Language learning through interactive games

Språkinlärning med interaktiva spel

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Foreword

This paper is the result of a joint collaboration between the two of us. The workload of the introductory sections including the literature review and theory was equally distributed between us. However, due to practical reasons, Eva was responsible for answering the first research question and Ece was responsible for answering the second question.

We would like to make use of this opportunity to express our gratitude to our supervisor, Shannon Sauro for all her assistance and guidance during the writing of this paper. A special acknowledgement also goes out to our family members and friends for all their support and encouragements.

Ece Khatibi & Eva Cowie
Abstract

The purpose of this study was to investigate language learning through the use of interactive games. A research synthesis was considered to be the most effective method as it was our intention to explore the research available on language learning and gaming. Although various studies have investigated the employment of interactive games in language learning, this field of research is still in its infancy. We juxtaposed neural correlates of language learning with that of interactive gaming and the findings indicated that there are both similarities and differences in the brain structures activated by gaming and those that are activated by language learning. Furthermore, we set out to investigate the employment of interactive games in the language classroom. Our findings indicated that interactive games are highly underused tools in language learning. In addition, we were able to identify techniques which could be used to employ interactive games in language learning. The technological advancement in our society which has shown to have a great impact on the youth of today has given rise to an increasing need for incorporating technology such as interactive games in education and for this reason it is necessary for teachers to receive education in implementing interactive games in the language classroom.

Keywords: FMRI, gaming, interaction, language learning, MMORPGs, Reinders, teaching
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1. Introduction

Research conducted in the field of computer and video games has shown that this type of gaming does in fact help to improve students’ language abilities; this is something that we too have observed during our teaching practice periods. In order to avoid confusion about the type of games under discussion, we will refer to computer and video games as interactive games.

According to Reinders (2012) employing technology, such as interactive games in education, allows teachers to solidify the connection between learning that occurs inside the classroom with that which occurs outside the school environment. This view is in line with sociocultural and interactionist perspectives on language learning.

James Paul Gee (2007) recognizes that there are language learning benefits for students who engage in playing interactive games simultaneously as he makes us aware of the critique that this field as a semiotic domain has attracted. According to Gee (2007) a semiotic domain is “An area or set of activities where people think, act and value in certain ways - an area like video gaming” (Gee, 2007, p. 19). An example of such a semiotic domain is a first person shooter game as it contains a certain type of content.

Thus, when we are referring to a semiotic domain, we refer to an interactive gaming platform where people are behaving, acting and valuing according to how one is expected to behave in this particular setting. Gee (2007) argues that the skills gained through playing these interactive games include skills such as active learning, critical thinking and problem solving. According to Psychology, these are skills we acquire through highly complex processes that occur in the brain, the human’s most important physical organ (Passer, Smith, Holt, Bremner, Sutherland and Vliek, 2009).

Passer et al., (2009) claim that although one cannot single out one specific area of the brain where learning takes place, it is possible to identify which parts of the brain are most heavily activated for example during the performance of a reasoning task. Gaming also elicits complex neurological processes in the brain associated with skill learning that have been explored in psychology.
1.1 Purpose and research questions

Thus, the primary purpose of this paper is to examine the current research available on language learning and gaming with an initial investigation into the findings from the field of neuroscience. Furthermore, by examining the research done on gaming and language learning, we will shed light on how research claims that teachers could incorporate these interactive games into their lessons.

To this end our research questions are the following:

1. Based on neuroscientific research, are there any similarities between the neurological processes that are activated during gaming and those that are activated during traditional language learning practices?
2. Based on the research on gaming and language learning, how can teachers use interactive games to facilitate language learning?

2. Literature review and theory

In order to provide a clear understanding of the processes involved in language learning that occur through the engagement in interactive games as well as through the use of traditional learning practices, we will in this section, explain and define some important themes and concepts. These concepts include neurological processes, language learning, sociocultural perspective, interactionist perspective and gaming.

2.1 Neurological processes

According to neuropsychology, which is the scientific study of the brain and behaviour, neurological processes refers to the processes executed in the nervous system of the body. Furthermore, the brain is identified as the human’s most important physical organ and this is where all our experiences and behaviors are registered and controlled from (Passer et al., 2009).
Nerve cells or neurons are considered to be the most basic units of the nervous system and each neuron consist of a cell body, dendrites and an axon. The axons, which connect to dendrites of neighboring neurons, passes messages to approximately 50 000 other neurons. This accounts for the occurrence of the estimated trillions of interconnections in the brain which leads to the vast number of complex activities that we are capable of performing (Passer et al., 2009). To demonstrate how this works, consider the following example: a game player who is playing a Massively Multiplayer Online Role-Playing Game (MMORPG) such as World of Warcraft (WoW) is instructed to kill monsters or collect some items in order to complete a mission. The player will then perform certain actions on his computer based on what he is able to see and hear. What happens in the brain is that stimuli are perceived through the visual and auditory sensory organs which allows for a number of interconnections between the neurons to occur, sending messages from the brain and spinal cord which are in charge of voluntary movements, to react in a certain way in order to receive the desired result (Passer et al., 2009). Thus, even if the player only stroke one key, this was the result of highly complex processes that were executed in the brain.

Such complex processes which are of concern to the current study, include the production and comprehension of language. The production of language according to Passer et al. (2009), occurs in Broca’s area which we find in the left hemisphere’s frontal lobe and speech comprehension in Wernicke’s area in the rear part of the temporal lobe. Furthermore, the recognition of words takes place in the occipital lobe, the visual area of the cortex and the formation and retrieval of memories occurs in the hippocampus in the limbic system. In addition, the interconnection between the amygdala and the hippocampus is responsible for creating emotional memories. According to Manns, Hopkins and Squire (2003) long term memories, that are essential in language learning, are formed and stored in multiple brain areas, however the hippocampus and its adjacent areas appear to play an important part in encoding certain types of long term memories.

In recent years, scientists have been able to study neurological processes through observing the activation of these different brain areas. Activation, according to the Oxford advanced learner’s dictionary, is described by stating that when one activates something, one makes something such as a device or chemical process start working (Oxford Advanced Dictionary, 2007). The technology employed by scientists in order to view brain activity is called brain imaging which can be done in the form of Magnetic Resonance Imaging (MRI) or Functional Magnetic Resonance Imaging (FMRI). Another tool used is positron-emission tomography
PET) scans, which generates a color picture of the brain on a screen showing the amount of energy emitted by a harmless radioactive substance injected into the subject’s bloodstream.

### 2.2 Language Learning

The concept of Language learning has been defined by Lightbown and Spada (2011) as the developmental process of an individual’s knowledge of the target language. However, for the purpose of this paper, there is a need to provide a broader definition of the processes involved in language learning. Thus, the definition coined by sociocultural theorist, Lev Vygotsky (1978) is the following:

> Learning is more than the acquisition of the ability to think; it is the acquisition of many specialized abilities for thinking about a variety of things. Learning does not alter our overall ability to focus attention but rather develops various abilities to focus attention on a variety of things (p. 86).

