EFFECTS OF GAMIFICATION ON ACHIEVEMENT, ENGAGEMENT AND INTRINSIC MOTIVATION AMONG STUDENTS OF DIFFERENT PLAYER TRAITS IN SCIENCE LEARNING

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A thesis submitted in fulfilment of the
requirements for the award of the degree of
Doctor of Philosophy (Educational Technology)

Faculty of Education
Universiti Teknologi Malaysia

AUGUST 2017

DEDICATION

To my beloved late father,
Sanmugam Verasamy,
to my loving mother
Letchimee Adiappan,
to my caring sister,
Ratnavalli
and to my supportive wife
Kavitha Selvarajoo

Thank you for all the support and guidance throughout my PhD. journey

ACKNOWLEDGEMENT

First, I would like to express my appreciation to God, for granting me the strength and ability to complete my study. I would also like to thank my late dad for his everlasting advice and encouragement to seek knowledge that has pushed me to where I am now.

I would like to thank my respected and adored supervisors, Prof. Dr. Baharuddin Bin Aris, Dr. Hasnah Binti Mohamed, Dr. Zaleha Binti Abdullah and Dr. Norasykin Bin Mohd. Zaid, who has been a beacon of light throughout my journey through my Ph.D. experience. Without their encouragement and support I would not come this far.

I would like to thank my fellow doctoral students Salihuddin Bin Md Suhadi and Azlina Binti Abd Rahman whom have been helpful and supportive throughout my studies. Especially to Salihuddin Bin Md. Suhadi who stood by me through the worst of times and the best of times.

I would also like to thank Prof. Dr. Mohd. Salleh Bin Abu, Prof. Dr. Baharuddin Bin Aris and Assoc. Prof Dr Mohd. Bilal Bin Ali for selecting me as part of the UTM-KPM synergy Programme G20 students; not forgetting the professional and helpful fellow students from the G20. I would also like to thank Assoc. Prof. Dr. Noraffandy bin Yahaya for guiding and taking care of the G20 students as well as encouraging me to go on the adventure of a lifetime; the internship in Radboud University, Nijmegen, Holland. I would also like to thank my supervisor in Radboud University, Dr. Henny van der Meijden, whom not only took care of me throughout my time there, but also advised me regarding the research.

Finally, I would like to thank my wife, Dr. Kavitha A/P Selvarajoo, for transferring herself from Kuala Lumpur to Johor Bahru to be by myside throughout my Ph.D. Journey. Last but not the least, I would like to thank my family: especially my mum, my sister and my brother in law for supporting me spiritually throughout writing this thesis and my life in general.

ABSTRACT

The infusion of educational technology on students depends not only on the purpose of learning but also on individual needs. This is vital in tackling issues of boredom and disengagement among students when it comes to learning Science. Therefore, gamification, use of game elements in non-gaming context has been adopted to help alleviate the issues. The research examined type of player traits, effects of gamification on engagement, intrinsic motivation and achievement levels, how game elements affect users as well as identify effects of player motivation as a mediating variable. Next, a model of gamification based learning and assessment was developed. A quasi-experimental research was carried out for 8 weeks. 28 students were in the experimental group and 26 students were in the control group. To reduce threats to the research, a dedicated system login, similar educator's teaching experience and schools with sufficient IT equipment were used. The experimental group was exposed to gamification online via *Zondle* platform and the traditional classroom used offline via infusion of game elements. Both groups were tested for intrinsic motivation levels using Intrinsic Motivation questionnaire, and the pre-and post-tests were used to identify their achievement levels. The experimental group were tested for player traits using Player Motivation questionnaires and their participation level was based on *Zondle* Platform usage. The player traits showed that 68% of the experimental group retained their player motivation types and the highest player trait was immersion. Meanwhile, the engagement levels of the experimental students using the gamified platform peaked for Topic 6 at 36.21 times login in comparison to the lowest which was Topic 7 with 5.2 times login. Intrinsic motivation levels of the experimental group showed that their levels of interest, effort, perceived choice and usefulness construct had significant changes at the end of the research. The analysis of achievement levels, showed that pre-and post-test scores of the control group were strong and positively correlated ($r=0.630, p<0.001$) and the experimental group's results were moderate and positively correlated ($r=0.496, p< 0.007$). There was a significant difference between pre-and post-test scores of the experimental group ($t=8.040$, $p<0.000$). As an indication of how game elements were affected, it was found that initially there was no preference. However, at the end of the research, the students favoured gamified leader board especially as it motivates them to be better academically and competitive. Meanwhile, badges were preferred offline as students prefer physically acquiring them, for online gamified learning, points and leader board were preferred. The mediating analyses in this research have paved the way to create a model for gamification based learning and assessment for future educators and researchers.

ABSTRAK

Penyebaran teknologi pendidikan pada pelajar bergantung bukan hanya pada tujuan pembelajaran tetapi juga untuk keperluan individu. Ini penting dalam menangani isu kebosanan dan penyendirian dalam kalangan pelajar apabila mempelajari Sains. Oleh itu, gamifikasi, penggunaan unsur-unsur permainan dalam konteks bukan permainan telah diterima pakai untuk membantu menangani masalah ini. Kajian ini mengkaji jenis ciri pemain, kesan gamifikasi terhadap penglibatan, motivasi intrinsik dan tahap pencapaian, pengaruh elemen permainan terhadap pengguna serta mengenal pasti kesan motivasi pemain sebagai pemboleh ubah pengantara. Selanjutnya, satu model pembelajaran dan penilaian gamifikasi telah dibangunkan. Penyelidikan kuasi eksperimen dijalankan selama lapan minggu. 28 orang pelajar berada dalam kumpulan eksperimen dan 26 orang pelajar berada dalam kumpulan kawalan. Untuk mengurangkan ancaman kepada penyelidikan, log masuk sistem yang berdedikasi, pengalaman mengajar pendidik yang sama dan sekolah-sekolah dengan kelengkapan IT yang mencukupi telah digunakan. Kumpulan eksperimen terdedah kepada gamifikasi atas talian melalui platform *Zondle* dan pembelajaran tradisional yang digunakan secara luar talian melalui penerapan elemen permainan. Kedua-dua kumpulan diuji untuk tahap motivasi intrinsik menggunakan soal selidik Motivasi Intrinsik, dan ujian pra dan pasca digunakan untuk mengenal pasti tahap pencapaian mereka. Kumpulan eksperimen diuji untuk ciri pemain menggunakan soal selidik Motivasi Pemain dan tahap penyertaan mereka berdasarkan penggunaan platform *Zondle*. Ciri-ciri pemain menunjukkan bahawa 68% daripada kumpulan eksperimen mengekalkan jenis motivasi pemain mereka dan sifat pemain tertinggi adalah Penyatuan. Sementara itu, tahap penglibatan pelajar eksperimen menggunakan platform memuncak untuk Topik 6 pada 36.21 kali log masuk berbanding dengan penglibatan rendah untuk Topik 7 dengan log masuk sebanyak 5.2 kali. Tahap motivasi intrinsik kumpulan eksperimen menunjukkan bahawa tahap minat, usaha, persepsi pilihan dan kegunaan meningkat pada akhir kajian. Analisis tahap pencapaian menunjukkan bahawa skor ujian pra dan pascaujian adalah kuat dan berkorelasi positif ($r = 0.630$, $p < 0.001$) dan keputusan kumpulan eksperimen adalah sederhana dan berkorelasi positif ($r = 0.496$, $p < 0.007$). Terdapat perbezaan yang signifikan antara skor ujian pra dan pascaujian kumpulan eksperimen ($t = 8.040$, $p < 0.000$). Sebagai indikator bagaimana elemen permainan dipengaruhi, didapati bahawa pada mulanya pelajar tiada apa-apa keutamaan. Namun, pada akhir penyelidikan, para pelajar menyukai "*leader board*" kerana ia mendorong mereka untuk menjadi lebih baik dari segi akademik dan berdaya saing. Manakala lencana dipilih di luar talian kerana pelajar lebih suka memperolehnya secara fizikal. Untuk pembelajaran gamifikasi atas talian, mata dan "*leader board*" dipilih. Analisis pengantaraan dalam kajian ini telah membuka jalan untuk menghasilkan model pembelajaran dan penilaian berasaskan gamifikasi untuk pendidik dan penyelidik masa depan.

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TIMMS	-	Trends in International Mathematics and Science Study
PISA	-	Programme International Student Assessment (PISA)
STEM	-	Science, Technology, Engineering and Mathematics (STEM)
ICT	-	Information, Communication and Technologies (ICT)
GBL	-	Game-Based Learning (GBL)
P.B.L	-	Points, Badges and Leader boards (P.B.L)
S.B.A	-	School Based Assessment (S.B.A)
MUD	-	Multi user dungeon (MUD)
MMORPGs	-	Massively Multiplayer Online Roleplaying Games
SBP	-	Sekolah Berasrama Penuh (SBP)
A.T.M	-	Automated Teller Machine (A.T.M)
CS	-	Computer science (CS)
GEQ	-	Game Experience Questionnaire (GEQ)
SIMS	-	Situational Motivation Scale (SIMS)
SNS	-	Social Network System (SNS)
API	-	Application programming interface (API)
PLE	-	Personal Learning Environments (PLE)
LIM	-	Live-Interest-Meter (LIM)
QS	-	Quantified Self (QS)
GTM	-	Gamification teaching method (GTM)
CTM	-	Conventional teaching method (CTM)
SEI	-	Student Engagement Instrument (SEI)
IMI	-	Intrinsic Motivation Inventory (IMI)
MSG	-	Mobile Serious Games (MSG)
SBCE	-	Set-Based Concurrent Engineering (SBCE)
L&SCM	-	Logistics and supply chain management
NDIVE	-	N-dimensional immersive virtual environment

SAP	-	Systems, Applications, and Products in Data Processing
ERP	-	Enterprise Resource Planning
GUI	-	Graphical User Interface
TRIZ	-	Teoriya Resheniya Izobretatelskikh Zadach (Theory of The Resolution of Invention-Related Tasks)
HVAC-R	-	Heating, Ventilation, Air Conditioning and Refrigeration
SL	-	Second Life
EF	-	Executive Functions

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Educational technology plays an important part in the growth of education. This is more evident with the turn of the century because the use of technology has diversified and improved rapidly all over the world. Thus, although the traditional techniques of teaching and learning are relevant and still have their effects on learners in general, the importance of technology in the field of education is indispensable due its effect on students learning. The benefits of technology — such as ease of access, improved motivation, wider participation, and its capability to amend learning structure — can open doors for continuous enhancement in the field of education (Pereira, 2012). It has been repeatedly pointed out that Malaysia is moving towards the status of a developed country. However, some researchers have claimed that the absence of infusion between technology and education in schools in the country can be attributed to various challenges, such as lack of Information and Communication Technology (ICT) training among teachers, improper equipment, and time constraints (Ali et al., 2009). These challenges may result in de-motivation among several students and teachers who are important stakeholders in the current system of education in Malaysia.

Taking into account that education is vital in promoting a country to become a developed nation, attention should be given to how to improve students' achievement. Considering the Malaysia context, recent years have witnessed debates regarding Malaysian students' achievement which has worsen in recent years until they became incapable to meet the minimum *Trends in International Mathematics and Science Study (TIMMS)* 2011 benchmarks for Maths and Science (Martin, Mullis, Foy, and Stanco, 2011) and in *Programme International Student Assessment (PISA)* 2012 (OECD, 2012). Therefore, a different approach needs to be considered in order to curb and prevent our education system from further drop behind. This is important as the world moves deeper into the 21st century, with the evolvement of methods of thinking in line with the latest advancements in technology. Life has moved from paper-based workspace to a virtual world where paper is only used as a medium to be kept on our racks. Furthermore, e-books can currently carry out the tasks of hardcover books. Therefore, education and technology are further incorporated to play an essential role in boosting the nations' chances towards academic excellence.

To foster the incorporation of technology in education, the Malaysian Education Ministry has taken some steps. An example of these steps is based on the Malaysian Education Blueprint — the First Shift — which focuses on providing equal access to quality education of an international standard and on improving the quality of four subjects: *Science, Technology, Engineering and Mathematics (STEM)*. In this shift, the government states that it needs to explore educational models using different modes whilst incorporating technology to enhance students' learning. According to Shift seven: Leverage Information, Communication and Technologies (ICT) To Scale Up Quality Learning Across Malaysia, students are allowed to maximise their use of Information and Communication Technologies (ICT) for distance in order to enable them to learn at their own pace, with teachers being the facilitators opposed to the content givers (Kementerian Pelajaran Malaysia, 2013).

