



NORTH-WEST UNIVERSITY

SCHOOL OF COMPUTER SCIENCE AND INFORMATION SYSTEMS

The Qualities of Games for Use in Education

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*A thesis submitted in fulfilment of the requirements for the degree of
Bachelor of Science Honours in Computer Science and Information Technology*

*for the
ITRI671 module*

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NORTH-WEST UNIVERSITY

Abstract

Faculty of Natural and Agricultural Sciences
School of Computer Science and Information Systems

Bachelor of Science Honours in Computer Science and Information Technology

The Qualities of Games for Use in Education

by Joshua ESTERHUIZEN

The Thesis Abstract is written here (and usually kept to just this page). The page is kept centered vertically so can expand into the blank space above the title too...

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Literature Review

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Appendix A

Ethics Form

Name: Joshua Esterhuizen

Title of project: The Qualities of Games for Use in Education

Supervisor: Prof Gunther Drevin

Starting and end dates of project: 15-Feb to 8-Nov

1. Have you read the information available related to research ethics (Chapter 5 of Researching Information Systems and Computing; BJ Oates and Chapter 13 of Writing for computer science, J Zobel; Manual for post graduate studies, available on efundi)?	Yes X	No
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2. Do you make use of people as source of data in your project (for example the completion of questionnaires or evaluation of products)?	Yes	No X
--	-----	---------

3. Are there any aspects of your research that you need permission from another party to use (for example use of property or tools)? If yes, provide more detail.	Yes	No X
--	-----	-------------

4. Describe your research question and give a short description of your plans for the collection of data. This project will attempt to find what qualities a game requires to be able to be used in an academic learning environment. The data collection to meet this goal will include the collection and review of various literature in the field of ludology with a specific look at serious games. Real-world examples of serious games will also be analysed in attempt to identify these qualities. As such the works of Frasca, G. will be a primary source of study.

5. Describe how you plan to provide information about yourself and the goals of your research to participants.

No participants will be involved.

6. Describe what methods you will use to get permission from participants in your study.

No participants will be involved. The publically available resources - assets, animations and anything else - will need to be cited however.

7. Will you be able to ensure that participants' information will be used in an anonymous, private and confidential way? How?

Yes

No

X

No participants will be involved.

8. Are there any foreseeable risks of damage (physical, social or psychological) to participants or the environment? If you answer yes, give detail of the preventative measures you will follow.

Yes

No

X

No participants will be involved and the research and development of an artefact is done digitally.

9. Are there any foreseeable risks to the NWU, for example lawful actions that may follow the research, or damage to the image of the university? If yes, give detail.

Yes

No


X

As the artefact would use third party assets, it is important to properly reference those, however they are publically available.

10. Are there any other ethical issues that may occur during the execution of the research (for example conflicting interests)? If yes, provide detail and explain how you plan to handle them.	Yes	No X
Since the artefact developed for this study is not intended for public distribution for any profits, there is no additional ethical issues. However, if it were to be distributed, the respective creators and distributors of the resources used, namely any assets and animations, would first need to be contacted for explicit permission to do so.		

I declare that the information contained in this form is accurate. I have attempted to identify the risks that may arise in conducting this research and acknowledge my obligations and the rights of the participants. I confirm that the research will be conducted in line with all University, legal and ethical standards.

Name of student: Joshua Esterhuizen

Signature: 

Date: 10 April

Name of study leader:

Signature:

Date:

Name of additional moderator:

Signature:

Date:

Appendix B

Research Proposal

SUBJECT GROUP COMPUTER SCIENCE AND INFORMATION SYSTEMS

Research Proposal for Honours project

1. Student initials, surname and student number

Initials	<input type="text" value="J"/>	Surname	<input type="text" value="Esterhuizen"/>	Student number	<input type="text" value="30285976"/>
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2. Degree for which student is registered

3. Name of supervisor

Initials and surname	<input type="text" value="Prof Günther Drevin"/>
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4. Proposed title

Title (preferably not more than 12 words)	<input type="text" value="The Qualities of Games for Use in Education"/>
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5. Problem statement and substantiation

Provide the theme and link with gaps in the literature and recent research in the area.

Indicate the research question, its actuality and how the research will endeavour to answer the question.

Education as it stands is still built on a system that is no longer needed in modern society. Ackoff and Greenberg (2008) explain that the current traditional methods of teaching are no longer as relevant as they once were as it is aimed to produce members of society that were likely to not question any fundamental aspects of how things operated. It is largely a system that focuses on teaching while disregarding learning as the last major stride in development in education was to industrialise it – having them operate efficiently like factories (Ackoff & Greenberg, 2008). One major flaw with this system currently is that it stifles the creativity and drive of some students as each level of education is largely the same and as such monotonous. As such, education is in need of some form of system to create an interest in learning for the students.