Krashen, as cited in Lightbown and Spada (1997) compares learning to acquisition, which he describes as, “a conscious process that occurs when the learner’s objective is to learn about the language itself, rather than to understand messages conveyed through the language” (p. 202). According to Reinders (2012) learning is defined as behavioral changes as a result of experiences one encounters. Behavioral changes could include for example, when an individual displays knowledge of a new language learned. Knowledge we gain, according to Reinders (2012) is a feasible construction that an individual achieves based on how the environment is experienced. This feasible construction is continuously adjusted to adapt to new experiences. Thus learning a language could be a continuous process. From a neuroscientific perspective, areas responsible for language learning in the brain can be identified to provide an understanding of the processes involved in language learning.
2.3 Sociocultural perspective

According to the sociocultural perspective, language learning has been identified by scholars as an experience influenced by environmental factors which the learner is exposed to or engaged in. Thus, engaging in activities such as online interactive games in a second language could be assumed to provide opportunities for language learning. According to Mahn (1999) sociocultural theories, with the educational psychologist, Lev Vygostky as its founder, have become widely recognized in learning and development as it became evident that social and cultural factors had such a central role to play. Language acquisition according to Vygotsky (1978) can provide a framework for what he viewed as the problem of the relation that exist between learning and development.

Vygotsky (1978) made a clear connection between how the individual and its immediate environment with social and cultural factors interact, in order for learning to occur. Furthermore, Vygotsky (1978) identified what he coined, the zone of proximal development. This zone, he claimed was, “the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers” (p. 86). Thus learning could be seen as occurring during interactive games when more experienced players interact with less experienced players in MMORPGs. These types of games could also be seen as promoting language learning since they are played by both native and non-native speakers of for example the English language, and the non-native speakers are therefore exposed to native speaker English in a more or less authentic context. The authentic context refers to the social environment created by the online interactive games, which are like communities where players are interacting in different ways such as following or giving instructions to one another.

The sociocultural perspective on teaching is an issue addressed by Lundahl (2009) in his book, *Engelsk språkidaktik. Texter, kommunikation, språkutveckling*. The term social is in this context used to describe both the social background of the individual and social interaction. Social background refers to the different communities which we as individuals belong to, like for instance our family, friends, and the music band that we may belong to and so on. Every community has their own rules and norms of what is accepted and also what is expected by their society. Our thoughts, ideas and values are colored by the communities that we belong to.
and thereby how we perceive reading and writing depend on how we have been subjected to different kinds of texts in our upbringing, in society and in school.

When the term social is used to describe the social interaction between people, it refers to the notion that language is used in some kind of social interaction and that the language classroom should be a place of cooperation, participation and communication (Lundahl, 2009, p. 113).

Lundahl (2009) argues that communication and interaction are crucial in learning, and this is mainly because language is seen as the tool that we as individuals use when we learn. Therefore it is argued that English should be used continuously during language lessons. However, Lundahl also explains that this interaction does not necessarily have to be in the form of a conversation between individuals in the classroom, for instance writing, reading and the inner conversations that we have, may also be considered as a form of interaction. This is something that other scholars in the field of research on game and simulation-based learning have also argued. They argue that games have the tools to support language learning in a number of ways (Peterson, 2009). Peterson (2009) claims that simulations and games provide gamers with purposeful task-focused interaction and expose them to a great deal of target language input. Thus as described by the sociocultural perspective, interaction amongst game players are often of benefit to language learners and this insight leads us to findings on language learning from the interactionist perspective.

2.4 Interactionist perspective

Krashen (1981) claims that language acquisition is dependent on the availability of meaningful interaction in the target language where speakers concentrate on conveying a message and not the correct form of how they express themselves. This type of interaction is certainly something that occurs during game playing and therefore an important aspect to consider in studying language learning that occurs through game playing. In the view of Krashen (1981), factors such as personality and motivation are interrelated in second language acquisition. Therefore, it can be predicted that personality traits such as self-confidence, self-esteem and an outgoing personality in addition to a lack of anxiety, are related to the acquisition of a second language.

In looking at adult second language learners’ ability to increase their proficiency, Krashen (1981) claims that in comparison to learners learning in formal environments, learners who find
themselves in informal environments may perform as well as or better than their peers in formal environments.

Krashen (1981) predicts that an individual who learns a language could be considered to be “a good language learner” if that individual:

- Is an acquirer, who first of all is able to obtain sufficient intake in the second language, and second, has a low affective filter to enable him to utilize this input for language acquisition. The good language learner may or may not be a conscious learner (p.41).

This definition of a good language learner could be assigned to gamers who display the qualities identified by Krashen (1981). They could be considered to be acquirers of the intake available during gaming, be relaxed and less inhibited to use the second language and they may or may not be learning the target language consciously.

### 2.5 Education and Technology

According to Reinders (2012) those who advocate the use of digital technology in education make themselves guilty of exaggerated idealism and therefore, educators respond by arguing that digital games have not achieved effective integration into school curricula and could be encouraging entertainment in schools rather than serious academic skills. As research on education through digital games is still in the early stages, sufficient support has not been established to confirm that academic skills are in fact enhanced through this type of education.

Furthermore, Reinders (2012) notes that the last two decades have seen technology in education emerging primarily as being driven by commercialization. One of the exaggerated expectations of digital technology in education according to Reinders (2012) is that just by its appearance in education, an expectation is created that learning environments will be transformed so that the roles of teachers become that of facilitators and students learn by collaborating with peers. The reality of how this works in practice is still an area in need of investigation since not much literature on this subject is currently available.

According to Prensky, the tell-test education is a tradition that is less than 300 years old, it came with the industrial revolution, which led to the need of testing people in schools in order to put people in the right jobs as quickly as possible. He also argues that the tell-test method actually worked well until the mid-twentieth century and the new technology change with the invention of radio, the telephone and the television did not affect this tell-test tradition in education at all. He argues that one reason why these technological changes did not affect the
teaching system in schools, could be that the education system made a strong effort to keep them out (2001, p. 75).

Prensky (2001) addresses how the education system has failed in incorporating technology into education. He explains that there generally is a tell-test method that is used in schools, that involves providing the learners with information and testing them afterwards. This is a tradition that has been going on for a long time in education; however the learners of today are changing rapidly and so should education.

This tell-test system in schools could possibly have gone on longer, however something came along that intervened and that is the technological change of computers and interactivity. Compared with other technology changes this was by far the biggest one. Some of the major changes that multimedia computing led to, was for instance that written language became less important and that passive media, such as books and TV were supplemented with active ones such as interactive games and the internet (Prensky, 2001, p. 75-76).

Prensky argues that the biggest reason why tell-test methods in school are failing today, is because the world of learners have changed radically due to this technological change. They no longer see themselves as containers that need to be filled with information, instead they see themselves as active doers and individuals that want to create and do. The main reason why education has not changed according to the learners’ needs is simply because this technology change happened so fast that education and training could not keep up (2001, p. 76).

2.5.1 Gaming

According to Gee (2007) gaming is referred to as the activity of playing video or computer games. Gee (2007) claims that even though playing computer or video games are usually seen as activities engaged in by teenagers, it is actually popular amongst people of different ages. Statistics from the European Union, for the year 2008 indicate that it is quite common among EU citizens between the ages 16-74 to download, and most probably play computer games. People all over the world like for instance the US, Japan and Sweden engage in gameplaying (Sylven & Sundqvist, 2012).