Therefore, in accordance with the plans of the Ministry of Education in the country, the education paradigms are to be shifted to include online learning, hybrid learning, and collaborative models. This is because students of the current generation

learn to be a part of a big network of learning that encompasses a large web-based community. From students' perspective, hybrid learning is no longer hindered by the weaknesses and the limitations of books and the constraints of classroom based learning. Rather, hybrid learning is the world that is turned to be the classroom for students' learning. This is supplemented by the arrival of android devices which have introduced a new fad which is a process of interaction with games. Thus, with an element that is as robust and addictive as a game, one can only imagine whether it can be harnessed and used to the fullest potential in various educational aspects. This has paved the way for the Gamification approach that uses game like elements or mechanics in non-gaming aspects. As supported by Edmonds (2012), game mechanics are frequently connected to learning encounters, for instance, helping in the advancement of knowledge and learning collaborative abilities, such as problem solving and teamwork.

1.2 Background to the Study

As the world progresses further into the age of technology, not only is it necessary for tools and devices to be advanced, but also the way someone lives, works, and studies. Technology will eventually become a way of life for all.

Technology progression in the new millennia has highlighted not only the need for the existence of educational technology, but also constant improvement of this technology. This is applicable even in other tools, such as television stations that are moving away from analogue signal to the digital one. It can be concluded that technology advancement is like a revolving door: out with the old and in with the new. Progression has been evident in technological tools, such as computers that were used to fill an extra room in the past to a size that can fit in your palm.

When it comes to games, the current evolution in technology, especially with the arrival of mobile devices, the rise of interaction with games has been obviously noticed. Prior to the arrival of mobile devices, people who wanted to play games needed to have either a game console or a handheld device. However, in the current

time in which games in computers and even in hand phones are widely available. Games are no longer a strange phenomenon. Furthermore, for some people playing games either on computers or hand phones has become a daily routine and an addictive part of their lives. This is supported by McGonigal (2010) who states that people all over the world use three billion hours a week playing online games. She also speculates that multiplayer adventure games, for instance World of Warcraft, reproduce the perfect environment for human performance where a player sets out on a journey, with complete controls over all movements. This game is furnished with everything important for a player to get proficient in the required skills. These qualities are related precisely to the essential precursors of motivation — a concept that may refer to purpose, autonomy, and mastery. This further contends that updating real world social structures to copy those of adventure games can enhance profitability and ability to take care of the current issues all over the world. Thus, it can be deduced that the capabilities of game in causing a change in human lives can go beyond its original intended purposes of fun.

Playing games is an example of an activity directed towards a definite end of purpose, a self-spurred task (Deterding, 2011a). Although there are some theories and models that have attempted to conceptualize motivation, Self-Determination Theory is arguably the well-researched psychological theory of intrinsic motivation. This theory has been shown to incorporate these diverse discoveries and ideas with respect to the motivational draw of video games into a small set of constructs installed in one inclusive theory of human motivation (Ryan, Rigby, & Przybylski, 2006). Furthermore, a few experimental studies have shown solid correlations between video game characteristics and need satisfaction on one hand and other relevant constructs such as enjoyment or intrinsic motivation on the other hand (Nicholson, 2012b; Lieberoth, 2014). When people are internally motivated, they tend to encounter investment and satisfaction, they feel skilful and have a self-determining attitude, they perceive the locus of causality for their behaviour to be internal, and in a few occasions they experience flow (Deci & Ryan, 1985). Flow, is a situation where the users are in a zone of comfort and immersion in completing a task where they can be so engrossed in the activity that they can ignore other aspects around them (Csikszentmihalyi, 1990). Therefore, it can be said that conjuring ones'

motivation is fundamental in guaranteeing that the inclination is voluntary and self-directed.

Need satisfaction theories contend that people search out and are more engaged in learning tasks when they are guaranteed to succeed, thus fulfilling their motivational needs, such as competence, self-sufficiency, or relatedness (Deterding, 2011a). In terms of motivational affordances, this means that the drive exists when there is a significance relationship between objectivism and the essential capability of learners. This, in turn, can allow the existence of satisfaction of needs when interacting with object. For example, according to Lewis, (2007) and Browne, (2013), Sudoku is a popular and addictive form of puzzle that is based on logic combinational numbers that are managed to create various instances of solution. This feature of this game helps players to keep focussed and motivated in completing the tasks. This relates to the fundamental concept of motivation which is Self-Determination Theory (Deci & Ryan, 1985) that can help in increasing acceptance as a productive approach to the psychological spur of video games (Ryan, Rigby, & Przybylski, 2006). Subsequently, the existence of motivation as precursor to engagement (Jang, 2008) is considered to be an important element that proves that users are attached or immersed due to the engagement factor. Interactive elements attract students' attention towards an activity (Beeland, 2002), leading them to be immersed and committed to the system (Dede, 2009). Therefore, engagement factors can be seen from the participation and involvement of users in an activity or learning tasks (Birch & Ladd, 1997; Fredricks, Blumenfeld, & Paris, 2004). As such harnessing users, motivational aspects can trigger the continual participation to complete a task or an activity presented to them.

Before any implementation in a classroom, the key elements of any transformation — which are the teacher and students — should be considered. According to Chee & Mehrotra (2012), the significance in teachers' preparation for game-based learning has to become more prevalent in the process of teaching and learning. The pressures that instructors confront when implementing game-based learning in the classroom bring up the challenges of setting up 21st century competencies (Voogt et al., 2013). This additionally highlights the centrality of educators' personality to the procedural aspects of shift and transformational

development. The findings of Voogt et al. (2013) also demonstrated that instructors need to manage complex individual needs of a students, notwithstanding overseeing social and institutional factors, when they explore the procedures of levelling up their teaching practice. Voogt et al. (2013) empathized that in spite of all the new mixture of engineering and improvement in learning, instructors need to acknowledge and be ready to furnish them with learning innovation because they are the key architects in educating the learners, subsequently building the future of the nation (Chee & Mehrotra, 2012). Unfortunately, the uncertainty and insecurity that exist in a teacher may lead to an incomplete experience of using games in teaching and learning. For many educators, the term "game" brings up the mental image of playing cards or board games like Monopoly and Scrabble where these games are brief and simplistic (Klabbers, 2003). Subsequently, when these educators are immersed into the world of current games, they tend to back away or rebel against it due to the misconception of complexity of creating and managing these games (Baek, 2008; Kenny & McDaniel, 2011). Thus, there is a need to find another way to alleviate the phobia teachers have towards game-based learning, whilst still retaining the advantages of learning via game-based learning.

Meanwhile, students nowadays are more familiar with video games as they are designated by as "digital natives" (Prensky, 2001). Digital natives are known as "native speakers" of the digital language of computers, video games, and the Internet; who were loosely born after the 1980s (Botthuri & Loh, 2008). For them, these technologies have always been a part of their lives (Johnson, Adams, & Haywood, 2011). Thus, they have become detached from school and its curriculum with effects on their levels of motivation, which in turn negatively affects their learning outcomes.

As there are various types of games being used in learning, three main current variations have been compared in some studies. These variations are Game-Based Learning (GBL), serious games and gamification. Game-Based Learning (GBL) refers to the use of video games as a tool in learning. The transformative resources of Game Based learning technologies have adverse and positive effects on STEM education (Prensky, 2001; Spires et al., 2008) as it makes the learning process more connected to the lives outside the school context. Vogel et al. (2006) found that

games were more effective than traditional classroom instruction on learners' academic learning gains and cognitive skill development (Green & Bavelier, 2003; Green & Bavelier, 2006). Squire et al., (2004) carried out a mixed method research on 8th graders in learning electromagnetic. They found that gaming group out-performed the conventional instruction. In another study, Clark et al. (2007) pointed out that studies on science learning through games revealed learning gains and science knowledge retentions. Yet, according to Hickey et al. (2009) games promoted better understanding of scientific concepts and achievement. This was also contributed by the formative feedback by the game. O'Neil et al. (2005) stated that educational games are not adequate to enhance learning, to assert individual differences, and to consider learners' needs. Serious Games is an "activity carried out mainly to achieve learning of serious context via games" (Pourabdollahian et al., 2012). This was emphasized by Egenfeldt-nielsen (2006) who stated that in serious games, the main focus is on learning and education through the employment of games, rather than focussing on fun and entertainment. On the other hand, gamification, which refers to the use of game elements in non-gaming context (Deterding et al., 2011; Gabe Zichermann & Cunningham, 2011), has been taken up as an easier way to introduce users to the excitement of games without infusing the full aspects of the game. In addition, Rughiniș (2013) stated that there is a difference between serious games and gamification. While serious gamers get involved in the game to win it, gamification constructs gameplay on defining a feat experienced as non-gameful, for example by getting an achievement badge for completing a task.

In the field of education, gamification is used in applications and processes to improve learning (Bellotti *et al*., 2012). This is supported by Zichermann and Cunningham (2011) who state that in education, game mechanics have been proven to be very useful tools for classroom learning. This was also supported by Ananth Pai, a former business executive who took up teaching at an elementary school (Ferguson, 2012; Richards, 2013). He reached this conclusion by incorporating games to his curriculum by using leader boards and social challenges. As the results showed a noticeable improvement in reading and Mathematics within 18 weeks, it can be understood that gamification does not have to be implemented in virtual world as the game mechanics can be transferred and used through life. Despite the success of gamified application in education, the path used to create the learning experience

was not discussed. Thus, there is a need to have a model or framework for the educators to use as a blueprint to implement these approaches in the teaching and learning process.

Consequently, Oak & Bae (2013) found that gamification, through the problem-solving activity of game stories with a play-minded approach and through fun, was employed to activate voluntary participation of the users. Consequently, this allowed immersion to be enabled. The strongpoints of gamification, which can unmistakably distinguish the reason, errands, behaviours, and that should be achieved, is rewarding when points are attained. This is to encourage the participants to differentiate and somehow manage the problems that they confront in the society, where individuals are staying and the components of fun, scores, level-ups and ranking rivalries are regarded to play a part of supporting voluntary support by prompting individuals' internal and external motivations. Even though the study is not exceptionally broad, the findings proposed that playing video games helps cognitive, social, motivational and emotional improvement. Oak & Bae (2013) also figured out that those video games have effects on students. Yet, there is a need for investigating this in school and in education in general.

The existence of the key elements in gamification, which are Points, Badges and Leader boards (P.B.L), has long been in and out of a student's life (Becker & Nicholson, 2016), and recently with the implementation of School Based Assessment (S.B.A). Despite the abolishment of points in assessing students, the existence of Bands or Level of achievement compensate the points element, whilst badges still exist in co-curriculum, and leader board despite being overlooked in classes nowadays (Werbach, 2014) still exists when a comparison is done with the students that achieved higher level of Bands or Levels in their school based assessment.

Based on these findings, it is vital to sustain and improve students' motivational needs via using an engaging form of approach such as gamification that can improve students' achievement in learning. The use of only game elements can encourage educators to implement gamification in teaching science. Subsequently, it can help various students who are digital natives and to connect this to their everyday lessons.

1.3 Statement of problem

Science, Technology, Engineering and Mathematics (STEM) are an integral part of education. The free fall of PISA and TIMMS ranking of Malaysia sends warning regarding students' achievement in the past few years. Therefore, the introduction of technology into the education was the next upgrade of the instruction method. Nevertheless a research by Craig et al., (2004) discovered that boredom towards learning correlated with the online Intelligent Tutoring System. Hence, just absorbing technology in education has not reaped the same effects as games or using social networking services such as Facebook, Google+, Twitter, and MySpace (Boyd & Ellison, 2007). This was because students do not feel that the technology is a tool for learning. Instead, students think that it is an essential part of their lives (Gardner & Eng, 2005). Therefore, this arises the need to consider an approach that fulfils the needs of various students and allows them to be immersed in the learning process.

Game based learning was found to have significant potential, especially in STEM education (Prensky, 2001). Therefore, Vogel *et al.* (2006) found that interactive games are effective for improving academic achievement and can contribute to the cognitive development. Lee & Hammer (2011), Hwang *et al.* (2013), and Oak & Bae (2013) suggest that playing video games can contribute to cognitive, social, motivational and emotional development. Based on their findings, it can be claimed that using games in learning can yield a successful utilization of technology in education. Yet, it is not easy to implement game-based learning into the teaching and learning process due to its disadvantages such as cost and time in creating these games (Muntean, 2011). Thus, the approach known as gamification — the use of game elements as opposed to creating the whole game itself (Deterding et al., 2011) — can be seen as the next best alternative for educators and the organization.