Virvou, Katsionis and Manos (2005) mention that computer games are popular among those in schools and as such provide a means to deliver content in an interesting and engaging manner. Providing learners in all levels of education with content or methods of delivery that they will enjoy will cause them to be more motivated to learn and look further into that specific topic (Ackoff & Greenberg, 2008). Annetta (2008) states that the movement to include video games in teaching and training began in 2003, two years after the field of ludology began to gain traction. These types of games are called “serious games”. These types of games have already had an impact on the military, medical

and higher business education fields early in their conception and this trend continues to day with most serious games being used within the medical fields specifically (Annetta, 2008). However, there were attempts to use serious games, as simulations, within physics and engineering (Deshpande & Huang, 2011). It is at this point that the study of serious games became more theoretical at lower levels and more applied at higher levels, with a great impact to medical fields and training. As such, there is a fair amount of theoretical research on specific aspects that relate to serious games as simulations and within ludology as a whole, but only a few mention the qualities a game needs to better present information to a user.

The main aim of this study is to answer the question: Can a digital serious game be effectively applied within a learning environment as a means to provide better engagement with content whilst still being enjoyable to learners? Thus, this study is conducted to collect information on what principles and qualities can be applied to a game in order to make it viable for learning as well as developing a level to demonstrate these principles.

6. Research aims and objectives

Provide the different general as well as the specific aspects which will form part of the research.

This study's primary aim is to determine if games as a whole can effectively be applied within a learning environment as a means to provide better engagement with content whilst still being enjoyable to learners. To reach this goal, an artefact in the form of a digital game will be developed that will involve specific sections which focus on other study's research in addition to this one. With regards to this study, the artefact will employ various audio-visual stimuli while adhering to the principles found to demonstrate how a game may be used in a learning environment.

To effectively reach the aforementioned aim, the following secondary objectives will have to be met:

1. A literature study will need to be performed with a focus on:
 - i. Ludology, narratology and simulation;
 - ii. The effects of games, both digital and analogue, in early development;
 - iii. The effects of games in other stages of life;
 - iv. Best games for learning
 - v. Previous attempts to integrate game use in learning;
2. Collect examples of games that employ some form of teaching or learning
3. Create an artefact similar to a digital game that can be played
4. Create a specific scene/level within the aforementioned artefact that specialises on delivering information through various audio-visual stimuli that incorporates the principles and qualities

found.

7. Basic hypothesis (where applicable)

N/A

8. Method of investigation

8.1 Literature study

Provide an indication only of which literature will be used in the study with a few key references. A summary of the literature is not required here.

The following areas of study and literature will be researched for this study:

Impact of Games in Early Development

- The Effect of Adventure Video Games on The Development of Student's Character and Behavior (Kristiadi, Hasanudin, Sutrisno and Suwanto, 2019)
- The best game in the world: Exploring young children's digital game -related meaning-making via design activity (Mertala & Meriläinen, 2019)

Effects of Games in General

- A Meta-Analysis of the Cognitive and Motivational Effects of Serious Games (Wouters , Van Nimwegen, Van Oostendorp and Van der Spek, 2012)
- Extensive childhood experience with Pokémon suggests eccentricity drives organization of visual cortex (Gomez, Barnett, Grill-Spector, 2019)

Games Best Suited for Education

- Ludology from Representation to Simulation (Frasca, 2002)
- Simulation versus narrative: Introduction to Ludology (Frasca, 2013)

The Use of Games in Learning

- Computer Games in Education (Mayer, 2019)
- Learning by Teaching versus Learning by Doing: Knowledge Exchange in Organic Agent Systems (Fisch, Janicke, Kalkowski and Sick, 2009)
- Serious Games for education and training (De Gloria, Bellotti, Berta, Lavagnino, 2014)

8.2 Methods of investigation

The proposed design, data acquisition, procedures, data processing, funding sources (but not a budget), mathematical methods, computer methods, etc.

This study will be conducted using the interpretivist paradigm and design science research and will include:

- A literature study on the impact of games during early development, the general effects of games, an overview of game types using ludology determine the best type of game suited for education and the uses of games in education and learning.
- Finding and discussing examples of “serious” games.
- Designing and developing an artefact to aid in determining the viability of games in education.
- Determination on whether the research was appropriately applied to the artefact.

