

# **Digital Game Based Learning: An Exploratory Analysis of Perceived Educational Benefits at a Junior High School Level**

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by

**Clay Christopher Johnson**

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## Abstract

Digital Game Based Learning (DGBL) incorporates innovative tools that are widely recognized as having considerable potential to foster and support active learning, problem-solving and communication while providing an environment that embraces practice and learning through failure. The many proponents of DGBL believe that its use can provide a teaching approach that is relevant to the digital needs of the youth of today. Indeed, there are many studies that document the many benefits associated with DGBL for both teaching and learning. However, as was discovered in this study, there are many issues concerning the successful implementation and adoption of constructivist teaching technologies such as DGBL. Computer games can be expensive to purchase and difficult to personalise. Moreover, learners and educators alike; need to be convinced of their effectiveness before buying into their use. Furthermore, many educators simply do not have the time; or the expertise, to be able to effectively design and create games of their own. A problem exacerbated by the, perceived, high level of specialist expertise normally associated with game development. While there are many theorized benefits associated with DGBL there are as many issues concerning its successful implementation. The main purpose of this study was to investigate these theoretical benefits by addressing the following research questions: Can DGBL positively influence teaching and learning? And can DGBL positively influence learner perceptions of Information Technology (IT), with specific reference to coding? A survey was deployed after the implementation of an intervention within Grade 8 Computer Literacy classrooms. The instrument explored the perceptions and effectiveness of DGBL and served to inform the closed-ended questions used in the follow-up focus group interviews. To further support the data, educator interviews also took place post-intervention. The study found that DGBL did have a positive effect on both teaching and learning. Educator and learner views were either reinforced or changed in favour of a DGBL approach to teaching IT. The study recommended, further study into the academic and inter-disciplinary benefits of DGBL be conducted. The study also recommends the development of a set of guidelines on the use of DGBL as a means to support 21<sup>st</sup> century skills development in the classroom.

**Keywords:** Digital Game Based Learning (DGBL), Gamification, Teaching Methodology, Computer Science, Information Technology, Learning Enhancement, Learner Motivation, Curriculum Content, Diffusion of Innovation (DoI). Intrinsic Motivation Inventory (IMI). Constructivist Learning Environment Scales (CLES). Technology Acceptance Model (TAM).

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# Chapter 1 : Introduction

## 1.1 Introduction

Since the Industrial Revolution, much has been done in the way of development in almost all spheres of life. Similarly, over the last 20 years much has been done in this country to address the Apartheid driven chasm between the haves and the have-nots. However, while this is true for every sector in society there remain many issues that plague education at large. Not least among these, are the issues surrounding the quality of education being delivered to the masses. Yearly comparisons of Matric (12<sup>th</sup> Grade) academic results speak to a huge discrepancy in the level of education being presented at private schools as to that at their public counterparts. It is undoubtedly a moot point to make but, to be sure, but there are many differences between public and private schooling. Certainly, there is much to warrant you sending your child to a private school – given that you can afford to do so. Indeed, parents who fork out large sums of money do so in the belief that they are affording their children the absolute best education money can buy. However, those who regard this reality may well be so inclined to ask the following question: Is it possible to close the gap between the quality of education being presented at private schools and its public counterparts? For those who believe it is possible, a follow-up question may well include the preposition '*how*'. Well, some literature suggests that a possible solution lay in the way information is disseminated. It is proposed, that if we were to standardize the quality of the delivery mechanism in teaching and learning then, perhaps, we have a chance at closing an altogether wide gap. In a traditional secondary curriculum, private or public, learners progress based on their ability to master a pre-defined set of objectives – mostly through listening or participating in structured activities with well-defined, pre-determined outcomes (Sqire, 2005). Now, while this may well suit many who view education

purely as a mechanical system, it does little in the way of inspiring creativity, promoting engagement with content, or fostering a level of intrinsic motivation among learners. In fact, one could easily argue, that the current results-driven educational system does little in the way of creating environments where curious young minds can flourish. Studies have shown, that a game-based approach to teaching and learning can, potentially, improve learning outcomes, engagement, and motivation to learn (Gee, 2003; Huizenga, 2017; Woo, 2014).

Certainly, there is an intense, almost palpable, sense of excitement that seems to permeate through formal educational settings when learners discover that their educators' approach to work is *'play'*. Many would argue, that the notion of play within a high-school classroom environment is counter-productive to the business of teaching and learning (Gee, 2007; O'Riley, 2016). However, seminal literature from esteemed authors such as Jean Piaget, Lev Vygotsky and in more recent times Marc Prensky, position play as a central tenet in a child's holistic development. Learning through play, can enrich the learning experience (Gee, 2003; Kafai, 2006) and collective problem solving to a degree that brings children to an altogether new level of learning (Chen, Wang, & Yu-Hsuan, 2015; O'Riley, 2016). But there are many complex issues that need to be addressed before successful implementation can be realised within a formal classroom setting. Understanding these issues, is a necessary prerequisite in the process of objectively leveraging the actual usefulness and quality of educational games as educational tools with its successful implementation (Berg Marklund, 2015). These issues include documentation and educator support, technical support, infrastructure support and issues involving alignment with curricula (Van Eck, 2006). Yet still, at the very heart of these issues lay a critical and rudimentary one — that of propensity towards change. Unless all stakeholders agree with relevant and necessary change modern education may well continue to

be dull and ineffective (Gee, 2005). But change should never be made without proven research backing it up. And so, it is upon a canvas of pure objectivity, that this research looks to provide, through investigation, unbiased data as to the educational value of Digital Game Based Learning (DGBL) within the South African education framework. Working within a constructivist framework, through a mix method of enquiry, an intervention was implemented to investigate the educational benefits of incorporating a learner-centered, DGBL approach to teaching curriculum content at a junior high school level. That said, the reader is encouraged to regard what this research is not. It is not the purpose of this research to present Game Based Learning, or the '*gamification*' of school curricula for that matter, as a generic solution to educational problems. Rather the main idea, or driving principle, behind this research is to present with the plausibility of implementing alternate teaching methods — as a means of enhancing the skills and motivation levels of the digital citizens of tomorrows world. With this in mind, and using this investigative intervention as a vehicle, this research looks to address the following questions:

1. What are learners and educator's perception of DGBL?
2. Why do learners and educators perceive DGBL the way they do?
3. How can DGBL be used to enhance the teaching and learning of IT?

## **1.2 Purpose of the study**

The purpose of this study was to investigate the educational value of Digital Game Based Learning to support teaching and learning in six Grade 8 Computer Literacy classes across three schools.

### **1.3 The statement of the problem**

Computer games are being used more and more in schools for educational purposes (De Freitas, 2006). If seen in a positive light by classroom educators, they can provide children with a playful and familiar opportunity to engage with content (Bourgonjon et al., 2013; Whitton, 2012). Therefore, it is the primary aim of this research to determine through investigation whether, or not, the integration of DGBL into a Grade 8 computer literacy program can positively influence the perceptions learners and educators have of DGBL. The research objectives, intrinsically linked to the research questions listed above, are:

- a) To determine what are educators and learner's perception about DGBL. These perceptions will be in line with Rodgers' Diffusion of Innovation (DOI) constructs/ characteristics that is: relative advantage, compatibility, complexity, trialability and observability.
- b) To understand why educators and learners perceive DGBL the way they do. This objective will be instructed by Ryan and Deci's Intrinsic Motivation Inventory (IMI) as well as Jonassen's Constructivist Learning Environment (CLES).
- c) To provide a possible framework for the implementation of DGBL in teaching and learning with a view to enhance teaching and learning. This objective will be informed by the qualitative dataset.

A subsidiary objective of this research is to help inform, through exposure to coding, learner decision when considering Information Technology (IT), as a learning area, in Grade 10. It was hoped, that an introduction to coding (via Scratch) at an early stage will help align educator and learner expectations, thus propagating future success. This might well, subsequently

decrease the commonplace high drop-out rate in IT. Moreover, it was hoped that exposure to the Scratch platform, during this investigative intervention, would help to establish grounds for further research into the viability of using DGBL to support collaborative learning practices within and without the classroom environment.

## **1.4 Background**

Indeed, many would argue that education is *the* most multifaceted and exigent issue of our age. An issue with bearing, not just within a national context. Certainly education, has proven to be a worldwide issue of great deliberation and dispute. Yet, even though humankind has born witness to incredible feats of ingenuity and design, over the last two hundred years, very little has been done to revise the nature of the education model we use today. Many 21<sup>st</sup> century schools, remain true to 18<sup>th</sup> century tenets that view teaching and learning in the same light that industries view generic, mass produced objects. Children today, as was the case hundreds of years ago, are grouped together based on age and ability (Kulik, 1992). This, potentially, flawed philosophy of education limits potential and creates an environment where children are left feeling inept should they fail to produce a bespoke high grade. This results in, it could be argued, an obscure and incorrect view of perceived ability and exclusivity. Perhaps nowhere, educationally speaking, is this more apparent than within the Information Technology and Computer Science faculty of research. It has been the experience of this author, that a primary reason for learners not wanting to elect Information Technology as a career, or as a field of research, involves the perceived high level of technical ability required to be able to code. However Digital Game Based Learning (DGBL), when employed using an intuitive environment such as the one Scratch provides, presents with a visual and visceral platform for developing computational thinking; a primary proponent of Computer Science. Using simple

click and drag gestures, learners are able to algorithmically structure programming blocks in the solution of graded problems or in the creation of products, such as games. Moreover, DGBL presents also with the potential to use commercial games that have been designed specifically for learning (Garris, Ahlers, & Driskell, 2002; Habgood, Ainsworth, & Benford, 2005; Rosas et al., 2003; Whitton, 2010). Educational games that offer many of the benefits of games created for entertainment, in terms of design quality, but are also designed to meet specific learning outcomes so that the game goals align with the learning goals. However these games can be expensive to purchase, and may be difficult to customize if they do not meet the exact requirements of the learners or curriculum (Whitton, 2012). In the sections that follow, the idea that learning can be facilitated by giving learners agency as creators of games rather than consumers, so that they become the developers and it becomes the process, not the product, will be presented as part of the authors' investigation into the perceived educational benefits of DGBL.

## **1.5 Motivation**

The role Information Technology has played, in the globalisation of virtually every sphere of society cannot be understated. The developing of new technologies, has also affected the manner by which information is disseminated. This is true too, as is suggested by Prensky (2001), of today's "*digital natives*" whose pedagogical interpretation of the world seems to be intrinsically linked to their relationships with existing and emerging technologies. Should this be the case, a challenge for modern day educators then becomes apparent — how does one remain relevant in a dynamic and evolving environment using traditional and, perhaps, irrelevant teaching methodologies? Many have sought to address this educational conundrum by adopting Digital Game Based Learning (DGBL), with varying degrees of success, either as

an instructional strategy or as a stand-alone learning environment (Huang, 2011; Papastergiou, 2009; Wang & Chen, 2010; Woo, 2014). A predominant theme, proponents of DGBL advocate for, are the positive effects its deployment has on both teaching and learning. This is true for those who would use actual games (either off the shelf or bespoke) to facilitate learning, those who would use methods normally associated with playing games (gamification - GBL) to teach, and those who would use the process of game making to teach concepts; as is the case with this research. In many instances though, DGBL is employed using commercial games that have been designed specifically for learning. These educational games that offer many of the benefits of games created for entertainment, in terms of design quality, are designed to meet specific learning outcomes. As a result, oftentimes, the game goals align with the learning goals — making for a simpler integration process. However, these bespoke games can be expensive to purchase and may be difficult to customize if they do not meet the exact requirements of the learners or curriculum. Indeed, the process of making mini games is often flaunted as being the best method for deploying DGBL (Van Eck, 2006). Moreover, using Scratch to create games, animation, music or art applications is easy since Scratch was purposefully designed to make introducing programming easy (Resnick et al., 2009). With a simple click and drag of the mouse, learners can develop an effective foundation in programming that could form the basis for building more advanced skills in the future. Simply put, the Scratch platform lends itself to DGBL. In fact, in the early stages of the Curriculum Assessment Policy Statements (CAPS) document, Scratch was indicated in Grade 10 Information Technology — as a means of introducing programming to learners. Unfortunately, educator frustration at not being able to fully complete the syllabus meant that, over time, many abandoned using Scratch as an introductory tool in Grade 10. Still, this convenient truth means that all the schools involved in the research will already have the infrastructure (technology) in place to facilitate its

implementation. It also means that the educators involved will be well equipped to continue working independently post-intervention, should they choose to adopt DGBL (innovation) as part of their teaching (methodology).

When one considers the exponential growth of technology over the last four decades it is fair to presume that, in the near future, not knowing how to code might well be akin to being illiterate or innumerate today (Crow, 2014). While it may invite a stretch of the imagination to suggest every job in the future will require programming skills; it certainly is not too bold to advocate for the importance of preparing learners to think, and view the world, in a new digital fashion (Crow, 2014; Daggett, 2010). By leveraging 14.6 million job postings the International Data Corporation (IDC), according to Anderson and Gantz (2013), was able to identify the top skills required for the positions expected to have the highest growth, and wages between 2013 and 2020. Residing at the top of the skill list, it may not surprise, was '*attention to detail*' and '*problem-solving ability*' (Anderson & Gantz, 2013); two linchpin principles of programming (Fincher, 1999; Woo, 2014).

Another view worth considering, is that many studies actually warrant the integration of education technologies and strategies, such as DGBL, into classroom environs in support of learning; regardless of the content being taught (Govender & Dhurup, 2014; Gülbahar, 2007; Kim & Hannafin, 2011). To be sure, many would argue indeed that technology can enhance learning (Carle, Jaffee, & Miller, 2009; Cutrim, 2008). However, as is suggested by Govender and Dhurup (2014), simply placing technology at the disposal of educators is not sufficient to ensure use — measures must be in place that will ensure educator confidence and a positive attitude. That said, in completing this research on DGBL, it was hoped that a positive hypothesis would be found in favour of educators incorporating, designing, and developing



strategies that would keep them and their methods relevant. Another mitigating factor by which the researcher was motivated into completing this research, was the unequivocal duty of educators to serve as agents of change to their learners and, perhaps more importantly, their contemporaries.

Lastly, one might argue that restrictions on curriculum content, combined with a myriad of other challenges educators face, can limit the amount time and energy dedicated to the needs of the children being taught. Furthermore, the reality many educators face is that of a performance based, results-driven education system (Mouton, Louw, & Strydom, 2012). In fact, the pressures of achieving high results through testing, one might argue, has become the driving force behind what children are expected to learn (Ballard & Bates, 2008). But, as educators we cannot possibly expect our learners to achieve high standards unless we are prepared to personalize the learning experience for each of them (Simmons, 2001). It goes without saying then that, and curriculum issues aside, educators want learners to embrace learning and not to become apathetic, passive, or resistant, individuals. Many believe DGBL provides with a means to achieve this end. Even more appealing, is the fact that DGBL research is undeveloped which makes it perfect for educators looking to explore tools that will make learning more meaningful to their students (O'Riley, 2016).

## **1.6 Contributions**

The primary purpose of this research is to add to a plethora of research on the subject of DGBL. Varied though they are, extant articles around DGBL remain largely anecdotal or advocated in its favour (O'Riley, 2016). That is to say, most of what is suggested around the gamification of current curricula and DGBL implementation lacks methodical process (O'Riley, 2016) and is not yet research proven (Shanahan, 2002). The unique academic value of this research was to

provide, through investigation, unbiased data as to the educational value of DGBL within the South African education framework. However, there are three subsidiary and intrinsically linked aims aligned to the implementation of this research. It is suggested that value to the body of knowledge is made in the following ways:

- The first of these aims is to present the Scratch coding platform as a straightforward, cost effective and intuitive medium for developing coding (programming) ability in junior high school (Grade 8). In doing so, it is hoped, a case could be made for an earlier introduction of coding in schools. Realising this at a legislative level could, subsequently, lead to a better showing of results in IT at Matric level;
- Next, this research could well present with an endorsement for learning facilitated by giving learners agency as creators of games rather than consumers. Learners assuming the role of developers, with the primary focus being on the process not the product, could well prove a case for constructivist learning environments and;
- Lastly, and perhaps most importantly it is hoped that this research will highlight the need for further research into establishing a set of norms and standards that will address the many challenges educators face when attempting to implement learner-centred tools (innovations), like DGBL, to aid teaching and learning.

It is important to constantly re-assert the criticality of educator impact on learning (J. Reeves, Redford, & McQueen, 2010). Studies involving educators present with a vehicle for developing professional learning beyond the point of entry into the profession (T. C. Reeves, 2006). That said, by nature this intervention affirms the link between research of this kind and excellence in teaching.

## 1.7 Location of the research

For the purpose of this research, a convenient sample was chosen from a group of Grade 8 learners from three high schools in the Durban area of KwaZulu-Natal, South Africa.

Count of To which ethnic population group do you belong?

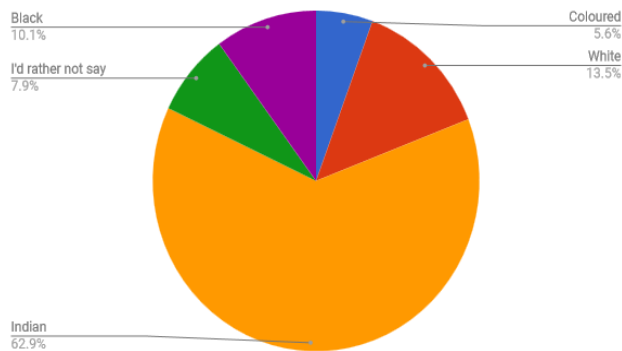


Figure 1.1 - Ethnic Demographics

Count of Which gender group do you belong to?

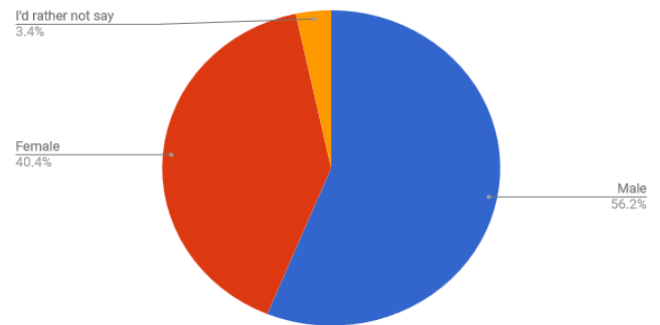


Figure 1.2 - Gender Demographic

The 89-strong sample, shown in Figure 1.1 and 1.2, was made up primarily of learners with an African Indian ethnicity (62.9%). The rest of the sample consisted of learners from an African White descent (13.5%), African Black (10.1%) and African Coloured or Mixed Race (5.6%). Less than 8% of the sample chose not to declare this information. The gender dispensation showed more male participants (56.2%) than females (40.4%). Less than 4% of the sample chose not to declare this information. In Chapter 3, the sample is discussed in greater detail.

## 1.8 Limitations

There are perhaps, many limitations one must placate when regarding the nature of interventions such as this. What this research presented, was a generalizable hypothesis proven using a microcosmic and very specific sample; chosen simply through necessary convenience. While evidence was indeed found to support the hypothesis, the fact that the intervention was

implemented, due to time and logistical limitations, only once at each school could be argued as a limitation of the study.

### **a) Games in Education**

Digital Game Based Learning (DGBL) presents with significant potential for increasing learner motivation (Huang, 2011; Papastergiou, 2009) all the while enhancing the effectiveness of teaching and learning (Chen et al., 2015; Yang, 2012). Yet computer game development has, in the recent past, required a high proficiency level in programming skills. A shortcoming that has, a) hindered the adopting and advancing of new learning technologies (Egenfeldt-Nielsen, 2011; Michael & Chen, 2006); and b) augmented educator perceptions of technical expertise required for game development (Whitton, 2012). Today, however, that limitation has been removed with the creation and availability of game creation engines such as Scratch, Unity and Kodu. Now educators and learners alike, have powerful tools with which they can create intuitive virtual environments for the incorporation of game elements into the teaching syllabus (Van Eck, 2006). This '*gamification*' of curriculum content provides schools with an opportunity to address problems involving learner motivation and engagement (Lee & Hammer, 2011). Moreover, educators using games to support teaching are now able to create an atmosphere that is intuitively responsive to the needs of the learner (McWhorter & Hudson-Ross, 1996). A feat due in no small part to the widespread, public interest generated by an on-going myriad of research conducted by DGBL proponents (Van Eck, 2006; Woo, 2014). Indeed if a game is well crafted, a player may well spend hours upon hours engrossed in it trying to master the, progressively harder, challenges it contains (Berg Marklund, 2015). Broadly speaking however, using computer games in teaching and learning can in many ways be problematic (Whitton, 2012). This despite the many, pedagogic, and motivational benefits

their use may offer. Another major barrier is cost, both in terms of the monetary expense of purchasing licenses and associated hardware; and also in terms of time taken for educators to develop the skills needed to be able to evaluate, or create games and the activities to support them (Whitton, 2010). There are also issues concerning, the acceptability of games within formal educational contexts (Bourgonjon et al., 2013). Moreover, practitioners need to be convinced of the potential of the medium as well as its limitations; and be confident in the use of '*new technologies*', such as games (Govender & Dhurup, 2014). Nevertheless, in our particular educational setting, where there is no need for niche topics, these general issues have been easily overcome due in no small part to the enthusiasm of the participants. This, of course, bears testimony to either; a) the appeal of a break from the normal mode of teaching, or b) a genuine attraction toward DBGL.