Rankin, Morrison, McNeal, Gooch and Shute (2009) define gameplay as an activity of social interaction with other players in virtual environments. They argue that these kinds of social interactions between gamers foster and promote learning. Massively Online Role Playing
Games (MMORPGs) create virtual environments, where all players have access to equal opportunities to thrive in a virtual world. Reinders defines a MMORPG as:

A genre of network-based role-playing game where large numbers of individual players interact within a graphically rich and permanent 2D or 3D virtual world that is usually based on a fantasy theme. Individual players assume the role of a character and are represented in the game by an avatar (Reinders, 2012, p 71).

**2.5.2 Types of interactive games**

According to the findings from the current study there are two types of interactive games, and these include serious games, which are games designed for educational purposes and commercial games also referred to as console games. Here we will present some examples of commercial games and look into the use of and the effect of both games designed for educational purposes and commercial games.

Yip and Kwan (2006) have looked at some educational games in their study. They argue that vocabulary learning is often seen as tedious by learners, this is true especially for those who are growing up in the digital age. Learning vocabulary in traditional ways is perceived as uninteresting by the learners, mainly because it only consists of memorizing unfamiliar words and spelling. Thus learners find it hard to become engaged in these kinds of lessons.

According to Yip and Kwan (2006) in investigating the effectiveness of online games with regard to vocabulary learning various studies were considered. In one study, three teachers and 100 undergraduate engineering students participated in an experimental study on the usefulness of computer games. The students were divided into two groups, where one of the groups learned some vocabulary through two selected game websites, while the other group learned the same vocabulary through ordinary lessons. The students of both groups had to conduct a pre-test and a post-test. The results of the tests indicated that the group that learnt vocabulary through computer games outperformed the group who had learnt through ordinary lessons.

The websites which contained the interactive games used in this study, were designed for educational purposes. Before choosing these games, the researchers reviewed relevant studies on vocabulary learning and they compiled a checklist of features for the assessment of websites which contained vocabulary games. Yip and Kwan (2006) explained that both websites that were used in their study were evaluated by them and they found that both of the websites were of satisfactory standard.
The responses of the learners that participated in the study, indicated that about 68% of the respondents preferred the use of the interactive games in the websites for vocabulary learning as opposed to traditional face to face language learning lessons. The students were also asked to list some key features for good vocabulary learning games. These features were amongst others, interaction with other players, the use of animation, sounds and music, a clearly defined scenario and motivation as in a balance between challenge and satisfaction (Yip & Kwan, 2006).

A group interview was conducted, with five students randomly selected from the group that participated in the vocabulary learning websites. They were asked to point out the strengths and the weaknesses they had noted in using interactive games for vocabulary learning. The researchers found that the students experienced the games to be easy, once in context, it gave positive reinforcement and although it demanded sophisticated game skills some students found that it was not challenging enough (Yip & Kwan, 2006).

According to Peterson (2009), there are different kinds of commercial games. One such game is a stand-alone simulation game, called SIMCOPTER. He argues that these kinds of stand-alone simulation games are beneficial for language learning. A stand-alone commercial simulation game, like SIMCOPTER, offers total immersion in a virtual city, creating a game scenario where a user is allowed to take on the role of a pilot who must respond to and take different decisions when problems like traffic jams and riots occur, in order to obtain bonuses and points for its efforts.

Another commercial game that researchers have attempted to explore in connection with computer assisted language learning (CALL) is the use of massively multipler online role-playing games (MMORPGs). Researchers claim that MMORPGs are seen as beneficial for language learning. These kinds of games bring together gamers and provide them with a challenging task and also role-playing within a network-based simulation (Peterson, 2009).

## 2.5.3 Interactive games and learning

To investigate how teachers can use interactive games in the language classroom, we believe that we needed to first establish some key features in interactive games that according to different scholars facilitate learning.
Prensky (2001) lists three main reasons why digital game-based learning works. The first reason is the added engagement that occurs when putting the learner in a gaming context. The second is the interactive learning process in these games and the third is the way that the two former aspects are combined.

In addition, Prensky (2001) and Peterson (2010, 2009), argue that there are some key interactive learning skills in Digital game-based learning. Some of the major factors that are argued by them that facilitate learning include the following:

*Practice and feedback:* When computers were newly introduced in learning they were often used by employing practice and feedback. Computers were very efficient at presenting a number of problems that could occur and also of documenting of how people responded to them. Some see this as drill and practice and this has also led to much criticism from many educators. However, Prensky (2001) argues that practice and feedback have an important part in digital game-based learning because it can be an ideal way of learning things that requires a lot of repetition. Examples of such things are various facts, physical skills (e.g., typing) and many aspects of language.

*Learning by doing:* Something that digital games offer is learning by doing. Doing is something that interactive games are particularly good at providing; they allow the learners to interact with them. However, Prensky argues that there are different kinds of doing. The drill and practice discussed earlier is one form of doing and others include exploring, discovering new things and active thinking like for instance problem solving. What is crucial in digital game based learning is active participation by learners (2001, p. 158).

This is also something Peterson (2010) argues in his paper, the kind of participation that is required in these interactive games leads to learners becoming totally immersed. The game-users in these types of games are completely immersed in the games, and in order to win or achieve certain goals the players need to be able to communicate and collaborate with co-players.

*Learning from mistakes:* Many scholars and theorists in learning can agree on the necessity of mistakes in learning. Anyone, who for instance has tried to solve a puzzle in a video or computer game and failed repeatedly knows that doing and failing (trial and error) comes as a natural process in learning. The reason that interactive games are good at this is because they give learners the motivation to keep playing and trying to succeed. There are differences between
the way the learners get feedback in traditional learning forms and in interactive games, in
traditional learning practices you often get feedback through for instance coaching or in a
written form, however in games feedback comes via action, something happens, you die or you
lose. Another aspect to point out concerning mistakes and failure in interactive games compared
to other kinds of learning, is that in games players often want to or are even motivated by the
game to fail and make mistakes, the reason for this being that the consequences of the failure
are often interesting and worth the trip and this is argued to facilitate learning (Prensky, 2001,
p. 159).

**Goal oriented learning:** Some digital game designers make a distinction between learning that
is fact oriented and learning that is goal oriented (learning to do something). A goal is an
important factor in interactive games, as it is what makes play into a game. The goal in an
interactive game is likely to be seen by the players as something worth reaching, this is however
not always the case in other learning environments (Prensky, 2001, p. 159-160).

**Discovery learning:** Discovery learning refers to the idea that you as a learner learn something
better if you discover it by yourself and not have it told to you by someone else. This kind of
learning is central in games, this concept of discovery learning is what most of games are all
about. You encounter a new problem, place or an enemy, and you experiment and try new things
until you find a solution (Prensky, 2001, p. 160).

**Task-based learning:** In most cases, traditional learning begins with some explanations and
demonstrations, and only afterwards move on to tasks that the learners’ are supposed to do. In
most interactive games, the explanations and the demonstrations are often skipped and the
learner is able to go straight to a series of tasks or problems that build on each other and that
slowly gets more difficult. When completing the task, the player slowly but surely learns the
skill. However, a downside with this method of learning, is that the learner may lose out in
learning the theory behind the skill (Prensky, 2001, p. 161).

**Situated learning:** This refers to the notion that the learner is put in an environment that is
similar or is an exact replica of where the learning material will be used in the future. It is argued
that, when learners learn in such environments, they do not only benefit from the learning
materials that are being taught, but also the culture that belongs to that particular environment.
Prensky (2001) argues that interactive games are highly good at creating situated learning, with realistic and engaging environments.