9. Provisional chapter division

Here it should be clear that there was proper reflection on the appearance of the final product (mini dissertation). Provide provisional titles of the various chapters, with a brief outline of the planned content of each.

The provisional chapter division is as follows:

Chapter 1: Introduction

The problem that is being researched, the viability of games in education and its affects during early development, is discussed in Chapter 1. Information on the background of this problem, similar research and the research contribution will be discussed. Furthermore, the aim of the study in addition to the planned method of conduct will be discussed.

Chapter 2: Literature Study

Chapter 2 will discuss the impact of games both in early development and in general in more detail, the accessibility of games as well as a focus on games being used in learning.

Chapter 3: Development of Accompanying Artefact

The accompanying artefact that will be developed as a part of the study will be discussed along with the development process of the artefact.

Chapter 4: Review of Collected Information

The means of data collection, processing and analysis will be discussed in this chapter along with the results of this data. This chapter will mostly deal with a review on what qualities and principles that could be applied to the artefact.

Chapter 5: Discussion on Results

A discussion on the results obtained will be presented in this chapter. As such, it will discuss how well the artefact demonstrates the qualities previously identified.

Chapter 6: Conclusion

The contents and results of the study will be briefly discussed and reiterated in an overview.

10. Literature references

Provide complete references to the literature referenced to in this proposal only.

Annetta, L. A. (2008). Video games in education: Why they should be used and how they are being used. *Theory into practice*, 47(3):229-239.

Deshpande, A. A., & Huang, S. H. (2011). Simulation games in engineering education: A state-of-the-art review. *Computer applications in engineering education*, 19(3):399-410.

Ackoff, R. L., & Greenberg, D. (2008). *Turning learning right side up: Putting education back on track*. Pearson Prentice Hall.

Virvou, M., Katsionis, G., & Manos, K. (2005). Combining software games with education: Evaluation of its educational effectiveness. *Journal of Educational Technology & Society*, 8(2):54-65.



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Student

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Supervisor

26/03/2021

.....
Date

Appendix C

Research Project Artefact - Academic Article

Linking Gamification, Ludology and Pedagogy: How to Use Serious Games for Various Knowledge Domains

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Abstract—Education as a whole has seen no major improvements for a long period of time while society has matured and grown rapidly in the same time frame. Due to this teaching and learning methods can be seen as stale to certain students. One way to solve this issue is with the implementation of some from of the technology that has developed over the years. This study looks at the possibility of adapting various domains of knowledge into digital games referred to as Serious Games. The implementation of serious games within teaching may help keep certain students engaged with the content being presented and create further interest in the topic. However, before reaching this stage the means to transform these knowledge domains into a serious games must be studied. This is done by focusing on three fields in particular, those being Gamification, Ludology and Pedagogy.

Index Terms—Education, Gamification, Knowledge Domains, Ludology, Pedagogy, Serious Games

I. INTRODUCTION

Education, as it stands, is still built on a paradigm that is no longer needed in modern society. One major flaw with the current system is that it stifles the creativity and drive of some students as each level of education is largely the same and is, as such, monotonous[2]. Therefore, education requires some form of system to create an interest in learning for the students.

Ackoff and Greenberg[2] explain that the current traditional means of teaching are no longer as relevant as they once were as it is aimed to produce members of society that were likely to not question any fundamental aspects of how things operated. It is largely a system that focuses on teaching while disregarding learning as the last major stride in development in education was to industrialise it – having them operate efficiently like factories[2]. It is a system that is designed to keep moving often employing a “No Child Left Behind” policy which results in almost no time for anything other than the standardised and constantly measured curriculum[10].

However, with the shift into the “information age”, the requirements of the workforce have also changed. The industrial age being a time of mass-production with the

emergence of various new processing technologies and the information age being characterised by the fact that information is being transmitted and generated at an ever-increasing rate due to further technological developments[10, 17]. The most notable changes between these ages is that the industrial age focused on conformity and compliance while initiative and diversity - where greater value is placed on each individual’s strengths and contribution to a project or organisation – is the focus of the information age[17].

Reigeluth[17] continues and states that the current paradigm of instruction is not focused on learning but rather categorisation. Ackoff[1] holds a similar viewpoint stating that there is more of a focus on teaching rather than learning. It should be noted that teaching and learning are very distinct from one another as both can take place without the other[1]. Learning is defined as increasing one’s ability to perform an act effectively while trying to meet an objective through acquiring new knowledge whereas teaching is the process of providing this knowledge[1]. Through this, it is clear that institutions under this paradigm aim to give learners a verbose vocabulary to speak on topics that they do not fully comprehend[1].