#### **b) Mixed Method Research**

Mixed method has, over the last two decades, developed into a popular approach to research in many disciplines and countries (Cresswell, 2003). However, definitional, paradigmatic and methodical issues continue to be raised by researchers who write about mixed methods (Bazeley, 2004). Indeed, there are many controversies involving the marrying of quantitative and qualitative methods (Creswell, 2011). However, there are two, potentially key, limitations intrinsically linked to this method of research. The first of these, occurs when one is trying to quantitate qualitative data. It is suggested, that qualitative data loses its flexibility and depth because qualitative codes are multidimensional, unlike their quantitative counterparts (Bazeley, 2004). So, while it is possible to quantify qualitative data; it can become time-consuming since it requires analysis and coding from unstructured to structured data (Driscoll, Appiah-Yeboah, Salib, & Rupert, 2007). This research addresses this issue, by using the

qualitative data simply as a means of giving bearing to the immutable quantitative data. The second issue associated with mixed method design, involves a lack of accuracy in collinearity (Roberts, 2000). As such, and due the time-consuming nature of collecting and analysing qualitative data, some researchers may well be inclined to reduce their sample size. Doing so, may well present researchers with the challenge of not having enough statistical power to support their findings (Driscoll et al., 2007). This impediment, however, does not affect this particular research in that while the sample size is, the qualitative data will not be quantified. By the same token though, the relatively small sample size may well make it somewhat difficult to generalize any findings pertaining thereto. Furthermore, trustworthiness might well present cause for concern since, since this researcher has very little experience working with multiple methods. That being the case, this research looks simply to investigate the purported pedagogical teaching and learning benefits associated with DGBL. The conclusions drawn herein, are based on an already widely researched academic framework — game-based learning and the gamification of school curricula. Both concepts are addressed, and heavily referenced in the chapters that follow. In summation, while there are limitations associated with mixed method inquiry they are, easily, overshadowed by the basic premise that this type of research presents with a vehicle for internal transformation. Whatever the case further, more collaborative participatory studies; involving other schools and colleagues with a broader, more random sample; could straightforwardly address these, and many other, key limitations.

### **c) Constructivism in Computer Science Education**

There is much research, appraised in Chapter 2, that details the many benefits of a constructivist approach to teaching and learning. Constructivists create realities based on a myriad of, largely, experiential interactions influenced by an existing and, somewhat foundational knowledge

base (Orey, 2010). When applied from an educational perspective, a constructivist approach can be used to empower learners; positioning them at the epicentre of the learning process as equal and active participants in the quest for knowledge (Beynon, 2009; Cole, 1992; Papastergiou, 2009). There are many learner-centered, constructivist approaches educators can use; Digital Game Based Learning (DGBL) is but one. Furthermore, the very nature of the Computer Science (CS) discipline, and by extension the content addressed in the Information Technology (IT) syllabus, encourages the use of exciting and engaging methods of disseminating information to a tech savvy youth — especially when one considers the nature of the internet driven information age. But, while literature abounds detailing the many benefits of a learner-centered teaching approach; the harsh reality at a grassroots level is that implementing DGBL correctly requires, to varying degrees, much hard labour from the educator (Karagiorgi & Symeou, 2005). Additionally, educators must have a clear understanding of what it is they want their learners to internalize from each experience with the technology (Chaisanit, Phangphol, & Suksakulchai, 2013; McWhorter & Hudson-Ross, 1996). Furthermore, educators must ensure specific objectives and milestones have been clearly communicated to their learners (Van Eck, 2006). More especially, both educator and learner have to have a fundamental understanding of what is to be assessed and how (Prensky, 2001). This necessitates explicit planning from the facilitator which, ultimately, spells more work. Moreover, the need for exemplary classroom management is, perhaps, magnified when using this approach and the need to be consistently on top of things can quickly become more evident until learners, a) get used to the style of teaching or, b) see value in its implementation. As a result, managing learner ability and motivation levels can prove to be difficult — especially when class sizes are large or when there is a great difference learner ability (Gray, 1997). Trying to find and maintain equilibrium in this regard, daily, can prove exhausting for

any educator. But teaching is not for the faint of heart and even though there are limitations involved in using this approach; the benefits certainly, in my view, placate the required work ethic. Still, it must be noted that any effort to successfully prove worth in generally deploying a learner-centered approach is reliant, largely it may be argued, on many factors not least of which — educator propensity for change (Govender & Dhurup, 2014).

#### **d) Issues concerning Scratch**

Replication of this research necessitates the introduction of the Scratch platform to junior learners. To be sure, that in itself is not a limitation, since Scratch is free to download and running it requires minimal processing ability from the host computer or network. But one must consider that many existing computer labs are, for the most part, reserved for senior classes in either IT or Engineering and Graphical Design (EGD). Moreover, and in some cases, labs are used by more than just the learners from computer related courses. These issues concerning use, can frustrate learners and educators alike and, oftentimes, mandate the appending of a regular use policies for computer labs. More especially, if learners intend working on their projects outside of regular class time. Furthermore, and generally speaking, computer configurations are not prepared with the Scratch platform in mind. Using Scratch requires equipment, where games are concerned, that is not standard such as headphones or speakers and video graphics cards. The cost implications can prove limiting for many schools should they wish to comprehensively deploy game developing into their curriculum; even if they wish to do so using the Scratch platform. That said, Scratch games do present with a very rudimentary, if not juvenile, end-product that may not excite experienced gamers. More advanced learners may quickly become disinterested by the prospect of developing low resolution applications that are not networkable or deployable to any mobile platform. Many



children fancy themselves, as creators of the next Angry Birds or Clash of Clans — two mobile games that have seen multi-national corporations built upon their huge, worldwide success. But, developing mobile gaming apps is incredibly complex and expensive due to costs related to training, software licenses and the deploying of apps to the mobile markets. In their defence, forward thinking developers at MIT (Massachusetts Institute of Technology) have addressed two critical flaws with the first edition of the Scratch software and version 2 is now capable of handling higher resolutions and allows for online deployment, editing and play. In regard to the nature of this research of course these, and any other issues involving the Scratch platform, can very easily be overcome since the environment, location of the research and sample size are all very small. As a result, the predominant limitation in using Scratch might instead involve the choosing between two divergent perspectives to using games for learning — instructionist and constructivist. What this means of course is that the issues concerning the Scratch platform are broader than simple speculation as to whether or not it provides with the best environment for implementing DGBL. One must regard the Scratch platform for what it was designed for — a simple and easy to use introductory platform for learning how to code. Doing so might well prove any issues, or limitations depending on your view, to be mute points rather than causes for concern. With that said, Scratch is much easier to use than any other programming language in that: you do not have memorise code, commands fit together like jigsaw puzzle pieces and are colour coded and error messages are rare (Resnick et al., 2009). In short, Scratch presents with a viable, proven, and easy to use platform from which to test the hypothesis.

## **1.9 Research design and methodology**

### ***1.9.1 Research methodology***

This study employed a mixed-method approach, using both qualitative and quantitative methods. The research instrument for the quantitative data collection was a questionnaire that was developed using variables from established theoretical frameworks. The questionnaire was implemented exclusively for learners online. The interviews with learners included closed-ended questions that were informed by the responses to the questionnaire. The interviews with the educators included open-ended questions that were also developed based on the analysis of the questionnaire responses.

### ***1.9.2 Context and sampling***

The participants in this study were Grade 8 learners from three Secondary Schools in Durban. Of the 105 learners officially invited to be a part of the research 89 completed the questionnaire and three groups of 6 took part in focus-group interview sessions. Aside from the researcher, there were 3 educators involved in the study.

### ***1.9.3 Methods of data collection***

In order to obtain data that would strengthen the aims of the study it was decided that it was necessary to use more than one data collection method. Interviews for learners and educators were developed based on the responses obtained from the online questionnaire. The conceptual framework included constructs the constructivist learning environment (CLES) (Jonassen, 1999), the intrinsic motivation inventory (IMI) (Deci & Ryan, 2003) and the diffusion of innovation (DoI) (Rogers, 2010).

#### ***1.9.4 Data analysis and interpretation***

Since the questionnaire was implemented online, using Google Forms, the data were captured automatically on a spreadsheet in terms of actual numbers, which facilitated statistical representation of the data in percentages and graphs. The analysis of the quantitative data incorporated the breaking up complex data into manageable themes, patterns, trends, and relationships based on proven constructs. These constructs were condensed into composite statements and are discussed further in chapter three. Analysing the qualitative data involved producing transcripts of the interviews. Once the transcripts were done, the researcher looked for themes and categories that were associated with the theoretical framework, keeping the research questions in mind. The analysis included data from the questionnaire and the interview.

#### ***1.9.5 Ensuring trustworthiness of the study***

To ensure credibility in this study, the researcher interviewed (using a digital voice recorder) the participants with an intention to gain insight into their experience with DGBL. Once the interviews were transcribed educators and learners were given the opportunity to read the transcripts to ascertain whether they were a true reflection of their responses. Data were also collected using a questionnaire. Collecting data from differences sources, as described in chapter three, adds to the strength of the validity, reliability, and trustworthiness of the study.

#### ***1.9.6 Ethical issues***

During the planning and implementation of this research project due consideration was given to ethical issues in using learners as part of the data collection method. All ethical procedures were followed, which included obtaining ethical clearance from the university and the

Department of Education as well as obtaining signed consent letters from the parents of the learners and the learners themselves.

## **1.10 Overview of the thesis**

This research was conducted, using mixed method research to determine the effectiveness of using a digital game-based learning methodology to optimize learner ability and motivation. This research was completed in self-contained classroom settings at three high schools located in KwaZulu Natal, South Africa. The learners were on a five-period class schedule and the intervention adhered to the school system calendar. Curriculum content being taught during the intervention included critical concepts normally taught in the Grade 10 IT syllabus — looping, branching and variable usage.

This research consisted exclusively of Computer Literacy learners in Grade 8, since Information Technology is not, as yet, scheduled on the state controlled national curriculum. The sample was heterogeneous in ethnicity and both quantitative and qualitative methods were used to measure the effectiveness of DGBL instruction in a junior high school classroom setting. The classes were conveniently selected and consisted of learners with mixed abilities. No pre or post-test was given, to measure any improvement in academics since the scope of this research negated its implementation. Learners were taught, for a period equalling one week using the learner-centered DGBL method. At the end of the research, learners were given a questionnaire to reflect their feelings about DGBL. An initial analysis of the questionnaire data was used, to inform the line of questioning used in the follow-up, semi-structured, focus-group interviews. Additionally, learners were observed for behaviour and engagement during regular class time over the week-long period. An online wiki was created and used as a Learning Management System (LMS) that provided with a means for learners to catalogue

their experience, to engage with learning materials, to engage with other learners and to upload generated content. The LMS proved invaluable in providing the researcher with key insights into the learner experience.

As has been stated, this research involved learners who will have had little to no exposure to programming using the Scratch platform. However, many should have at least been exposed to basic computer software suites, like Microsoft Office. Furthermore, the majority of the Grade 8 learners seemed comfortable, before the research intervention commenced, with being able to access and upload projects to the Scratch website. The roadmap for this research involved the following stages:

- i. Preparing all four classes for participation, as a convenience sample, in this research.
- ii. Establishing baseline Learning Outcomes (LO's) as characteristics for inclusion in all project designs for the allotted period.
- iii. Incorporating DGBL into teaching and learning.
- iv. Observing and recording learning responses over the week-long period.
- v. Gathering survey statistics (Questionnaire and Interviews).
- vi. Analysing and drawing conclusions from results.

To limit the negative connotations associated with studies of this nature, in regard to external validity or generalizability, great effort will be made to increase the internal validity of the data collection devices. Moreover, since it cannot be avoided that all four groups will take part in

the research as part of a convenience sample, effort will be made to ensure qualitative data be collected as a means of endorsing any findings. It is hoped that, in deploying this design, any differences that appear in the data will be as a result of exposure to DGBL rather than due to an already academically diverse sample.

## **1.11 Structure of the study**

Chapter one introduces the study and presents the research topic, research questions, problem statement and rationale of the study. Chapter two provides a literature review about the research topic, including articles on a) the use of games in education; b) digital game-based learning or DGBL; c) understanding the challenges to using DGBL and; d) constructivism as a theoretical framework within computer science education. Included in this chapter are the theoretical frameworks that make up the conceptual model used to gauge responses in this study. Chapter three discusses the methodology used in the research and includes reference to the integrating technology for inquiry (NTeQ) framework (Morrison & Lowther, 2001) and the technology acceptance model (TAM) (Davies & West, 2014) – both of which were used as a means of tailoring material that would garner learner buy-in in the shortest amount of time. The mixed-methods approach (Cresswell, 2003; Creswell & Clark, 2007; Driscoll et al., 2007; Johnson & Onwuegbuzie, 2004; Zohrabi, 2013) was used for data production, with both qualitative and quantitative methods applied. The questionnaire constituted the quantitative approach for producing data regarding the learners' attitudes towards DGBL. The qualitative approach incorporated focus group (learners) and one-on-one (educator) interviews, post intervention. Chapter four is discussed the research findings. Tables and graphs are used to show the findings from the questionnaire, and thematic analysis (Boyatzis, 1998) is applied to analyse data from the interviews. The research questions are answered in this chapter. The validity, reliability,

and trustworthiness (credibility) of the research findings and ethical issues are also discussed. Chapter five presents the analysis of the data and chapter six presents an argument as to why DGBL should be used in classrooms to support teaching and learning.

## **1.12 Conclusion of the chapter**

In this chapter Digital Game Based Learning (DGBL) is presented, as a well-researched innovation for teaching and learning. Presented herein, is the framework and setting wherein this research takes place. Furthermore, great effort has been made to present cause for a research of this nature. It has been shown, that even though commercial games have been identified as being the most suitable approach to DGBL (Van Eck, 2006); the focus of this research is to incorporate the practice of designing games, using the Scratch interface, as one part of the learning process (Robertson, 2012). The other part involves, using mixed method research, an exploratory analysis into:

1. The perceived motivational benefits linked to using DGBL.
2. Learner perception toward coding and Information Technology.
3. Learner perception toward careers in the Computer Science field.
4. How DGBL benefits both teaching and learning.

In the next chapter, this research will present the views of esteemed scholars regarding the use of games in education. Moreover, a review of literature concerned with DGBL are regarded. Further to that, literature concerned with understanding the challenges associated with DGBL are addressed. Also, literature on the application of a constructivist approach to teaching and learning within computer science education is presented. After which, this

research looks to take in hand literature concerned with the theoretical frameworks used, in this research, to gauge responses to DGBL. Finally, this research will look to emphasize niche worth in the research, through the analysis of said scholars' works.



## **Chapter 2 : Related work**

### **2.1 Introduction to chapter**

This chapter will review the literature of scholars who have studied the relationship between DGBL instruction, learner achievement, and motivation. The literature reviewed herein will provide evidence that a DGBL learner-centered instructional approach is effective in increasing learner achievement, ownership, behaviour, and attitude. Furthermore, evidence of constructivism, being used successfully as a theory of learning within the computer science landscape, is also presented. Ultimately it is the work of scholars, whose works are presented herein, who have provided the background information, strategies, and techniques key in helping this author identify a gap this research looks to fill. That is to say — research abounds with articles on a) the use of games in education; b) digital game-based learning or DGBL; c) understanding the challenges to using DGBL; d) constructivism as a theoretical framework within computer science education and; e) theoretical frameworks used to gauge responses in this study. From these theoretical frameworks, a conceptual framework (f) was developed specifically for this study. Apart from investigating the many anecdotes and empirical works regarding the benefits of DGBL, this article looks to provide reasons why its implementation positively affects both teacher and learner perceptions.

#### **a) Games in Education**

Should you ask the average anyone to associate single words with the word 'games' you would, in all likelihood, be bombarded with words like, fun, play, sport, and contest. Ask a more academically astute audience, and you may well end up with responses that include words such as expensive, trivial, distracting and divertissement; depending on the number of degrees

associated with the members of your audience, of course. Regardless, it is with a fair degree of certainty that one can say — your responses will be as diverse as the individuals giving them. It could even be argued that, aside from love, there are few other subjects that command such overarching responses so directly linked to one's age as one's view toward the idea of playing games. It seems almost as though, there is an inverse relationship between one's age and one's willingness to engage in play. Perhaps no more is this view prevalent, than in the field of education. As a young child, playing games is encouraged and even forms part of the schooling curriculum (Dewey, 2013). As children grow up, the way they play changes following the course of their cognitive development (Rieber, 1996; Rosas et al., 2003). However, the further up the formal education ladder one climbs the more frowned upon its inclusion appears to become (Rieber, 1996) — to the degree that there is now a huge gap between what children do for fun and what they are required to do at school (Shute, 2011). Of course, adults do play in many senses of the word. But, unlike children, adults have serious work-related commitments that oftentimes fly in the face of play (Prensky, 2001b). Still, one has to wonder how many parents wish they were able to abandon all sense of decorum and join their children up on the jumping castle while at one of the numerous birthday parties they are forced to regularly attend. Repressed inhibitions aside, it appears as though the older we get the more complicated our view of play becomes. So, how do we define this most rudimentary of words? Play as a concept is difficult to define (Rieber, 1996). It appears to be one of those constructs, Rieber (1996) suggests, that are completely obvious at the tacit level but extremely difficult to explain in concrete terms (p.43). What remains clear though, is that regardless of context, as Vygotsky (1967) points out, one cannot simply define play on the basis of pleasure (p.1). The use of play, within an educational context, is by no means a new phenomenon (Piaget, 2013; Plass, Chun, Mayer, & Leutner, 1998; Vygotsky, 1967). Piaget and Cook (1952), for example, describe play

as being an integral component to a child's cognitive development (Flavell, 1963; Piaget & Cook, 1952). DeLoache (1987) moves further, drawing a direct correlation between play and symbolic thinking ability (p.1556) — one of the most significant developments of early childhood (DeLoache, 1987; Plass, Homer, & Kinzer, 2015). Of course, not all methods of play earn a crucial role in child development. According to Lillard et al (2013), despite 40 years' worth of research concerning the role of 'pretend play' in education, there is little evidence to suggest its unequivocal worth (p.27). Hands-on play however, according to Lillard et al (2013) who quotes Hirsh-Pasek (2009), remains the most positive means yet known to help in young children's development (Hirsh-Pasek, 2009; Lillard et al., 2013). Still, by and large, literature associates play within a formal setting, almost exclusively, with children in the early childhood development phase.

In the modern age, game-based learning has grown a new, more trendy, digital guise. Today, Digital Game Based Learning (DGBL) aims to make use of the many inherent positives associated with computer games, an integral part of our social and cultural environment (Papastergiou, 2009a). Digital gaming, is now a multi-billion dollar industry and studies have shown that children, aged between 8 and 18, spend more time in front of a screen than every other activity aside from sleep (Chaudhary, 2008). Developing teaching strategies that incorporate games within the learning environment has always been an aspiration, one could argue, of dynamic and forward-thinking educators. Similarly, many educationalist; over the last few decades; have raised the question of how to take advantage of the promise of digital games for educational purposes (Plass et al., 2015). The fact is, according to Tobias et al (2014), there are few instructional methods capable of engaging similar levels of interest among learners, or of inducing them to persist on tasks for as long, as do games (p.37). The many

concepts that are important in the context of games, such as motivation, have aspects relating to a myriad of theoretical foundations – cognitive, affective, motivational, and socio-cultural (Plass et al., 2015). It is within this diverse framework that a vast body of knowledge has developed in relation to our understanding of the role of play in a child’s cognitive development. Over time, this body of knowledge has informed our understanding of educational games while simultaneously generating greater interest in the fields related thereto (J. P. Gee, 2003; Papastergiou, 2009b; Plass et al., 2015). So, what makes games engaging? According to Prensky (2001) computer games are, potentially, the most engaging pastime in the history of the humankind (p.106). He attributes his view to the following elements:

- i. Games are fun and provide a sense of enjoyment and pleasure.
- ii. Games are a form of play that provides with an intense and passionate involvement.
- iii. Games have rules that provide with structure.
- iv. Games have goals that offer motivation.
- v. Games are inherently interactive and intrinsically engage.
- vi. Games provide outcomes and feedback that offers learning.
- vii. Games are adaptive and offer flow.
- viii. Games have win states that offer ego gratification.
- ix. Games have conflict/ competition/ challenge/ opposition that offers adrenaline.
- x. Games offer problem solving that sparks creativity.
- xi. Games have interaction that provides with a sense of social grouping.
- xii. Games have representation and story that illicit emotion (p.106).

Another view, as to why playing games are so engaging, involves contemporary learning theory change. Early learning theory, argued that the human mind worked much the same as a

computing device (J. Gee, 2008). However contemporary learning theory (Bransford, Brown, & Rodney, 2003) suggests that humans think, and subsequently learn, by manipulating "*abstract symbols via logic like rules*" (J. Gee, 2008). In other words, we are continually running simulations in our minds, based on past experiences, in order to solve problems in a logical fashion. In school-age children, this translates to the continual creating of new relationships between being the semantic and the visible (Vygotsky, 1967) — that is to say between thought and reality. Indeed, many major theories of cognitive development attribute this '*symbolic functioning*' to play (DeLoache, 1987). So long as educators guard against turning play into yet another teacher-directed activity (Bodrova & Leong, 2015), it can even help towards a blurring of the lines between assessment and learning (Shute, 2011). Subsequently, reducing or completely removing learning test anxieties all the while maintaining validity and reliability (Shute, Hansen, & Almond, 2008). Removing test anxieties will, inevitably, create an environment where the lowered consequences of failure encourages risk taking and self-regulated learning (Plass et al., 2015).

With potential for greater learner engagement, collaboration, and opportunities for personalized learning (O'Riley, 2016) it is no surprise that over the last three decades, electronic games have cemented their place as integral constituents of socialization (Hammond, Cheney, & Pearsey, 2015; Padilla-Walker, Nelson, Carroll, & Jensen, 2010). Today's children, the world over, are easily able to acquire proficiency in digital literacy through play (Demeulle, Lowther, & Morrison, 1998; Kolikant, 2010). Moreover, in many instances these "*digital natives*", according to Prensky (2001), purportedly develop said skills and adapt to new technologies absent adult instruction. In fact, it has been suggested that children today have become disengaged with traditional educator-centered means of instruction (Mascolo, 2009).

A problem exacerbated, suggests the Center for Mental Health in Schools at UCLA (2008), by the increasing numbers of educators who are forced to 'learn-on-the job' how to handle children who manifest commonplace learning, behaviour, and emotional problems (p.3). Indeed, learners nowadays, according to Van Eck (2006), require multiple streams of information, prefer inductive reasoning, want frequent and quick interactions with content and have exceptional visual literacy skills (p.17). These traits tend to favour instruction that supports motivation, cognitive success and performance outcomes (Woo, 2014). This explains, perhaps, why games are already widely used by primary school teachers, parents and other institutions with an interest in learning (Plass et al., 2015). What it does not explain, is why games are not extensively used academically in high schools especially when one considers that today's youth have grown up on a "*diet of video and PC games*", and are more adept at '*Googling It*' than perusing the pages of a textbook (Chaudhary, 2008).