As a teaching and learning process that involves both traditional and online teaching methods are deemed the best fit for students (Finlay, Desmet, & Evans, 2004; Hannay, M., & Newvine, 2006), this current study considers that the best learning path is the one that combines both these processes. Implementation of gamification in education has reaped contrasting results either via offline or online

methods. Through the online method, Schouten *et al*. (2011) and Barata et al. (2013) found that improvement in the achievement levels of the students was not significant, even though engagement and motivation levels were found to have increased. Whilst Filsecker & Hickey (2014) instead found that there was no significance when it came to engagement and motivation, they also reported that the gamification rewards system played a part in boosting participants' learning. Similarly, when it came to the offline form of gamification, Spence *et al.* (2012) and Hong & Masood, (2014) successfully showed the improvement in motivation when using gamification. Furthermore, Spence *et al*. (2012) looked into users' need regarding how to use the library tools because it is important to examine the needs of the users over the organisation (Nicholson, 2012). On the other hand, Hong & Masood (2014) just adhered to Glover' (2013) argument which highlighted that the need to identify levels of motivation and that creating gamification should be done and planned at the same stage. There are two shortcomings of these findings: (1) the findings were based on questionnaire feedback alone; and (2) the time frame of the research was too short to see whether the positive effect was due to gamification or the sudden introduction of a new learning method. The contradictory findings achieved via online gamified method and the incomplete process framework given in the implementation process of the offline or traditional learning method creates a need to look at the effects of gamification via both online and offline methods on the users.

In the context of Malaysia, gamification research by Ong *et al*. (2013) looked into the potential effects of gamification based on prior experience of post graduate students and found it to be encouraging and feasible for implementation. In another study, Hong & Masood (2014) examined the use of offline method to find out the effects of gamification and traditional classes in learning Geography for secondary school students. They reported some significant improvements in motivation. However, this was not significant when it came to engagement. Generally speaking, in Hong and Masood (2014) the implementation time was too short to look at its validity. Similarly, Tan, Noor, & Wang (2014) looked into Gamification of TRIZ (*teoriya resheniya izobretatelskikh zadach*), which literally means "theory of the resolution of invention-related tasks", in order to make the learning process explicit while maintaining the fun factor. Tan, Noor, & Wang (2014) addressed the planning phase of the gamified program as well as the challenges encountered during the

development process. In another study, Fah *et al.* (2016) investigated how teaching and learning methods of English at the tertiary education level happens while incorporating gamification. It found that gender difference was not significant when it came to learning via gamification. Subsequently, it was found that the participants had positive attitudes towards using acceptance of gamification (PLE) in language learning and showed positive intention in using gamification in their future language learning. This reveals that there was no need to look into the gender effects on gamification. However, there was a need to look extensively into implementing gamification in Malaysian education system.

Another aspect that appeared to be lacking in a gamified environment is the need for the existence of social element. As stated by Morrison & DiSalvo (2014), gamification platform, such as the Khan academy, can be more effective with social interaction. Barata *et al*. (2013) also pointed out the need for social elements as the users felt the need to create online groups to undertake the tasks. This was further enforced by Morschheuser *et al*. (2014)who found that gamification which promoted social interaction led to quality feedback among students and with teachers/tutors. The only downside of the study of Morschheuser *et al*. (2014) is that participation level was too low and it was not stated what caused this. Therefore, this creates another gap for future researchers to consider, focusing on the effects of social elements towards gamification.

When it comes to playing games, there are many types of player need or motivation that represent their player traits when they are engaged in a game (Charles, Kerr, & McNeill, 2005; Deterding, 2011b). Although in gamification, Epema and Iosup (2014) looked into gamification using Bartle's player motivation scale (Bartle, 1996) and reported a high success rate, what seemed to bring dispute is the change in describing the player traits. A revised version of Bartle's player motivation scale by Yee (2006) considers player motivation scale for online platform gamers as compared to Bartle's player motivation scale that was created based on multi user dungeon (MUD) gamers. The usage of player traits as an early indication system to identify the individualistic needs of students will help future researchers in either game based learning, serious games or gamification. With the Gen-Z students being born into a world filled with technology (Fister Gale, 2015), the use of

technology in entertainment especially games is not a major surprise. Thus, instead of looking at the negatives of games and weeding it out, it would be more meaningful if interest in these games is cultivated properly. Therefore, this current study used Yee's player motivation scale for two reasons: (1) it is a revised version of Bartle's player motivation scale and (2) it was based on online platform game player motivations. Besides that, Yee's player motivation will be suitable as it helps map out players' traits in participating in the gamified learning process, thus supplementing another aspect of this field of research. Hence, the researcher intends to see the effects of gamification on the achievement, engagement and motivation levels of among students of different player traits in learning science.

In summary, this current study is intended to fill the gap in gamification where it aims at infusing gamification into the learning process of students with different player traits, via both online and traditional or offline classroom. Besides that, based on the discrepancies of past researches, this current study considers how gamification based learning affect students' achievement, engagement, and motivation.

1.4 Research Objective

This current study aims at addressing the following objectives:

i. To examine the types of Player Traits that exist among students.

ii. To identify the effects of using the gamification approach in learning and assessment in learning Science on:

   (a) students' engagement level

   (b) students' intrinsic motivation

   (c) students' achievement level

iii. To identify how gamification elements are affected after using the gamification based learning and assessment in learning Science.

iv. To identify the effects of player motivation as a mediating variable on students' engagement, motivation and achievement in learning Science.

v. To propose a model of gamification based learning and assessment through an online and offline platform to enhance the engagement, motivation and achievement in learning Science.

1.5 Research Questions

This current study aims at investigating and providing insights to the following research questions:

i. What are the types of Player Traits that exists among the students?

ii. What is the effect of using the gamification approach in learning and assessment in learning science?

(a) What is the students' engagement level after using the gamification based learning and assessment in learning Science?

(b) What is the students' intrinsic motivation after using the gamification approach in learning and assessment in learning science?

(c) What is the students' achievement level after using the gamification based learning and assessment in learning Science?

iii. How are the gamification elements affected after using the gamification based learning and assessment in learning Science?

iv. What are the gamification elements that mediate the effect of player motivation on engagement, intrinsic motivation and achievement?

v. What is the suitable model of gamification based learning and assessment through an online and offline platform that can enhance the learning of Science?

1.6 Theoretical Framework

This current study was carried out based on the theoretical framework shown in Figure 1.1. The theoretical framework guided the study in identifying the theories involved in implementing this research both online and offline.

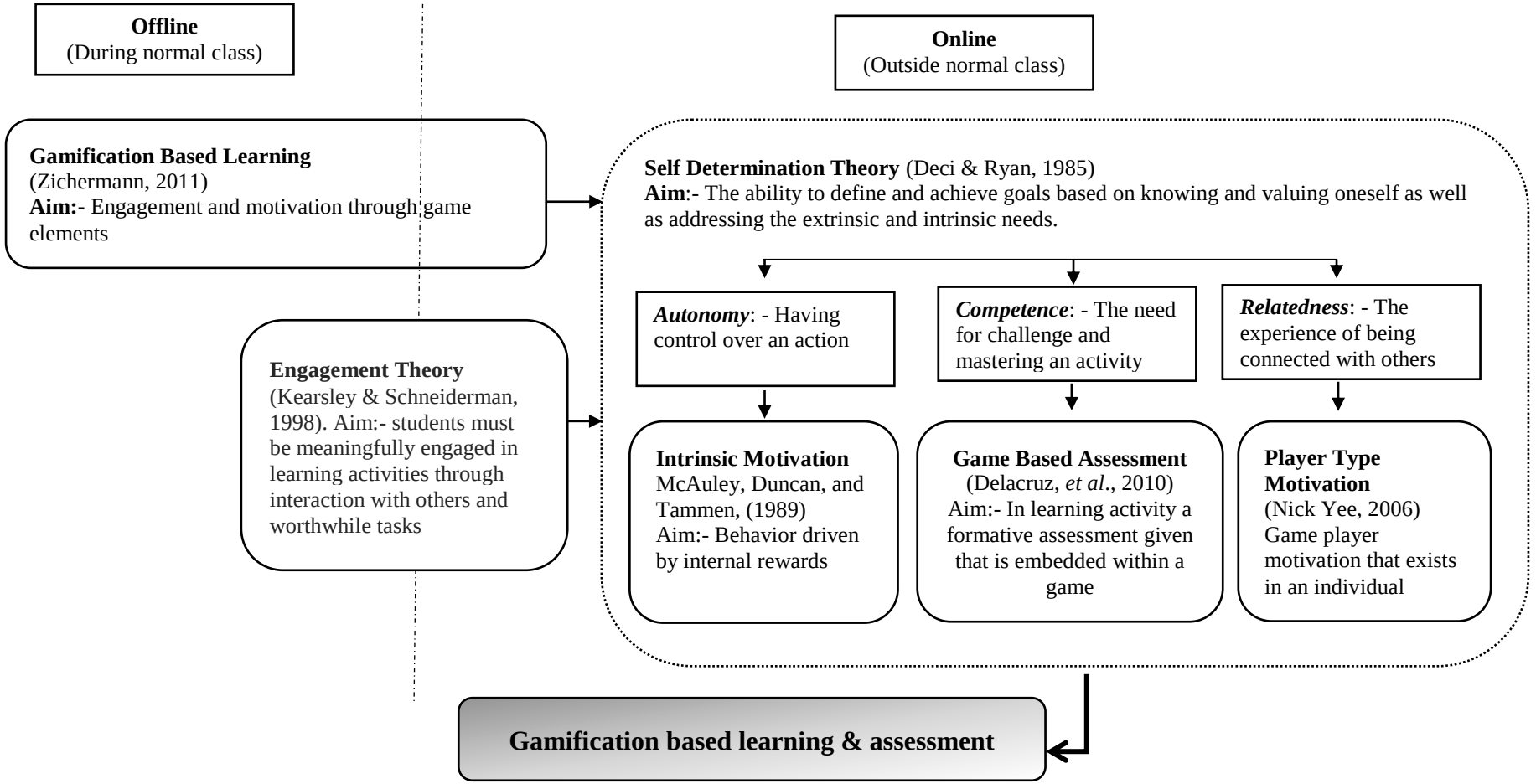

Figure 1.1 Theoretical Framework

Piaget (1952) and Gehlbach (1991) state that play on its own does not necessarily result in the formation of new cognitive structures. Although it allows the children to practice things they had previously learned, it does not necessarily result in learning new things. In other words, play reflects what a child has already learned but does not necessarily teach the child anything new. In relation to games, according to Salen & Zimmerman (2004), the element of play and games are related to:

1. Games are a subset of play as there are many playful activities where some of these are games but others are not.

2. Play is a subset of games as rules, culture and play are the three aspects of the game phenomena.

Based on this principle, the use of play in other forms was formulated as play was the foundation of games. Though there were many categories of games used in learning, three were highlighted in this research. They are Serious games, Game-based learning and Gamification, with the latter being the latest approach introduced in the field.

Self-determination theory by Deci & Ryan (1985) discusses the ability of someone to define a task in hand and achieve goals based on knowing and valuing the ability of oneself as well as addressing the extrinsic and intrinsic needs. It is a well-known theory of motivation and personality needs that encompasses competence, autonomy, and relatedness (Ryan & Deci, 2000). Competence invokes the need for mastery and challenging oneself that are attained via the game based assessment that exists in the gamified learning process. Autonomy invokes the need to be in control, where the participants can undertake the tasks of their choice and strife for the gamification elements they deemed to satisfy. Relatedness invokes the need to be connected with others. This can be attained by identifying individual player motivation traits and identifying how it interrelates with the gamified learning process the participants go through.

As gamification is about using game elements in creating video game such as experiences to the users, there is a need to emphasize the offline or traditional classroom, whereas the students will be exposed to the game elements. However, they need to know that it exists for the main objective of learning topics in Science. Based on engagement theory of Kearsley & Schneiderman (1998), to ensure a meaningful engagement towards the gamification elements and tasks, game elements were applied in the traditional classroom to allow teachers to control the elements of gamification that might be beyond learners' capacity. This allowed the students to concentrate and undertake tasks that are within the range of their competency. It should be noted that it is improbable for a teacher to consider a student individually or one on one in a normal learning environment. Thus, the combination of classroom activities and support of a gamified learning environment assists in identifying students' motivation and engagement level that enhanced learning Science.

On the part of online lesson, the gamified environment is based on the approach of game-based learning which is a teaching-learning activity that is implemented in a formal or informal educational with the help of game settings (Gee, 2003). This may include games that are designed mainly for fulfilling learning objectives such as educational games and mainstream games that are originally developed for fun, but instead they are used to pursue learning objectives (Freitas & Staalduinen, 2009). A sound and well-created educational game can be seen to promote the use of educational theories in classroom (Amory & Seagram, 2003)

As the gamified environment has game elements such as points, badges, and leader boards (Zichermann & Cunningham, 2008; Deterding & Dixon, 2011), assessment distributes the game elements to the students. Based on Zichermann, (2011), to achieve a successful Gamification based learning, it is emphasized that there is a need to put fun first, followed by education. This can be achieved by relating achievement attained by students in the learning process with game elements such as points, badges, or leader board.