Due to this aforementioned paradigm shifts between the ages and in what requirements are desired by most organisations in the information age, a shift in instructional theory is also needed – one such as going from making use of passive learning through traditional teaching means to one that is centred on active learning[17].

With the recent developments in technology and the fact that technology, in general, is becoming more accessible, some institutions have adopted some forms of digital learning or supplement traditional teaching with digital assistance. Deshpande and Huang[7] state that the current generation of students is the first to grow up with abundant access to technology. They continue to state that, on average, these students spend almost double the time playing video games

as they do reading[7]. It can be assumed that from when Deshpande and Huang's[7] published this work that this figure has increased as with technology and video games as industries.

Virvou, Katsionis and Manos[20] echo the point that computer games are popular among individuals who are in schools and as such could provide a means to deliver content in an interesting and engaging manner.

According to Annetta[3], the movement for the inclusion of digital games to be used in teaching and training environments first started in 2003, two years after the field of ludology, the study of games, began to gain traction in academic literature. This initiative is what started the concept of a serious game as one that can be used in an academic sense to relay information. After this point in time, various examples of serious games were made for purely academic study purposes and had found a very large use in simulation for use as explanation aides and medical training.

As such, the motivation behind this study is to further investigate the possibility of using video games as a means to encourage learning in teaching environments as current means of teaching may not be optimal for some individuals. This will be accomplished through studying literature in the relevant fields and identifying the instances where it is viable.

II. LITERATURE REVIEW

A. *Serious Games and Ludology*

Ludology is the formal and academic study of games and has roots in studying games through a cultural and social lens by discussing how each interacts with the so-called "spirit of play"[11]. However, relatively recently, as early as 2001, the field has shifted and now encompasses the study of digital computer-based games as this is when the first academic peer reviewed journal on the topic was published as well as several international conferences taking place[9].

As such, this study will use the definition provided by Gonzalo Frasca, "Ludology can be defined as a discipline that studies games in general, and video games in particular"[9]. Frasca[9] further elaborates on his statement that the field of ludology has a focus on discussing and understanding the individual elements of games as well as creating models to explain the various mechanics and rules of games.

"Serious games" were introduced as digital concepts in 2002 through the Serious Game Initiative which was spearheaded by David Rejeski and Ben Sawyer[6]. The initial intention for serious games was for them to be used as a means of training certain tasks and skills[6] – this was typically done through simulation type games which will be discussed in greater detail further on.

Squire[18] provides a definition for games as a simulation

and states that these simulations attempt to model reality in a consistent manner usually through modelling physical or social systems through another system – which in this case would be a computer and the digital video game. There are two main types of simulations, Hi-fidelity and low fidelity. Hi-fidelity simulations attempt to model every possible interaction in a given system, phenomena or environment as accurately as possible[18]. In contrast, a low fidelity simulation will make use of a fair bit of abstraction as it aims to only demonstrate a few key characteristics of the phenomena or environment[18]. Games as simulations would comprise of both of these types depending on the content that it attempts to simulate.

Virvou, Katsionis and Manos[20] mention that the endeavour to create serious games has yet to reach schools due to certain criticisms about games in general that hinders this. This is due to the fact that discussions around games by educators have largely focused on the social consequences of playing games instead of the educational potential games hold[18]. Due to this the study of serious games became more theoretical and discussion-based at lower levels and more applied with actual use at higher levels. This can be seen by implementations implemented in several fields including medical rehabilitation, ecological studies, learning languages and business studies[4, 5, 16, 19]. These types of games have already had an impact on the military, medical and higher business education fields early in their conception and this trend continues to this day with most serious games being used within the medical fields specifically[3, 6]. However, there were attempts to use serious games, as simulations, within physics and engineering[7].

Deshpande and Huang[7] describe the use of games as a means of simulation for specific sections of work in physics and engineering courses as an addition to traditional teaching as it provides a relatively simple way to demonstrate certain phenomena. As such these authors discuss the simulation aspect of games rather than the narrative as when dealing with a simulation digital game it typically lacks most narrative elements in the traditional sense[7].

B. *A Pedagogical Approach*

Pedagogy is the field that deals with the transferal of knowledge in an educational environment through several lenses such as social, political and cultural[14]. As such it encompasses the fields and discussions of instructional design and theory as well as any learning theories – of which several are particularly useful to this study.

Learning by doing functions on the principle that skills can be improved through practice and self-perfection on a particular topic or knowledge base[8]. This means of instruction has become increasingly popular amongst companies where they are able to make use of "on the job" training as it allows for a person to be productive immediately as well as become more proficient at tasks gradually[8].