## **b) Digital Game Based Learning**

Even though digital games have been incorporated into teaching and learning from as early as the 1970's the term Digital Game-Based Learning (DGBL), according to Felicia (2011), was first made popular by Prensky (2001) then Gee (2007) (p.1). In his seminal work, Prensky (2001) argues that "*today's learners are no longer the people our educational system was designed to teach*" (p.1). Sadly, education today still implements, to varying degrees, an instructional model that was developed centuries ago; by the great thinkers of an Industrial Age; as a means of producing "*functional members of society*" (Robinson, 2012). Although sensitive to the socio-economic needs prevalent at the time it is, today, widely accepted that an educator-centered instructional model; especially one involving ability grouping (Kulik, 1992) and limited learner participation (Mascolo, 2009); can favour only a small percentage of

learners (Grossman & Stodolsky, 1995; Simmons, 2001). The resulting future spells, for many high school underachievers and drop-outs, much frustration and oftentimes failure in the face of the myriad of challenges today's highly complex society presents with (Simmons, 2001). Put simply — in order to circumvent an exponential rise in high school academic, and subsequent social, inequalities Robinson (2012) suggests new approaches to instruction. Simmons (2001) concurs stating that, nowadays, instruction should especially connect to the needs and learning styles of the children being taught (p.2). Woo (2013), Karoulis and Demetriadis (2005) echoed these findings and argued further; stating that learner-centered instructional models, such as DGBL, can provide with a framework that supports cognitive success and performance outcomes (p.291) (p.18). Moreover, and since, computers provide learners with a familial ontological reality (Ben-Ari, 1998) and since digital literacy has become more common, if not inherently universal, DGBL can provide with effective stepping stones for learners to be able to construct new knowledge (Prensky, 2001b) regardless even; of the field of study (Papastergiou, 2009b; Van Eck, 2006; Wang & Chen, 2010). Felicia (2011) and Huang (2011) support this view and argue that children today are exposed to digital devices from a very young age, and have developed skills that can, and should, be acknowledged by engaging and teaching them through video games (p.1) (p.3). By definition, DGBL places the learner at the very center of the learning process (Chaisanit, Phangphol, & Suksakulchai, 2013). Doing so can, surely, impart a level of ownership that will both positively affect behaviour and attitude toward learning (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005; Ng, 2012; Yang, 2012). The residual effects of which, it can be argued, can indicate an overall increase in learner academic performance by combining entertainment with information (Chaudhary, 2008). Furthermore, Digital Game Based Learning (DGBL) presents with significant potential for increasing learner motivation as well (Erhel & Jamet, 2013; Huang, 2011; Papastergiou, 2009a; Woo, 2014), all

the while enhancing the effectiveness of teaching and learning (Tobias, Fletcher, & Wind, 2014; Wang & Chen, 2010; Yang, 2012) by incorporating fun into the process (Prensky, 2001b).

It should come then as no surprise that, to many, playing games is fun. Learning on the other hand is, oftentimes, a difficult and challenging experience. It does not require a great stretch of the imagination to realise that a marriage between these two concepts, play and learning, is mandatory to avoid a punctuated equilibrium in education in an otherwise rapidly evolving digital world. A review of empirical research over the last two decades shows that, in general, DGBL is engaging and can be used to create exciting lessons; to provide the impetus for learning content and for developing both cognitive and meta-cognitive skills (Huizenga, 2017a). But, DGBL is not limited just to the using of games or game concepts within the formal classroom setting. Nor is its use restricted to the use of, sometimes, limiting, and expensive commercial-off-the-shelf (COTS) games. Indeed, there is a third approach, touted by many according to Van Eck (2006), as the "*Holy Grail*" of DGBL approaches (p.6). Through game developing, now learners of any subject can enjoy the opportunity of becoming agents of their own learning. As creators of games, learners take on the role of experts in their own digital realms. And, if Prensky (2001) is to be believed, anyone with any level of expertise can begin using DGBL on some level, much quicker than you think (p.19). The important question now would be — *how* do educators use games most effectively as educational tools rather than; *can* they be used to support learning (Squire, 2005). Yet computer game development has, in the recent past, required a high proficiency level in programming skills. A shortcoming that has, a) hindered the adopting and advancing of new learning technologies (Egenfeldt-Nielsen, 2007, 2011; Michael & Chen, 2006); and b) augmented educator perceptions of technical expertise



required for game development (Whitton, 2012). Today, however, that limitation has been removed with the creation and availability of game creation engines such as Scratch, Unity and Kodu. Now, educators and learners alike have powerful tools with which they can create, according to Van Eck (2006), intuitive virtual environments for the incorporation of game elements into the teaching syllabus (p.3). This 'gamification' of curriculum content, according to Lee and Hammer (2011), provides schools with an opportunity to address problems involving learner motivation and engagement (p.2). Moreover, educators using games to support teaching are now able to create an atmosphere that is intuitively responsive to the needs of the learner (McWhorter & Hudson-Ross, 1996). A feat due in no small part, to the widespread public interest generated by an on-going myriad of research conducted by DGBL proponents (Van Eck, 2006; Woo, 2014). In essence, video games recruit learning and mastery as a form of pleasure (J. Gee, 2008). By engaging a person to such a degree that self-consciousness disappears (Tobias et al., 2014), good games recruit good learning (J. P. Gee, 2003) and provide with the motivation to learn (Huizenga, 2017a). The primary reason we need motivation in our classrooms is because learning takes effort (Prensky, 2001b). A failure to use positive reinforcement, of course, would mean that educators may well be tempted to motivate through fear instead of fun. Such as it is in many schools across the globe, where academic results or physical and mental abuse are commonplace motivators for jaded educators struggling with both content delivery (Simmons, 2001), the pressures of achieving high results through testing (Ballard & Bates, 2008; Mouton, Louw, & Strydom, 2012) or a lack of conviction and confidence in new technologies (DW Govender & Dhurup, 2014).

In regard to DGBL, it has been shown there exists two perspectives to using games for learning — instructionist and constructivist (Kafai, 2006). The instructionist, accustomed to thinking in

terms of making instructional educational materials, turn naturally to the concept of designing instructional games. This particular approach favours the use of Commercial-Off-The-Shelf games (COTS). However, there exists many and more issues involving successful implementation. Not least among these issues is the standardisation of complexity, flexibility and replayability of the games used in an instructionist approach to DGBL (Squire, 2005). Still, this approach is easiest to kick-start and is, as such, more popular among DGBL proponents. Far fewer people have sought to turn the educational tables — by making games for learning instead of playing games for learning. Rather than embedding *lessons* directly in games, constructionists have focused their efforts on providing learners with greater opportunities to construct their own games — and to construct new relationships with knowledge in the process. Ultimately though, both of these approaches have had success in the classroom (Rosas et al., 2003) since they both provide with competition, collaboration, an authentic context, usability and feedback with regard to the role of the educator and the ability of the learner (Huizenga, 2017b).

### **c) Understanding the challenges to using DGBL**

It would be naive to believe that using DGBL is plain sailing. For that matter, the same can be said for implementing any other 'new' innovation (DW Govender & Dhurup, 2014; Desmond Govender & Govender, 2009; I. Govender & Govender, 2010) especially when you consider teacher resistance towards technology-centered learning environments (Rosas et al., 2003). That said, questions will need to be answered by all stake-holders should a push towards DGBL be mandated. These questions are summed up by Van Eck (2006) and include the following:

1. How do we organise the games around the curriculum?
2. How do we align the games with curricula content?

3. Are all games, developed by learners or otherwise, going to be equal or standardized?
4. How will these games be assessed?
5. Who will develop supporting documentation?
6. Who will provide the technical support?
7. How will the financial implications be addressed?
8. How will the issue of infrastructure be addressed?
9. Who is responsible for the on-going research and development? (p.13-14)

Moreover, in developing nations, these issues are exacerbated by the fact that most schools lack the required resources (MolokoMphale & Mhlauli, 2014). Furthermore, many children come from broken or dysfunctional homes (Rammala, 2009). In post-apartheid South Africa this issue is compounded by the fact, not all learners have equal opportunities or experience equal access to quality education (Motala, 2011). With broad financial inequality at the heart of many underlining issues in South Africa (Motala, 2006) a very real, direct subsequence is simply a lack of computer availability (Rosas et al., 2003). But, in spite of all of the associated financial challenges facing DGBL implementation; at the heart of the real issue remains mindset change — from schools organized around social control to ones that place the emphasis on learning (Squire, 2005). Part of the process of facilitating this change involves, one might argue, a clarity of understanding what DGBL entails. Given the long history of efforts to align fun and learning (Breuer & Bente, 2010) coupled with the use of so many buzzwords being thrown around regarding games and education; it is not difficult to find confusion reign as to their precise meaning, or taxonomy associated with DGBL (Tobias et al., 2014) — let alone instruction as to its use in the classroom. Especially, when one considers that DGBL requires a pedagogical approach that is unfamiliar to many traditional educators (Van Eck,

2006). Additionally, assessing knowledge, skills and understanding does present problems for traditional measurement models when using DGBL (Shute, 2011). That being said, much of the research surrounding DGBL can hardly be defined at an epistemological level (Breuer & Bente, 2010) as they lack sound empirical evidence (All, Nunez Castellar, & Van Looy, 2014). Rather, much of the research into DGBL is either advocacy or anecdotal and is reliant, almost exclusively, on data methodically collected from observations and surveys (All et al., 2014; O'Riley, 2016). Despite great interest in DGBL, literature shows few efforts to scientifically apply motivational theories to understanding learning in games — even in the presence of an extensive theoretical and empirical foundations in motivation (Plass et al., 2015). This means of course, that there is gap in the not yet proven research (Shanahan, 2002) when it comes to a prescribed set of norms and standards; the likes of which will ensure unilateral success (Berg Marklund, 2015) — perhaps even, in the absence of an educator. Most especially, studies incorporating quantitative data collection are very few (O'Riley, 2016). Currently there are no studies, to speak of, that incorporate a mixed-method approach based on established frameworks — albeit ones that were not developed specifically with DGBL in mind. The resulting conceptual framework, developed for this study, is discussed in detail later in this chapter. That said, the researcher feels it prudent to share definitions of some of the terms related to DGBL:

**Edutainment:** a portmanteau used to describe any attempt to make learning in the classroom enjoyable or, more enjoyable as it were (Breuer & Bente, 2010).

**Gamification:** a word used to describe the incorporation of game elements into non-game settings (Lee & Hammer, 2011)

**Game Based Learning (GBL):** a term used to describe the incorporating of any kind of game (card games, board games, sports games etc. ) into a learning environment (Van Eck, 2006).

**Digital Game Based Learning (DGBL):** a branch of serious games that involves any marriage between educational content and computer games (Prensky, 2001a).

**Digital Game Based Learning Environment (DGLE):** a multimedia game-based learning environment where external materials are used to enhance learner motivation (Woo, 2014).

**Serious games:** a commercial side to game usage that falls into the realm of art, advertising, training and therapy (Breuer & Bente, 2010).

**Gameplay:** a word used to describe the activities and strategies used, by designers of games, to ensure player engagement and motivation when playing through a game (Prensky, 2002).

**E-Learning:** the combining of (digital) media and learning (Rosenberg, 2001).

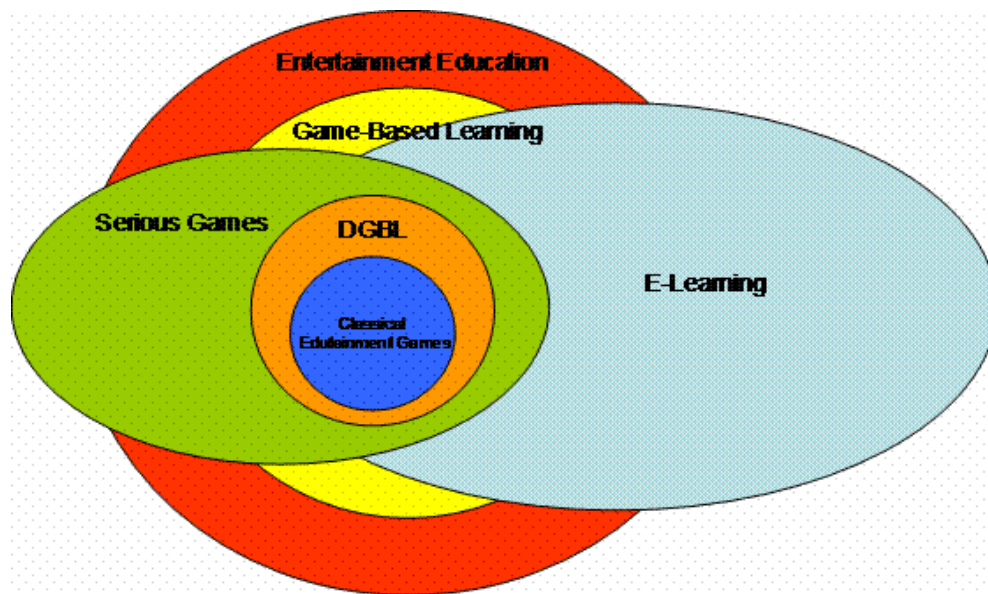


Figure 2.1: The relationship between DGBL and similar educational concepts (Breuer & Bente, 2010).

With an increase in the popularity of games, a general disengagement with traditional education coupled with on-going research by proponents of DGBL it is no surprise that there is widespread interest in games as learning tools (Van Eck, 2006). In fact, DGBL has been already become common-practice for use in many industries (Chaudhary, 2008). The military use simulations to train pilots on new equipment, businesses employ product training using game software and hospitals instruct new employees using virtual patients. So, what does DGBL promise in the education sector? According to Prensky (2001) computer games are, potentially, the most engaging pastime in the history of the humankind (p.106). He attributes his view to the following elements:

- Finally, motivation can be found to learn subject, or content, that is difficult to teach.
- Small groups of developers can work collaboratively towards radically improving both teaching and learning.
- Free learning tools and game-creator software makes it easy for experts, educators or even learners to create bespoke games. In some cases, with very little effort or coding knowledge.
- The Internet can act as a conduit to a plethora of resources with an exponentially dynamic field.

With DGBL, an authentic learning experience is predicated because learners are constantly engaged as they learn to solve problems in tune with the progress on the game (Chaudhary, 2008). DGBL shows great potential for positive improvements in academic performance (Ferguson, 2014). Furthermore, and perhaps most importantly, DGBL stokes creativity rather than suppresses it. Digital games enhance decision-making skills (J. P. Gee, 2003) and actually encourage failure (Squire, 2005). And, if a child is not motivated by extrinsic negative influences

like fear of failure — then their limitations, regardless of what they are, can drastically be reduced if not completely removed. Still, getting long term buy in from learners involves the creating of games that delicately balance three key elements: a challenge, a response and feedback (Plass et al., 2015). All three elements begin a loop in the game, when feedback amounts to a new challenge or prompts the player to a different response to the original challenge. Of course, this suggests that much work on the educator side prior to setting class work or assignment objectives. However, one could argue that the inclusion of key game design features serves the same purpose (see Figure 2.2).

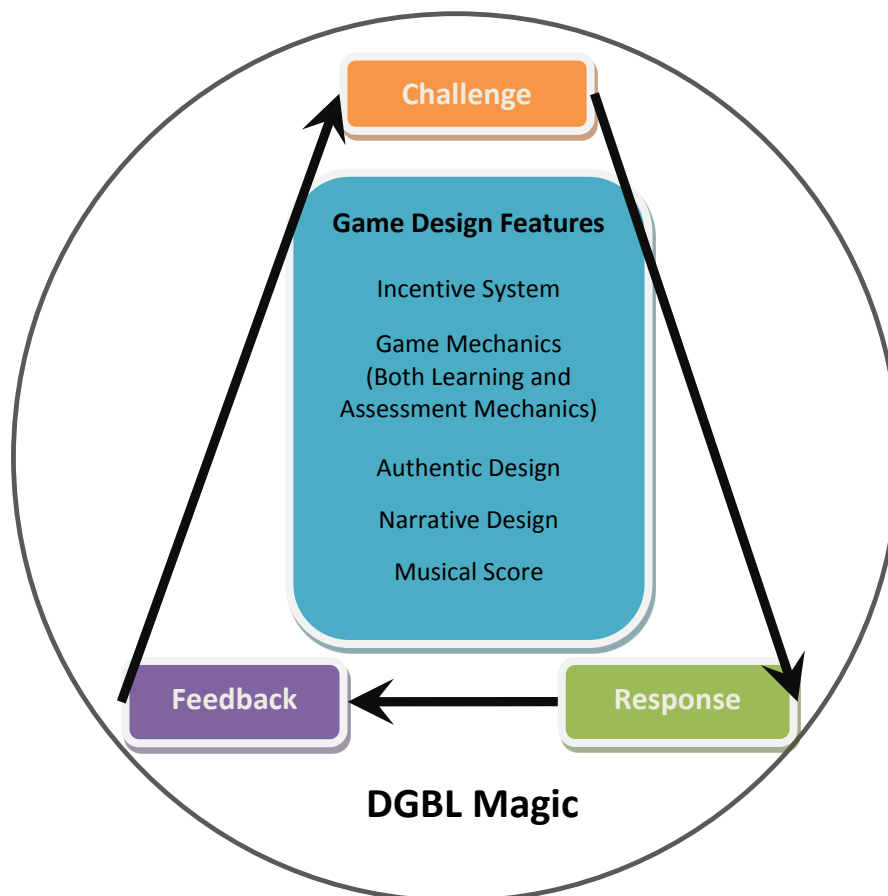


Figure 2.2: The Magic Circle Model of Developing Games (Plass et al., 2015)

#### **d) Constructivism in Computer Science Education**

Recent studies show constructivism, as the dominant theory in the field of instructional design (Karagiorgi & Symeou, 2005; Nagowah & Nagowah, 2009; Van Hoorn, Monighan-Nourot, Scales, & Alward, 2014). According to the constructivist theory, knowledge is actively constructed using an adaptive and experiential process rooted in the manner by which an individual views the world (Hendry, 1996; Mayer, 1992). Hence, according to Karagiorgi and Symeou (2005) who reference Solomon (1994), a learner should be viewed as a scientist who actively constructs knowledge while striving to make sense of the world using personal filters: experiences, goals, curiosities and beliefs (p.2)(Cole, 1992). In a world where, today, information is instantly accessible — constructivism can provide with an eclectic application of learning strategies (Karagiorgi & Symeou, 2005). Luo et al (2005) augment this view and argue further that rapid development of Information and Communication Technologies (ICT's) have encouraged the adoption of teaching models, such as DGBL, that are based squarely on the constructivist theory (p.490). In comparison to other teaching methodologies — approaches based on constructivism share the following characteristics:

- i. learners have more control over the learning process,
- ii. collaborative work allows learners to improve communication skills leading to;
- iii. an increased capacity to learn (Noor-UI-Amin, 2013).

These characteristics apply to all learning disciplines since the basic tenet of the constructivist theory is — that knowledge is constructed by the learner (Ben-Ari, 1998). But, while research shows constructivism to be influential in Science and Mathematical education, Ben-Ari (1998), the same is not true, perhaps of Computer Science education (CS) — and by extension Information Technology (IT) since CS and IT share many epistemological traits (p.1). Because



constructivism is concerned more with method than subject matter, according to Gray (1998) and because of its influence in other learning areas, one is almost tempted to assume a seamless application within CS education (p.7). Furthermore, the digital nature of IT, the availability of content, tutorials, Learning Management Systems (LMS) coupled with the digital aptitude of many tech savvy learners (Prensky, 2001b; Van Eck, 2006) somewhat encourages independent or co-relational learning within a game-based, constructivist framework (De Freitas, 2006; de Freitas et al., 2012). But Govender and Govender (2012) caution against flippant application of this approach within CS education and found that the complex nature of some CS principles, which oftentimes require higher levels of thinking in solving computer related problems, favour face-to-face time interaction between learners and educators (p.6). This view is congruous, according to Beynon (2009), with Piaget's principle of assimilation before abstraction (p.15). Simply put — in order for learners to construct new knowledge they should already have an existing framework of understanding (Karagiorgi & Symeou, 2005). Unfortunately, CS learners, argues Ben-Ari (1998), do not have an effective cognitive structure wherefrom reference to programming-related concepts can be made (p.8). Successful performance in CS education mandates the establishing of a standardized, normative reality that learners can intuitively develop their knowledge base from (Ben-Ari, 1998). But how important is a working knowledge of what happens inside a computer? du Boulay (1989) suggests that without instruction to the contrary learners establish their own ideas as to the inner workings of a computer (p.289). In fact, in reaching his conclusions Ben-Ari (1998) endorses this view, to a degree, and finds that a constructivist pedagogical stance to CS education can indeed be sustained (p.16). The biggest problem for novice programmers then, would not be the understanding of basic concepts but rather learning how to apply them (Ala-Mukta, 2003). It moves then, that even in the absence of an epistemological reference learners can develop

programming prowess. Moreover, should learners perceive value in the task assigned, argues Tuan et al (2005), they will actively engage and integrate their, perhaps indirectly related, existing knowledge with their new CS experiences (p.641)(Tuan\*, Chin, & Shieh, 2005). The broader, and somewhat complementary, picture is that few disciplines offer the same amount of potential to engage with absolutely every aspect of modern life than computing (Beynon, 2009; Papastergiou, 2009a). Still, it must be said that while many support a constructivist approach to CS education (Ben-Ari, 1998; Beynon, 2009; Karagiorgi & Symeou, 2005) literature exists that warrants caution in its use (I. Govender & Govender, 2012). Many educationalists encourage further, more in-depth research into the methodological and empirical aspects of adopting this approach for educational purposes (de Freitas et al., 2012; Holmboe, McIver, & George, 2001); especially from a CS educational perspective (Beynon, 2009). What remains almost universally accepted however, is that constructivist teaching approaches can be used to cultivate independent learning, communication, problem solving and critical thinking ability (Luo, Stravers, & Duffin, 2005). It moves then that if the focus, in CS education and purely from an introductory perspective, is on the product being produced and not the syntax or semantics being used in the creation of said product; that using a learner-centered model such as DGBL within a constructivist framework can be successful.