According to Delacruz *et al*. (2010) and Delacruz (2011), in a learning activity formative assessment can be given by the teacher or it can have embedded within a game. With a game based assessment, the students can either assess themselves or

even assess the performance of their peers. If scoring rules for the game are tied to learning goals, tying the rubric to scoring rules can make assessment transparent (Delacruz, *et al*., 2010 ; Delacruz, 2011).

Yet, a mere implication of assessment that suits all students can lead to the creation of a meaningless form of gamification (Nichloson, 2012). Therefore, this current study intends to find a way to identify learning paths that suit all students. To support this, this current study examined the approach discussed by Richard Bartle (1996). Through his research on Multi User Dungeon (MUD), the findings found that those who play games are guided by certain types of motivation. His initial findings were refined by Yee (2006) who found that an updated model of player motivation had three main components and 10 subcomponents:

i) Achievement: Advancement, Mechanics, Competition
ii) Social: Socialising, Relationship, Teamwork
iii) Immersion: Discovery, Role-playing, Customization, Escapism

The researcher used Massively Multiplayer Online Roleplaying Games (MMORPGs) to gather data via questionnaires. Yee (2006) differed from Bartle by stating that the constructs are overlapping sets of psychological and social 'motivations' based on player behaviour and preferences.

The Intrinsic Motivation Inventory (IMI) is a measuring instrument used to examine the users' experience based on the tasks or activities carried out. The instrument scale was used to identify the participant's interest/enjoyment, perceived competence, effort, perceived choice, value and pressure faced or felt during an activity or task. Although the original scale was created by Deci & Ryan (1985), the Intrinsic Motivation Inventory (IMI) was only later successfully validated by McAuley, Duncan, & Tammen, (1989), who reported that this scale deemed to be suitable.

Subsequently, the use of game elements, such as points, badges and leader boards, allowed the researcher to come up with a model of gamification — a model that is based learning and assessment in learning Science.

1.7 Conceptual Framework

Generally, the conceptual framework of this research has two types: a process framework and a content framework. A process framework shows the stages of which the research moves from initiation to the ending, meanwhile a content framework discusses the relationship between variables. This current study employs these two frameworks.

While Figure 1.2 shows the content framework of the research, Figure 1.3 presents the process framework of the research.

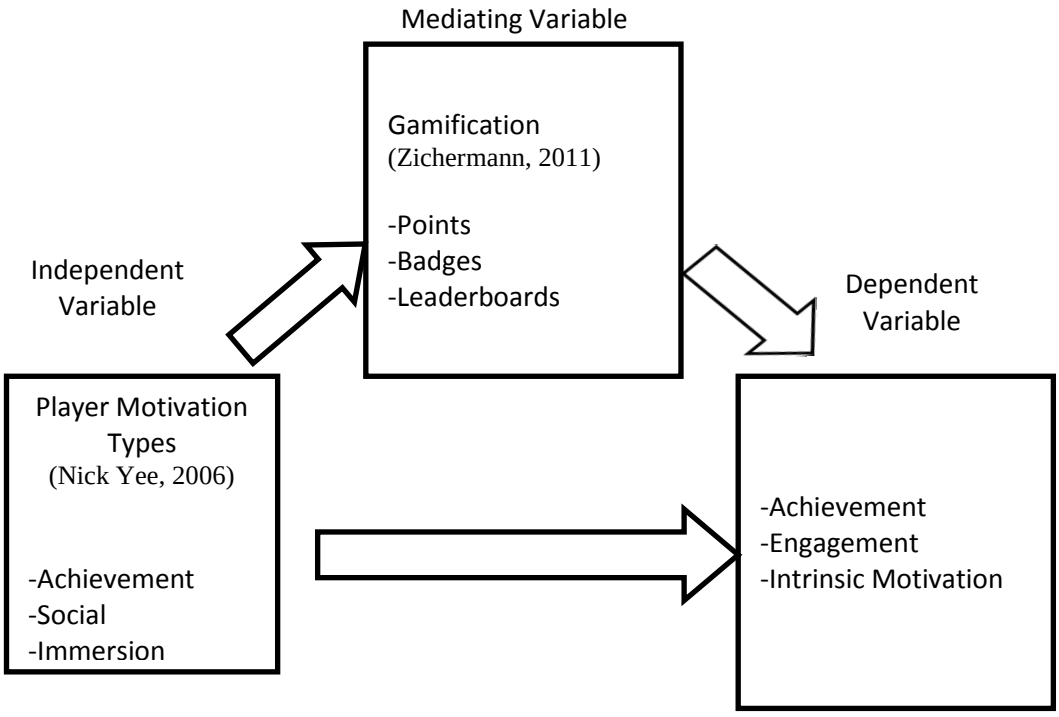

Figure 1.2 Content Framework of the research

The content framework of this current study shows the variables used in this research. The mediating variable comprises game elements found in gamification. These elements are points, badges, and leader boards. The dependant variables are the participants' achievement, engagement towards gamification, and students' motivation. The independent variables are the player motivation. It is also to be noted

that this research looks into the classic mediation method (Baron and Kenny, 1986). This framework is adopted to ensure a meaningful gamification based learning.

The process framework, as shown in Figure 1.3, starts with three aspects: an offline (traditional classroom), online learning, and assessment method. For the offline method, the teacher infuses game elements such as points, badges, and leader board into the traditional classroom of teaching and learning. To identify the Player Traits throughout the research, Player motivation types by Yee, (2006) are used as benchmark for the teachers to know the students' motivation, thus allowing the researcher to identify the distinct traits of students towards learning with the help of gamification based learning. When it comes to online platform, the infusion of gamification's game elements and player motivation characteristics pave the way in creating a Gamification Based Learning and Assessment Model.

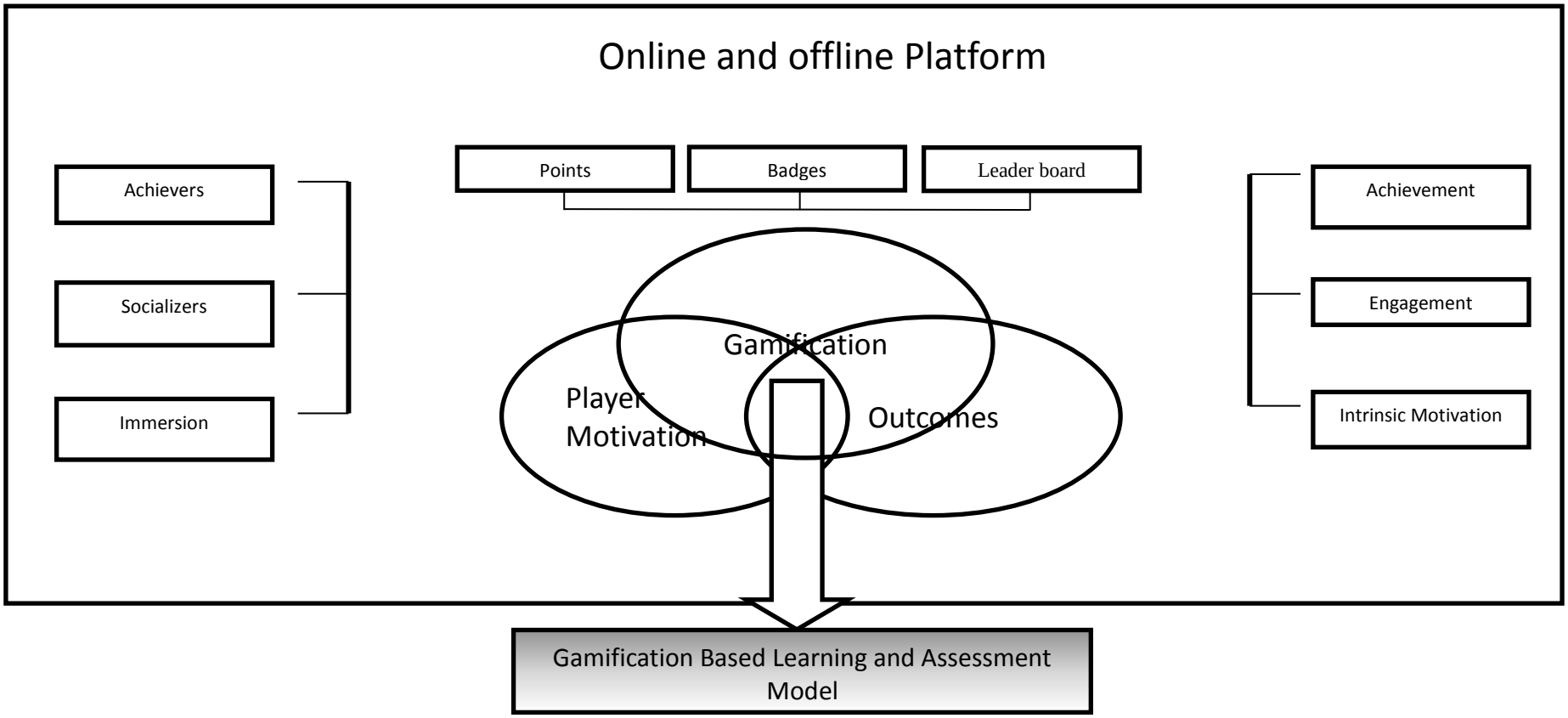

Figure 1.3 Process Framework of the research

1.8 Research Rationale

Gamification is an approach that has been implemented in several fields, such as commerce, health and learning. Its influence can be seen in Starbucks, where if you buy 10 cups of coffees, you will get one free (Huotari & Hamari, 2012). This can be found also in airlines. For example, Air Asia (Airline Company) with loyalty programme, collecting points through the purchase of airline tickets where the accumulated points can be redeemed by its users to get rewards (Xu, Weber, & Buhalis, 2013). With this gamification, the usage of points and badges in Starbucks where the use of game mechanics in non-gaming elements exist. Therefore, gamification work indirectly in the background using extrinsic rewards to promote their products (Crowley, Breslin, Corcoran, & Young, 2012; Nicholson, 2015).

Therefore, looking at other methods that can invoke the intrinsic factors. For instance, an app created by Nike, Nike Running (Diewald, Möller, Roalter, & Kranz, 2012; King, Greaves, Exeter, & Darzi, 2013), promotes the user to jog a certain distance per day, per week, and allows them to share their progress with friends (Gabe Zichermann & Cunningham, 2011). Despite the hidden agenda in it to promote its product, the product motivates and pushes the users to work out and stay healthy. So, the extrinsic factors eventually make the users go for the intrinsic value of losing weight or staying healthy.

The vast difference between the extrinsic and intrinsic motivation can be seen in another running app which is Zombie Run. The app creates a scenario from a zombie movie when the users are being chased by zombies and must run for their lives (Erenli, 2013; Knaving et al., 2013; Morford, Witts, Killingsworth, & Alavosius, 2014). Although the extrinsic motivation is rather illogical, it intends to create an intrinsic motivation, which is to stay alive, thus pushing a person to jog for improving his or her health in the process.

In school, gamification has been used all along, in a different perspective. Whereas points are used by gamification to rank the students via the examination marks, badges are achieved through achievement in class or during lesson. For

instance, the teacher can give a student a star for his effort or even the use of the written praise such as good or excellent (Kapp, 2012; Mekler et al., 2013). In some cases, the number of star accumulated is exchanged with simple rewards that will improve the motivation and the engagement of the students in the classroom. Yet, with the changing of time, student's motivation continues to vary (Barata et al., 2013). They require and strife for more to satisfy their intrinsic needs and motivation. For instance, in extracurricular activities such as scouts, getting certain badges pushed the students to learn more and do more for the chance of attaining these badges (Deterding, 2012; Glover, 2013) . This is a case where there is valueless extrinsic reward, but students' strife for it, satisfying their internal desires or in other words, intrinsic motivation.

Therefore, gamification needs to be infused into the way that can educate the students (Nicholson, 2012b). Using an interesting; technology based platform, this research hopes to take the word of assessment out the minds of the students and make it into play, something fun to do (Barata et al., 2013; Arnold, 2014; Sanmugam et al., 2014). Using the fun factor, one can ensure that the assessment get done, and at the pace of the student's capabilities. In this way, the students challenge only themselves, with no distraction of grades and failing the subject.

Yet, it cannot be taken up as a vague assumption that all students are slow or have limited capabilities. Therefore, to identify this, Nick Yee's Player Motivation Types questionnaire (Yee, 2006) is used where it helps to identify whether the students can be seen as having the characteristics of achievers, socializers, explorers, or socializer. With this, what drives and motivates the students can be identified, whilst using the gamification in learning Science. Thus, this can help in creating a model of gamification based learning that helps to pave the way for future researchers and educators in teaching and learning.