The learning by teaching method works under the assumption that learners are able to increase their understanding of a certain topic by teaching it to other learners[8]. This method of learning has garnered more usage recently as it is a viable means of learning in environments with too few teachers or instructors and increases the overall learning process[8]. Learning methods that place the learner in control are very flexible and as such can be incorporated when attempting to teach various and different fields or subjects[1].

Gibson et al.[10] list and summarise several learning and instructional design theories that have the potential to be applied to a game used for learning. This study will, however, only look at Merrill's First Principles of Instruction as it is the most recent of the ones depicted and is one that is very expansive and as such can be used in a variety of manners[10].

Before discussing the principles that the name refers to in this theory, Merrill[15] provides a few definitions for the terms made use of. A principle in this context is a relationship that is always true regardless of the environment it is applied within – this being the driving factor for deciding to make use of this theory[15]. A practice is any instructional activity[15]. A program is a means of instruction that makes use of several practices[15]. Merrill[15] states that the first principles described are able to be implemented in any instructional system or environment as they are “design-oriented” and as such relate more to creating learning environments rather than describing the means of knowledge transfer. Each of the following principles is also accompanied by three “corollaries” each of which Merrill[15] likewise explains.

The first principle of Merrill's First Principles of Instruction is that the learning is problem centred. This principle describes three corollaries, the first of which being “Show Task” which states that learners should be shown the types of problems they will be solving or will be able to solve with the knowledge that they attain[15]. The next is the “Task Level” which explains that the problems presented should keep learners engaged due to the complexity and not just the action of solving it[15]. The last corollary, “Problem Progression” describes that the problems presented should have some form of increasing complexity while still being comparable to the previous iteration of the type of problem[15].

The second principle is Activation which means that learning happens whenever previous experiences are used[15]. The first corollary, “Previous Experience”, states that the learning process is enhanced when a learner is able to draw upon relevant past experiences and apply the associate knowledge as a foundation for new knowledge[15]. “New Knowledge” is the second and explains that learners should be provided with a relevant experience as an additional foundation to add to their knowledge base[15]. The last corollary is “Structure” and details that learners should be encouraged to organise

new knowledge according to some relevant structure[15].

The third principle, Demonstration, proposes that learning takes place when the activities that are undertaken impart the knowledge instead of stating the information[15]. “Demonstration Consistency” explains that any examples or visualisation should be kept in line with the original learning goals[15]. The next is “Learner Guidance” and states that learners should be shown where the relevant information for problems can be found be it in the form of comparative examples or various representation of one source[15]. “Relevant Media” explains that when media is used as a means of demonstration, different types can be used provided that they do not fight for a learner's attention[15].

The fourth principle is Application which states that learning takes place when learners actively solve problems with the new knowledge they have acquired[15]. “Practice Consistency” is similar to Demonstration consistency but with a focus on the application of knowledge[15]. “Diminishing Coaching” is where the learners are provided with relevant feedback, but it is slowly lessened over time[15]. It is also important that the problems provided to learners for practice have a good variety, as explained as “Varied Problems”[15].

The fifth, and final, principle is Integration which is when the knowledge a learner has acquired is used by them in their everyday life[15]. The first corollary, “Watch Me”, explains that learners are provided to showcase the new knowledge or skill they have acquired[15]. “Reflection” deals with giving learners time to be able to debate with others on the topic involved[15]. Lastly, “Creation” states that learners should be able to make use of their new knowledge or skill in some personal capacity[15].

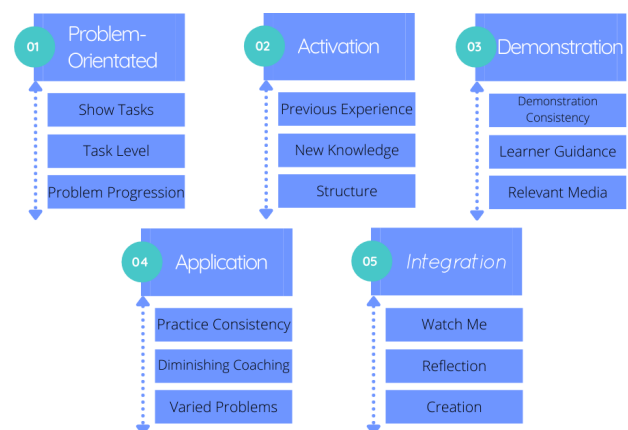


Fig. 1. Own Image summarising Merrill's First Principles

The principles and corollaries provided by Merrill[15] provide an expansive and detailed structure to be used when developing any learning opportunity making it an exceptional choice to adapt specifically to a digital game learning system.