*Role playing:* Role playing is so much a part of many interactive games, and it is argued that it is very likely to increase learning (Prensky, 2001, p. 162). This is also something that Peterson (2009) addresses in his paper. He explains that role playing in the form of anonymity, could be a factor in the effectiveness of language learning in interactive games. This may help decrease affective variables that hinder learning in traditional classrooms, which include variables such as anxiety and low self-confidence.

*They expose players to language in its authentic format:* Peterson (2009) explains in his article that theorists argue that game- and simulation- based learning have the tools that support language learning in many aspects. For instance, gamers of both games and simulations are interacting in tasks that have specific purposes, which motivate interaction. These gamers are simultaneously exposed to the target language while engaging in these interactive games.

*The concept of mediation:* Peterson (2009) also explains one important factor, which is the concept of mediation, the process where higher mental activities are acquired through social interaction. According to this view, computers and language can be seen as mediating tools that allow learners to obtain language via interaction with peers that are more knowledgeable.
3. Method

In addressing the purpose of this investigation, which is to examine current research available on language learning and gaming, a research synthesis was considered to be the most effective method as the subject of gaming and language learning have proven to be the subject of many recent research investigations. A research synthesis has been defined as “the systematic secondary review of accumulated primary research studies (Norris & Ortega 2006, p. 4). According to Norris and Ortega this research method is a valuable method in helping us make sense of available research. This resulted in our decision to use the different sections found under the result and discussion section. Furthermore, it is stated that it allows us to understand how a particular question has been addressed and what the next course of action should be in the investigation (Norris & Ortega, 2006). In the case of our area of interest, we are conducting a synthesis on the literature available on language learning through interactive games and the specific sections we investigate include brain activation in language learning, brain activation in gaming, the role of memory, interactive games and teaching, the absence of the use of digital games in education and how to use digital games in teaching.

Thus, in the retrieval of research articles that may be relevant to our investigation, two online database searches, Linguistics and Language Behavior Abstracts (LLBA) and PsycINFO were used. A broad anywhere search on LLBA using the search terms or combination of terms “Language learning and technology”, “gaming and language learning” and “computer assisted language learning” was conducted. On the PsycINFO database the search terms “brain activity” and “language learning” and “brain activity” and “gaming” were used.

In our choice of relevant research material, we had the following inclusion and exclusion criteria. The number of articles identified as relevant to our study came to a total of 49 of which 21 were used for the purpose of this study. In addition a range of scholarly books on the subjects of gaming, language learning and psychology were used and this came to a total of six. When it came to research on gaming, it was the intention to use only the most recent research articles, therefore we avoided including studies conducted prior to the year 2000. However, this exclusion rule could not be applied to studies on theories of language learning. Scholars such as Lev Vygotsky and Stephen Krashen who are pioneers in this field, had made the connection between learning and interaction before the technology change with computers occurred.
4. Results and Discussion

The following section will deal with answering our research questions. We will firstly discuss brain activation as it occurs in language acquisition and gaming respectively as well as take a closer look at the role of memory. Secondly, we will discuss the current use of interactive games in education and explore more recent suggestions on the use of interactive games in education.

4.1 Brain activation in language acquisition

The current study has shown as indicated by Passer et al. (2009) that there are indeed not one but several areas in the human brain associated with language learning. Furthermore, in the view of Krashen (1981) research into the field of neurological correlates how language is acquired is increasing at a rapid rate, and it has become more difficult for those who are not specialists in this area to provide an adequate evaluation of the research which has been conducted. We have therefore merely attempted to identify the brain structures that have come under attention as being involved in language learning and compared these with the brain structures identified as being engaged during gaming. In addition, since language learning consists of various aspects, identification of these areas need to be correlated with the functions performed by each. According to Opitz and Friederici (2004) one of the crucial questions of language learning involves the question of the acquisition of grammatical knowledge. Furthermore, they state that it is commonly agreed that rule-based learning of natural grammars is mediated by the left prefrontal cortex, especially Broca’s area, because it is the rule-based processing centre of acquired syntax. In the study by Strange et al. (2001) cited in Opitz & Friederici (2004) subjects were requested to make grammatical judgments to letter strings for which the governing rule and the letters that comprised the exemplars were periodically changed. The researchers observed that activity in the left hippocampus was modulated by changes of exemplars, but not by changes of grammatical rules.

The aim of the experiment was to investigate the neural correlates of rule-based and similarity-based grammar acquisition Opitz & Friederici (2004). This was done by employing an artificial grammar system, having participants learn it in its original form, and then introducing systematic changes. Brain activity was scanned during the learning of the novel
forms of the grammar. The researchers observed clear dissociations between both types of learning in grammaticality judgment performance as well as in brain activation. Furthermore, it was also noted that changes in word position without any phrase structure rule change did not affect learning performance, whereas the introduction of a new phrase structure rule led to a decrease in performance (Opitz & Friederici, 2004).

The researchers also noticed that although the word condition showed no effects in terms of grammatical judgment performance, a clear regulation of brain activity occurred in the left anterior hippocampus. This result is consistent with the view that the left hippocampal system mediates similarity-based learning, which dominates the initial phase of the acquisition of a language-like grammar (Opitz & Friederici, 2004). Thus, based on the results of this study one can make the deduction that, the hippocampus plays a role in language learning and the hemisphere involved in this case is the left hemisphere.

Krashen (1981) identified cerebral dominance or lateralization in the brain as that which is most obviously related to language. Thus, he acknowledged the findings from neurological research which indicated that it is the left hemisphere that is accountable for linguistic performance in adults and the right hemisphere for spatial relations (Krashen, 1981). Furthermore, Krashen (1981) claims that one cannot be certain that puberty is the stage at which the development of cerebral dominance is complete as he highlights a number of studies pointing to a much earlier completion of cerebral dominance. According to Krashen one could identify the following developmental course of cerebral dominance:

1. Most of us are born with a predisposition for left hemisphere language, and there is thus some specialization right from the start, enough to be detected by EEG and AER, and to influence the development of unimanual motor skills.

2. This degree of lateralization increases until about age 5, by which time most aspects of language processing are lateralized to the left hemisphere at the adult level. This accounts for the brain damage and hemispherectomy data, which show some right hemisphere contribution to the language function before age 5.

3. Certain aspects of language are not entirely lateralized to the left hemisphere until later, perhaps by puberty. These aspects of linguistic competence may be those that are necessary for the perception of longer and more complex stimuli (Krashen, 1981, p. 75).
In addition to identifying the left hemisphere as responsible for linguistic performance, Krashen (1981) points out that suggestions have been made that the right hemisphere also plays a role in second language acquisition. One such study conducted by Hull and Vaid (2006) concluded that it may not be the effect of strong left hemisphere dominance responsible for language activity in general, rather it could be that it depends on whether the individuals in question are mono or bilingual. They also claim that the age at which bilingualism occurred is important as they found that late bilinguals, i.e. from the age of 6 years were left hemisphere dominant and early bilinguals were bilaterally organized for language (Hull & Vaid, 2006). The results from the study by Hull and Vaid (2006) correspond to a significant extent with the findings from Krashen (1981) as outlined above in his developmental course, where he identifies that lateralisation increases until about age 5.