1.9 Research Importance

Based on the Malaysian Education Blueprint, it is stated that incorporating technology in education as well allowing students to learn at their own pace. Yet, with the additional of intrinsic motivation, there will be no need for the teacher to worry about pace because students' needs of achievement and motivation guide students to the finish line. Therefore, the importance of this current study to the students, teachers, and the Ministry of Education is presented in the following sections.

1.9.1 Students

For students, the gamified assessment system allows students to participate in an environment that is suitable for the 21st century education, whilst at the same time the system does not demotivate the students as they carry out the tasks at their own pace and their own level of understanding. Besides that, the availability of leader board pushes the high achiever to strive for.

1.9.2 Teachers

Teachers are able to identify the types of assessment that motivates a certain group of students, and at the same time by identifying the player motivation types, the teacher can create a higher level of assessment for those students. In a way, a teacher can use the gamified system for easier assessment.

1.9.3 Ministry of Education

By introducing the gamified system in the school based assessment, it is hoped that the system can help teachers tackle the levels/bands of their lessons. Therefore, reinforcing and continuing the implementation of school based assessment can be done without much hassle and objection.

1.10 Research Scope and Limitations

The scope of the study is discussed in this sub-section.

1. The scope of this study is confined to the students in Sekolah Berasrama Penuh (SBP) in Johor
2. In this study, the gender issue is not looked into, and the data was collected from heterogeneous groups.
3. The learning content is limited to the Science subject using the 2013 syllabus of the Ministry of Education, Malaysia.
4. The topics chosen for the gamified study is accessed based on the preliminary study carried out at the schools, through questionnaires answered by the teachers and students.
5. The infusion of gamification is used as a part of the lesson not the lesson as a whole, as to not interrupt the school based learning being carried out by the teacher.

Meanwhile, the results of this study are limited to the following:

1. The availability of technology in the schools that are used for the preliminary studies, pilot studies and the real research.
2. Prior knowledge of students and teachers in games and in using computers.
3. It cannot be assumed that the sample represents the whole population of Form 1 students in the state because this study focuses on only Sekolah Berasrama Penuh (S.B.P) in Johor. Yet, it can provide useful information for answering the problem faced in these types of schools.
4. The amount of time each student is exposed to the online platform.
5. The flexibility of gamified platform to accommodate the teaching and learning process.

1.11 Operational Definitions

Several operational definitions used in this research are discussed in the following sub-sections.

1.11.1 Gamification

Gamification is an approach that incorporates game elements in non-gaming context (Deterding, Dixon, Khaled, et al., 2011; Deterding, Dixon, Sicart, et al., 2011). For this research, during the learning process, gamification is infused in both online and offline classes. During the offline or traditional classes, game elements are introduced via emphasizing and highlighting the already existing pints in marks from worksheets and leader board from student ranks. As additional badges are introduced as an added incentive that acts as a form of commendation or reward based on students' actions, either individually or in groups.

During the online classroom, game elements exists in points via scores from the completed online tasks, leader board from the accumulated points of the tasks, and badges achieved from accomplishments through the online and offline based rewards.

1.11.2 Science

For this research, the subject chosen in implementing the gamification based learning and assessment system is Science for Form 1 students. This is chosen as it is a foundation subject that paves the way towards advanced scientific topics, such as physics, chemistry, biology and engineering as well as a precursor before achieving the successful integration STEM (Science, Technology, Engineering and Mathematics) education which is vital in shaping the future of the nation workforce (Tseng, Chang, Lou, & Chen, 2013). The topics chosen to be gamified are Topic 6 — Sources of Energy (Sumber Tenaga) — and Topic 7 Heat (Haba).

1.11.3 Intrinsic Motivation

Intrinsic motivation is normally defined as a behavioural measure of ones' "free choice" to carry out a task based on internal needs or rewards (E. L. Deci, Eghrari, Patrick, & Leone, 1994; Ryan & Deci, 2000).

In this current study, the intrinsic motivation is identified via the Intrinsic Motivation Inventory by McAuley, Duncan, and Tammen (1989). The level of intrinsic motivation of the students in this current study is identified in pre-and post-gamified intervention. This is done to see the level of the students prior to the experiment and after the experiment.

1.11.4 Player Motivation

In this research, Player Motivation used to identify different game player motivation that exists in the students. Based on the three different types of Player Motivation by Yee, (2006); Achievement, Social, Immersion, where based on the majority tendency, these traits are used as a benchmark and independent variable against the other variable in this current study.

1.11.5 Engagement

In this current study, the engagement elements are analysed based on the participation level of the students in the gamified learning tasks (Birch & Ladd, 1997; Fredricks et al., 2004). In this current study, engagement elements are seen through the number of times a student logs into the gamified system in the online platform and completes each of the subtopics given to them via the gamified platform. A successful login is recorded only after the students complete all the questions given to them within the tasks. Students are also allowed to re-login into the tasks without restrictions.

1.11.6 Model of gamification based learning

The model of gamification based learning that is acquired from the research will enable future researchers to fully utilize gamification as an approach during traditional and online classroom to improve the Science learning aspects (Kühne, 2005a). It will act as a blueprint for educators to use a reference to ensure creating a meaningful gamified learning experience for the students.

1.12 Summary

This chapter reviewed the problem background, problem statement, and the purpose of the study, theoretical framework, and research questions, significance of the study, research scope, and limitations of the study. Lastly, the chapter discussed the operational definitions used in the study.

The key focus of this study is to look at the effects of implementing gamification in online and offline modes. This is done through engagement, motivation, and achievement in learning Science at Malaysian Secondary Schools, whilst identifying Player Motivation of the students in identifying the right path of learning for the students.

REFERENCES

Abt, C. . (1987). *Serious games*. University Press of America.

Ali, W. Z. W., Nor, H. M., Hamzah, A., & Alwi, N. H. (2009). The conditions and level of ICT integration in Malaysian Smart Schools. *International Journal of Education and Development Using ICT*, *5*(2), 21–31.

Amory, A. (2009). Learning to Play Games or Playing Games to Learn? A Health Education Case Study with Soweto Teenagers. *Australasian Journal of Educational Technology*, *26*(6), 810–829.

Amory, A., & Seagram, R. (2003). Educational game models: conceptualisation and evaluation. *South African Journal of Higher Education*, *17*(2), 206–217.

Anderson, J. Q., & Rainie, H. (2012). *Gamification : Experts expect " game layer s " to expand in the future , with positive and negative results*. Pew Internet & American Life Project.

Annetta, L. A., Minogue, J., Holmes, S. Y., & Cheng, M. T. (2009). Investigating the impact of video games on high school students' engagement and learning about genetics. *Computers and Education*, *53*(1), 74–85.

Arnab, S., Lim, T., Carvalho, M. B., Bellotti, F., De Freitas, S., Louchart, S., … De Gloria, A. (2015). Mapping learning and game mechanics for serious games analysis. *British Journal of Educational Technology*, *46*(2), 391–411.

Arnold, B. J. (2014). Gamification in Education. (*ASBBS) American Society Of Business And Behavioral Sciences*.

Attali, Y., & Arieli-Attali, M. (2015). Gamification in assessment: Do points affect test performance? *Computers and Education*, *83*, 57–63.

Babakus, E., Carl E Ferguson, J., & Jöreskog, K. G. (1987). The Sensitivity of Confirmatory Maximum Likelihood Factor Analysis to Violations of Measurement Scale and Distributional Assumptions. *Journal of Marketing Research*, *24*(2), 222–228.

Baek, Y. K. (2008). What Hinders Teachers in Using Computer and Video Games in the Classroom? Exploring Factors Inhibiting the Uptake of Computer and Video Games. *CyberPsychology & Behavior*, *11*(6), 665–671.

Baker, S. R. (2004). Intrinsic, extrinsic, and amotivational orientations: Their role in university adjustment, stress, well-being, and subsequent academic performance. *Current Psychology*, *23*(3), 189–202.

Baki, R., Leng, E. Y., Zah, W., Ali, W., Mahmud, R., Sahandri, M., & Hamzah, G. (2008). The perspective of six Malaysian students on playing video games : Beneficial or detrimental ? *US-China Education Review*, *5*(11), 11–21.

Barata, G., Gama, S., Jorge, J., & Goncalves, D. (2013). So fun it hurts - Gamifying an engineering course. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (Vol. 8027 LNAI, pp. 639–648).

Barata, G., Gama, S., Jorge, J., & Goncalves, D. (2013). Engaging Engineering Students with Gamification. *2013 5th International Conference on Games and Virtual Worlds for Serious Applications (VS-GAMES)*, 1–8.

Barata, G., Gama, S., Jorge, J., & Gonçalves, D. (2011). So Fun It Hurts–Gamifying an Engineering Course. *Foundations of Augmented Reality*, 10.

Barata, G., Gama, S., Jorge, J., & Gonçalves, D. (2013). Engaging Engineering Students with Gamification An empirical study. *2013 5th International Conference on Games and Virtual Worlds for Serious Applications (VS-GAMES)*, 1–8.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*(6), 1173–1182.

Bartle, R. (1996). Hearts, clubs, diamonds, spades: Players who suit MUDs.

Bartlett, J. E., Kotrlik, J. W., & Higgins, C. C. (2001). Organizational research: Determining appropriate sample size in survey research appropriate sample size in survey research. *Information Technology, Learning, and Performance Journal*, *19*(1), 43.

Becker, K., & Nicholson, S. (2016). Gamification in the Classroom : Old Wine in New Badges. In *Learning, Education and Games* (pp. 61–85).

Beeland, W. D. (2002). Student Engagement , Visual Learning and Technology : Can Interactive Whiteboards Help ?

Bellotti, F., Berta, R., De Gloria, A., Lavagnino, E., Dagnino, F., Ott, M., … Mayer, I. S. (2012). Designing a Course for Stimulating Entrepreneurship in Higher Education through Serious Games. *Procedia Computer Science*, *15*, 174–186.

Berkling, K., & Thomas, C. (2013). Gamification of a Software Engineering Course and a detailed analysis of the factors that lead to it ' s failure. *Interactive Collaborative Learning (ICL), 2013 International Conference*, (September), 525–530.

Birch, S. H., & Ladd, G. W. (1997). The teacher-child relationship and children's early school adjustment. *Journal of School Psychology*, *35*(1), 61–79.

Black, P., & Wiliam, D. (1998). Inside the Black Box : Raising Standards Through Classroom Assessment By Paul Black and Dylan Wiliam. *Phi Delta Kappan*, *80*, 139–144, 146–148.

Bostan, B. (2010). Explorations in player motivations: Virtual agents. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (Vol. 6243 LNCS, pp. 262–269).

Botthuri, L., & Loh, C. S. (2008). Once Upon a Game: Rediscovering the Roots of Games in Education. In C. T. Miller (Ed.), *Games: Purpose and Potential in Education* (pp. 1–22). Springer Science.

Boyd, D. M., & Ellison, N. B. (2007). Social Network Sites: Definition, History, and Scholarship. *Journal of Computer-Mediated Communication*, *13*(1), 210–230.

Bragg, L. A. (2007). Students' conflicting attitudes towards games as a vehicle for learning mathematics: A methodological dilemma. *Mathematics Education Research Journal*, *19*(1), 29–44.

Brislin, R. W. (1970). Back translation for cross-cultural research. *Journal of Cross-Cultural Psychology*, *1*, 185–216.

Browne, C. (2013). *Game Analytics*.

Bryman, A., & Cramer, D. (2005). *Quantitative data analysis with SPSS 12 and 13: a guide for social scientists*. Psychology Press.

Butler, D. L., & Sellbom, M. (2002). Barriers to Adopting Technology for Teaching and Learning. *Educause Quarterly*, *25*(2), 22–28.

Butt, T. (2012). Adaptive Practice, 1–10.

Cardona-Rivera, R. E., & Young, R. M. (2012). Characterizing Gameplay in a Player Model of Game Story Comprehension. In *Proceedings of the International Conference on the Foundations of Digital Games* (pp. 204–211).

Chantzi, A. E., Plessa, C., Gkanas, I. C., Tsolis, D., & Tsakalidis, A. (2013). Design and Development of Educational Platform in Augmented Reality Environment using Gamification to enhance Traditional , Electronic and Lifelong Learning Experience Categories and Subject Descriptors. *BCI'13*, *i*, 92–95.

Charles, D., Kerr, a, & McNeill, M. (2005). Player-centred game design: Player modelling and adaptive digital games. In *Proceedings of the digital games research conference , 285*(6), 285–298.

Chee, Y. S., & Mehrotra, S. (2012). Reflective, Reflexive Guided Appropriation: Facilitating Teacher Adoption of Game Based Learning in Classrooms. In *6th European Conference on Games Based Learning* (pp. 109–116).

Cheng, M. T., Lin, Y. W., & She, H. C. (2015). Learning through playing Virtual Age: Exploring the interactions among student concept learning, gaming performance, in-game behaviors, and the use of in-game characters. *Computers and Education*, *86*, 18–29.