It does, however, lack a comprehensive discussion on how to keep learners engaged with the content and, as such, the next subsection will discuss some theories pertaining to the role of motivation in learning.

Another important factor to consider is how to keep learners engaged and motivated with the instructional material. One model for motivating learners is the ARCS Model which was developed by John Keller which is frequently referenced in the aforementioned field of instructional design[12]. It is comprised of four main elements with each focusing on designing instruction in a different way[12].

The first of these is Attention and it is an element that is concerned with gaining and then keeping the learners' interest. There are three main methods to accomplish this with the first being gaining attention through the use of relatable examples or surprise. The next is to create curiosity within the learners through means such as role-playing or hands-on examples. The last means to keep attention is the variability which means periodically changing the method of delivery[12].

Relevance refers to having the content be relevant to the learner and Kapp[12] mentions that this can be done through orienting the environment around achieving goals, creating a link between the motives of learners and that of the instruction means, displaying that the content is in somewhat familiar to the learners and finally developing a model of the results of learning the presented knowledge.

Another element of this model, Confidence, is the expectations of success set by the learner and as such when they meet these expectations they are confident in their ability to do the work[12]. This can be aided by providing learners with clear expectations and requirements upfront about the skill or knowledge. It is also helpful to provide smaller opportunities to succeed as with each success the learners will become more confident[12].

The last element in the ARCS model is Satisfaction and is concerned with giving learners a sense of accomplishment and that the effort in the learning process has some value and weight to it[12]. This can be accomplished by allowing learners to see how their newfound knowledge can be used, either through the use of a real-world demonstration or via some form of simulation[12].

C. Gamification and the Knowledge Domains

Gamification can be defined as making use of game-like mechanics, aesthetics and thinking to create motivation, solve problems and produce a more suitable learning environment[12]. Kapp[13] states that while gamification makes use of game elements, it only makes use of a few of them as in a gamified system, in a gamification context, learners are not constantly engaged in playing

the game as there are sections of respite from this, such as video explanations. While elements such as points and achievements are found in most games, gamification strives to add more than just these to a classroom as with the absence of other elements and only points and badges, the resulting system is one that is dull[13]. Kapp[13] continues stating that gamification adds much more to create an interesting system such as narrative aspects and continuous feedback to learners to create and upkeep their motivation and engagement with the system.

Gamification is often not implemented within a classroom but is rather presented to learners through some external means – such as a digital game [13]. It should be noted, however, that a serious game can be the result of the gamification of some content but gamification does not always have to produce a serious game as a result [13].

Kapp[12] describes various types of knowledge and how to begin developing a gamified system to effectively teach each of them. This provides the ground work for answering the question this study poses and as such allows for a more in depth discussion on how to implement serious games. These knowledge domains are described as[12]:

- Declarative Knowledge is usually comprised of facts and jargon within a topic.
- Conceptual Knowledge is the grouping of related information that have an underlying common descriptor.
- Rules-Based Knowledge is strict statements linking concepts.
- Procedural Knowledge is a progression based path to reach an outcome.
- Soft Skills are general strategies for dealing with various social interactions.
- Affective Knowledge deals with topics about subjective phenomena such as emotions.
- Psychomotor Domain deals with making use of cognitive knowledge through physical skills (hand-eye coordination is an example of this).

One important aspect to note about these knowledge domains is that they are not mutually exclusive as one particular topic can be placed in several of them as the components of that topic may require multiple domains to be properly contained under them.

III. METHODOLOGY

The following steps were taken to determine how serious games can be used for the various knowledge domains:

- 1) Literature surrounding the applicable fields was researched
- 2) Case studies concerning serious games was studied and similarities noted
- 3) Select theories that aid this process were pinpointed
- 4) From this research, recommendations for the knowledge domains were made

A. Sampling of Literature

During this phase key fields of study were identified for use in working towards the goal of this study. As discussed above, these included the fields of pedagogy (the study of instructional theory), ludology (the study of games with a focus on digital games) and gamification (the use of game-like elements to solve problems). Studying the literature in each of these fields yielded literature that is undoubtedly useful to this study as pedagogy gave insight into instructional theories used in education, ludology provided the necessary understanding of how to study games and the elements that each uses and gamification provided insight into the different knowledge domains and how to best approach each in a teaching environment in addition acting as a bridge for connecting pedagogy to the serious games in ludology.