Evidence from further research on lateralization, has also implicated the right hemisphere as being involved in linguistic performance. The study conducted by Ibrahim, Israeli and Eviatar (2010) investigated whether readers of Hebrew, who read from right to left, would generalize this language processing strategy to reading English words. They instructed participants who were native speakers of English and Hebrew respectively to complete a word recognition task where each of the hemispheres observed the words horizontally. The study showed that the Hebrew speakers performing the task, indicated a similar pattern to what they had showed in Hebrew. The Hebrew participants did indeed generalize their native-language processing strategies to the English language task. Thus according to Ibrahim, Israeli and Eviatar (2010) this means that Hebrew as an L1 triggers right hemisphere involvement and not left hemisphere involvement in processing written verbal stimuli.

According to Wixted and Squire (2010) the brain structures involved in recognizing something we had previously encountered, is the medial temporal lobe. They maintained that the two processes that form a part of recognition involves recollection and familiarity and recent studies have investigated to what extent these are dependent on the hippocampus and other structures of the medial temporal lobe. In language learning, recognition and memory of grammatical and other linguistic experiences could be seen as enhancing linguistic performance. There have been different views taken on this question, with one view indicating that the hippocampus supports both processes and another view that it only supports recollection. Wixted and Squire (2010) recognized that several studies indicated that patients who had a damaged hippocampus showed impaired recognition and recall, which suggests that both the recollection and familiarity processes are supported by the hippocampus.
In one study event-related functional magnetic resonance imaging was used to shed light on which brain areas are activated during word learning and which of these areas are correlated with semantic language knowledge (Breitenstein, Jansen, Deppe, Forster, Sommer, Wolbers, Knecht, 2005). Fourteen healthy subjects had to learn 45 concrete nouns through an associative learning principle over the course of the five blocks during EFMRI. A control condition with no-learning was also administered. Increasing vocabulary proficiency was associated with activity changes within the left hippocampus and the left fusiform gyrus and an increasing activation of the left inferior parietal cortex. These changes were not observed during the no-learning condition. Furthermore, subjects who showed less suppression of hippocampal activity over learning blocks, scored higher on semantic knowledge in their native language and learned the novel vocabulary more efficiently (Breitenstein, 2005). The results of the study conducted indicated that the hippocampus plays a significant role in acquiring novel words into the mental lexicon and being able to successfully encode novel words depends on neural activity synchronisation between the left hippocampus with the left fusiform gyrus and with the left parietal cortex. Furthermore, less suppression of hippocampus activity during learning predicts vocabulary learning success according to this study (Breitenstein, 2005).

4.2 Brain activation in gaming

Brain activation research on language learning included research on hemispheric dominance (lateralization) as well as the identification of the various brain structures being activated and the functions performed by these. Similarly, the more limited investigation into the activation of brain structures during gaming has focused in particular on identifying these structures as well as hemispheric dominance. This body of research will be addressing brain activation observed during gaming in general and not necessarily on gaming for the purpose of language learning due to limited research available in this area. Towards the end of identifying brain structures engaged during interactive game playing, an investigation into brain activation and gaming amounted to the finding of a study employed by the Rehabilitation Gaming System (RGS). The RGS, according to Prochnow, Bermudez I Badia, Schmidt, Duff, Brunheim, Kleiser, Seitz and Verschure (2013), is a virtual reality-based paradigm for the rehabilitation of neurological patients following brain damage such as stroke, which investigates which brain areas are involved in higher-order visuomotor processing in a virtual reality (VR)-based training
environment provided by the RGS. The results indicated that the task of catching virtual balls through the use of an avatar, resulted in significant increases in participants’ blood oxygenation level-dependent (BOLD) activity in the medial frontal gyrus, right parahippocampal and fusiform gyri as well as the left hippocampus (Prochnow et al., 2013). Furthermore, they also found that merely observing the avatar catching the balls, brought about bilateral activations in the occipital and temporal lobes. Thus, they noted that the areas that became activated during playing the game included medial frontal gyrus, right hippocampal and fusiform gyri and the left hippocampus. A noteworthy point according to the researchers was the occurrence of left dominance in the brain activation patterns regardless of the fact that the participants used both hands to press the buttons and that the balls was visible in both visual fields.

Further left hemisphere activation during game play have been observed in other studies. In a study conducted by Han, D., Bolo, N., Daniels, M., Arnella, L., Lyoo, K. & Renshaw P. (2011) comparing brain activity in desire for video games by using the first person shooter game War Rock and craving for drugs or pathological gambling the following results were obtained. The experimental group that responded to video game stimuli showed a significant amount of activity in the left inferior frontal gyrus, left parahippocampal gyrus, which is the grey matter surrounding the hippocampus, right and left parietal lobe, right and left thalamus and right cerebellum in comparison with the control group (Han et al. 2011). The values of a self-report measure of desire was correlated with those in the left inferior frontal gyrus, right parahippocampal gyrus as well as the right and left thalamus.

According to Wais, Wixted, Hopkins and Squires (2006) we are able to explain something when we recognize that this is something we have encountered previously, and this type of memory is referred to as recognition memory which has been widely studied. Remembering specific details about a previously encountered situation is part of the recollection process and when we know that something has been encountered without any information about the situation we encountered it in, we display familiarity. This study conducted by Wais et al. (2006) found that hippocampal damage could lead to impaired recollection and familiarity of events. We would therefore not be able to recollect previously encountered events if we have experienced damage to our hippocampus. Furthermore, it is possible to deduce that in both processes of learning a language and playing a video game, memory of previously encountered situations facilitate both processes since what we remember serves as a foundation for learning new information simultaneously as it indicates that new knowledge have been accrued.

In the study conducted by Wais et al. (2006) rewards that could be received also seemed to have an influence on the rate at which recognition occurred. This phenomenon gave us an
insight into gamers’ motivation to continue playing games and thereby continuing to learn. There are continuous rewards throughout each game which players are motivated to receive and thereby acquiring new knowledge about not only a new language but all new situations they encounter. Thus we can deduce that if the classroom situation includes the element of a rewards system on an individual level in some form, this could facilitate students’ performance. Such rewards systems could take different forms such as a points or credits which could be achieved on the completion of tasks.

**Table 1. Identification of the various brain structures being activated:**

<table>
<thead>
<tr>
<th>Brain structure</th>
<th>Activated by language learning</th>
<th>Activated by gaming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hippocampus (MTL)</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Fusiform gyrus</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Inferior parietal cortex</td>
<td>x</td>
<td>o</td>
</tr>
<tr>
<td>Medial frontal gyrus</td>
<td>o</td>
<td>x</td>
</tr>
<tr>
<td>Parahippocampal gyrus</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Occipital lobe</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Broca’s area (FL)</td>
<td>x</td>
<td>o</td>
</tr>
</tbody>
</table>

MTL = Medial Temporal Lobe        FL = Frontal Lobe

An analysis of the brain activation patterns identified in the two types of activities indicates that there are several structures that are activated by both gaming and language learning. As shown in Table 1, the brain structures that are common both to activation during language learning and during gaming include the hippocampus, the fusiform gyrus, the occipital lobe and the temporal lobe. According to Squire et al. (2004) the hippocampus and its adjacent areas play and important part in long term memories. Thus, we will take a closer look at the role of memory.
4.3 The role of Memory

Reinders (2012) states that gaming involves rules that players need to learn in order become skilled in them. This aspect also characterizes language learning which consist of grammatical rules which are important for learners to grasp in order to enhance their linguistic proficiency. According to Reinders (2012) one could link the development of gameplaying skills to that of the development in language learning. He identifies a dual-system model of language, consisting of associative lexicon memory and rule-based processes. In the view of Reinders (2012) this model is different from other dual- system language models as the lexicon and grammar are part of declarative memory as well as procedural memory. Declarative memory and Procedural memory Reinders explains as follows:

Declarative memory is specialized for learning arbitrary associations between form and meaning which, in the case of the meanings of non-compositional words (e.g., boat, house and ran - words whose meaning and referents are not relatable to their form) make up the mental lexicon. With regards to language, the procedural system consist of rules that carry out mental operations in real time, transforming morphology and syntax by manipulating symbols (Reinders, 2012, p. 141).