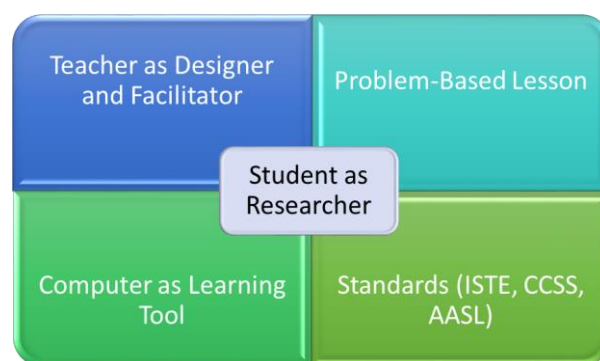
Many recent studies, have investigated the issues surrounding the movement to reform education through the adoption and integration of Information and Communication Technologies (ICT's) into the teaching and learning environment (DW Govender & Dhurup, 2014; I. Govender & Govender, 2010; I. Govender et al., 2014). These studies have shown that while many educators welcome change, many more are intimidated by ICT or feel ill-equipped to ably implement it. Those who are brave enough to implement change, these studies show,

largely find themselves poorly supported to be able to sustain it. Educators who do implement change, either due to administrative mandate or a variety of other variables seem ever ready to move on to the next method (Bourgonjon et al., 2013). Should this be the case then, one could argue, a loss in the creditability of the method could occur resulting in a degree of broken trust. This could negatively affect learners, educators, and society as a whole. Not everyone embraces change. Those amiable towards it, do not always seek to implement it. Those who consider themselves indifferent, fail to realize that real, or effective, change takes time. Just because it looks like it may not be working, does not mean it will not work. Perhaps dissonance, is an essential part of effective change. Whatever the case, a prevalent theme in the literature suggests that, until we place the learner at the center of the debate, educators may well see numerous changes taking place without ever noting any significant progress. A change from a traditionalist approach to a constructivist one, can certainly provide educators with a pragmatic methodology that fosters critical thinking and intrinsic motivation in learners (Gray, 1997). Indeed, educator propensity for change lies at the heart of successful adoption of, constructivist, learning approaches such as DGBL. By embracing change, an educator propagates the retention of content by positioning the learner at the epicentre of meaningful learning.

#### **e) Theoretical Frameworks**

For this study, several theoretical frameworks were espoused — the Technology Adoption Model (TAM), the Constructivist Learning Environment Scale (CLES), the Diffusion of Innovation (DoI) and the Intrinsic Motivation Inventory (IMI). From these, a conceptual framework was developed with a view to gauge educator and learner perceptions of DGBL, as a form of ICT integration. Initially, once the coursework content for the intervention was decided upon, the iNtergration Technology for inQuiry (NTeQ) model was used to help design

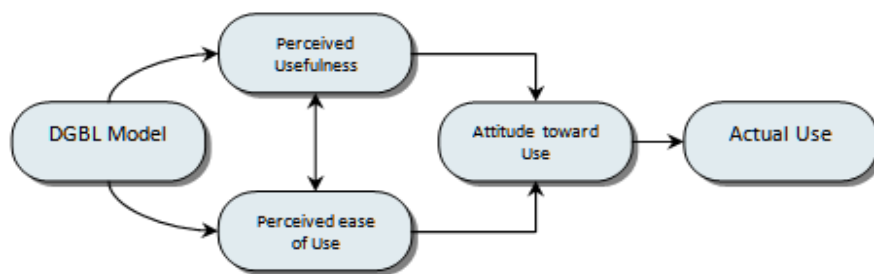
the means of delivery. Essentially providing with the 'how' to deploy DGBL, the NTeQ is a ten-step lesson design process for integrating technology into problem-based, inquiry-based, or project-based learning (Lowther & Morrison, 1998). Constructivist in origin, the NTeQ model places the learner at the center of the learning process by allowing them to take on the role of the researcher. This aligned perfectly to the goals of this study. That is to say, that since face-to-face time was limited, learners would be encouraged to complete a considerable amount of coding, for their games, at home. This meant of course, that copious planning had to be completed beforehand since with NTeQ, the educator plays the role of designer and facilitator (see Figure 2.3). That said, the NTeQ model provided with an (already) proven platform from which to work.



**Figure 2.3:** *The iNtegrating Technology for inQuiry (NTeQ) adapted from Morrison and Lowther's Integrating Computer Technology into Classroom Skills: Skills for the 21st Century (4th Edition, 2008)*

Since the intervention for this study required that the participants create games, an important part of the planning phase involved deciding upon the games they would create. Furthermore, it was important to align the games being created to the content being taught. In light of this, the Technology Acceptance Model (TAM) (see Figure 2.4) was looked at as a means of tailoring material that would garner learner buy-in in the shortest amount of time. Developed

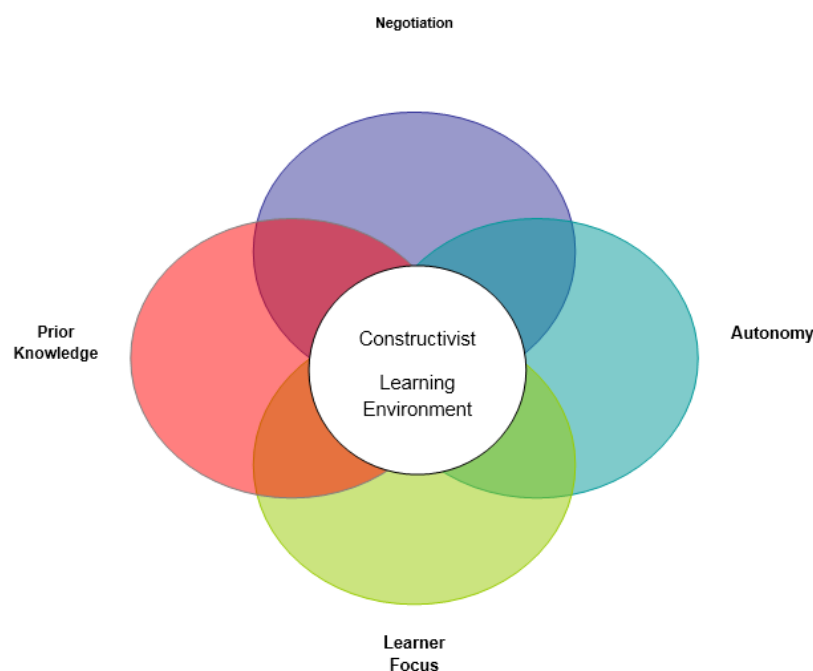
specifically as a means for modelling user acceptance of information systems (Davis, Bagozzi, & Warshaw, 1989) the TAM hypothesizes that people consider a technology more useful when it is easy to operate (Bourgonjon et al., 2013). TAM theorizes that two particular beliefs, *perceived usefulness* and *perceived ease of use*, are of primary significance for computer acceptance behaviours (Figure 2.4) (Davis et al., 1989). This view played an important, foundational, role in developing the classroom lesson plans used in this research. With this in mind, one of the games chosen for inclusion (Helicopter) had already attained cult-status in the mobile app environment. It was hoped that by including at least one ‘commercialized’ game, learners would see ‘cool’ value in being able to recreate it. Helicopter, a simple to code, low-res graphics, highly addicting one-button game was originally created by David McCandless in 2014. A direct spin-off of this game, Flappy Bird, went on to make its developer, Dong Nguyen, \$50 000 per day of advertising income. The rest of the games, discussed further in the next chapter, were either invented by the researcher or were spinoffs of other works. However, none of the games used in the study were complex or long.



**Figure 2.4:** *The Technology Acceptance Model (TAM), version 1, adapted from Davis, Bagozzi & Warshaw’s comparison of two theoretical models (Davis, 1989)*

Next, to help gauge learner attitude towards instruction within a constructivist learning environment, the Constructivist Learning Environments (CLEs) theory was used (see Figure

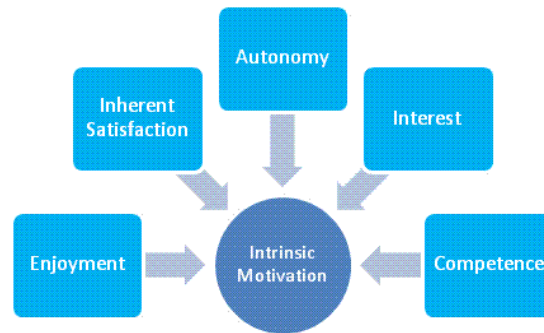
2.5). CLES offers, a comprehensive set of methods that foster problem solving and conceptual development (Jonassen, 1999). Developed initially by Taylor et al, CLES enables educators and researchers to monitors their development of constructivist learning environments (Taylor & Fraser, 1991). It is suggested that in order to foster a constructivist learning environment prior knowledge — which focuses whether the educator set problems for learners to investigate that extend existing knowledge, learner negotiation — which focuses on whether the educator’s pedagogical attention extends beyond the traditional social activity of learners helping each other to solve problems, learner autonomy — which focuses on whether the educator gives learners license to solve problems in their own way, and learner focus — which focuses on whether the educator effectively facilitates learning are all mandated (Jonassen, 1999). Items from these scales were included in the instrument, along with others from each of the theories mentioned herein.



**Figure 2.5: A Conceptual Model of The Constructivist Learning Environments Theory (CLES) adapted from Jonassen’s *Designing Constructivist Learning Environments* (Jonassen, 1999)**

Using ICT's as learning tools, within a meaningful context may lead, in some schools, to significant pedagogical outcomes and can prove beneficial to both educators and learners (Wilson-Strydom, Thomson, & Hodgkinson-Williams, 2005). When one considers GBL in this regard, or DGBL for that matter, it is largely viewed from a motivational perspective, as emphasis is placed on the ability of games to engage and motivate (Plass et al., 2015). By providing experiences that learners enjoy and want to continually engage in, DGBL seems like an obvious fit into many modern-day classroom environments (J. P. Gee, 2003). Yet, even the most flawlessly created learning modules are doomed to fail if the learners are not motivated to learn. Motivation is perhaps, the most overlooked facet of instructional strategy (Karoulis & Demetriadis, 2005). From an academic perspective, literature shows efforts to recognise the specific elements that contribute towards making games engaging and motivational tools (Anderson & Gantz, 2013; Plass et al., 2015). These elements include — incentive systems, game mechanics, visual aesthetics, game narrative and musical score (J. P. Gee, 2003; Plass et al., 2015; Squire, 2011). With this in mind, current motivational theories focus on answering questions that emphasise a myriad of factors that shape motivation (Plass et al., 2015). Theoretical frameworks designed, for understanding why learners '*decide to*' learn a particular thing tend to focus on the intrinsic motivation of said learners (Plass et al., 2015). That is to say, on learners doing activities for the sake of the activity rather than for some, external, reward. However, some contemporary motivation theories, such as Deci and Ryan's self-determination theory, argue that motivation cannot simply be viewed as a dichotomy of intrinsic and extrinsic factors but rather as device that satisfies innate psychological needs for competence, satisfaction, enjoyment, interest and autonomy (Deci & Ryan, 2003; Ryan & Deci, 2000). In this study, the Intrinsic Motivation Inventory (IMI), a model of the self-determination theory, was used as part of a conceptual framework to gauge intrinsic motivation values (see

Figure 2.6). Along with scales from the other theoretical frameworks, scales from the IMI were used in the research instrument. The paramount concern being for learners to see themselves as being in control of their own learning experiences.



**Figure 2.6:** A Conceptual Model of The Intrinsic Motivation Inventory (IMI) adapted from Deci and Ryan’s work on self-determination theory (Ryan and Deci, 2000; Deci and Ryan, 2005)

To gauge both educator and learner propensity towards DGBL, this study looked towards Rodgers' Diffusion of Innovation (DoI) theory (see Figure 2.7). According to Rodgers (2010), diffusion is the five-stage process by which an innovation is communicated through certain channels over time among the members of a social system (p.5). Diffusion, he goes on to say is a special type of communication concerned with the spread of messages that are perceived as new ideas (p.6). An innovation, simply put, is “*an idea perceived as new by the individual*” (Rogers, 2010). In other words, innovations involve ideas, practices, or objects that are perceived as new by an individual or other unit of adoption. The characteristics of an innovation, as perceived by the members of a social system, determine its rate of adoption. The five main elements in the diffusion of new ideas are:

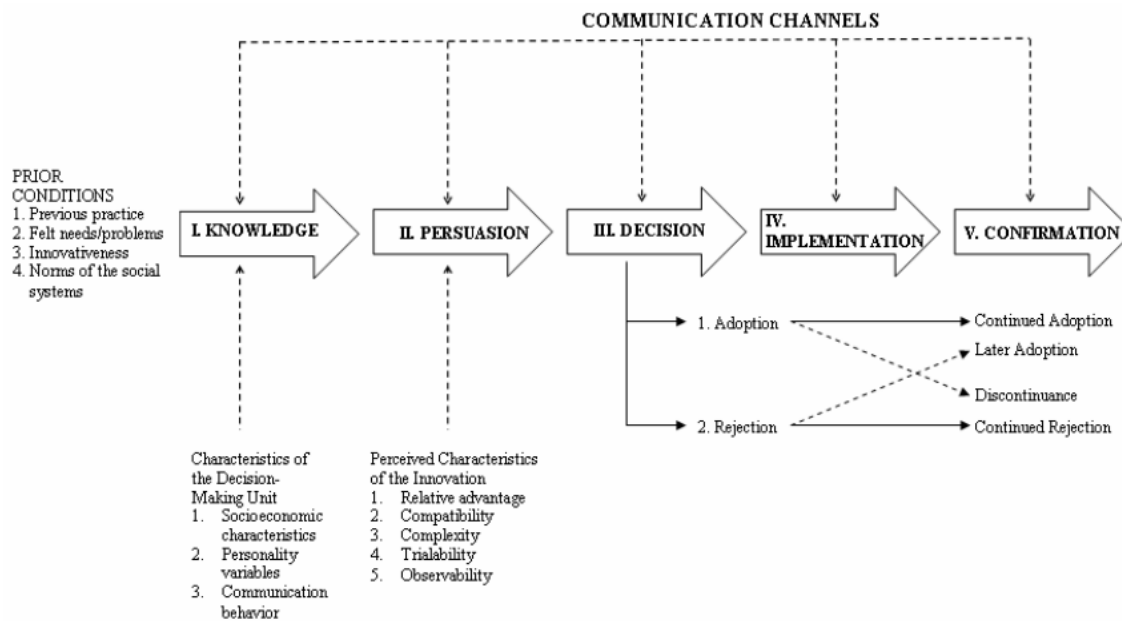
- Knowledge: to make a decision about the innovation
- Persuasion: to see value in the innovation



- Decision: to adopt or reject Innovation
- Implementation: of the innovation
- Confirmation: within the given context (Rogers Everett, 1995)(p.165) (Rogers, 2010)(p.11)

In this study, Rodgers' second step of diffusion was singled out — persuasion. Persuasion, according to Rodgers (1995), occurs when an individual develops either a favourable or unfavourable attitude to the innovation (p.164). This element, was dissected as a means of drawing specific focus on the issue of proving an, already established, positive hypothesis. That is to say, can participants be persuaded to adopt DGBL and in so doing prove it can indeed positively affect both teaching and learning. Sensitive to the issue of time, this research looks to test DGBL's ability, or lack thereof, to entice and persuade educators and learners to become active participants in the teaching and learning process. According to Rodgers (2010), for an innovation to spread and be adopted, over a short time, the following factors must be considered:

- Relative advantage
- Compatibility
- Complexity
- Trialability and,
- Observability (Rogers, 2010)(p.12)



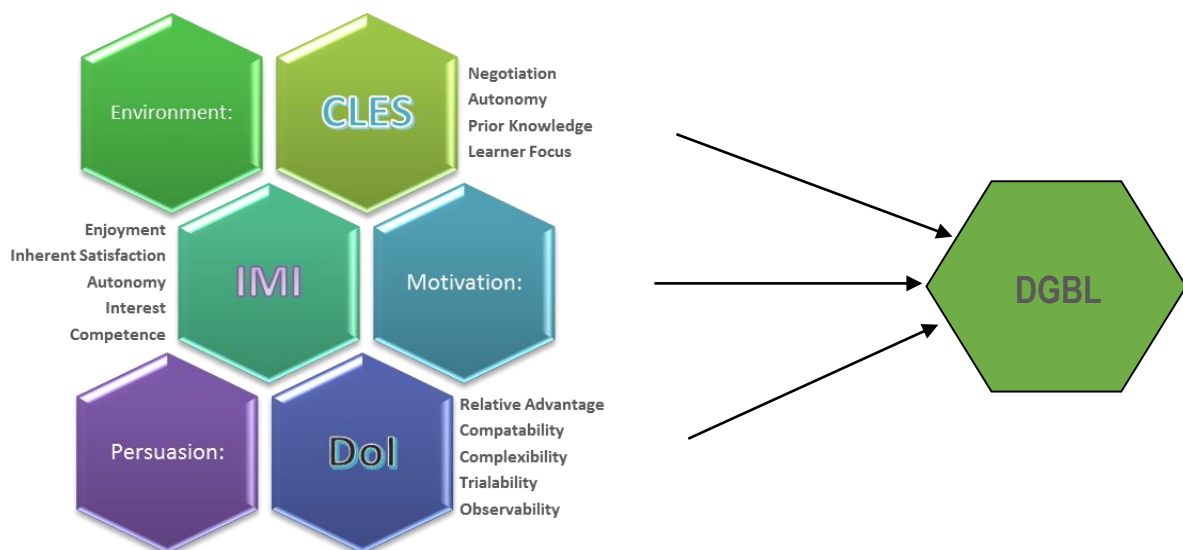
**Figure 2.7. A Conceptual Model of The Diffusion of Innovation (DoI) adapted from Rodgers' Diffusion of Innovations: Third Edition (Rodgers, 1983)**

Simply put, should the participants of this study see value in DGBL (innovation) then they could well *accept* it and decide to use it further (Finley, 2003; McKenzie, 2001; Parisot, 1995; Spotts, 1999). The word ‘acceptance’ is used by scholars with a myriad of backgrounds and approaches. Furthermore, in literature, the word acceptance does not seem to have one single and unique definition. Some suggest that acceptance can be defined as a user’s decision about how and when they will use technology (Bagozzi, Davis, & Warshaw, 1992; Davis, 1989; Davis et al., 1989; Martínez-Torres et al., 2008). Martínez-Torres et al (2008) notice that initial use (acceptance) is the first critical step toward e-learning (p.2). They go on to say though that sustainable success, regardless of the technology, depends on continued, regular use (continuance) (Martínez-Torres et al., 2008). In as far as this study is concerned, DGBL is treated as a technological innovation. As has been stated, there appears to be a large variety of, in some instances seminal, studies focused on ICT acceptance and its successful integration (Abdul-Gader, 1996; Adams, Nelson, & Todd, 1992; Igbaria, Guimaraes, & Davis, 1995; Ngai,

Poon, & Chan, 2007). For this study, a conceptual framework was developed as a means of addressing the research objectives laid out in the next section.

### f) Conceptual Framework

Since this research makes use of several theoretical frameworks, noted above, a conceptual framework was necessary in order to systematically analyse the epistemologically collected data (Bertram & Christiansen, 2014). To determine whether, or not, educators and learners could be ‘*persuaded*’ towards using DGBL to aid teaching and learning — scales from the DoI theory were used (Figure 2.7). To garner insight into why educators and learners perceive DGBL the way they do — scales from the CLES theory were used (Figure 2.5). And finally, to verify DGBL’s ability to enhance both the teaching and learning of IT — scales from the Intrinsic Motivation Inventory (IMI) were used (Figure 2.6). These scales have proven validity and have been used in many studies (Grace, 2016; Seaborn & Fels, 2015; Woo, 2014). It is important to note, that the primary theory being used in this study is the DoI. In figure 2.8, shown below, is a conceptual mock-up of the framework developed specifically for this study.



**Figure 2.8.** A Conceptual Model of the framework for this study. Adapted using factors garnered from the IMI, DoI and CLES

In closing, this researcher looks to add to a plethora of research, on the subject, by presenting DGBL as part of a viable methodology for teaching and learning within the South African education framework. Subsequently, it is hoped this research will present the Scratch coding platform as a straightforward, cost effective and intuitive medium for developing coding ability, in junior high school. Lastly, and perhaps most importantly it is hoped that this research will highlight the need for further study into the establishing of a set of norms and standards that will address the many challenges teachers face when attempting to implement learner-centered tools, like DGBL, to aid teaching and learning.

## **2.2 Overview of the chapter**

In this chapter we have reviewed literature detailing issues surrounding:

- a. the use of games in education;
- b. game based learning;
- c. constructivism as a theoretical framework for use within computer science education;
- d. educator propensity toward ICT integration and change in light of some of the issues concerning practitioner enquiry research;
- e. theoretical frameworks and resulting conceptual framework (f) used to gauge responses in this study.

The literature regarded in this chapter, has shown the teaching of CS concepts and content to be prevalent with a myriad of complex issues. Not least among these, has been the issue of showing relevant stakeholders the need for; and the viability of; implementing change across the curriculum. Literature has shown that while DGBL does present with a ubiquitous and

exciting learner-centered teaching technology; there remain many complex issues surrounding its deployment that should not be overlooked or understated. If executed correctly however, research shows that, a constructivist approach to teaching and learning within CS education; can prove to be successful in helping individuals construct new knowledge.

### **2.3 Issues concerning implementation**

Many children lack the forward-thinking ability to be able to see value in electing, and committing, to doing Information Technology (IT) in high school. Many educators of this discipline also, lack the capacity; due to a wide range of either intrinsically or extrinsically mitigating circumstances; to effectively implement positive change to the manner in which they facilitate learning. While literature abounds, with data showing insight into the use of video game methods and technologies at a higher education level little research outlines its use at a junior high school level. Moreover, much work has been produced detailing the motivational benefits game technologies provide. Yet more works highlight issues pertaining to a constructivist approach to teaching computer science; as well as issues concerning the integrating of Information and Communication Technologies (ICT's) into the school curriculum. However, in analysing the broad spectrum of literature presented herein it has been discovered that no work has been done detailing the implementation of Digital Game Based Learning (DGBL), or proving its benefits, at a junior high school level using proven theoretical frameworks. And so, in answering the research questions this dissertation looks to fill a gap in the research that will, hopefully, address the following questions:

1. Can DGBL guarantee the type of active learning where learners solve problems, answer questions, formulate questions of their own, discuss, explain, debate, or brainstorm during and outside of classrooms?

2. Can DGBL encourage a cooperative learning environment where learners work in teams on problems and projects under conditions that assure both positive interdependence and individual accountability?
3. Can DGBL allow for inductive teaching and learning where learners are presented with challenges, using questions or problems, and learn curriculum content within the context of addressing the challenges?