The bulk of this phase was spent reading articles and identifying which would be useful for this study. It was also during this phase that select case studies were found. These case studies proved useful as each made use of different design principles and as such became another set of literature to be studied.

B. Collection of Case Studies and Determine Similarities

As case studies were accumulated, only those found that discussed - either directly in great detail or indirectly during the game's description - the design principles followed were selected to be used. Notably, many of those chosen had a focus on some form of digital and cyber security including specific mentions to phishing and social engineering [Sheng2007, Dincelli2020].

The following step after finding these case studies was to identify their design principles and determine the major ones that most, if not all, made use of as well as how successful the game was found to be - which is determined in the individual publication either by trails of being judged by experts.

C. Pinpointing Connected Theories

Once enough literature had been acquired and studied, the connections between each of the fields' theory and case studies' design principles were noted. This was in attempt to identify an overall pattern in the development of serious games for use particularly for educational or training purposes. This included mapping the similarities between the instructional theories to the design principles of each case study while noting which fields of knowledge the games are a part of.

D. Extrapolate to other Knowledge Domains

For the knowledge domains that the case studies do not directly relate to, recommendations for them will be generated out of what has been found. In addition to this, certain design principles used by the case studies can be directly applied to these domains.

IV. FINDINGS

As described in the methodology, a large aspect of the findings comes from the literature review conducted. However, the literature review only provided segmented information that must still be distilled. This includes making note of what instructional theory is most pertinent to this study and breaking down the case studies. It also includes a short discussion on the initial reconsiderations from Kapp[12] regarding the knowledge domains.

A. Helpful Instructional Theories

B. Case Studies and the Similarities in Design Principles

TABLE I
DESIGN PRINCIPLES DEFINED BY CASE STUDY

SETA Artefact	Anti-Phishing Phil	Happy Hippo
Story-based Reflection	Story-based Reflection	Clear and Simple Goals
-	Conceptual-Procedural	Quality of Feedback and Rewards
-	-	Structure of the Challenge
-	-	Motion-based Interaction
		Simplicity

C. Initial Knowledge Domain Recommendations

V. SYNTHESIS FROM RESEARCH

A. Recommendations per Knowledge Domain

B. Limitations and Future Research

REFERENCES

- [1] Russell L Ackoff. "Teaching versus learning". In: *Systems practice* 4.3 (1991), pp. 179–180.
- [2] Russell L Ackoff and Daniel Greenberg. *Turning learning right side up: Putting education back on track*. 2008. ISBN: 0132716429.
- [3] Leonard A Annetta. "Video games in education: Why they should be used and how they are being used". In: *Theory into practice* 47.3 (2008), pp. 229–239.
- [4] James William Burke et al. "Serious games for upper limb rehabilitation following stroke". In: *2009 Conference in Games and Virtual Worlds for Serious Applications* (2009), pp. 103–110.
- [5] Robert Costanza et al. "Simulation games that integrate research, entertainment, and learning around ecosystem services". In: *Ecosystem Services* 10 (2014), pp. 195–201.
- [6] Alessandro De Gloria, Francesco Bellotti, and Riccardo Berta. "Serious Games for education and training". In: *International Journal of Serious Games* 1.1 (2014).
- [7] Amit A Deshpande and Samuel H Huang. "Simulation games in engineering education: A state-of-the-art review". In: *Computer applications in engineering education* 19.3 (2011), pp. 399–410.
- [8] Dominik Fisch et al. "Learning by teaching versus learning by doing: Knowledge exchange in organic agent systems". In: *2009 IEEE Symposium on Intelligent Agents* (2009), pp. 31–38.