According to Reinders (2012), the skills used in language acquisition and the skills used in gaming both involve proceduralization. He argues that by connecting these two types of proceduralization, one can enhance success in learning a language. He claims that studies have already shown that games have been used to train learners' language skills to the extent that they showed native-like brain activation. These studies were experimental and conducted under controlled conditions.

Reinders (2012) also explores a technique used to measure brain activity, which is the ERP technique that produces electrophysiological data corresponding to brain activity during linguistic and other cognitive processes. According to Reinders there are a number of experiments that have researched second language processing and which have included video games to investigate a possible connection. One could thus assume that this subject has become increasingly interesting to neurolinguists who have started to investigate this field of research.

Thus far, all research under scrutiny in this study implicate the hippocampus as the brain structure activated during both game playing and language learning. Manns, Hopkins and Squire (2003) state that something, that is still under investigation, is whether the hippocampus
is uniquely implicated in episodic memory which is described as the memory that we have of events that are specific to a particular time and place or whether it could possibly also be of importance for semantic memory, which is described as the learning of facts. In addition, they claim that even if distinguishing between semantic and episodic memory does not shed light on the function of the hippocampal region, this distinction does help us to understand how the frontal lobe works. These are neurological processes that affect language learning and therefore of relevance to the current discussion (ibid).

According Hulten, Laaksonen, Vihla, Laine and Salmelin (2010) acquiring new words and successfully maintaining this new vocabulary involves the memory system. In their study they conducted, participants had to learn the names of objects in their native language during 3-6 daily training sessions where they had to learn 50 names of objects based on pictures of these objects. From the MEG data collected, all participants showed similar cortical activation, with activation advancing from the occipital cortex to the parietal, temporal and frontal cortices. Furthermore, access to the new words could be predicted by a change of neural activation in the left inferior frontal and posterior temporal cortices from the end of the learning phase to the time of the recording which occurred one week later. These changes in neural activation could even be observed ten months after the training phase.

Hulten et al. (2010) claims that the same cortical networks appears to be active during both processes of acquisition and maintaining new words in long term in memory. They argued that an underlying factor why participants showed enhanced brain activation even ten months later, could be related to how much attention participants had paid and how motivated they were during the learning phase. They also note that these were issues that could have been observed during the learning phase but that they were not noted. Furthermore, they indicate that the consolidation of the newly acquired word items could have occurred automatically and thus showed the increased activation.

Colzato, van den Wildenberg, Zmigrod & Hommel (2013) acknowledge that a highly relevant issue in recent years has been to what degree video games have influenced people’s daily lives. This has been a particular concern in light of the controversy surrounding the experiences associated with violent video games. The results of their study indicate that video game players playing first person shooter games could update their working memory or short term memory more accurately and faster than non-video game players. They also claim that the relationship between their observations and playing video games may in fact not be as straightforward, and explain this claim by stating that it could be that pre-existing neurodevelopmental factors and or pre-gaming learning experiences played a role. The individuals in the studies
may have had a genetic predisposition to favor executive control or might have been more inclined to be drawn to video games and these could have been misinterpreted. Thus we can draw the conclusion that there are various factors to consider in determining the reasons underlying success in language learning through the use of interactive games.

4.4 Interactive games and teaching

4.4.1 The absence of the use of digital games in education

Prensky explains in his book, *Digital game-based learning*, that despite the fact that most children today spend numerous hours playing computer games, digital game-based learning is only slowly becoming a part of the US school system. This is something we believe is also the case here in Sweden. He also argues that many educators believe that learning and playing games do not belong in school, and that schools are places for learning to read and write and do mathematics. However, there are others that claim that computers are the future and should definitely be a part of what schools are teaching (2001, p 187).

Reinders also points to this in his book, *Digital games in language learning and teaching*, that aside from the use of digital games for entertainment purposes, game-based technologies have also been used in the military, business and the medical sectors, however there are very few game-based technologies that are being used for educational purposes. Nevertheless, over the last years educators have more and more started to acknowledge the potentials of learning through digital games (2012, p. 17-18).

Reinders argues that teaching language through digital games involves having a task-based approach, having activities in which various aspects of the language learning process, i.e. intercultural, communicative, vocabulary and grammatical aspects are incorporated (2012, p. 22).

An additional researcher who acknowledges the lack of digital games in education is Nicola Whitton (2012). She argues that despite their being numerous pedagogical and motivational benefits of using digital games in education, their use is in many ways problematic. Whitton claims that the biggest problem is cost, both in the sense of buying digital games and also in terms of the time it takes for educators to attain the skills to evaluate or develop games. There are also problems with regard to the acceptability of games in education and the need for
educators to be convinced of the benefits of digital games in learning and teaching, as well as their limitations. This is important in order for them to feel secure enough to use games in their lessons.

According to Reinders (2012) one of the main reasons to incorporate digital games into the educational system has been to re-engage some of the under motivated and underachieving students. These students have experienced difficulties in school due to the fact that the education system has not been able to change along with the technological advances. Reinders argues that the classroom environment and the way learners work and learn have changed. For instance whereas language learners over a century ago typically engaged in grammar translations which centred around teachers’ instructions, today’s learners are more prone to work in pairs or smaller groups where they interact with each other and the teacher in the target language. Therefore, a system that relies on a lecture-based format is perhaps not an ideal way of teaching for language teachers (2012, p. 20-21).

4.4.2 How to use digital games in teaching

In this section, we are going to shed light on some of the major ideas that have been discussed by different researchers regarding how educators could address the issue of incorporating interactive games into their lessons in order to facilitate learning. The major ideas that were uncovered in this research included, referencing to games or their storylines in the classroom in order to increase relevance for learners and incorporating games for the teaching of culture. In addition to the above mentioned ideas, developing more cost-effective digital games like for instance alternate reality games was also brought to light. Other ideas uncovered on the subject of how to incorporate interactive games into lessons, involve teachers learning from games and applying these techniques to traditional teaching methods as well as providing learners with the opportunities to create their own interactive games. These themes will be explored further in the following sections.
Stanley and Mawer (2008) address in their paper the question of why language teachers should concern themselves with computer games. They discuss and use the term computer games in its broadest sense, to refer to all digital gaming. They also explore questions such as, what games can be used and how they can be used.

The new generation of learners is growing up with computer games and this is changing their expectations on education. Therefore, teachers need to motivate their learners by appealing to their interests and thereby making their lessons relevant to the specific needs of these learners and. One way of doing this is to incorporate interactive games into language teaching.