Chin, S. H. (2009). On application of game theory for understanding trust in networks. In *2009 International Symposium on Collaborative Technologies and Systems, CTS 2009* (pp. 106–110).

Choi, J., & Medalia, A. (2010). Intrinsic motivation and learning in a schizophrenia spectrum sample. *Schizophrenia Research*, *118*(1–3), 12–19.

Chou, Y. (2015). Octalysis – complete Gamification framework. Retrieved from http://yukaichou.com/gamification-examples/octalysis-complete-gamification-framework/

Christy, K. R., & Fox, J. (2014). Leaderboards in a virtual classroom: A test of stereotype threat and social comparison explanations for women's math performance. *Computers and Education*, *78*, 66–77.

Clark, D., Nelson, B., Sengupta, P., & Angelo, C. D. (2007). Rethinking Science Learning Through Digital G ames and Simulations : Genres , Examples , and Evidence, 36–41.

Cobb, P., Confrey, J., DiSessa, A., Lehrer, R., & Schauble, L. (2003). Design Experiments in Educational Research. *Educational Researcher*, *32*(1), 9–13.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research Methods in Education*. *Education* (6th ed.). London and New York: Routledge.

Conroy, R. (2015). Sample Size: A Rough Guide, 1–30.

Craig, S., Graesser, A., Sullins, J., & Gholson, B. (2004). Affect and learning: An exploratory look into the role of affect in learning with AutoTutor. *Journal of Educational Media*, *29*(3), 241–250.

Creswell, J. W. (2012a). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). University of Nebraska–Lincoln.

Creswell, J. W. (2012b). *Research design: Qualitative, Quantitative, and mixed methods approaches*. *Journal of investigative surgery : the official journal of the Academy of Surgical Research* (Vol. 25).

Crowley, D. N., Breslin, J. G., Corcoran, P., & Young, K. (2012). Gamification of citizen sensing through mobile social reporting. *4th International IEEE Consumer Electronic Society - Games Innovation Conference, IGiC 2012*.

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal performance*. *Optimal experience: Psychological studies of flow in consciousness*.

DeBurr, D. (2013). *Build Gamified Websites with PHP and jQuery- Engage ,empower, and educate with gamified websites*. Birmingham- Mumbai: Packt Publishing.

Deci, E. L., Eghrari, H., Patrick, B. C., & Leone, D. R. (1994). Facilitating internalization: The self determination theory perspective. *Journal of Personality*, *62*(1), 119–142.

Deci, E., & Ryan, R. M. (1985). *Intrinsic motivation and self- determination in human behavior*. (E. Aronson, Ed.). New York and London: Plenum Press.

Deci, E., Vallerand, R., Pelletier, L., & Ryan, R. (1991). Motivation and Education: The Self-Determination Perspective. *Educational Psychologist*, *26*(3), 325–346.

Dede, C. (2009). Immersive Interfaces for Engagement and Learning. *Science*, *323*(5910), 66–69.

Delacruz, G. C. (2011). Games as formative assessment environments: Examining the impact of explanations of scoring and incentives on math learning, game performance, and help seeking. *Dissertation Abstracts International Section A Humanities and Social Sciences*, *72*, 1170.

Delacruz, G. C., Chung, G. K. W. K., & Baker, E. L. (2010). *Validity Evidence for Games as Assessment Environments. CRESST Report 773. National Center for Research on Evaluation, Standards, and Student Testing (CRESST)*.

Deterding, S. (2011a). Situated motivational affordances of game elements : A conceptual model. In *CHI 2011 Workshop Gamification : Using Game Design Elements in Non-Game Contexts Introductory Papers Gamification : Using Game Design Elements in Non-Gaming Contexts* (pp. 3–6).

Deterding, S. (2011b). Situated motivational affordances of game elements : A conceptual model. *Chi 2011*, (Deterding, S. (2011). Situated motivational affordances of game elements : A conceptual model. Chi 2011, 3–6.

Deterding, S. (2012). Gamification: Designing for motivation. *Interactions*, *19*(4),

Deterding, S., & Dixon, D. (2011). From Game Design Elements to Gamefulness : Defining " Gamification ," 9–15.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From Game Design Elements to Gamefulness : Defining " Gamification ." In *MindTrek '11 Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments* (pp. 9–15).

Deterding, S., Dixon, D., Sicart, M., Nacke, L., & O'Hara, K. (2011). Gamification : Using Game Design Elements in Non-Gaming Contexts. In *PART 2-Proceedings of the 2011 annual conference extended abstracts on Human factors in computing systems* (pp. 5–8).

Dickey, M. D. (2007). Game design and learning: A conjectural analysis of how massively multiple online role-playing games (MMORPGs) foster intrinsic motivation. *Educational Technology Research and Development*, *55*(3), 253–273.

Diewald, S., Möller, A., Roalter, L., & Kranz, M. (2012). Gamification-supported exploration of natural user interfaces. *Adjunct Proceedings of the 4th International Conference on Automotive User Interfaces and Interactive Vehicular Applications*, (OCTOBER), 47–48.

Dixon, D. (2011). Player Types and Gamification. *CHI 2011 Workshop Gamification Using Game Design Elements in NonGame Contexts*, 12–15.

Djaouti, D., Alvarez, J., Jessel, J., & Rampnoux, O. (2011). Origins of Serious Games. In *Serious Games and Edutainment Applications* (pp. 25–43).

Domínguez, A., Saenz-De-Navarrete, J., De-Marcos, L., Fernández-Sanz, L., Pagés, C., & Martínez-Herráiz, J. J. (2013). Gamifying learning experiences : Practical implications and outcomes. *Computers and Education*, *63*, 380–392.

Domínguez, A., Saenz-De-Navarrete, J., De-Marcos, L., Fernández-Sanz, L., Pagés, C., & Martínez-Herráiz, J. J. (2013). Gamifying learning experiences: Practical implications and outcomes. *Computers and Education*, *63*, 380–392.

Domínguez, A., Saenz-de-Navarrete, J., de-Marcos, L., Fernández-Sanz, L., Pagés, C., & Martínez-Herráiz, J.-J. (2013). Gamifying learning experiences: Practical implications and outcomes. *Computers & Education*, *63*, 380–392.

Drachen, A., Canossa, A., & Yannakakis, G. N. (2009). Player modeling using self-organization in Tomb Raider: Underworld. In *CIG2009 - 2009 IEEE Symposium on Computational Intelligence and Games* (pp. 1–8).

Eastwood, J. L., & Sadler, T. D. (2013). Teachers' implementation of a game-based biotechnology curriculum. *Computers & Education*, *66*, 11–24.

Eck, R. Van. (2006). Digital Game-Based Learning : It ' s Not Just the Digital Natives Who Are Restless. *Educause Review*, *41*(2), 1–16.

Edelson, D. C. (2001). Learning-for-use: A framework for the design of technology-suported inquiry activities. *Journal of Research in Science Teaching*, *38*(3), 355–385.

Edmonds, S. (2012). Gamification of learning. *Training & Development In Australia*, 20–23.

Egenfeldt-nielsen, S. (2006). Overview of research on the educational use of video games. *Digital Kompetanse*, *1*(3), 184–213.

Engeser, S., & Rheinberg, F. (2008). Flow, performance and moderators of challenge-skill balance. *Motivation and Emotion*, *32*(3), 158–172.

Epema, D., & Iosup, A. (2014). An Experience Report on Using Gami fi cation in Technical Higher Education. In *Proceedings of the 45th ACM technical symposium on Computer science education - SIGCSE '14 (2014)* (pp. 27–32).

Erenli, K. (2013). The Impact of Gamification. *International Journal of Emerging Technologies in Learning*, *8*(Special Issue 1: "ICL2012"), 15–21.

Eriksson, B., Musialik, M., & Wagner, J. (2012). Gamification - Engaging the Future, (June).

Esper, S., Foster, S. R., & Griswold, W. G. (2013). CodeSpells : Embodying the Metaphor of Wizardry for Programming. In *Proceedings of the 18th ACM conference on Innovation and technology in computer science education* (pp. 249–254).

Fah, L. Y., Lee, C. S., Adnan, H., & Fook, F. S. (2016). Gamification at Universiti Malaysia Sabah: A case study of enhancing English among undergraduate students. *Jurnal Pemikir Pendidikan*, *7*, 57–72.

Farhangi, S. (2012). Reality is broken to be rebuilt: how a gamer's mindset can show science educators new ways of contribution to science and world? *Cultural Studies of Science Education*, 1037–1044.

Ferguson, D. M. (2012). The Gamification of Legal Education : Why Games Transcend the Langdellian Model and How They Can Revolutionize Law School, 629–657.

Filsecker, M., & Hickey, D. T. (2014). A multilevel analysis of the effects of external rewards on elementary students' motivation, engagement and learning in an educational game. *Computers & Education*, *75*, 136–148.

Finlay, W., Desmet, C., & Evans, L. (2004). Is It the Technology or the Teacher? a Comparison of Online and Traditional English Composition Classes. *Journal of Educational Computing Research*, *31*(2), 163–180.

Fister Gale, S. (2015). Forget Millennials: Are You Ready For Generation Z? *Chief Learning Officer*, *14*(7), p.38-48.

Fredricks, J., Blumenfeld, P., & Paris, A. (2004). School Engagement : Potential of the Concept , State of the Evidence Authors (s): Jennifer A . Fredricks , Phyllis C . Blumenfeld and Alison H . Paris Published by : American Educational Research Association Stable URL : http://www.jstor.org/stable/3516. *Review of Educational Research*, *74*(1), 59–109.

Freitas, S. De, & Staalduinen, J.-P. Van. (2009). A Game Based Learning Framework Linking Game Design and Learning Outcomes. *Learning to Play: Exploring the Future of Education with Video Games*, 1–37.

Fu, Y. C. (2011). *The Game of Life : Designing a Gamification System to Increase Current Volunteer Participation and Retention in Volunteer-based Nonprofit Organizations*.

Gage, N., & Berliner, D. (1992). *Educational Psychology* (5th ed.). Princeton, New Jersey: Houghton Mifflin Company.

Gardner, S., & Eng, S. (2005). What Students Want: Generation Y and the Changing Function of the Academic Library. *Portal: Libraries and the Academy*, *5*(3), 405–420.

Garris, R., & Ahlers, R. (2002). A Research and Practice Model. *Simulation and Gaming*, *33*(4), 441–467.

Gee, J. P. (2003). What video games have to teach us about learning and literacy. *Computers in Entertainment*.

GEHLBACH, R. D. (1991). Play, Piaget, and Creativity: The Promise of Design. *The Journal of Creative Behavior*, *25*(2), 137–144.

Gibson, D., Ostashewski, N., Flintoff, K., Grant, S., & Knight, E. (2013). Digital badges in education. *Education and Information Technologies*, pp. 1–8.

Glover, I. (2013). Play As You Learn : Gamification as a Technique for Motivating Learners. *Ed Media 2013*, 1999–2008.

Green, C. S., & Bavelier, D. (2003). Action video game modifies visual selective attention. *Nature*, *423*(May), 3–6.

Green, C. S., & Bavelier, D. (2006). Effect of action video games on the spatial distribution of visuospatial attention. *Journal of Experimental Psychology. Human Perception and Performance*, *32*(6), 1465–78.

Hainey, T. (2010). *Using games-based learning to teach requirements collection and analysis at tertiary education level*. University of the West of Scotland.

Hakulinen, L., & Auvinen, T. (2014). The Effect of Gamification on Students with Different Achievement Goal Orientations. *2014 International Conference on Teaching and Learning in Computing and Engineering*, 9–16.

Hakulinen, L., Auvinen, T., & Korhonen, A. (2013). Empirical study on the effect of achievement badges in TRAKLA2 online learning environment. In *Proceedings - 2013 Learning and Teaching in Computing and Engineering, LaTiCE 2013* (pp. 47–54).

Hamari, J. (2013). Transforming homo economicus into homo ludens: A field experiment on gamification in a utilitarian peer-to-peer trading service. *Electronic Commerce Research and Applications*, *12*(4), 236–245.

Hamari, J. (2015). Computers in Human Behavior Do badges increase user activity ? A field experiment on the effects of gamification. *Computers in Human Behavior*, 1–10.

Hamari, J., & Koivisto, J. (2013). Social Motivations To Use Gamification : An Empirical Study Of Gamifying Exercise. In *Proceedings of the 21st European Conference on Information Systems SOCIAL* (pp. 1–12).

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in Human Behavior*, *54*, 170–179.

Hannay, M., & Newvine, T. (2006). Perceptions of Distance Learning : a Comparison of Online and Traditional Learning. *Journal of Online Learning and Teaching*, *2*(1), 1–11.