That said, it must be mentioned that studies have shown learner-centered teaching approaches, such as is DGBL, to be time consuming. This reality has undoubtedly affected the manner in which this study has been implemented — the details of which are noted in the chapter that follows. Suffice to say, and in contradiction to the research reviewed, the key to successfully proving; or disproving for that matter; the hypothesis this article presents involved an immediate introduction of the new method to the participants. Worth noting though is that, educators hoping to find digital games a simple solution to a complex problem are doomed to share a sobering date with disappointment. The implementation of DGBL, requires that many structures are in place before success can be realised. Ultimately, as is the case with studies such as this, working with a prescribed sample tends to negatively affect the generalizability of the claims made herein. This too, has had a bearing on the methods used to collect and analyse data, and is detailed in the next chapter.

## **2.4 Conclusion of the chapter**

Today, many educators struggle to create the twenty-first century classrooms needed to meet the ever-growing needs of twenty-first century learners; all the while battling to improve on academic results (Ballard & Bates, 2008; Mouton et al., 2012). Yet, in this maelstrom of grit and determination, educators find themselves faced with devastating reports detailing this

nation's deplorable ranking where STEM subjects (Science, Technology, Engineering and Mathematics) are concerned. According to the World Economic Forum (WEF) Global Competitiveness Report, from 2014, South Africa ranked 144 out of 145 countries rated for their cognitive developing in the STEM fields. Thus, it could be argued, that since high school graduates are failing at an alarming rate (Labuscagne, 2013) and since universities seem to frown upon the quality of those lucky enough to pass (Jansen, 2014) — more must needs doing to address a number of pertinent issues surrounding the state of teaching and learning in this country. Moreover, it could also be argued that new vibrant and exciting models for disseminating information must be explored as a means of addressing poor academic scores. It follows, that the usefulness of educational technologies such as DGBL must needs be investigated. A close reading of the studies, reviewed in this chapter, revealed a number of issues surrounding the successful implementation of such a model. Most importantly, it was found that there are a number of benefits attributed to using games in teaching and learning (Barab et al., 2005; Bourgonjon et al., 2013; Lee & Hammer, 2011; Papastergiou, 2009a). Another issue that emerged from the literature, was that success with a teaching methodology that includes DGBL hinges on educator propensity toward ICT integration (DW Govender & Dhurup, 2014), which in itself is closely linked to educator concerns about the complexity involved in implementing (Bourgonjon et al., 2013; Desmond Govender & Govender, 2009) and the discussion about whether, or not, educators differ from professionals in terms of their level of innovativeness (Park & Oliver, 2008; Shedd & Bacharach, 1991). In addition, there has been reviewed a great deal of evidence, according to (Robinson, 2012), that shows young people today lack the ability to be productive members of society because they lack critical thinking and problem-solving skills. Skills that are integral, for success in careers within the computer science field (Anderson & Gantz, 2013). Programming prowess aside, South African

national statistics have shown poor results even for the theoretical component of the IT syllabus at Grade 12 level (Labuscagne, 2013). These results reveal, that learners struggle even to regurgitate theoretical elements of the IT syllabus, that favour rote-learning. Year after year, educators are pressed to improve upon the preceding years' results. A results-driven pressure, that may well explain why many educators opt to teach to the test. It may well also explain, why many IT educators, and perhaps even learners, resent change. Yet, one must consider that educators are so often evaluated and remembered by how good a motivator he or she was (Prensky, 2001b). Indeed, if the method provided the impetus rather than the educator (Prensky, 2001b) so much more could be realised to improve the quality of both teaching and learning (p.100). Perhaps, if we could find a way to employ an integrated and automated assessment tool, for use with technologies like DGBL, then educators would be more inclined to utilize them (Shute, 2011).

In this chapter, the perceived benefits of a constructivist based DGBL model for teaching and learning are investigated. The claims made by the articles referenced herein, through mix method research, are scrutinized using dependable methods of data collection. In investigating these claims, this article puts forward an impetus for change that will, hopefully, guide and inspire others to do the same. Since knowledge cannot simply be transferred or downloaded between minds, educators today; more than ever; are at pains trying to discover and develop new ways of getting their learners to engage with content. In order to consider DGBL as a viable vehicle for getting learners, and educators, to engage with content the research presented in this chapter is, in the chapters that follow, further explored along with other works pertaining to the research design.



## Chapter 3 : Methodology

Although not an exclusive or revolutionary concept, using games as a means of achieving motivation in learning has, by and large, managed to generate much interest from all stakeholders in education. In fact, video games and their potential within the learning environment have become a topic for heated debate over the last few years (O'Riley, 2016). And, if the proponents of DGBL are to be believed, there is much that investiture in the potential of games can bring to both teaching and learning. But, most theorist and practitioners choose to implement DGBL using a reflexive approach — that is to say people either use bespoke games to teach a concept or incorporate game-like principles into the formal classroom setting (J. P. Gee, 2005, 2007, 2009; Squire, 2011). Now, while these approaches to using DGBL have shown positive results (Berg Marklund, 2015; S. I. De Freitas, 2006; Papastergiou, 2009a; Woo, 2014) there is another alternative. Making games, arguably, presents with much more latent capability than the other two DGBL approaches (Huizenga, 2017b). By giving learners agency as active creators of games, they are encouraged to reflect on existing knowledge in order to apply it to new situations (Huizenga, 2017b). In many instances, as was the case with this study, even when there is no existing experience to draw from; learners were able to create rudimentary games with basic instruction and with the Internet as a resource. In every instance, learners showed pride and excitement at being able to realise a completed task using code. Most demonstrated complete engagement in the activities. That said, this study focused on the perceived education value of using Digital Game Based Learning (DGBL) at a junior high school level in an Information Technology (IT) literacy class setting. The schools included in this study represented a cross-section of schools available within the South African landscape. This study looked to address the following questions:

4. What are learners and teacher's perception of DGBL?
5. Why do learners and teachers perceive DGBL the way they do?
6. How can DGBL be used to enhance the teaching and learning of IT?

In order to address these questions, the following theoretical frameworks were used:

1. To determine what are the teachers and learner's perception about DGBL. These perceptions will be in line with Rodgers' DOI constructs/ characteristics that is: relative advantage, compatibility, complexity, trialability and observability.
2. To understand why teachers and learners perceive DGBL the way they do. This objective will be instructed by Ryan and Deci's Intrinsic Motivation Inventory as well as Jonassen's Constructivist Learning Environment.
3. To provide a possible framework for the implementation of DGBL in teaching and learning with a view to enhance teaching and learning. This objective will be informed by the qualitative dataset.

In summation, it is within an interpretivist paradigm, thorough mixed method research, this study looks to investigate the perceived educational benefits associated with DGBL. Much effort has been made, to offset the many limitations associated with this type of research. In this Chapter are discussed these and other issues pertaining to the research design. So, while it may well be prudent to regard the many limitations aligned to studies of this nature, as has extensively been discussed in the preceding chapters, indeed it would appear the many advantages, herein noted, serve well as ballast.

### **3.1 Statement of the Problem**

Can Digital Game Based Learning (DGBL) increase learner propensity toward engaging with Information Technology (IT) content at a Grade 8 level? It is hypothesized that a Digital Game Based Learning (DGBL) framework, when implemented into a Grade 8 digital literacy program, can positively influence teaching and learning effectiveness as well as learner perception of Information Technology (IT). It is hoped, that through exposure to coding, learner decision when considering Information Technology (IT) as a learning area in Grade 10, will become more informed. Furthermore, it is hoped that by exposing learners to coding at such an early stage in their high school careers, educator and learner expectations will become more easily aligned — thus propagating future success.

### **3.2 Overview of the chapter**

In this chapter, are revisited the issues surrounding DGBL that this research looks to address. The research instruments used in the collecting and analysing of the data are presented. The nature of the research design is presented and the setting wherein the research takes place are discussed. Next, the nature of the sample and imitations imposed by the nature of this study; in using said sample; are described. Following this, the devices used in the collection of both quantitative and qualitative data are outlined. Moving on from this, the techniques used in the analysis of the data collected are discussed. Mention is made thereafter, of the details describing how the data was recorded and reported on. Once the analysis techniques are reviewed, the chapter is closed with a conclusion.

### 3.3 Research instruments

For this study, a survey was chosen as the research style due, in no small part, to the pragmatic and economical faculties their use provides. A structured questionnaire was used as the research instrument for collecting quantitative data using mostly closed-ended questions. The data collected from the questionnaire was analysed using statistical methods discussed below. To inform the construct validity of the questionnaire, a pre-study survey was conducted. The resultant 58-item composite questionnaire was deployed digitally to 106 learners. Wherever possible, previously validated scales were used; the intention being to further reinforce fitness for purpose. The questionnaire itself consisted of seven parts:

- i. Demographic information including variables such as grade, gender, and ethnic group.
- ii. Background information detailing the experience with technology or computer skill set level for each of the participants.
- iii. Information Technology (IT) subject impression, with specific reference to coding, using scales adapted from the Intrinsic Motivation Inventory (IMI).
- iv. Propensity toward Game Based Learning (GBL) again using scales adapted from the IMI.
- v. Attitude toward a learner centred teaching approach using scales and variables adapted from the Constructivist Learning Environment Scale (CLES).

- vi. Predisposition toward the adapting of new technologies, such as Digital Game Based Learning (DGBL) using scales and items adapted from the Diffusion of Innovation (DoI) framework.
- vii. Open ended closing thoughts to illicit deeper qualitative responses concerning the learner experience.

To score each of the items included in the relatively long 58-item instrument, a seven-point Linkert-type scale (*1 very untrue of what I believe — 7 very true of what I believe*) was established using the Manual for the Patterns of Adaptive Learning Scales (PALS) and is shown in Appendix A. It was decided that to avoid potential measurement errors, normally associated with limited choice, a seven-point scale would be used instead of the more orthodox five-point one. According to Nunnally and Berstein (1994), who in their seminal work provide with a concise and didactic perspective on psychometric theory, having more scale points presents with a better balance between points of discrimination and response options — consequently negating any possibility of participants interpolating between two points (Bernstein & Nunnally, 1994)(p.67). That said, to measure general experience and learner propensity toward the use of games in learning a scale was adapted using the Intrinsic Motivational Inventory (IMI) — a multidimensional measurement device used in numerous studies (Bourgonjon et al., 2013; Ryan & Deci, 2000). The IMI produced five subscales that assessed the participants' relatedness to the content being taught (six items in the questionnaire), their interest and enjoyment level (seven items in the questionnaire), their perceived choice in being a part of the process (three items in the questionnaire), their felt pressure or tension (four items in the questionnaire), and their effort (three items in the questionnaire). Each of the subscales included at least one item, (R), indicating a negatively

asked question that necessitated the reversing of the score for the participants' response on that item. Both the perceived choice and perceived competence concepts are theorized to be positive predictors of both self-report and behavioural measures of intrinsic motivation (Ryan & Deci, 2000). Comparatively speaking, the perceived pressure and perceived tension concepts are theorized to be negative predictors of intrinsic motivation (Ali, 2011; O'sullivan et al., 2011). Moreover, the perceived value and perceived usefulness subscale are thought to involve the idea that people internalise and become self-regulating, with respect to activities that they experience as useful or valuable for themselves (Ali, 2011; O'sullivan et al., 2011). Lastly, the relatedness subscale, it is suggested, has bearing for research concerned with gauging or assessing interpersonal interactions (Bourgonjon et al., 2013).

To measure propensity toward a learner-centred constructivist teaching approach, scales were again adapted from a reliable, well researched source (Nix, Fraser, & Ledbetter, 2003) — the Constructivist Learning Environment Scales (CLES). Four subscales were adapted that assessed the participants' views on negotiation, prior knowledge, autonomy, and educator involvement during class. Each of the subscales had two items in the questionnaire, except for educator involvement, which had three. Next, to measure propensity toward the use of Digital Game Based Learning (DGBL), a technology adoption model was used. It is suggested that people might see value in adopting new technology should it, a) fit in with their style of learning, b) prove to be efficient, c) have an advantage over previous practices, d) prove not to be complex, e) show observable results and f) allow for experimentation prior to adoption (Rogers, 2010; Rogers Everett, 1995). Moreover, Rodgers (2010) identifies the five primary factors that affect attitude towards a technology (p.37). These are — relative advantage, compatibility, complexity, observability and trialability. Effort was made, to ensure instrument

validation through the study of the psychometric quality of each of the adapted scales. Once the questionnaire had been implemented, post-intervention, a preliminary analysis was completed in an attempt to guide the proceeding interviews. An overview of the items and scales, excluding demographically information, are shown below in **Table 3.1**.

Scale	Composite Statement	Question Numbers
Perceptions of ability	I was proficient in Computer use before joining Eden.	1 to 6
Perceptions of the Scratch Interface	I feel comfortable and secure learning to code using Scratch.	7 to 22
Perceptions on using Games in T&L	I enjoyed learning this way and felt motivated.	23 to 32
Role of Teachers	My teacher affirmed and supported me.	33 to 41
Perceptions on a Constructivist approach (DGBL)	I was comfortable working and learning collaboratively.	42 to 54
Perceptions on IT (The Subject)	I now know more about the nature of IT and CS.	55 to 58

**Table 3.1 - Coding Sheet Composite (CLES, IMI and DoI)**

To augment the findings of the questionnaire and provide insight into the degree to which learners felt the principles of constructivism were implemented in the IT class, relative to the other classes in school — an interview was designed and implemented (see Appendix C). The semi-structured interviews, using open-ended questions, were digitally recorded, and transcribed using audio transcription software. The face-to-face interviews involved three focus-groups (each numbering 6 participants) instead of one-to-ones as a means of creating a safe and comfortable environment. Internal reliability was addressed through the random selection of each of the focus-group participants. To further address the internal validation of the instruments used in this study, as well as the consistency of the data collection process, the questions included in the final draft for interview were reviewed several times. To address the views of educators, three structured one-to-one interviews with open-ended questions were implemented — after both the intervention and preliminary analysis of the questionnaire was complete (see Appendix D). Full ethical protocol was adhered to at every stage during the research process.

### **a) Research Design**

Once fitness for purpose was established, much investigation into the formulating of correct scales was undertaken. In light of this, the research design was constantly updated. As a result, an exploration of similar studies revealed a mixed method approach to data collection as being the most appropriate for this type of study (Cresswell, 2003; Zohrabi, 2013). Furthermore, the nature of this niche study called for an interpretivist paradigm since insight into learner perceptions was required in order to either endorse or refute the hypothesis — that is to say whether or not a DGBL approach can indeed positively affect teaching and learning. It must be mentioned then, that prior to the study beginning, very few participants had a working knowledge of coding within the Scratch environment. It is strongly felt that this has not negatively affected reliability since the object of this study was not to measure learner skills or proficiency levels using the platform but, rather, to gauge the effectiveness of a constructivist teaching technology — DGBL. In fact, it could even be argued that using DGBL, with Scratch as a platform, does not require any prior knowledge or skills on the part of the learner. That said however, effort was made to improve upon trustworthiness and the internal validity of the research instruments, as has been mentioned, by conducting an informal pre-study survey.

### **b) Setting**

This research intervention took place at three schools, representing a cross-section of institutions available in South Africa. At the time of the study, the researcher taught Information Technology (IT) in the Further Education Training (FET) phase. It should be noted by the reader that, in the junior high school phase, IT is not a registered, governmentally endorsed subject. In most South African schools, a basic computer literacy course precludes the grade 10-12 IT syllabus which, for many, provides with the first exposure to computing



devices. Furthermore, many schools, mostly in the public sector, either do not see value in offering IT between grades 8-12 or simply do not have the resources to properly introduce and support its deployment. It follows then, that even though effort was made to include a cross-section of schools, the findings of this study have limited generalizability. Chronologically speaking, this study took place during the first quarter or term of the schooling year which ran between the months of January and April.

The primary mitigating factors behind this study involved professional development, the pursuit of an improving upon the researcher's own educational practices and the broadening of the body of knowledge in the field of education. A request for permission to complete this mixed-method research was submitted to the coordinator of the Masters program at the University of KwaZulu-Natal (UKZN). Once this was acquired, a request for permission to conduct this study was submitted to the Department of Education's KwaZulu-Natal branch. Eventually, all stakeholders approved, and this research study was able to commence. All ethical principles concerning research practice were regarded and attempts were made, throughout the study, to respect them. Participants were briefed as to the nature of the research being conducted and were given a clear explanation, both of what the study entailed, and of what was expected of them. The same was true for the educators taking part (see Appendix E). However, complete autonomy was never sort or, garnered since all learners were expected to code several prescribed games, using the Scratch platform, in order to fulfil intervention requirements. Nevertheless, while all learners were expected to be a part of the study, each of them was given the choice as to whether or not they wished to complete the online questionnaire. That said, of the 106 invited to complete the questionnaire at the end of the intervention 89 did so. Moreover, it was expressed to all participants that an absolute level of

confidentiality would be maintained throughout the study. The exclusion of sensitive demographical data in the research instruments ensured confidentiality. Those who indicated they wished to complete the survey were encouraged to be honest and impartial. In addition, participants were constantly reassured throughout the process. It was articulated to them that, under no circumstances, would any of the views they expressed negatively affect their marks or, for that matter, the researcher's view of them.

Next, a written parental consent form was issued specifically for the eight randomly selected interview participants (see Appendix F). In addition, parents were given the opportunity to have questions fielded, and fears allayed, at a junior high school learner information evening prior to the commencing of the study. All present, saw value in the study and the content being taught; even if many did not completely understand the nature of DGBL. To summarize, the issue of non-maleficence was easily accomplished since the study seemed to successfully position the learner at the epicentre of the process. In light of this, when completing the questionnaire each participant was given generic login credentials for accessing the computer network. And, in the same token, a hyperlink to the questionnaire was placed onto each desktop — avoiding the need for access to personal email addresses and, as a result, ensuring anonymity. Worth noting, is that some participants requested the hyperlink be emailed to them so that they could complete the questionnaire at home. This meant that their email addresses were merely captured by the Google Form software online. These participants email addresses were not used in any way, post study. Worth mentioning, is that all ethical principles were satisfactorily regarded throughout the duration of the study.

### C) Study Participants

As has already been stated, all the participants of this study were thirteen-year-old Grade 8 learners, enrolled at schools where IT is offered only as part of a digital literacy program. In general, no coding is addressed at this level as the focus is more on basic computer usage, internet usage and Microsoft Office products. The ethnic demographic for the study, as shown in Figure 3.1 below, consisted of a majority African Indian child at 62.9% of the sample that completed the questionnaire. Next, followed the African White demographic with 13.5%, the African Black demographic with 10.1% and the African Coloured, or mixed race, with just 5.6% of the sample. The remaining 7 participants chose not to share this information.

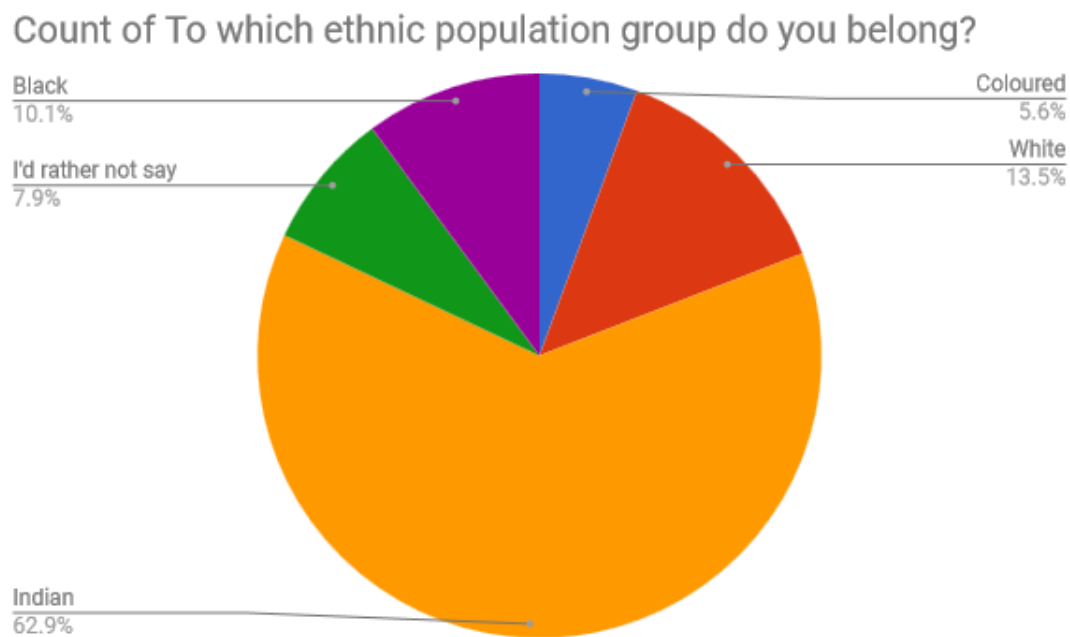
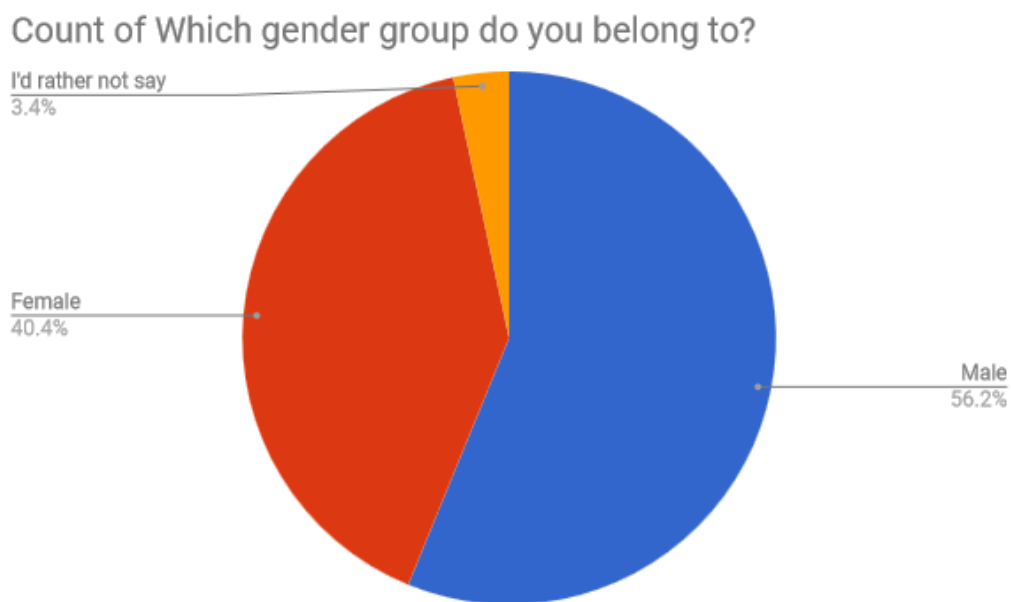


Figure 3.1 - Ethnic Demographics

Overall, the gender dispensation, shown in Figure 3.2 below, showed a greater number of male participants (56.2%) than females (40.4%). Three participants chose not to share this information. Of the African Coloured demographic two were male, showing a higher percentage (78%) of female mixed-race participants. Of the African Black demographic there

were four males and five females (55%). Of the African White demographic there was an equal spread of six males and six females (50%). The African Indian demographic was the only one that showed a higher ratio of boys, thirty-one, to girls twenty-four (45%). Of the three participants who chose not to share their gender, one intimated African Indian descent while the other two chose not to share ethnic information as well. Of the seven participants who chose not to share their ethnic information — three identified with male as their gender, two identified with female and the remaining two, already discussed, chose not to share this information.