Stanley and Mawer (2008) explain that today’s learner would rather play “normal” games than educational games. Therefore, there is a need for teachers to make their lessons relevant to these learners by either allowing them to bring portable games and consoles to language classrooms or by simple referring to these games in some way. This way, you are as a teacher acknowledge the world of the learner and make the class interesting for them. Nothing is stopping the teachers from using examples in the classroom from different computer games, such as stories and different characters from these games. Evidence presented by different scholars actually shows that people are spending more time playing interactive games in their spare time than they are watching television and movies.

Stanley and Mawer (2008) argue that for language teachers, the most effective way to engage today’s learners is by making use of free online games. One can also find commercially available language learning CD-ROMs and websites especially designed for language learning that integrate computer games. They claim that many of these educational games are in many ways more educational than fun. Another way to employ computer games in the classroom is to make use of existing games that have been proven to be fun and to create different tasks around them. They also mention that many of the console games that have been proven to be fun are more engaging, and also contain authentic language in context, this is something that many of the educational games lack.

According to Anderson, Reynolds, Yeh and Huang (2008) there is an ongoing debate amongst educators concerning whether to use authentic material in the second and foreign language classrooms. However one thing that most educators agree on is that, whether the materials that they use are modified or authentic, they should be adapted to the comprehension levels of the learners. Anderson et al. argue that future researcher of games should take this into consideration when matching learners’ abilities to games with the right ability level. Finding games with relevant and useful content for learners with poor English abilities is a never-ending
challenge, a challenge they believe could be overcome if game designers were more aware of the impact digital games have on language learners.

Anderson et al. (2008) argue in their study that computer games that are properly designed with activities for the language classroom can be a good aid for learning language. They claim, that similar to movies and other sorts of media, interactive games are a resource that can facilitate language learning.

An issue Anderson et al. (2008) encountered during their study, is that when using authentic texts in the language classroom, teaching of culture becomes essential. Teaching of culture plays an important role in language learning when using digital games in the classroom, mainly because learners may not always be familiar with the culture in the digital game they are playing. In Anderson et al. study, the subjects were not familiar with the military culture and this made them perform badly.

This is also something that Chen and Huang (2010) mention in their study, Examining the potentials of computer games for English learning. The participants in their study pointed out this very issue that they encountered when gaming, the problem of not having knowledge about a particular culture. They complained several times that the colloquial language used in the interactive games was hard to comprehend. Therefore the authors of this study, suggests that when using foreign language interactive games in the classroom the teachers may have to explain to the students some cultural knowledge of that country. In other words, the teachers should be there to assist the learners when using interactive games in the language classroom, in this way the students will learn the most from gaming and will not be overwhelmed by some obstacles which they may encounter. However, Chen and Huang also point out that while helping the students learn and gain as much knowledge as possible, from interactive games the teachers should also be careful with not intervening too much, so they will not destroy the pleasure of playing games. If there is too much intervention from the teachers, this may lead to the students losing interest in playing and that could negate any advantage that game-based learning may have offered.
Prensky explores in his study, the problem of technology and education. There is simply not enough time or perhaps the will from educators to use computer games in schools. Therefore he believes that the ideal way for technology to make a difference in schools, is not in schools, rather at home (Prensky, 2001, p. 187, 195).

The availability of good interactive games for students in the home environment is a good way of incorporating games into the educational system, parents can buy these interactive games and encourage their children to play them at home. He also claims that bringing this digital game-based learning to the home environment, might be helpful in view of the fact that the increase in population is causing concerns about finding classroom space for learners in the future (Prensky, 2001, p. 195).

Something that Prensky recommends parents do, when choosing interactive games for educational purposes at home, is that they buy these games together with their children rather than just for them and to try out different kinds of interactive games with them, like for instance drill, puzzle and exploration games. What becomes essential is that parents listen to their children’s reactions and work with them. This is mostly because if parents purchase games based on what their children enjoy and find fun, than this will in turn make the learning process come easier for the children (2001, p. 196).

Prensky also argues that parents’ biggest issue is not to pull their children away from the computer, because if that is where they really want to be, than they will find a way to get there. The important thing is rather to make it worth their being there and to turn interactive games into something that the children can enjoy, have fun with and learn at the same time (2001, p. 198-199).

Whitton (2012) presents in her paper three alternative ways of using digital games in the classroom. The first one involves educators trying out more cost-effective ways when incorporating games into their lessons.

Whitton (2012) argues that educators and lecturers often have good ideas for computer based games to help and assist their teaching and that there are many options to explore that could help them to implement these ideas. One such an idea is the use of alternate reality games (ARGs). ARGs offer potentials for teachers to create low cost and engaging game-based learning experiences. The emergence of ARGs are relatively new and; they differ from other computer games in the sense that they combine real life and narrative in an ‘alternate reality’, by using different online and real life artefacts such as web tools, social networking sites, interactive storytelling and physical places. In other words, they merge the real world with the
digital world and produce another version of reality. These games can be played by the users for several weeks or even months. These games also provide the learners engaging and collaborative platforms, where they can also be supported to cooperate and work together in order to attain desired learning outcomes. Some of the learning benefits that ARGs offer, are the ability to facilitate problem solving because of the difficulty levels, the rewards attained, the use of narrative that stimulate curiosity and the frequent delivery of challenges that makes the games engaging and fun to learn from. However what makes alternate reality games ideal for use in education is that they appear to be based on simple, existing technologies that do not require high end production values or technical expertise, which in turn makes them an affordable option.

Another option in creating affordable games for the use of education is the use of free or inexpensive game development toolkits. Some of these toolkits include Adventure game Studio (www.adventuregamestudio.co.uk) for developing adventure games, Game Maker (www.yoygames.com/gamemaker) and inform (www.inform-fiction.org) for creating interactive fiction. These game builder sites are easy to access from the web and also inexpensive. While these game builder kits do not have the same graphic quality and fidelity as commercial games do, they can still be effective for learning and engaging learners (Whitton, 2012).

According Whitton (2012), game-based learning is not only about using games to teach; another way of seeing the potentials of digital games in learning is by looking at them, not only as tools for teaching, but also as objects to be studied and learnt from by teachers. Games, whether they are digital or not, embodies some specific features that facilitate learning. They create stimulating, motivating and engaging environments that are safe and free from ramifications in the real world. Digital games also provide the learners with a platform that supports interaction as we described in the section on the interactionist perspective.

Games like, for instance, adventure games, role playing games and simulations, apply techniques such as problem solving, repetition, mistake making, experimenting and the use of regular feedback that allows the players to see immediate results of their actions. These are all aspects of games that are more than often taken for granted, but do have a role in their effectiveness in learning. Therefore, the study of games that helps to see and apply the different techniques that are used in these games for the purpose of teaching, offers another beneficial way of using games for learning (Whitton, 2012).

Two major aspects that Whitton (2012) argues should be taken into consideration when examining digital games for learning, is firstly that digital games provide safe and fun
environments in which making mistakes are an accepted and natural part of the games. Players are not always expected to complete a game and solve all the problems at once; in fact, that might even seem tedious for them. Secondly, something that should be looked closely at by educators, is the successful interaction design used in digital games. This includes for instance the use of visual and auditory media, which include using pictures, graphics, video and sounds affectively in a single environment.

According to Whitton (2012) further study of the techniques used in digital games that facilitate learning and how to apply them in teaching is something that would allow future teachers to effectively use these techniques in their lessons without the expense of high-end developmental projects.