- [9] Gonzalo Frasca. “Simulation versus narrative: Introduction to ludology”. In: 2013, pp. 243–258. ISBN: 0203700457.
- [10] David Gibson, Clark Aldrich, and Marc Prensky. *Games and simulations in online learning: research and development frameworks: research and development frameworks*. IGI Global, 2006.
- [11] Johan Huizinga and Richard Francis Carrington Hull. *Homo Ludens. A Study of the Play-element in Culture.*[Translated by RFC Hull.] 1949.
- [12] Karl M Kapp. *The gamification of learning and instruction: game-based methods and strategies for training and education*. 2012. ISBN: 1118096347.
- [13] Karl M Kapp. “What is gamification”. In: *The gamification of learning and instruction: game-based methods and strategies for training and education* (2012), pp. 1–23.
- [14] Guofang Li. *Culturally contested pedagogy: Battles of literacy and schooling between mainstream teachers and Asian immigrant parents*. 2012. ISBN: 0791482545.
- [15] M David Merrill. “First principles of instruction”. In: *Educational technology research and development* 50.3 (2002), pp. 43–59.
- [16] Jim Ranalli. “Learning English with The Sims: exploiting authentic computer simulation games for L2 learning”. In: *Computer Assisted Language Learning* 21.5 (2008), pp. 441–455.
- [17] Charles M Reigeluth. “A new paradigm of ISD?” In: *Educational technology* 36.3 (1996), pp. 13–20.
- [18] Kurt Squire. “Video games in education”. In: *Int. J. Intell. Games & Simulation* 2.1 (2003), pp. 49–62.
- [19] Yu-Hui Tao, Chieh-Jen Cheng, and Szu-Yuan Sun. “What influences college students to continue using business simulation games? The Taiwan experience”. In: *Computers & Education* 53.3 (2009), pp. 929–939.
- [20] Maria Virvou, George Katsionis, and Konstantinos Manos. “Combining software games with education: Evaluation of its educational effectiveness”. In: *Journal of Educational Technology & Society* 8.2 (2005), pp. 54–65.

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Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, ac, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

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Number equations consecutively. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

$$a + b = \gamma \quad (1)$$

Be sure that the symbols in your equation have been defined before or immediately following the equation. Use “(1)”, not “Eq. (1)” or “equation (1)”, except at the beginning of a sentence: “Equation (1) is . . .”

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Please don’t use the `{eqnarray}` equation environment. Use `{align}` or `{IEEEeqnarray}` instead. The `{eqnarray}` environment leaves unsightly spaces around relation symbols.

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- The word "data" is plural, not singular.
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- In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
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- In your paper title, if the words "that uses" can accurately replace the word "using", capitalize the "u"; if not, keep using lower-cased.
- Be aware of the different meanings of the homophones "affect" and "effect", "complement" and "compliment", "discreet" and "discrete", "principal" and "principle".
- Do not confuse "imply" and "infer".
- The prefix "non" is not a word; it should be joined to the word it modifies, usually without a hyphen.
- There is no period after the "et" in the Latin abbreviation "et al."
- The abbreviation "i.e." means "that is", and the abbreviation "e.g." means "for example".

An excellent style manual for science writers is [b7].

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The class file is designed for, but not limited to, six authors. A minimum of one author is required for all conference articles. Author names should be listed starting from left to right and then moving down to the next line. This is the author sequence that will be used in future citations and by indexing services. Names should not be listed in columns nor group by affiliation. Please keep your affiliations as succinct as possible (for example, do not differentiate among departments of the same organization).

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Headings, or heads, are organizational devices that guide the reader through your paper. There are two types: component heads and text heads.

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TABLE II
TABLE TYPE STYLES

Table Head	Table Column Head		
	<i>Table column subhead</i>	<i>Subhead</i>	<i>Subhead</i>
copy	More table copy ^a		

^aSample of a Table footnote.

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity "Magnetization", or "Magnetization, M", not just "M". If including units in the label, present them within parentheses. Do not label axes only with units. In



Fig. 2. Example of a figure caption.

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ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

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Please number citations consecutively within brackets [b1]. The sentence punctuation follows the bracket [b2]. Refer simply to the reference number, as in [b3]—do not use “Ref. [b3]” or “reference [b3]” except at the beginning of a sentence: “Reference [b3] was the first ...”

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Unless there are six authors or more give all authors’ names; do not use “et al.”. Papers that have not been published, even if they have been submitted for publication, should be cited as “unpublished” [b4]. Papers that have been accepted for publication should be cited as “in press” [b5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

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REFERENCES

- [1] G. Eason, B. Noble, and I. N. Sneddon, “On certain integrals of Lipschitz-Hankel type involving products of Bessel functions,” *Phil. Trans. Roy. Soc. London*, vol. A247, pp. 529–551, April 1955.
- [2] J. Clerk Maxwell, *A Treatise on Electricity and Magnetism*, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
- [3] I. S. Jacobs and C. P. Bean, “Fine particles, thin films and exchange anisotropy,” in *Magnetism*, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.
- [4] K. Elissa, “Title of paper if known,” unpublished.
- [5] R. Nicole, “Title of paper with only first word capitalized,” *J. Name Stand. Abbrev.*, in press.
- [6] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, “Electron spectroscopy studies on magneto-optical media and plastic substrate interface,” *IEEE Transl. J. Magn. Japan*, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetism Japan, p. 301, 1982].
- [7] M. Young, *The Technical Writer’s Handbook*. Mill Valley, CA: University Science, 1989.

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