**Figure 3.2 - Gender Demographic**

On average, computer classes are scheduled for a single hour period each week at each of the schools. That said, the 5-hour long intervention had to be spread out over 5 weeks. All the learners who participated in this mixed-method research were registered for already established IT literacy classed, and function without remediation. All learners demonstrated capability, in successfully completing classroom and homework assignments. All classes were administratively organized, by school management, based on social interactions rather than

ranked academic ability. As a result, each class had a mixed-ability grouping. No academic averages were noted for this study.

### **3.4 Sampling technique**

Some would argue that most researchers, producing works within an interpretative paradigm share, at best, a conservative regard for the issue of whether, or not, their data is broadly representative (Bertram & Christiansen, 2014). Moreover, research that concerns itself with any sociological issue tends to focus on the *process* of gathering in-depth description and analysis (Bertram & Christiansen, 2014; Hammond et al., 2015). Oftentimes one might argue, as is the case with research of this nature, that the research itself predetermines the population group. The method for appropriating the sample for this study, as has already been noted, was largely convenient due to the pragmatic, hands-on nature of the hypothesis. However, effort was made to address the issue of bias in that the focus-group interviewees were randomly selected to participate in the post questionnaire interviews. Of course, the selected participants were given the option to opt out of being a part of the interviews. Thankfully none chose this option, although concession was made to replace any participants with others also randomly selected. Still, it could easily be argued that the sample used in this study does not authentically represent the broader population given, in no small part, that the nature and number of schools taking part in this study. Furthermore, since this study did not cater for data detailing the financials of the participants' parents or guardians, no effort was made to investigate this issue with the school administrations. It was felt, that this did not have immediate bearing on the nature of the study itself. Worth noting once more though, is that many children in South African come from impoverished households. This endemic reality, one might easily argue, severely limits the amount of access and the quality of access they have to the computer

technology necessary to reinforce coding concepts outside of school. But this study does not intend to present DGBL as being a blanket solution to the highly complex issues facing education today. Instead, this study looked to provide with an investigation into the suppositions surrounding the effects of a particular teaching and learning innovation, within a constructivist framework, that could very easily be adapted and expanded upon to increase generalizability and impartiality. While environment and background can, unquestionably, affect the way in which people view the world; the financially elevated status of some of the population group was deemed as being negligible to any perceived bias in the data collected (Cole, 1992; Gray, 1997; Hendry, 1996).

### **3.5 Data collection**

For any learner-centered teaching approach to be successfully implemented, educators must needs communicate to their learners the relevance and importance of what is to be taught before they can become motivated to learning the material being taught (McWhorter & Hudson-Ross, 1996). The same can be said, one might argue, of generating a level of invested interest from learners towards learning to code using DGBL. With that in mind, and before implementing this study, it was determined that any data collected should comprehensively speak to whether, or not, learners saw real-world value in learning through DGBL. Once a sense of purpose, or vested interest, was established it was determined that the following computer science concepts would be included during the DBGL teaching phase: the use of data structures (variables), repetition (repeat and repeat until) and branching (if and nested if else). With regard to the research instrument, of particular interest was the items; garnered through qualitative data collection; pertaining to learner attitude toward the inclusion of these abovementioned structures in game developing. Of equal importance, was the other issues; discussed in the next

chapter; that arose as a result of the semi-structured interviews. The same was true, of the structured interviews with the educators as well.

In establishing a research design, after deciding upon the research topic and researching the literature, a method of organizing the data was created. Shown on the next page, is a categorized overview of the data items used in the study as a means of gauging learner propensity toward the use of DGBL within a constructivist framework. The items shown in Table 3.2 were adapted using the Constructivist Learning Environment Scales (CLES) as a means of gauging attitudes toward a learner-centred teaching approach. The items derived from the Diffusion of Innovation (DoI), shown in Table 3.3, were used to gauge learner propensity toward the integration of new learning technologies into teaching and learning. In Table 3.4 is shown the items, adapted from the Intrinsic Motivation Inventory (IMI), that were used to gauge learner thoughts and feelings toward the subject Information Technology (IT), its content and the way it was taught.

Scale	Survey Q_Num Anchors	Questions
Negotiation:	36R - negatively asked (Reverse Score)	In IT, I don't ask other learners about their ideas.
	40 - positively asked	I talk with other learners about the most sensible way of solving a problem.
Prior Knowledge	35 - positively asked	My teacher gives me problems to investigate.
	41R - negatively asked (Reverse Score)	The things I learn about are not really interesting.
Autonomy	37 - positive asked	I do investigations into solving problems in my own way.
	33 - positively asked	I ask my peers about their ideas.
Learner Focus	34 - positively asked	My teacher helps me to think about what I learned in past lessons.
	38R - negatively asked (Reverse Score)	My teacher does NOT insist that my activities be completed on time.
	39 - positively asked	My teacher shows the correct method for solving problems.

**Table 3.2 - Attitude toward a Constructivist Learning Environment (CLES)**

Scale	Survey Q_Num Anchors	Questions
Relative Advantage	42 - asked positively	How satisfied are you with the quality of Learning involving Games?
	43R - negatively asked (Reverse Score)	How dissatisfied are you with problem solving process involved in this module?
	44 - asked positively	How would you rate your understandability of the content taught during this time?
Compatibility	45 - positively asked	How do you feel about the classroom discussions?
	46 - positively asked	How do you feel about interacting with your classmates?
Complexity	47 - positive asked	Did you find interacting with the content to be frustrating?
	48 - positively asked	Did you find the Scratch system to be rigid and inflexible to interact with?
	49 - positively asked	Did you find it easy to get the system to do what you wanted it to do?
Triability	50 - positively asked	How easy was it to recover from mistakes when using the technology?
	51 - positively asked	How easy was it to explore all of features of the technology?
Observability	52 - yes/ no	I learned new ways of using the Scratch from a classmate.
	53 - yes/ no	I changed my way of using Scratch based on what I learned from a classmate.
	54 - yes/ no	I learned new ways of doing science from working with a classmate.

**Table 3.3 - Attitude toward DGBL (Diffusion of Innovation - DoI)**

Scale	Survey Q_Num Anchors	Questions
Relatedness	10 - positively asked	Did you ever feel really distant from the content being taught?
	15 - positively asked	How would you rate your inclination toward registering for IT in Grade 10?
	20 - positively asked	I really feel like I could come to see value in using Scratch, learning to code.
	24R - negatively asked (Reverse Score)	I'd really prefer not to learn content in this way.
	31 - positively asked	I think it's likely that I could become a computer programmer.
Interest/ Enjoyment	9 - positively asked	While you were interacting with Game Developing, were you thinking about how much you enjoyed it.
	13 - positively asked	Would you describe interacting with the IT course content as very enjoyable?
	17 - positively asked	I found IT to be very interesting.
	18 - positively asked	I enjoyed learning to code using Scratch very much.
	21 - positively asked	Using Scratch was fun.
	26R - negatively asked (Reverse Score)	I thought Game Developing was very boring.
Perceived Choice	29 - positively asked	I thought interacting with content was very interesting using Game Dev.
	12 - positive asked	Did you ever feel like you had choice about being taught in this fashion?
	22R - negatively asked (Reverse Score)	I feel like I didn't really have a choice about learning to code using Scratch.



	27 - positively asked	I felt like I was allowed to do what I wanted to do while making games.
<b>Pressure/ Tension</b>	11 - positively asked	Did you ever feel at all nervous about being taught to code using Game Developing in Scratch?
	19 - positively asked	I felt tense while completing tasks using Scratch.
	25 - positively asked	I was anxious while learning in this way.
	30 - positively asked	I felt pressured to do well.
<b>Effort</b>	23 - positively asked	I tried hard to make the most of the time spent learning to code using Game Developing.
	28 - positively asked	I tried very hard while learning using Game Dev.
	14R - negatively asked (Reverse Score)	I didn't put much energy into interacting with the content.

**Table 3.4 - Attitude toward Information Technology (Intrinsic Motivation Inventory - IMI)**

After establishing the variables to be used in the data collection process; an instructional plan (see Appendix B) was created outlining the relevant activities to be implemented during the mixed-method research; that would include the abovementioned CS concepts. Once the instructional plan was completed, it was decided that an assessment rubric was not mandated as a means of drawing a term mark from each of the participants. It must be said though, that an assessed academic mark, or learner score, could very easily have been drawn and may well have affected educator views regarding the value of DGBL. However, in-depth statistics involving test scores necessitate the implementation of pre and post testing using specific cross-referencing techniques (Cresswell, 2003). More especially, time constraints prevented the deployment of such expansive inclusions to this study, even though the data might well have divulged important insight into the academic dexterity of DGBL. Perhaps, as part of a future works, the inclusion of an assessment rubric (see Appendix G) could very well add noteworthy and intrinsic value to the, perceived, value of DGBL. Referencing learner scores, might well also speak to the plausibility of further study within this field. Nevertheless, to ensure time efficacy, the questionnaire (available online for review at <https://goo.gl/6A8TP5>), was deployed over a school week as, and when, each class was timetabled to have their computer literacy class. To ensure a level of privacy the interviews, deployed during class time,

necessitated the removal of learners from class during teaching time. Thankfully, school management allowed for the overtly intrusive and, perceived, frivolous nature of the interviews and arranged for the use of an unused room. And, while many learners wished to participate in the interviews due, partially, to a genuine desire to assist in the study or; due to the excitement tethered to a break from the norm, whatever the case, it was found that the full sample, randomly selected, presented with a level of maturity and sincerity that belied their ages. It was, however, unfortunate that there was only time for a limited number of participants. But thankfully, they each provided more than just generic information. The resulting qualitative data was digitally recorded, transcribed, and is available for review upon request. It was hoped that the results, discussed in the following chapter, would endorse the quantitative data collected and provide specific insights into the learners' psyche.

In as far as the practical steps, used in facilitating this method of instruction, much preparatory work was garnered, and insight gained from many research articles; some of which are reviewed in the previous chapter; as well as other online resources. The instructional plan (Appendix B) is a direct result of this research and, it is believed, remains true to the desired outcomes for Information Technology (IT) — as is outlined in the Curriculum Assessment Policy (CAPS) document. Moreover, great effort was made to develop an online repository, discussed further in the next chapter, as a means of gauging learner propensity toward engaging with content. The resulting Wikispaces website catalogued learner logins and logged all activity automatically. This subject specific wiki encouraged collaboration and allowed for a safe, secure space for groups of learners to engage with content that included embedded YouTube video tutorials on Scratch. The included discussion forums further addressed and supported the issue of collaborative communication between learners. Learning Management

Systems (LMS), such as the wiki used during this study, allow for active involvement and an increased engagement with course material and discussion (I. Govender & Govender, 2010). However, it must be said, the LMS and the content taught were not the focus for this study. Instead, learners were encouraged to bounce ideas for their games off of each other both during lesson time and outside of school. This learner-to-learner co-operative learning technique was used as an instrument to balance out mixed abilities in class. Co-operative learning, is discussed by some as being an effective method for connecting the focus on individual learning (McWhorter & Hudson-Ross, 1996). The co-operative learning techniques, used during this study, fall into the category of inquiry or discovery-based learning (McWhorter & Hudson-Ross, 1996). For each lesson, once the initial instruction was completed, effort was made to encourage discussion and collaborative problem solving as a means of empowering the participants by making them responsible for their work and actions (Lee & Hammer, 2011). Over the course of the study, learners were repeatedly encouraged to engage with the content on the Scratch website as well as on the wiki. As a result, the wiki simply complemented the face-to-face time spent with learners during class. The wiki can be viewed at <http://gr8it.wikispaces.com/>. Participants will continue to have access to the wiki after the study. Content will be continually uploaded along with the research findings of this study.

### **3.6 Recording and reporting**

Before determining the effectiveness of any type of instruction, educators need to first have a clear understanding of relevant, associated terms even if they are not regularly applied (Chaisanit et al., 2013; Cresswell, 2003). Validity, one such term, is defined as the meaningfulness and trustworthiness of data that is influenced by design and methods of research (Bertram & Christiansen, 2014). It includes three measures — content, construct,

criterion (Ferrance, 2000). Validity in data collection, as is stressed by Bertram and Christiansen (2014), in interpretivist research must "*reflect the participants' reality*" (p. 188). Cresswell (2003), furthers this view by reiterating the importance of designing instruments that improve upon construct validity (p.224). Furthermore, the online wiki, acting as an LMS, allowed for on-going and prevalent discussions between the researcher and the participants. The open-ended interview questions, answered by participants, along with the questionnaire show that data collection and treatment remain consistent. Furthermore, the documented questions and online discussions will provide with a means for checking the accuracy of the recording and reporting process.

Using a combination of data collection instruments, a term Bertram and Christiansen (2014) refer to as triangulation; can increase the data description's trustworthiness. Indeed, a prevalent goal for this research endeavour was to minimize errors and biases so that the fundamental framework, for this study, could be replicated by others. Still, no one can be fully objective. Furthermore, this study may well fall short in effectively ensuring accurate and consistent data capture. Nevertheless, it is the opinion of this researcher that every effort was made to ensure this study be free of unfair, offensive, and disparate impact bias. Moreover, consideration was given to ensure an unbiased recording and reporting process. Certainly, one that did not offend or unfairly penalize any demographic including gender, race, ethnicity, socioeconomic status, or religion. This study, using conveniently selected participants, attempted to show dependability through the reliable manner by which data was digitally captured, backed up and analysed. It successfully established a traceable and easily accessible chain of evidence which, hopefully, connects both research questions to the data analysis and the resultant conclusions. Furthermore, this research also provides with complete and accurate supporting data; again,

available upon request; that will no doubt aid other researchers. It is believed that dependability is shown in the detailed method provided in this chapter of the thesis. A certifiable link between the research design, data collection instruments and variables to the research questions endorses this view.

### **3.7 Analysis techniques**

Because research in the interpretivist paradigm generally, according to scholars Bertram and Christensen (2014), looks to understand a social situation oftentimes its application indicates a protracted engagement between data sources and researcher (pg. 191). In this regard, the credibility of this research article is greatly increased due to the relationship between the researcher and the participating sample. That said, although every effort was made to ensure a transparent research process a shortage of time prevented the researcher from allowing the participants to check, or comment on, the accuracy of the transcriptions. Nor was it possible, to achieve intercoder reliability in the process of analysing or coding the data. Still, attempts were made to positively affect reliability in that all data has been made available for external validation of these findings.

### **3.8 Conclusion of the chapter**

In this chapter, the research was presented from a methodological perspective. A research framework was herein presented — including research design, fitness for purpose, research instruments, instrument validity and research limitations. The primary purpose for the research, an investigation into the perceived benefits of a constructivist based DGBL model for teaching and learning, was re-emphasized. The claims made by the articles referenced in this chapter, through mixed-method research, are scrutinised using dependable methods of data collection. In investigating these claims, this article puts forward an impetus for change that

will, hopefully, guide and inspire others to do the same. Since knowledge cannot simply be transferred or downloaded between minds, educators, today more than ever, are at pains trying to discover and develop new ways of getting their learners to engage with content. In order to consider DGBL as a viable vehicle for getting learners, and educators, to engage with content the research presented in this chapter, and in the chapters that follow, are explored along with other works pertaining to the research design.

## **Chapter 4 : Research Findings and Discussion**

This mixed method inquiry looked to investigate, through observation and analysis, the effects of Digital Game Based Learning (DGBL) within a closed junior high school environment. What were participants and teacher's perceptions of DGBL, a constructivist teaching innovation? Furthermore, why was it that they perceived DGBL the way that they did? Still further, how could DGBL be used to enhance the teaching and learning of Information Technology (IT) specifically? The three above-mentioned research questions predetermined the framework for the grouping and analysis of the data shown below.

### **4.1 Capturing and Analysing the Data**

The quantitative data, collected using a questionnaire (Appendix A), were expressed through the results of the instructional plans (Appendix B) developed for the Grade 8 classes. A proposed assessment rubric (Appendix G), showed potential for an academic grading in future works associated with DGBL but, held no bearing on the dataset used in this study. Administering the survey online, using Google Forms, simplified the data analysis process — due to the many embedded tools included in the freely available software and the interconnected nature of Google Apps. Special attention was given to developing a survey that would, accurately, identify correlations between participant attitude and level of engagement with content during DGBL. To give substance to the quantitative data, qualitative data was captured using both semi-structured (learner focus groups – Appendix D) and structured (educators – Appendix E) interviews. These were digitally recorded. The transcriptions of these interviews, along with the original recordings, are available upon request. The results of both

datasets are organized according to the three research questions addressed in this study as stated above.

Before gathering data for any of the three research questions it was established that, in order to ensure a structured implementation of this survey, an instructional plan had to be developed. The resulting plan (Appendix B) incorporated existing concepts from Grade 10 IT — repetition, branching as well as the concept of using variables for handling values. By incorporating existing concepts, that are based around mandatory Learning Outcomes (LO's), it was hoped that a case could be made for DGBL allowing for an earlier adoption of, perceived, high level concepts should the focus be on the process and not the product. That is to say, participants were shown a mainstream game they all would have knowledge of, like Helicopter, and questions were asked as to how elements of the game were created. This thematic approach to DGBL, encouraged both critical thinking and creative thought since there were many ways in which gravity, in the example of the Helicopter game, could have been coded. In adopting this approach, it is believed, a further endorsement is made in favour of the content covered during the study. In other words, the content remained relevant and appropriate for all who participated. Furthermore, much effort was made to ensure the activities, included in the abovementioned plans, allowed for effective participant-to-participant collaboration. As a further means of empowering and encouraging participation, an online Wiki was created for all to use ([www.gr8it.wikispaces.com](http://www.gr8it.wikispaces.com)). The Wiki served as an online receptacle, for participant interaction with content and collaborators; and was used both inside and outside of normal school time. More especially, the Wiki provided with the means for the researcher to catalogue progress. Participants were registered to the Wiki, using email accounts, and given access to key Scratch related tools. Each participant was encouraged to document the collaborative



process digitally by uploading their progress, concerns, discussions, and accumulated work. In this regard, qualitative data was obtained from the Wiki itself since an embedded feature allowed for an analysis of time spent online as well as participant contributions towards the developing games. The results from the Wiki analysis showed a general propensity toward interacting with the content and tools available online from the entire population. But, while all participants did, to varying degrees, engage with content both inside and outside of normal classroom time not all participants saw value in working collaboratively. During one of the focus-group interviews, it was established that mixed-ability grouping presented with work contribution difficulties. Simply put, participants with a weaker programming ability felt they had contributed less toward the creating of their game product. Another interviewee echoed these sentiments and felt that weaker participants prefer to take a "*back seat*" (Participant 64), during collaborative activities so as not to seem "*stupid*" (Participant 64) in front of their peers. These and other insights, were garnered during the interview process and are discussed in greater detail in Chapter 5. In any event each of the participants, who took part in the interviews, was asked the same set of open-ended questions (see Table 4.1). These questions, developed once an initial analysis of the quantitative data was complete, looked to add gravitas to the findings of that data.

**1) Describe your experience with IT before participating in this study.**

Have you made games before using Scratch or any other software tool?

Do you feel DGBL can be used to enhance the teaching and learning of Information Technology?

Please explain your answer.

**2) What are your feelings about using DGBL as an approach to learning?**

Was the experience fun?

<p>Was it challenging?</p> <p>What were some of the challenges you faced?</p> <p><b>3) Do you feel DGBL can be used to teach and learn in other subjects?</b></p> <p>Why do you feel that way?</p>
--

**Table 4.1 Focus Groups Interview: Open-ended questions**

In due course, the interviews succeeded in validating the trends observed online using the Wiki. Most all of the participants had, to varying degrees, engaged with their peers and course materials online, outside of class time. Although initially some had trouble logging into the Wiki, all were able in the end to upload and comment on work; many even from their phones or tablets. The data recovered from the interviews is discussed, in detail, in the sections that follow; suffice to say it succeeded in corroborating the quantitative data findings.

## **4.2. Research Question One**

In this section are outlined, the main findings related to research question one posed in Chapter 1. In Chapter 3 was outlined, as is surmised in Table 3.5, the scales and items used to assess the following research question.

### **4.2.1. What are learners and teacher’s perception of DGBL? (DoI)**

In order to gauge the effectiveness of any new innovation, according to Rodgers' Diffusion of Innovation theory, several major factors must be considered (Rogers Everett, 1995). The first of these involves perceptions about the relative advantage, or perceived usefulness, of the technology in question — to assess this variable the survey instrument included three questions (items 42-44). The second factor involves the compatibility with current learning practices and

the bespoke innovation — to assess this variable the survey instrument included two (items 45, 46). The third factor involves the simplicity or non-complexity of the innovation — to assess this variable the survey instrument included three questions (items 47- 49). The fourth factor speaks to the degree to which the innovation may be experimented with existing technology — to assess this variable the survey instrument included two questions (items 50, 51). And the last of these factors, addresses the issue of observability — to assess this variable the survey instrument included three questions (items 52-54). A more detailed explanation of the Diffusion of Innovation (DoI) and the Technology Acceptance Model (TAM) is available in Chapter 2 and 3.

Participant attitudes towards the use of DGBL in teaching and learning, is represented by a mean score on a 7-point scale, where 7 (Strongly Agree) represents the maximum score of the scale, 6 (Agree), 5 (Moderately Agree), 4 (Neither Agree or Disagree), 3 (Somewhat Disagree), 2 (Disagree) and 1 (Strongly Disagree), represents the minimum score. A zero indicates no entry. For each of the factors: relative advantage (items 42, 43R, 44), compatibility (items 45, 46), non-complexity (items 47, 48, 49), trialability (items 50, 51), and observability (items 52, 53, 54). A variable is computed to represent a participant's average score. The polarity for negative statements (R), was reversed to get a correct and meaningful score using *Google Form Add-ons*. These included statements linked to a Yes (7), No (1) or Maybe (4) answers.