According to Whitton (2012) instead of simply learning by playing the games, learners could also learn by developing and creating these games by themselves. They could merely use the free or inexpensive game development toolkits mentioned earlier. Whitton argues that this is an option that many learners would find interesting and be enthusiastic about. This gives the learners more control over the process and supports communication and teamwork. However she argues that, this idea of learning from games and identifying whether they do well and how this later could be used in education could also in a sense be problematic. The use of some of the game techniques such as scoring and prizes could be perceived by learners as trivialising learning or that too much emphasis is put on game objectives and less on the learning process.

Whitton (2012) also argues that it is crucial for educators to remember that some features in digital games that seem motivational for some learners, may not be the case for all learners. These include in particular the use of competition and fantasy. This pedagogical way of teaching will also mean that learners will have to use other skills that they may not be used to using, skills such as teamwork, negotiation, planning and time management. For the teachers’ part, a trust and willingness to except a new role is needed, moving from the role of being the holder of the knowledge to the role of co-learner.
5. Summary

Language learning through the employment of technologically advanced systems such as gaming is currently a highly researched field and a phenomenon that we as educators need to pay more attention to. Although the connection between language learning and gaming has been explored more specifically by linguists, there are very few studies available from neuroscience making this explicit connection. The neuroscientific studies that have been retrieved for the purpose of this study indicate that there are several brain structures that are involved in both language learning and gaming that correspond. The identified brain structures that are similar for both activities include the hippocampus, the fusiform and hippocampal gyri, the occipital and the temporal lobes. In addition, based on the research, it was established that in both processes of learning a language and playing an interactive game, memory of previously encountered situations facilitate both processes, since what we remember serves as a foundation for learning new information simultaneously as it indicates that one has accrued new knowledge.

Furthermore, although earlier studies have identified language as being dominated by the left hemisphere in the brain, more recent studies have shown that this phenomenon may not be true for all language learners (Hull & Vaid, 2010).

The research conducted on the use of interactive games in education indicates that there is an absence of game-based technologies used specifically for educational purposes. In addition, the research shows that educators need to be informed of the benefits as well as provided with techniques of how to use digital games for teaching and learning. Furthermore, the different studies shown in this research synthesis suggests different ways of using interactive games to facilitate learning. Prensky (2001) mainly suggests and encourages parents to use interactive games with their children for learning outside school. In his view, this is a way to overcome the problem of the lack of technology in education. As mentioned earlier, Prensky believes that there is simply not enough time or perhaps the will from educators to use computer games in schools; therefore parents and learners would gain from taking matters into their own hands.

Whitton (2012) presents in her paper three alternative ways of using digital games in the classroom. The first option entails developing simple and economical digital games, such as alternate reality games, virtual worlds or using one of the many game-builder toolkits to create educational games. The second option that is presented by Whitton, involves teachers learning
from games and applying these techniques to traditional teachings. The key here is learning from games, rather than with games. That which is under discussion here are some of the techniques that are used in interactive games that facilitate learning, techniques that can also be used in traditional teaching practices. The last alternative mentioned by the author is allowing the learners to create their own digital games, so that it becomes the actual process of creating the game, and not the product, which enables learning.

Anderson, Reynolds, Yeh & Huang (2008) and Chen & Huang (2010) point to, amongst other things, the necessity of explaining to the students some cultural knowledge of the country the game is based on. According to them, this could be considered necessary to help the learners understand the context of the game, and to ease the learning process.

Anderson et al. (2008) and Whitton (2012) also point to the need to take into consideration the type of learners and also their comprehension levels when applying digital games in lessons.

Stanley and Mawer (2008) argue amongst other issues, that for language teachers, the most effective way to engage today’s learners, is to use free online games. In addition, they also inform us that teachers can make use of websites that are specifically designed for language learning that incorporates computer games.
6. Conclusion

The current study has made it evident that even though this field of research is a relatively new area, many researchers have investigated brain activation in language learning and brain activation in gaming respectively. However, only a limited number of researchers, identified by this study, have made a correlation between the activation that occurs during gaming and that which occurs during language learning.

Thus, many scholars, who have investigated brain activation in our area of interest, have come to the conclusion that there are several structures involved in the employment of both language learning and gaming that can be identified. Furthermore, according to studies conducted by Krashen (1981) and Hull & Vaid, (2006) it became clear that, language may not be lateralized to the left hemisphere of the brain as previous studies have claimed.

In the studies identified by this research synthesis, the researchers have implicated the medial temporal lobe, the hippocampus as well as the parahippocampal and fusiform gyri in the involvement of language learning. Studies by Prochnow et al., 2013 and Han et al., 2011, have implicated the left hippocampus, the medial frontal gyrus, right hippocampal and fusiform gyrus, parietal lobes and the thalamus in both hemispheres in the involvement of gaming. Therefore we conclude that there are differences in the brain structures involved in language learning and gaming, although similarities have also been identified. It is however imperative to point out that as we are not trained in the field of neuroscience, it is not possible to make a qualified deduction on how different these activation patterns are. Furthermore, the number of the studies that were investigated for the purpose of this paper could also have influenced our findings.

Reinders (2012) sees a link between the development of gameplaying skills and that of the development in language learning and he identifies a dual-system model of language with lexicon and grammar being a part of declarative and procedural memory. This viewpoint is also shared by Hulten, Laaksonen, Vihla, Laine and Salmelin (2010) who claim that acquiring new words and successfully maintaining this new vocabulary involves the memory system. Thus we can draw the conclusion that there are various factors to consider in determining the reasons underlying success in language learning through the use of interactive games.

The research discussed in the current study regarding using interactive games in education, also indicates that interactive games are highly underused tools in language teaching. Furthermore, the research shows that interactive games ought to be considered as tools that
could be considered as highly effective in learning, and should in the future be included in education. However, the research discussed in this research synthesis also shows that when using interactive games in the classroom, aspects such as cultural knowledge and different learner types should be taken into consideration by the teachers. Some concrete tips in how to use digital games is mainly presented by the researchers Whitton (2012) and Stanley & Mawer (2008). One point that is only raised by Prensky (2001) is how to use interactive games outside the school environment for the purpose of learning. Furthermore, Prensky claims that what becomes crucial for parents when choosing games for their children, is that they listen to their children’s responses and wishes. If parents purchase games which their children approve of and find enjoyable, this will ease the learning process for the children.

It is proposed that if we as educators want to connect to learners and make the lessons interesting for them, then we need to acknowledge the world of the learners; and digital games are a big part of today’s learners’ world.

Based on our findings we suggest that future studies need to further investigate the connection between the neural correlates of language learning in comparison with that of gaming. A further suggestion for future research according to Reinders (2012) involves investigating how one could combine the rules of a second language morphosyntax with gameplay processes, in order to make grammar proceduralized during developing skills in gameplay and simultaneously instill in learners a meta-awareness of the structure of the second language used during gameplay. Furthermore, the issue of employing games in education with students experiencing medical conditions such as ADHD and Dyslexia could also be explored.

On a cautionary note, we are by no means advocating that parents and teachers should allow minors to spend an unrealistic amount of time playing interactive games as there are some obvious health risks involved in condoning such behaviour. Our conclusion is that it has been indicated that language learning benefits could be attained through gaming but that the contexts within which these games are used need to be monitored and supervised by individuals who have received adequate training, or parents who are well informed in the use of games in order to promote language learning.
References


