like to stay underground. 2) Because the food they like to eat is not growing on the surface. 3) Because they like the cold temperatures in their caves underground. **4) Because there is not very much atmosphere there for them to breathe.**		0				
5. How did the Kaylid adapt to the changes on their planet? 1) By sleeping during the period with the temperature not suitable for them 2) By traveling in a spaceship to other planets with their preferable conditions 3) By changing the atmosphere with skills of releasing the gases from the rocks **4) By learning to live underground and digging deep with their sharp claws and machines**	0					

Sylcari Questions						
1. Which is true to describe the appearances of Sylcari? **1) They have 4 thin arms and a strong tail.** 2) They have two small eyes which are sensitive to light. 3) They have three fingers that can grab food. 4) They have a long tail that is for hunting.	0					
2. Choose the correct answer about the buildings and how to build them for the Sylcari. 1) They make the buildings with a metal and grass. 2) They train other species to build their homes for them. 3) Their buildings last for a very long time without falling apart **4) The Sylcari built cities along the sides of their undersea mountains.**	0					
3. Choose all the right description(s) among below statements. **a) The Sylcari live in the pure water.** b) The Sylcari are able to live even in the freezed area like ice. **c) The Sylcari eat as swim in the rich water.** d) They use voice and vibration to communicate with other species. e) They build very tall buildings which cover large areas.	0					
4. Where can the Sylcari find their most important food? 1) along the floor of their ocean 2) in very dark places like caves **3) on top of the oceans in places with no ice** 4) where it can get enough radiation of the sun	0					
5. Why did the Sylcari begin to study the plants and animals of their world? 1) To grow their own food to eat **2) To make medicines to cure the disease** 3) To make machines and build their homes 4) To develop a planet-wide communication network	0					
Wroft Questions						
1. How can you describe the Wroft on their appearances? 1) The Wroft is very short and thin. 2) At the back of their bodies the Wroft have little wings. 3) The Wroft have very long flagella at the top of their body. **4) Part of the Wroft's body is like a bag which can spread out to make the Wroft 10 feet side.**	0					
2. For what are the Wroft not able to live on a world that has magnetic field or too much lightning? **1) For the electricity their bodies make** 2) For the flagella through which they take the air in 3) For the wings with which they can flap very fast to move 4) For the bag part of their bodies covered with areas that can light up	0					
3. Choose the wrong answer to describe how the Wroft communicate. 1) The Wroft do not have a written language. **2) The Wroft use vibration under their oceans to communicate.** 3) The other species do not understand their language very well. 4) The Wroft flash the lights along their bodies to communicate with each	0					

other.						
4. Which is correct about the dwellings and habitat of the Wroft? **1) The Wroft live in the atmosphere.** 2) They build any structures on the surfaces. 3) The Wroft need very thin atmosphere for them to breathe. 4) They are very weak at the lightening, the Gravity, and the temperature.	0					
5. Where do the Wroft get their fuel for space ships? 1) From the gases taken from Jakala-Tay **2) From the new air which the Wroft take in and change** 3) From the substance mixed with other gases and plants 4) From the current of the wind through which they travel	0					

Appendix C: Game Engagement Questionnaire (GEQ)

Items	No	Sort of	Yes
1. If someone talks to me I don't hear.			
2. I feel like I can't stop playing.			
3. The game feels real.			
4. I play without thinking how to play			
5. Playing makes me feel calm.			
6. My thoughts go fast.			
7. I play longer than I meant to.			
8. I lose track of time.			
9. I feel different.			
10. Time seems to stand still or stop.			
11. I really get into the game.			

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Vita

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