Factors related to Technology Adoption	Mean	Median	Mode	Standard Deviation
Relative Advantage	5.05	5.00	6.00	1.52
Compatibility	5.51	6.00	7.00	1.62
Complexity	4.46	5.00	5.00	1.77
Trialability	4.83	5.00	5.00	1.42
Observability	5.32	6.00	7.00	1.76
<b>Averages</b>	5.03	5.40	6.00	1.62

**Table 4.2: Participant perceptions in terms of factors related to attitude toward DGBL.**

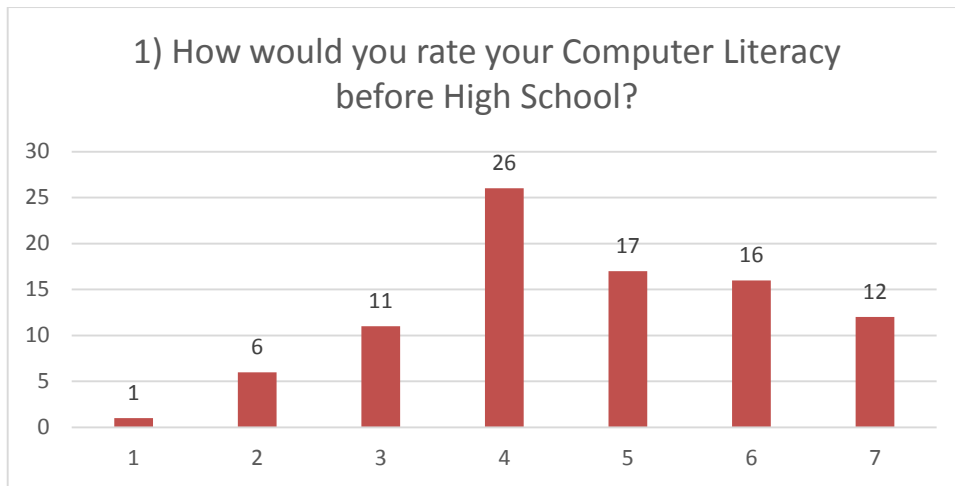
Overall, the participants' perceptions of DGBL appear to be moderately in favour of DGBL, with an overall mean score of 5.03, and an average standard deviation of 1.62 (Table 4.2). A new technology, will be increasingly diffused if potential adopters perceive that the innovation has an advantage over previous innovations, is compatible with existing practices, is not complex to understand and use, and shows observable results (Rogers, 2010; Rogers Everett, 1995). Participant responses seem to indicate a positive attitude toward the relative advantage of DGBL as an educational tool (mode = 6.00; SD = 1.67) (Table 4.2). Even more impressive, are participants' perceptions of the compatibility of DGBL with current classroom practices (mean = 5.51; SD = 1.62) and its observable results (mode = 7.00; SD = 1.76) (Table 4.2). Moreover, most participants indicate that learning to code using DGBL suits their learning preferences and level of computer knowledge. Some see value, as well, in using DGBL across many inter-disciplinary learning activities. Participant 3, in one of the focus-group sessions, stated that he had, along with two other Grade 8 collaborators, made for his 6-year old brother a Scratch game that teaches basic math. That game, along with several others, has since been deployed to the Scratch website (<https://scratch.mit.edu/>). It would appear, that many of the participants seem certain that DGBL fits well into their curriculum goals. Furthermore, participant perceptions of the simplicity of engaging with content using DGBL, after the

negative items are reversed, are also above a point of neutrality (mean = 4.83; SD = 1.42) (Table 4.2). In fact, as one participant put it, learning to code using Scratch was so easy “*even a child could do it*” (Participant 2). In regard to the level of complexity associated with learning to code by developing games using Scratch, participant responses are also positive (median = 5.00; SD = 1.77) (Table 4.2). Lastly, participant responses on the observability subscale again indicate a positive perception with an average mean score of 5.32 (Table 4.2). Most of the participants, who took part in the interviews, endorsed these views, and reported an overall positive experience. In the interviews with the educators, it was discovered that the learners who had experienced IT at other schools (in Grade 7), had no trouble with their perception of what Scratch entailed and found the experience to be “*quite enjoyable*” (ED3). Conversely, those to whom working with computers was new, “*were anxious*” (ED1) and were found, by their educators, to be “*afraid of the concepts*” covered in the intervention (ED2). Furthermore, as was noted by another educator, their perception seemed “*to out-way the actual level of difficulty of completing tasks using Scratch*” (ED2). This resulted in those new to the interface, taking longer to complete tasks not because of a lack of intelligence or ability, as the same educator put it, but rather because their perception of being inferior, in accumulated knowledge, in comparison to other learners — which ultimately negatively affected their end result or game product. Nevertheless, it would appear as though most educator views of their learners’ perception of DGBL was positive. One educator stated that her learners, “*perceived Scratch as fun, as their creativity was allowed to be explored and implemented*” (ED3). In a follow-up question, when asked why she felt her learners perceived DGBL in the way that they did, she stated that Scratch was “*a very child-centered, user friendly tool*” that gives learners “*a very basic grounding in the concept of coding*”, something she ascribes as being a, “*fantastic*

*foundation to build on*” (ED3). She moved on to say, “*what kid wouldn’t enjoy developing their own game?*” (ED3).

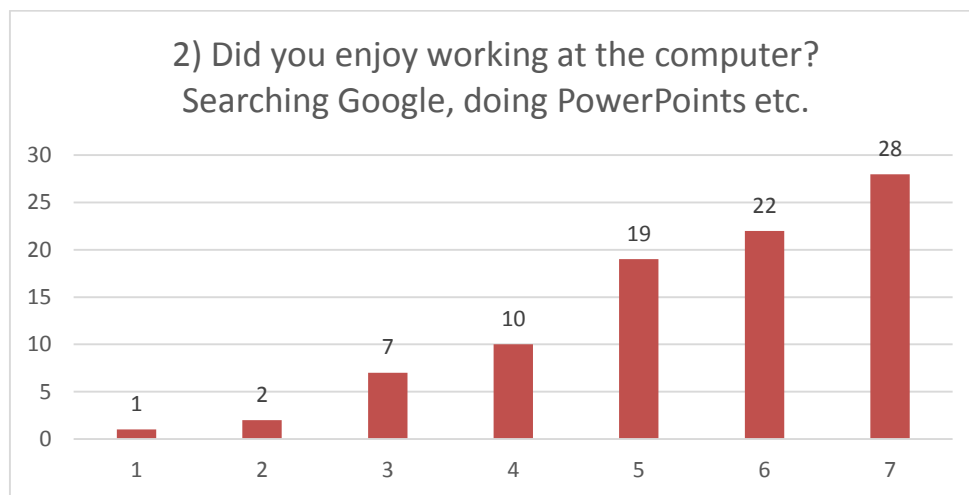
#### **4.2.2. What are the participant's perceptions of their level of computer competence?**

As is noted in the literature review, while many people see value in computers, and by extension computer programming, many more are intimidated by the perceived difficulty associated with the content taught (DW Govender & Dhurup, 2014). In fact, Govender and Dhurup (2014) contend, that educators who feel insecure by their lack of knowledge and experience, can lack confidence in their attempt to integrate computer technologies, like DGBL, into their classroom instruction (p.1219). It could easily be argued, that the same could be said of high school learners. Since IT is not a mandated subject area, for Grades 8 or 9 here in South Africa, the onus falls to school managements to enforce its inclusion. By tweaking the curriculum, as is the case at some high schools, it is hoped that a foundation for future success in IT can be laid. Perhaps it could be said then, that there is a direct relationship between mortality rates in IT between Grades 10-12 and a lack of early exposure to important CS concepts. Whatever the case, to support the dataset for the first research question participants were asked to rank their computer literacy and technology proficiency; prior to the deployment of this study (Figures 5.1 – 5.3). This background data collection employed a seven-point Likert-type scale (where *1 indicated — I believe my ability is extremely poor, 5 indicated — I believe my ability is average and 7 indicated — I am extremely confident of my ability*). It was found that, generally, the participants felt confident working with computers even before coming to high school. About 20.2%, about 18 participants, rated their ability as being below average (Figure 4.1 shown on the next page).



**Figure 4.1: Item 1 of 3 detailing background data of perceived ability prior to intervention.**

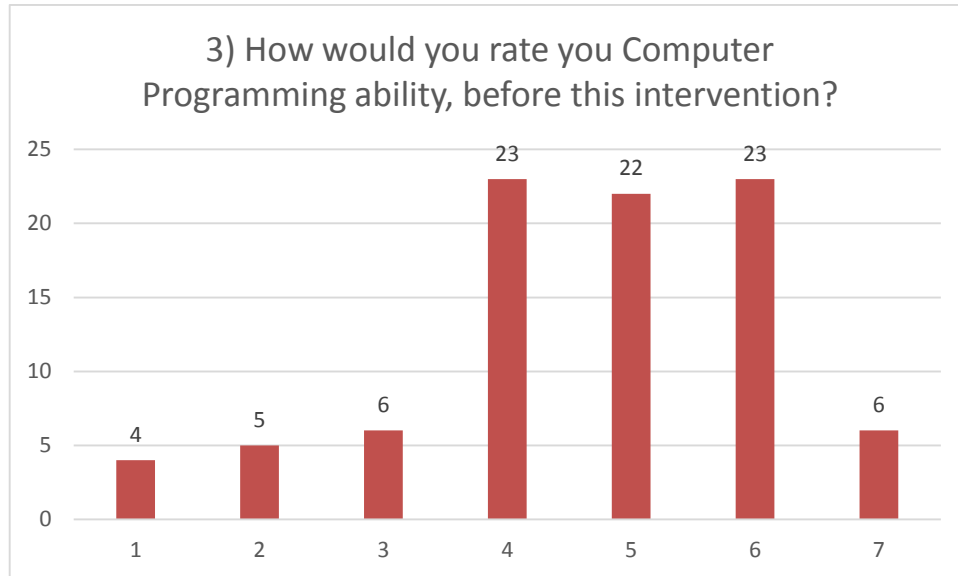
More than half of the sample found they enjoyed working with computers, prior to the intervention, and saw value in knowing basic skills – like using MSOffice Suite and being able to browse the Internet. In fact, almost a third of the sample (28 participants), about 31.5%, absolutely loved having access to computers in primary school (Figure 4.2 shown below).



**Figure 4.2: Item 2 of 3 detailing background data of perceived ability prior to intervention.**

With regard to perceived programming ability, the data showed a median score of 4.50 and a mode of 4.00. Participant responses recorded a somewhat positive view of their perceived ability (mean = 4.65; SD = 1.47) (Figure 4.3 shown on the next page). This result came as a bit

of a surprise, as it indicated that programming was being taught, to some degree, in some primary schools. Perhaps, more research needs doing at a primary school level to investigate these claims further.

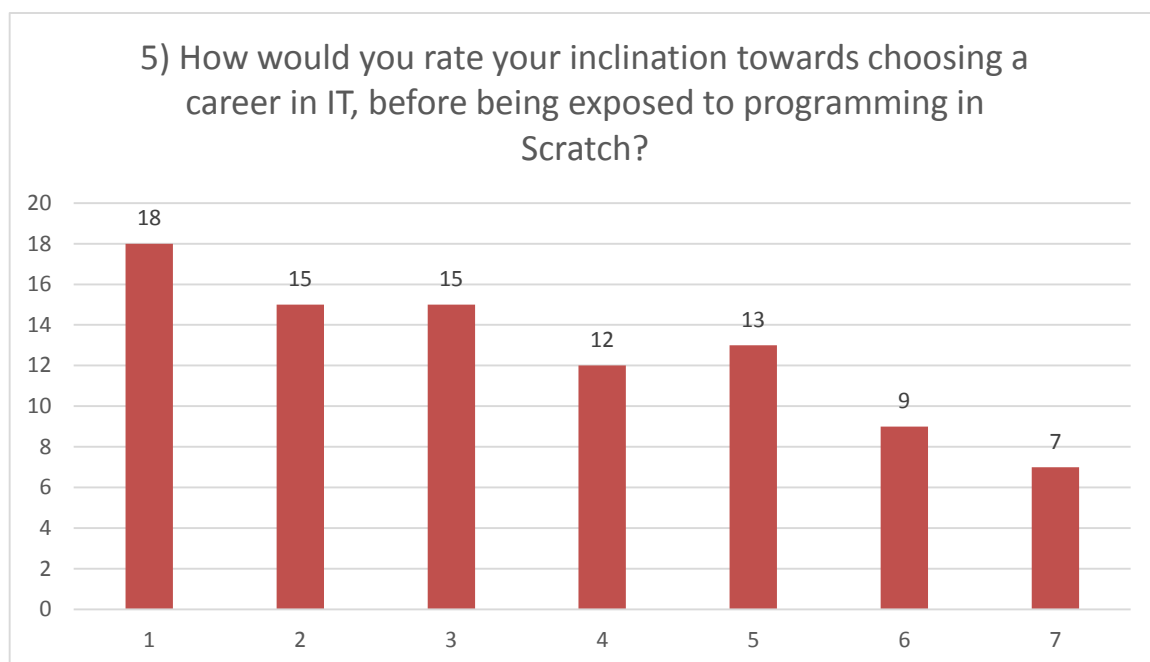


**Figure 4.3: Item 3 of 3 detailing background data of perceived ability prior to intervention.**

The idea that children love playing digital games, was endorsed in the interviews and the entire sample associated game development with programming. Still, as was shown in item 4 of the questionnaire, about 12.4% of the sample intimated that they had no idea what IT entailed prior to the intervention. However, the data also showed that an unexpectedly low number of participants associated programming with high intellect; at 15.7% of the sample (14 participants). This could, perhaps, be due to the fact that background information was only requested post-intervention; at a time where learners found they had been able to complete tasks with relative ease. Or, it could quite literally mean that learners are no longer put off by the, perceived, academic exclusivity normally associated with computer programming. Not surprising though, was that 24.7% never envisioned themselves as game developers — rather, they associated the skill with '*geek-dom*' and '*nerd-ship*', two eloquent terms several



participants were kind enough to share during one of the focus-group interview sessions. Another surprise was that many believed they would have eventually developed the skills to be able to create games on their own what with the, "*many free courses available online*" (Participant 66). Almost a third, saw value in IT and dreamt of someday joining Google or any other tech giant. This could, perhaps, be related to the fact that so many had had prior experience with coding in primary school. But, while some saw value in learning IT even before entering high-school (18% of the sample), many more indicated a disinclination towards pursuing a related career. To enumerate, prior to being exposed to programming using the Scratch interface, participant views indicate a prevalent mode of 1 (Not likely to pursue a career in IT – Figure 4.4 shown below). The rest of the rating for this item included 5 — *I am not sure I will pursue a career in IT* and 7 — *I am extremely confident I will pursue a career in IT*.



**Figure 4.4: Learner inclination towards possible careers in IT, prior to intervention.**

This view, however, did change post-intervention as is shown in item 55 of the questionnaire — where more than 23% of the sample reconsidered possible careers in IT (21 participants). Although, 43.8% still thought it was interesting but remained fixed on their position of interest, 24.7% felt that they loved it now more than ever. A combined 6.8% of the sample (6 participants) either still did not like IT or were simply indifferent at the prospect of it. While these results are encouraging, the reader is cautioned to regard them within the context of this study. This study involved participation from forward-thinking educators who teach in reasonably equipped computer labs. As has been shown, many learners entered high school with a reasonable level of IT ability. To be sure, research has shown this is not true of the broader population in South Africa. So, while learner perceptions of competence levels were largely positive, it must be said that, without basic computer skills at their disposal it is unlikely other educators will be able to start to integrate Information and Communication Technologies (ICT's) successfully into the school curriculum (DW Govender & Dhurup, 2014). Indeed, the very same logic can be applied in the instance where educators, as was the case in this study, look to do so while teaching complex CS concepts. Participants and educators must need present with a basic level of competence so as to limit a myriad of problems associated with the implementation DGBL or similar innovations — especially with novice learners. The data certainly, does not speak to the view that all people perceive all things related to IT as being complex and exclusive. Moreover, while participants perceive a definite relationship between fun and game playing; there appears to be an unambiguous detachment from fun when the relationship with the game takes on the format of that of the developer rather than player. In any event, the issues addressed in this section are discussed further in Chapter 5. With this in mind, the reader is encouraged to remember that the findings, discussed thus far, reflect the participants' views on their competence level prior to engaging with DGBL or the Scratch

platform. In the following sections these results are juxtaposed with participant views and sentiments post-DGBL.

### **4.3. Research Question Two**

In this section are outlined, the main findings related to research question two posed in Chapter 1. In Chapter 3 was outlined, as is surmised in Table 3.4 and Table 3.6, the scales and items used to assess the following research question.

#### **4.3.1. Why do learners and teachers perceive DGBL the way they do? (CLES and IMI)**

Trying to translate the philosophy of constructivism into actual practice, can prove to be a challenge (Karagiorgi & Symeou, 2005). Indeed, educator attitude toward adopting and deploying new teaching philosophies can prove a key element in realizing a successful implementation (DW Govender & Dhurup, 2014). To gauge whether or not DGBL had a positive effect on teaching and learning the Intrinsic Motivation Inventory (IMI) was selected. To gauge how participants responded to being taught within a constructivist learning environment, the Constructivist Learning Environment Scales (CLES) was selected as part of a conceptualised framework discussed in Chapter 2. In combining scales from these two frameworks, it was hoped that insight could be acquired as to why the participants felt the way they did about DGBL. To reinforce the quantitative data, qualitative data were collected.

In Chapter 3, it was explained that peoples' attitudes towards a learning environment can be quantified by assessing their responses to four factors. These factors include negotiation, prior knowledge, autonomy, and focus. For this part of the study, participants were asked to respond to 9 Likert-type statements, dealing with their attitudes toward a constructivist learning environment. These items were designed to measure the effective negotiation between

participants (items 36R and 40); prior knowledge (items 35 and 41R); autonomy (items 37 and 33) and the educators' role in maintaining participant focus (items 34, 38R and 39). Participant perceptions are represented by a mean score on a 7-point scale, where 7 (Strongly Agree) represents the maximum score of the scale, 6 (Agree), 5 (Moderately Agree), 4 (Neither Agree or Disagree), 3 (Somewhat Disagree), 2 (Disagree) and 1 (Strongly Disagree) representing the minimum score. A zero indicates no entry. For each of the factors — negotiation, prior knowledge, autonomy and focus a variable is computed to represent an individual's average score. The polarity for negative statements (R) was reversed to get a correct and meaningful score using *Google Form Add-ons*.

<b>Attitude toward a Constructivist Learning Environment (CLES)</b>	<b>Mean</b>	<b>Median</b>	<b>Mode</b>	<b>Standard Deviation</b>
Negotiation	4.73	5.00	7.00	1.81
Prior Knowledge	5.26	6.00	7.00	1.71
Autonomy	4.74	5.00	7.00	1.73
Learner Focus	5.51	6.00	7.00	1.74
<b>Averages</b>	5.06	5.50	7.00	1.75

**Table 4.3: Participants' Attitude toward a Constructivist Learning Environment (CLES)**

Overall, the participants' perceptions of a constructivist learning environment seem to be positive, with an overall mean score of 5.06, and an average standard deviation of 1.75 (Table 4.3). A new learning environment, becomes easily adopted should participants perceive ownership through negotiation, if the environment proves to be more engaging than existing practices and if learning in the environment shows observable results (mean = 5.48; SD = 1.76) (Table 4.3 above) (Nix et al., 2003). In regard to prior knowledge and the educators' role therein, overall participant responses showed a positive view (mean = 5.26; SD = 1.70). This correlates to the data discussed in the preceding section and can be down to knowledge acquired, by some, in primary school. Moreover, the median point (6.00) and mode (7.00) seem

to suggest that effort was made, by the researcher, to effectively implement a constructivist learning environment. When compared to the other variables, perceived autonomy showed a marginal variance (mean = 4.74; SD = 1.73) (Table 4.3 on the previous page), suggesting more could be done to encourage participant investigation into solving problems after their own fashion. Nevertheless, it would seem the majority were of the view that the educator played an active role in maintaining participant focus throughout the process (mean = 5.51; SD = 1.74). Here, the data showed many participants shared an extremely positive view of the educator (median = 6.00; mode = 7.00) (Table 4.3 above). In the end, it seems fair to presume that there exists a general satisfaction in learning to code, within a constructivist environment, even when the content covered includes complex computer science concepts; as was discussed in Chapter 3. This view and others, discussed further below, was endorsed by the findings of the interviews. When asked to compare their experience to time spent in a traditional classroom environment, 40.4% of the participants were unmoved in their view of the learning process (Figure 4.5 shown below); and found the increased interaction with their classmates to be invaluable. However, 36.0% did take advantage of using a peer as a resource which left 23.6% unsure.

53) Did you change your way of using Scratch based on what you learned from a classmate?

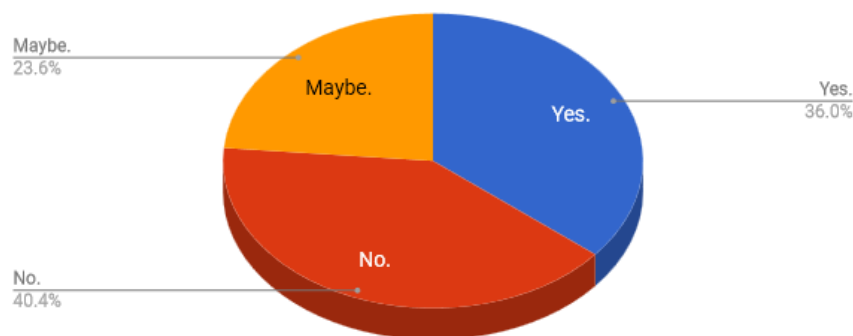
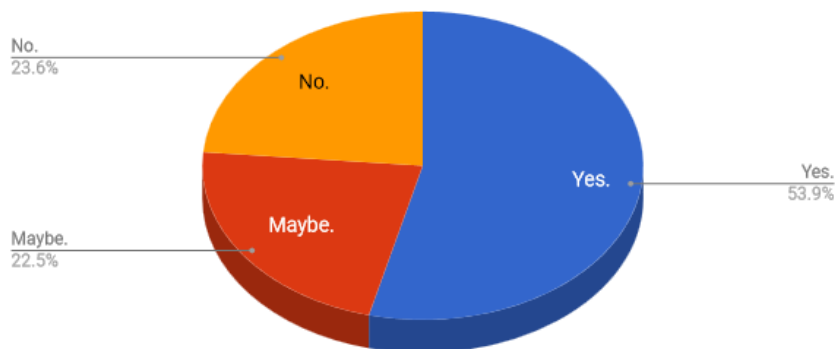


Figure 4.5: Learner perception of classroom collaboration.