Hanus, M. D., & Fox, J. (2014). Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. *Computers & Education*, *80*, 152–161.

Herzig, P., Strahringer, S., & Ameling, M. (2012). Gamification of Erp systems-exploring gamification effects on user acceptance constructs. *Multikonferenz …*.

Hess, T., & Gunter, G. (2013). Serious game-based and nongame-based online courses: Learning experiences and outcomes. *British Journal of Educational Technology*, *44*(3), 372–385.

Hickey, D. T., Ingram-Goble, A. A., & Jameson, E. M. (2009). Designing assessments and assessing designs in virtual educational environments. *Journal of Science Education and Technology*, *18*, 187–208.

Hitchcock, G., & Hughes, D. (1995). *Research and the teacher: A qualitative introduction to school-based research*. Psychology Press.

Hong, G. Y., & Masood, M. (2014). Effects of Gamification on Lower Secondary School Students ' Motivation and Engagement. *International Journal of Social, Education, Economics and Management Engineering*, *8*(12), 3487–3494.

Horgas, A. L., Yoon, S. L., Nichols, A. L., & Marsiske, M. (2008). Considerations in Determining Sample Size for Pilot Studies. *Research in Nursing & Health*, *31*(4), 341–354.

Huotari, K., & Hamari, J. (2012). Defining Gamification - A Service Marketing Perspective. In *Proceeding of the 16th International Academic MindTrek Conference* (pp. 17–22).

Hwang, G.-J., Sung, H.-Y., Hung, C.-M., Yang, L.-H., & Huang, I. (2013). A knowledge engineering approach to developing educational computer games for improving students' differentiating knowledge. *British Journal of Educational Technology*, *44*(2), 183–196.

Ifenthaler, D., Eseryel, D., & Ge, X. (2012). Assessment for Game-Based Learning. In *Assessment in GameBased Learning* (pp. 1–8).

Iosup, A., & Epema, D. (2014a). An experience report on using gamification in technical higher education. In *Proceedings of the 45th ACM technical symposium on Computer science education - SIGCSE '14* (pp. 27–32).

Iosup, A., & Epema, D. (2014b). An experience report on using gamification in technical higher education. *Proceedings of the 45th ACM Technical Symposium on Computer Science Education - SIGCSE '14*, (2008), 27–32.

Jackson, L., Gauntlett, D., & Steemers, J. (2008). Children in virtual worlds: Adventure Rock users and producers study. *Media*, *2008*(July), 1–66.

Jaffer, U., John, N. W., & Standfield, N. (2013). Surgical Trainee Opinions in the United Kingdom Regarding a Three-Dimensional Virtual Mentoring Environment (MentorSL) in Second Life: Pilot Study. *JMIR Serious Games*, *1*(1), e2.

Jang, H. (2008). Supporting students' motivation, engagement, and learning during an uninteresting activity. *Journal of Educational Psychology*, *100*(4), 798–811.

Johnson, L., Adams, S., & Haywood, K. (2011). *The NMC Horizon Report: 2011 K–12 Edition*. *New Media Consortium*. The New Media Consortium.

Julious, S. A. (2005). Sample size of 12 per group rule of thumb for a pilot study. *Pharmaceutical Statistics*, *4*(4), 287–291.

Kallio, K. P., Mayra, F., & Kaipainen, K. (2011). At Least Nine Ways to Play: Approaching Gamer Mentalities. *Games and Culture*, *6*(4), 327–353.

Kapp, K. M. (2012). The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education - *Google Books*. *The Gamification of Learning and Instruction*.

Kappen, D. L., & Nacke, L. E. (2013). The Kaleidoscope of Effective Gamification : Deconstructing Gamification in Business Applications, 1–4.

Karlsen, F. (2011). Entrapment and Near Miss: A Comparative Analysis of Psycho-Structural Elements in Gambling Games and Massively Multiplayer Online Role-Playing Games. *International Journal of Mental Health and Addiction*, *9*(2), 193–207.

Ke, F. (2009). A Qualitative Meta-Analysis of Computer Games as Learning Tools.

Kearsley, G., & Shneiderman, B. (1998). Engagement theory: A framework for technology-based teaching and learning. *Educational Technology*, *38*(5), 20–23.

Keengwe, J., Kidd, T., & Kyei-Blankson, L. (2008). Faculty and Technology: Implications for Faculty Training and Technology Leadership. *Journal of Science Education and Technology*, *18*(1), 23–28.

Kelley, K. (2007). Sample size planning for the coefficient of variation from the accuracy in parameter estimation approach. *Behav Res Meth*, *39*(4), 755–766.

Kementerian Pelajaran Malaysia. (2012). *Dasar Pendidikan Kebangsaan* (3rd ed.). Putrajaya: Bahagian Pendidikan Guru.

Kementerian Pelajaran Malaysia. (2013). Pelan Pembangunan Pendidikan Malaysia, 2013-2025.

Kenayathulla, H. B., Alias, N., Daud, M. K. A. M., Kamaruddin, S. N. A. S., & Shaharom, M. S. N. (2013). The Application of Quasi-experimental Approach in Educational Research. In S. Siraj, N. Alias, D. Dewitt, & Z. Hussin (Eds.), *Design and Developmental Research, Emergent Trends in Educational Research* (pp. 93–103). Kuala Lumpur, Malaysia: Pearson Malaysia.

Kenny, R. F., & McDaniel, R. (2011). The role teachers' expectations and value assessments of video games play in their adopting and integrating them into their classrooms. *British Journal of Educational Technology*, *42*(2), 197–213.

Kim, S. (2013). Analysis of Engineering Students ' Needs for Gamification based on PLEX Model. *Journal on Knowledge and Data Engineering*, *1*(1), 1–7.

King, D., Greaves, F., Exeter, C., & Darzi, A. (2013). "Gamification": Influencing health behaviours with games. *Jrsm*, *106*(3), 76–78.

Kirriemuir, J., & McFarlane, A. (2004). Literature Review in Games and Learning Literature Review in Games and Learning. *Context*, *3*(2), 208–213.

Klabbers, J. H. . (2003). 4 . The Gaming Landscape : A Taxonomy For Classifying Games. In *Level Up: Digital Games Research Conference* (pp. 54–67).

Klimmt, C., & Hartmann, T. (2006). Effectance, self-efficacy, and the motivation to play video games. *Playing Video Games: Motives, Responses, and Consequences*, (December), 133–145.

Knaving, K., Björk, S., Network, I. Mmers., University of Ontario Institute of, T., University of, W., & University of Waterloo Stratford, C. (2013). Designing for fun and play: Exploring possibilities in design for gamification. *1st International Conference on Gameful Design, Research, and Applications, Gamification 2013*, 131–134.

Koivisto, J. (2013). Social Motivations To Use Gamification : an Empirical Study of Gamifying Exercise.

Krejcie, R. V, & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, *38*, 607–610.

Kühne, T. (2005a). What is a Model. *Language Engineering for Model-Driven*, 1–10.

Kvale, S. (1996). The interview situation and the quality of the interview. In *Interviews: An introduction to qualitative research interviewing* (pp. 124–159).

Kvale, S. (2006). Dominance Through Interviews and Dialogues. *Qualitative Inquiry*, *12*, 480–500.

Landers, R. N., & Landers, A. K. (2014). An Empirical Test of the Theory of Gamified Learning: The Effect of Leaderboards on Time-on-Task and Academic Performance. *Simulation & Gaming*, *45*(6), 769–785.

Lee, J. J., & Hammer, J. (2011). Gamification in Education: What , How , Why Bother? *Academic Exchange Quarterly*, *15*, 1–5.

Lee, M. J., Ko, A. J., & Kwan, I. (2013). In-Game Assessments Increase Novice Programmers ' Engagement and Level Completion Speed. In *Proceedings of the ninth annual international ACM conference on International computing education research - ICER '13* (pp. 153–160).

Leedy, P. D., & Ormrod, J. E. (2012). *Practical Research, Planning and Design* (10th ed.). Pearson.

Leng, E. Y., Zah, W., Baki, R., & Mahmud, R. (2010). Stability of the Intrinsic Motivation Inventory (IMI) For the Use of Malaysian Form One Students in ICT Literacy Class, *6*(3), 215–226.

Lenth, R. V. (2001). Some Practical Guidelines for Effective Sample Size Determination. *The American Statistician*, *55*(3), 187–193.

Lewis, R. (2007). Metaheuristics can solve sudoku puzzles. *Journal of Heuristics*, *13*(4), 387–401.

Li, C., Dong, Z., Untch, R. H., & Chasteen, M. (2013). Engaging Computer Science Students through Gamification in an Online Social Network Based Collaborative Learning Environment. *International Journal of Information and Education Technology*, *3*, 72–77.

Lieberoth, A. (2014). Shallow gamification – psychological effects of framing an activity as a game (w.i.p.-title). *Games and Culture*, *in review*, 1–20.

Lieberoth, A. (2015). Shallow gamification testing psychological effects of framing an activity as a game. *Games and Culture*, *10*(3), 229–248.

Martens, R. L., Gulikerst, J., & Bastiaens, T. (2004). The impact of intrinsic motivation on e-learning in authentic computer tasks. *Journal of Computer Assisted Learning*, *20*(5), 368–376.

Martin, M. O., Mullis, I. V. S., Foy, P., & Stanco, G. M. (2011). *TIMSS 2011 International Results in Science*.

McAuley, E., Duncan, T., & Tammen, V. V. (1989). Psychometric Properties of the Intrinsic Motivation Inventory in a Competitive Sport Setting: A Confirmatory Factor Analysis. *Research Quarterly for Exercise and Sport*, *60*(1), 48–58.

McGonigal, J. (2011). Reality is broken. *New York*, *169*, 402.

McGonigal, J. E. (2010). *Gaming can make a better world*. Palm Springs, California, U.S.A.

McHugh, M. L. (2012). Interrater reliability: the kappa statistic. *Biochemia Medica*, 276–282.

Mcilrath, D. A., & Huitt, W. G. (1995). The Teaching-Learning Process : A Discussion of Models. Retrieved January 14, 2016, from http://www.edpsycinteractive.org/papers/modeltch.html

McNamara, C. (1999). General Guidelines for Conducting Interviews.

Meder, M., Plumbaum, T., & Hopfgartner, F. (2013). Perceived and actual role of gamification principles. In *Proceedings - 2013 IEEE/ACM 6th International Conference on Utility and Cloud Computing, UCC 2013* (pp. 488–493).

Mekler, E. D., Brühlmann, F., Opwis, K., & Tuch, A. N. (2013). Disassembling Gamification: The Effects of Points and Meaning on User Motivation and Performance. *CHI '13 Extended Abstracts on Human Factors in Computing Systems on - CHI EA '13*, 1137.

Michael, D. ., & Chen, S. L. (2005). *Serious games: Games that educate, train, and inform*. Muska & Lipman/Premier-Trade.

Mihalca, L., & Miclea, M. (2007). Current Trends In Educational Research. *Romanian Association for Cognitive Science*, *XI*(1), 115–129.

Moccozet, L., Tardy, C., Opprecht, W., & Leonard, M. (2013). Gamification-based assessment of group work. *2013 International Conference on Interactive Collaborative Learning, ICL 2013*, (September), 171–179.

Moore, G. C., & Benbasat, I. (1991). Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation. *Information Systems Research*, *2*, 192–220.

Morford, Z. H., Witts, B. N., Killingsworth, K. J., & Alavosius, M. P. (2014). Gamification: The intersection between behavior analysis and game design technologies. *Behavior Analyst*, *37*(1), 25–40.

Morris, B. J., Croker, S., Zimmerman, C., Gill, D., & Romig, C. (2013). Gaming science: the "Gamification" of scientific thinking. *Frontiers in Psychology*, *4*, 607.

Morrison, B. B., & DiSalvo, B. (2014). Khan academy gamifies computer science. In *Proceedings of the 45th ACM technical symposium on Computer science education - SIGCSE '14* (pp. 39–44).

Morschheuser, B. S., Rivera-Pelayo, V., Mazarakis, a., & Zacharias, V. (2014). Interaction and Reflection with Quantified Self and Gamification: an Experimental Study. *Journal of Literacy and Technology*, *15*(2), 136–156.

Muntean, C. I. (2011). Raising engagement in e-learning through gamification. In *Proc. 6th International Conference on Virtual Learning ICVL* (pp. 323–329).

Nasser, F., & Wisenbaker, J. (2003). A Monte Carlo Study Investigating the Impact of Item Parceling on Measures of Fit in Confirmatory Factor Analysis. *Educational and Psychological Measurement*, *63*, 729–757.

Nicholson, S. (2012a). A User-Centered Theoretical Framework for Meaningful Gamification. In *Games+ Learning+ Society* (pp. 1–7).

Nicholson, S. (2012b). A User-Centered Theoretical Framework for Meaningful Gamification A Brief Introduction to Gamification Organismic Integration Theory Situational Relevance and Situated Motivational Affordance. *GamesLearningSociety 80*.

Nicholson, S. (2015). A recipe for meaningful gamification. *Gamification in Education and Business*, 1–20.

O'Donovan, S. (2012). Gamification of the games course. *Acesso Em*, 1–8.

O'Neil, H., Wainess, R., & Baker, E. (2005). Classification of learning outcomes: evidence from the computer games literature. *The Curriculum Journal*, *16*, 455–474.

Oak, J., & Bae, J. (2013). Smart Multiplatform-Based CPR Game App Design. *Advanced Science and Technology Letters(Games and Graphics 2013)*, *39*, 20–23.

Oblinger, D., Oblinger, J., L., & Lippincott, K. (2005). *Educating the Net Generation. Educational Leadership* (Vol. 56).

OECD. (2012). Student performance (PISA 2012).

Oinas-kukkonen, H., & Harjumaa, M. (2009a). Communications of the Association for Information Systems Persuasive Systems Design : Key Issues , Process Model , and System Features Persuasive Systems Design : Key Issues , Process Model , and System Features. *Communications of the Association for Information Systems*, *24*(28), 485–500.

Oinas-kukkonen, H., & Harjumaa, M. (2009b). Persuasive Systems Design : Key Issues , Process Model , and System Features, *24*(1).

Ong, D., Yeng, C. Y., Hong, C. W., & Young, K. T. (2013). Motivation Of Learning : An Assessment Of The Practicality And Effectiveness Of Gamification Within A Tertiary Education. In *World Academy of Researchers, Educators, and Scholars in Business, Social Sciences, Humanities and Education (In association with the Academy of World Finance, Banking, Management and IT) Conference Proceedings* (Vol. 1, pp. 131–146).

Papastergiou, M. (2009). Digital Game-Based Learning in high school Computer Science education: Impact on educational effectiveness and student motivation. *Computers & Education*, *52*(1), 1–12.

Pellegrino, J. W., Chudowsky, N., & Glaser, R. (2001). *Knowing what students know: The science and design of educational assessment*. *Committee on the Foundations of Assessment*.

Peng, W., & Hsieh, G. (2012). The influence of competition, cooperation, and player relationship in a motor performance centered computer game. *Computers in Human Behavior*, *28*(6), 2100–2106.

Pereira, S. (2012b). *Knowledge management and learning technology*. London: Koros Press Limited.

Piaget, J. (1952). Play, dreams and imitation in childhood. *Journal of Consulting Psychology*.

Pourabdollahian, B., Taisch, M., & Kerga, E. (2012). Serious Games in Manufacturing Education: Evaluation of Learners' Engagement. *Procedia Computer Science*, *15*, 256–265.

Prensky, M. (2001). Digital Natives, Digital Immigrants Part 1. *On the Horizon*, *9*(5), 1–6.

Prensky, M. (2003). Digital game-based learning. *Computers in Entertainment*, *1*(1), 21.

Reiners, T., Wood, L. C., Chang, V., Gütl, C., Herrington, J., Teräs, H., & Gregory, S. (2012). Operationalising gamification in an educational authentic environment. In *IADIS International Conference on Internet Technologies & Society* (Vol. 2012, pp. 93–100).

Richards, C. (2013). Utilizing a Modular Approach to Gamification to Improve Nutrition and Fitness in Children, 1–18.

Rothman, D. (2014). A Tsunami of Learners Called Generation Z. *Maryland Public Safety Online Journal*, *1*(1).

Rowe, J. P., Shores, L. R., Mott, B. W., & Lester, J. C. (2011). Integrating learning, problem solving, and engagement in narrative-centered learning environments. *International Journal of Artificial Intelligence in Education*, *21*(1–2), 115–133.

Rughiniș, R. (2013). Gamification for Productive Interaction Reading and Working with the Gamification Debate in Education. In *The 8th Iberian Conference on Information Systems and Technologies CISTI 2013* (pp. 1–5).

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American Psychologist*, *55*(1), 68–78.

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The Motivational Pull of Video Games: A Self-Determination Theory Approach. *Motivation and Emotion*, *30*(4), 344–360.

Salen, K., & Zimmerman, E. (2004). *Rules of play: game design fundamentals. 2004*. *Massachusetts Institute of Technology*.

Sánchez, J., & Olivares, R. (2011). Problem solving and collaboration using mobile serious games. *Computers & Education*, *57*(3), 1943–1952.

Sanmugam, M. (2014). Gamification and Serious Games : - The enigma and the use in Education. *ISQAE 2014 3rd International Seminar on Quality and Affordable Education*.

Sanmugam, M., Aris, B., Mohammed, H., Mohd. Zaid, N., Abdullah, Z., & Sanmugan, Mageswaran A/L; Aris, Baharuddin bin; Mohammed, Hasnah bt.; Zaid, Norasykin bt. Mohd.; Abdullah, Z. bt. (2014). Gamification: Potentials and Challenges in Teaching and Learning in Science. *Konvensyen Antarabangsa Jiwa Pendidik 2014*, (June 2015), 11–13.

Sanmugam, M., Zaid, N. M., Mohamed, H., Abdullah, Z., Aris, B., & Suhadi, S. M. (2015). Gamification as an educational technology tool in engaging and motivating students; An analyses review. *Advanced Science Letters*, *21*(10), 3337–3341.

Sawyer, B., & Rejeski, D. (2002). *"Serious games: Improving public policy through game-based learning and simulation."*

Schaufeli, W. (2013). What is Engagement? *Employee Engagement in Theory and Practice*, 1–37.

Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit Measures. *Methods of Psychological Research Online*, *8*(2), 23–74.

Schoenau-Fog, H., & Henrik, S.-F. (2014). The Player Engagement Process – An Exploration of Continuation Desire in Digital Games. *DiGRA 2011 Conference: Think Design Play.*, *6*, 1–18.

Schouten, D., Pfab, I., Cremers, A., Dijk, B. Van, & Neerincx, M. (2011). Gamification for low-literates Effects on motivation , user experience , and study design. *Computers Helping People with Special Needs*, 494–501.

Schunk, D. H. (2011). *Learning theories : an educational perspective*. *Learning*.

Sektor Pengurusan Hal Ehwal Murid, B. (2016). *Dasar, Syarat Dan Prosedur Pengambilan Murid Sekolah Berasrama Penuh Kementerian Pendidikan Malaysia Tahun 2016*.

Serin, O. (2011). the Effects of the Computer-Based Instruction on the Achievement and Problem Solving Skills of the Science and Technology Students. *Turkish Online Journal of Educational Technology*, *10*(1), 183–201.

Shim, K. J., Srivastava, J., & Hsu, K. W. (2011). An exploratory study of player performance, motivation, and enjoyment in massively multiplayer online role-playing games. In *Proceedings - 2011 IEEE International Conference on Privacy, Security, Risk and Trust and IEEE International Conference on Social Computing, PASSAT/SocialCom 2011* (pp. 135–140).

Shute, V. J., & Ke, F. (2012). Games, Learning and Assessment. In *Assessment in Game-Based Learning: Foundations, Innovations, and Perspectives* (pp. 43–58).

Simões, J., Redondo, R. D., & Vilas, A. F. (2013). A social gamification framework for a K-6 learning platform. *Computers in Human Behavior*, *29*(2), 345–353.

Spence, M., Foster, J. A., Irish, R., Sheridan, P. K., & Frost, G. S. (2012). "Gamifying" a library orientation tutorial for improved motivation and learning. In *2012 ASEE - American Society for Engineering Education Annual Conference*.

Spires, H. A., Lee, J. K., Turner, K. A., & Johnson, J. (2008). Having Our Say : Middle Grade Student Perspectives on School , Technologies , and Academic Engagement. *Journal of Research on Technology in Education*, *40*, 497–515.

Squire, K., Barnett, M., Grant, J. M., & Higginbotham, T. (2004). Electromagnetism supercharged!: learning physics with digital simulation games. In *International Conference on Learning Sciences* (pp. 513–520).

Tan, W. H., Noor, N. F. M., & Wang, Y. (2014). Gamification of Inventive Principles: A Case Study of Triz Puzzle Game. *Proceedings of the Serious Games Conference 2014*, *19*(Isssg), 159–164.

Taylor, G., Jungert, T., Mageau, G. A., Schattke, K., Dedic, H., Rosenfield, S., & Koestner, R. (2014). A self-determination theory approach to predicting school achievement over time: The unique role of intrinsic motivation. *Contemporary Educational Psychology*, *39*(4), 342–358.

Thom, J., Millen, D. R., Dimicco, J., & Street, R. (2012). Removing Gamification from an Enterprise SNS. In *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work* (pp. 1067–1070).

Thompson, P. (2013). The digital natives as learners: Technology use patterns and approaches to learning. *Computers and Education*, *65*, 12–33.

Tong, T., & Chignell, M. (2013). Designing Game-Based Cognitive Assessments for Elderly Adults. In *Proceedings of the First International Conference on Gameful Design, Research, and Applications - Gamification '13* (pp. 127–130).

Tseng, K. H., Chang, C. C., Lou, S. J., & Chen, W. P. (2013). Attitudes towards science, technology, engineering and mathematics (STEM) in a project-based learning (PjBL) environment. *International Journal of Technology and Design Education*, *23*(1), 87–102.

Tüzün, H. (2007). Blending video games with learning: Issues and challenges with classroom implementations in the Turkish context. *British Journal of Educational Technology*, *38*(3), 465–477.

Tüzün, H., Yılmaz-Soylu, M., Karakuş, T., İnal, Y., & Kızılkaya, G. (2009). The effects of computer games on primary school students' achievement and motivation in geography learning. *Computers & Education*, *52*(1), 68–77.

Tyler-Smith, K. (2006). Early Attrition among First Time eLearners : A Review of Factors that Contribute to Drop-out , Withdrawal and Non-completion Rates of Adult Learners undertaking eLearning Programmes. *Journal of Online Learning and Teaching*, *2*(2), 73–85.

Unger, K., Schwartz, D., & Foucher, J. (2013). Increasing Employee Productivity through Gamification and Blended Learning. *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education*, 2538–2545.

Vallerand, R. (1997). *Toward a hierarchical model of intrinsic and extrinsic motivation*. *Advances in Experimental Social Psychology* (Vol. 29).

Vansteenkiste, M., Lens, W., & Deci, E. L. (2006). Intrinsic Versus Extrinsic Goal Contents in Self-Determination Theory: Another Look at the Quality of Academic Motivation. *Educational Psychologist*, *41*(1), 19–31.

Vogel, J. J., Vogel, D. S., Cannon-Bowers, J., Bowers, C. A., Muse, K., & Wright, M. (2006). Computer Gaming And Interactive Simulations For Learning: A Meta-Analysis. *Journal of Educational Computing Research*.

Voogt, J., Erstad, O., Dede, C., & Mishra, P. (2013). Challenges to learning and schooling in the digital networked world of the 21st century. *Journal of Computer Assisted Learning*, *29*(5), 403–413.

Vorderer, P., Hartmann, T., & Klimmt, C. (2003). Explaining the enjoyment of playing video games: the role of competition. *ICEC '03 Proceedings of the Second International Conference on Entertainment Computing*, (February), 2–10.

Walker, A., & Shelton, B. E. (2008). Problem-Based Educational Games : Connections , Prescriptions , and Assessment Problem-Based Educational Games : Connections. *Journal Of Interactive Learning Research*, *19*, 663–684.

Werbach, K. (2014). (Re)defining gamification: A process approach. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (Vol. 8462 LNCS, pp. 266–272).

Wilson VanVoorhis, C. R., & Morgan, B. L. (2007). Understanding power and rules of thumb for determining sample sizes. *Tutorials in Quantitative Methods for Psychology*, *3*(2), 43–50.

Xu, F., Weber, J., & Buhalis, D. (2013). Gamification in Tourism. *Information and Communication Technologies in Tourism*, 525–537.

Yee, N. (2002). Facets: 5 Motivation Factors for Why People Play MMORPG's.

Yee, N. (2006). Motivations for play in online games. *Cyberpsychology & Behavior : The Impact of the Internet, Multimedia and Virtual Reality on Behavior and Society*, *9*(6), 772–5.

Yu, C., & Ohlund, B. (2014). Threats to validity of research design. *Threats to Validity of Research Design*.

Zichermann, G., & Cunningham, C. (2008). *Gamification By Design*. *Vasa*.

Zichermann, G., & Cunningham, C. (2011). *Gamification by design: Implementing game mechanics in web and mobile apps*. O'Reilly Media, Inc.

Zohar, A. (2013). Scaling up higher order thinking in science classrooms: the challenge of bridging the gap between theory, policy and practice. *Thinking Skills and Creativity*, *10*, 168–172.