Encouraging was the fact, that more than half the sample found they had learned new ways of using the Scratch platform through an interaction with a classmate (Figure 4.6 shown below); thus, endorsing collaborative learning.

52) Did you learn new ways of using Scratch from a classmate?

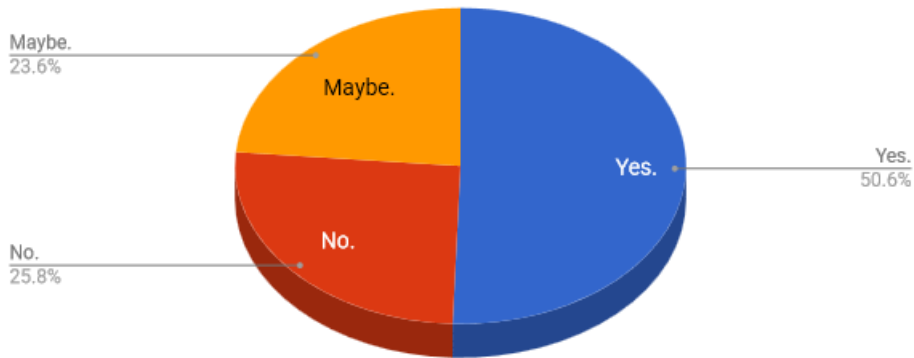


**Figure 4.6: Learner perception of peer learning with CLES environment.**

Equally encouraging, it was found that the environment fostered a sense of interdependence among participants with 50.6% sharing this view (Figure 4.7 shown on the next page). This speaks, perhaps, to the faculty of a learning environment to cater for mixed ability teaching and learning. Indeed, it was observed that some of the stronger academic participants enjoyed sharing their ideas and skills with some of the weaker ones. Still, it cannot be overlooked the fact that not everyone enjoyed, or found themselves to have benefitted from, collaborative game developing and learning. To be sure, 23.6% of the sample were found to be unsure of their view of this item, while 25.8% registered an irrefutable scepticism (item 54 shown below). During the focus-group interviews, a participant echoed this view stating that "*working with people is hard, except if you're working with Participant N*" (Participant N: in the researcher's view, is an approachable top achiever who has successfully endeared herself to many of her

classmates) (Participant 69). Social dynamic, it would appear, can affect the degree to which participants are prepared to interact with each other.

54) Did you learn new ways of learning content from working with a classmate?



**Figure 4.7: Learner perception of peer learning with CLES environment.**

A human trait, that extends into the classroom is that most children are naturally competitive. But, should it be effectively manipulated this trait can be used, by an educator, to augment the teaching and learning process. Still, there might always be, as was certainly the case in this study, some learners may well have a negative experience working with their peers. Several interviewees shared this view stating, in summary, that they were too "*scared to show they didn't know something*" because some of the "*smarter kids*" made them "*look stupid*" in front of others (Focus Group 3). It is very difficult, even for the most astute of educators, to completely oversee and micro manage all social interactions. Constructivist teaching, is meant to foster critical thinking in independently motivated participants (Gray, 1997). While there is evidence suggesting a successful intervention, perhaps more could be done in future works to address this pertinent issue of inclusivity between participants. When looking at participant behaviour, three aspects were considered during class time — positive peer interaction, on-task collaboration with other participants and active participation. Although participant behaviours

were not recorded, using any instrument, overall it did seem as though most of the participants were actively participating at least most of the time. Some participants had to be encouraged to engage every so often, but most remained true to the task at hand. Outside of class time became harder to manage. However, regular checks of the Wikis showed habitual updates and discussions between participants.

As is noted in Chapter 3, the IMI provided with the scales for assessing participant attitude toward being taught IT using a DGBL approach. Participants' attitudes were grouped and quantified by assessing their responses to five factors. These factors included relatedness, interest or enjoyment, perceived choice, pressure or tension and effort. For this part of the study, participants were asked to respond to 22, Likert-type statements dealing with their attitude towards IT and DGBL. The items, are designed to measure the degree to which participants could relate to the content taught and the method it was taught in (items 10, 15, 20, 24R and 31), the level of enjoyment experienced (items 9, 13, 17, 18, 21, 26R and 29), their perceived choice or autonomy (items 12, 22R and 27), the level of pressure experienced (items 11, 19, 25 and 30) and an account of the effort they invested in completing tasks (items 23, 28 and 14R).

Participant perceptions are represented by a mean score on a 7-point scale, where 7 (Strongly Agree) represents the maximum score of the scale, 6 (Agree), 5 (Moderately Agree), 4 (Neither Agree or Disagree), 3 (Somewhat Disagree), 2 (Disagree) and 1 (Strongly Disagree) represents the minimum score. A zero indicates no entry. For each of the categories — relatedness, interest/ enjoyment, perceived choice, pressure/ tension, and effort a variable is computed to represent an individual's average score. The polarity for negative statements (R) was reversed to get a correct and meaningful score using *Google Form Add-ons*.



<b>Factors related to Technology Adoption</b>	<b>Mean</b>	<b>Median</b>	<b>Mode</b>	<b>Standard Deviation</b>
Relatedness	4.36	5.00	7.00	2.06
Interest/ Enjoyment	5.23	6.00	7.00	1.67
Perceived Choice	4.48	5.00	4.00	1.84
Pressure/ Tension	4.26	4.00	7.00	2.01
Effort	5.00	5.00	7.00	1.70
<b>Averages</b>	4.67	5.00	6.40	1.86

**Table 4.4: Participants' attitudes towards Information Technology (IMI)**

Table 4.4 illustrates the distribution of mean, median, mode, and standard deviation (SD) scores on the attitude toward DGBL as an innovation. As Table 4.4 shows, the overall attitudes of the participants toward DGBL are somewhat positive, with an overall mean score of 4.67 (SD = 1.86). Slightly positive attitudes are evident, within the relatedness (mean = 4.36), enjoyment (mean = 5.23), perceived choice (mean = 4.48), tension (mean = 4.26) and perceived effort (mean = 5.00) domains. This augurs well for DGBL, and suggests participants are motivated to engage with content when it is used in the classroom; as is also noted by Woo (2014) (p303). These positive attitudes created an atmosphere that encouraged interdependent teaching and learning sensitive to the needs of a mixed ability class. Focusing on the needs of the participant, created a nexus between achievement, accountability, expectation, and the quality of classroom instruction; as was noted by Ballard & Bates (2008) (p.578).

In the closing part of the questionnaire (items 55 - 58) participants were asked to reflect, briefly, upon their experience of DGBL post-intervention. Item 55 looked to gauge whether or not learner perceptions of IT and CS had changed post-intervention. This item included 5 choices for the participants ('I still do not like IT'), ('I think it is interesting, but it is not for me'), ('I have changed my view of IT and am considering a future in this field'), ('I am indifferent' and 'I love it more than ever'). Item 56 and 57 were scored using a 7-point scale, where 7 (Strongly

Agree) represents the maximum score of the scale, 6 (Agree), 5 (Moderately Agree), 4 (Neither Agree or Disagree), 3 (Somewhat Disagree), 2 (Disagree) and 1 (Strongly Disagree) represents the minimum score. And item 58, the last item in the questionnaire, was an open-ended invitation for participants to add anything else they found pertinent to the study. It was found that the intervention did alter participant perceptions of IT and CS at large. From a pre-intervention mean score of 4.75 (item 4, SD = 1.68), to a post-intervention mean score of 5.14 (item 57, SD = 1.69). Certainly, this view was echoed in the interview sessions, where participants indicated their IT knowledge extended only to MS Office Suite prior to the intervention. Interestingly, one participant found that his Scratch knowledge was fortified by his experience on Code.org (the 1 hour of code initiative founded in the United States). Furthermore, some 21 participants (23.6%) found that the experience had completely altered their view and are now considering a possible future in IT. Moreover, 25.8% felt that they loved IT now more than they did prior to the intervention. Most interesting though, was that while almost half the sample (43.8%) found themselves to be enamoured with IT, given the choice, they still had no intention of pursuing a future in it (Figure 4.8 shown on the next page). The remaining 6.7% of the sample were either indifferent or remained unmoved in their view.

55) Has this experience changed, or altered, your view of Information Technology and Computer Science at large?

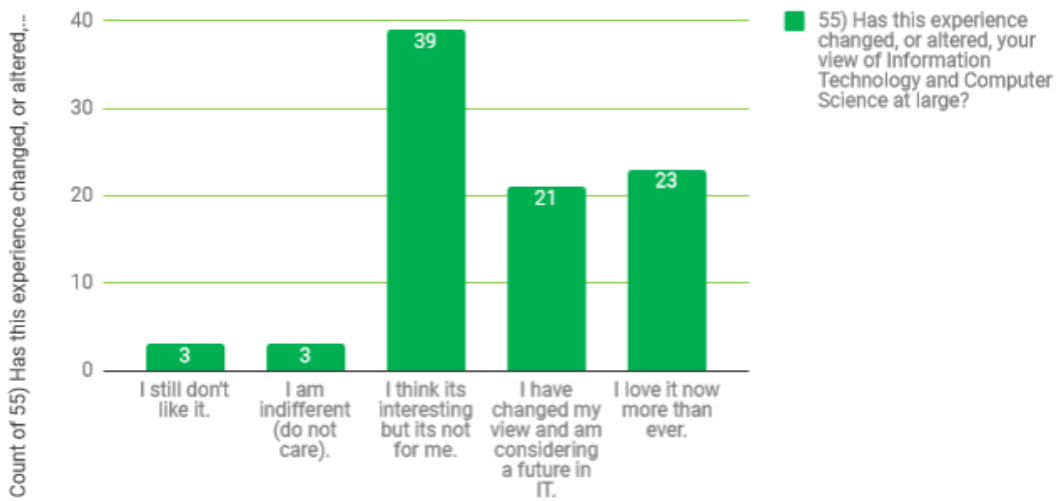


Figure 4.8: Learner perception of IT and CS post-intervention.

Therefore, it would seem as though most of the participants saw value in the study, its implementation, the teaching method, and the coursework covered. Indeed, these findings speak to the relevance of introducing IT at a junior phase, regardless of the teaching methods used to do so (Figure 4.10 shown on the next page). Even though, the results show a mean score of 4.12 (SD = 2.2) for those keen to register for IT in Grade 10 (Figure 4.9 shown below), it is encouraging to regard these numbers in context (mode = 7).

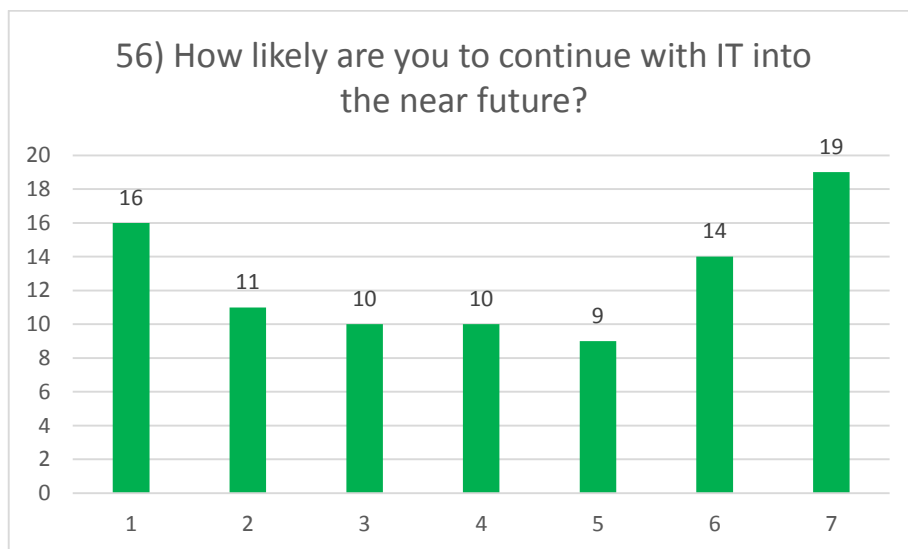
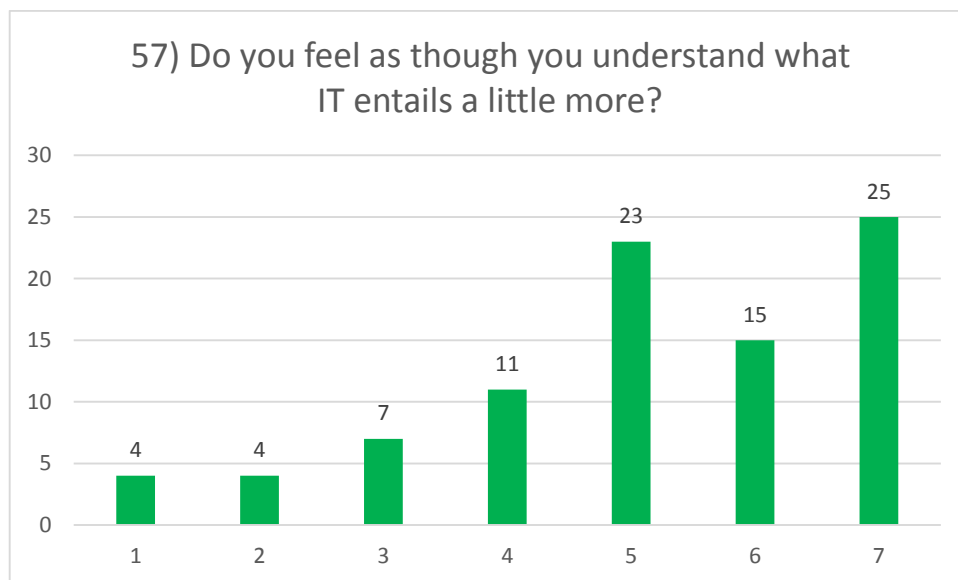


Figure 4.9: Learner perception of IT, post-intervention.

Developing the skills required for the jobs of the future, mandates an early introduction to CS related subjects like IT (Anderson & Gantz, 2013). Surely this experience, has shown participants some value in having a handle on IT in general. If this is not the case, then it can certainly be argued that this experience has successfully presented participants with insight into the realm of IT by way of coding using a DGBL approach. Indeed, there was a marked improvement in participant perception of IT and a general positive perception of DGBL as an innovation of instruction (Figure 4.10 shown below). The findings in the interviews supported this data, in that several participants suggested that IT “*is the future*” and that, quite maturely, “*without it (they) face the very real possibility of not being able to find good jobs*” (Focus Group 1). One educator supported this view, stating that technology “*in moderation, is important in the classroom*” (ED1). In a follow-up question, the educator identified technology as oftentimes being the cause of many childhood ailments including depression, anxiety, insomnia, and low self-esteem. “*A good balance*”, was cited as a possible compromise between traditional teaching methods and DGBL (ED2).



**Figure 4.10: Learner perception of IT, post-intervention.**

#### **4.4. Research Question Three**

In this section are outlined, the main findings related to research question three posed in Chapter 1. In Chapter 3 was outlined, the design of the interviews that took place between both teachers and learners. The results of which were used to assess the following research question.

##### **4.4.1. How can DGBL be used to enhance the teaching and learning of IT?**

Throughout the intervention, participants showed tremendous aptitude and capacity in being able to self-study and work collaboratively. In addition, many displayed an eagerness to showcase their progress to both their peers and the researcher. Interacting with intrinsically motivated participants, has had a reciprocated effect on the researcher's experience of DGBL. That said, while designing and developing original computer games can be, perhaps, beyond the expertise of some educators there exists an untold power in individual enthusiastic teaching staff (Whitton, 2012). Even when a good game design idea is used, only as a starting point, ill-equipped educators can do no wrong should they release their participants' creative, collaborative, and technical expertise by allowing them to translate the design into a working game. In the end, the participants reported that they did learn to create rudimentary games and that they enjoyed being able to do so. In the interviews, some reported that they had more success in understanding concepts by using the '*Hour of Code*' initiative, Code.org, at their own pace at home. Moreover, many reported that in making the games they indeed found a motivation to learn subject-related knowledge. However, this view should be taken in the context that participants were not taught said content using traditional teaching methods. Therefore, they had no grounding from which to draw an objective comparison with being taught that content using DGBL. Nevertheless, others reported possible high paying careers in game development and being paid to play games as being their motivation to learn how to code.

Although this view may seem naive, it does somewhat speak to a wider issue that has plagued education in general. That is to say, the issue of real-world relatedness to content being taught at school. By the same token, there seems to be a misalignment between what is required of high schooling from universities and what is required of universities by places of work. Indeed, using games to teach allows for learners to learn through problem-solving or enquiry without the fear of failure or rejection. Games encourage learning through practice, repetition, mistake-making and experimentation (Whitton, 2012). But make no mistake, game creating can be a tediously long and complicated process that requires much ability in the educators trying to facilitate its use. Making mini-games to communicate a concept, as was done in this study, is much more manageable and appropriate to education (Van Eck, 2006) than trying to create one of the typically large, commercial type games many are familiar with. However, this in itself can present with an issue of longevity, in that learners may come to feel restricted and bored with making, perceived, insignificant small games. But educators could easily address this issue and, if managed correctly, could easily journey together with their learners in learning how to create serious games. With the availability of commercial grade games engines, such as Unity 3D and the Unreal Engine; and with vast number of video tutorials available thereto related, it is not hard to imagine how the role of the educator can change in with the modern world. From that of the *'fountain of all classroom-based knowledge'*, to that of a *'creative classroom-based muse'*. Doing so, could speak further to the ability of DGBL to merge education with the *'real world'*. Still, the reality of using DGBL with learners as designers, within a traditional institutional framework, might well prove to be ineffective. Curriculum based learning outcomes and assessment standards, clearly outline what is to be taught, and when, in a results-driven state-controlled framework. And, if using DGBL is meant to simply replace the way which knowledge is disseminated in schools; then it is doomed to fail since

many educators will simply argue that they do not have the time, or the energy, to successfully substitute what has always worked for them. No, what is needed; in order to successfully enhance teaching and learning; is a fundamental redesign of the curriculum itself — from an existing focus on assessment for evaluation, to an assessment of learning (Lim, 2008). Until education stops fostering an environment, where educators are forced to teach to the test; we will continue to see a stifling restriction on creativity and ingenuity. All the while, short-sighted naysayers may well be inclined to highlight the many drawbacks associated with DGBL. That is to say that DGBL: is time-consuming, requires tremendous commitment and ability from educators, requires a great deal of supporting infrastructure and that it does not easily align itself to all subjects (Whitton, 2012).

#### **4.4.2 Overview of Learner Perception of DGBL**

In as far as an overview of participant perceptions, the following, composite statements were developed (see Table 4.5 on page 114) using scales from the questionnaire. These statements involved participant perceptions of — their IT ability pre and post intervention, the Scratch interface, using games in teaching and learning, collaboration, and the role of the teacher in the classroom. Because of practical considerations regarding the length of the questionnaire, the number of items included in each of the scales were limited. That being the case, with regard to the participants' own awareness of their proficiency of basic computer skills and game developing this study endeavoured to support the notion that changes were never going to be overnight. In fact, this study sees itself as being part of an awareness raising process, in South Africa, occurring over time. The completion of the questionnaire, therefore, is considered to be a crucial point of departure in establishing an alignment between expectation and future success in the field of IT. As is noted earlier in this chapter, an interesting finding of the questionnaire

is that participants, generally, rated their IT ability higher than was expected. Certainly, this flies against much research in the field of economic disparity in this country since there can be no ability without access to the necessary equipment (Motala, 2006, 2011; Mouton et al., 2012). However, this mismatch is important, in that it shows more stake-holders are now seeing value in exposing learners, at an earlier stage in their development, to coding. Nevertheless, for those in this study, who did not have access to computer technologies; many were "*amazed by the amount they were able to learn in such a short period of time*" (Focus Group 3). This also corresponds well with the interview data, in that some felt the most challenging part of the intervention was trying to troubleshoot glitches rather than understanding content. In as far as the Scratch platform was concerned, the questionnaire showed a mean score of 4.65 in its favour. It was decided to explore this issue further in the interviews. Generally speaking, while many participants found the interface easy to engage with; others found working online with the Code.org interface to be more suitable. Moreover, interviewees felt that working in class created a subtle atmosphere of pressure — especially if they did not complete tasks without aid or on time. It was subsequently further emphasised that being able to work at home, watching YouTube tutorials, certainly aided self-confidence since the biggest challenge some hi-flyers faced was "*trying to translate what's in your mind into an actual game*" (Focus Group 2). Not surprisingly, the overall impression of using games to aid teaching and learning was positive (mean = 4.88). Interestingly in the interviews, participants maintained that games *could* be used in other subjects as well due to its 'fun' characteristic. When asked in what guise they would suggest its use, some replied through the making of subject-related mini games, others suggested the incorporation of game-like principles (by being able to re-write a test until they passed) and one suggested playing subject-related games. In response to a follow-up question one interviewee suggested that, making mini-games for other subjects "*opens up the possibility*



of learning coding and content” specifically for that subject (Participant 75). This will encourage “content related researching ability”, he went on to add (Participant 75). Perhaps cross curricula assessment, is an idea worth exploring where learners make bespoke mini-games for one subject and submit the code for assessment in IT. Though, as another interviewee pointed out, in response to this suggestion — it could very well mean double jeopardy for those who are not good at both subjects. In their response to the issue of the role of the educator during class time, participants generally felt that they were affirmed and supported during the entire process (mean = 5.11). This bodes well for the notion that the role of the educator, in a constructivist learning environment, should be that of a supporting one (mean = 4.94). In a finding that supports the questionnaire, several interviewees said that they preferred being able to express themselves through their work without constantly being told what to do. It is thus apparent that DGBL, in the view of the participants, was successful in adding value to both the teaching and learning process. Futhermore, it was obvious that the Scratch interface was easy to pickup and that the content taught was easy to grasp; when taught in the context of the game dynamics. The overall attitude towards DGBL is reflected as having a mean score of 4.77. Obviously, the analysis of the learners' responses to DGBL shows that much work still needs to be done to ensure unilateral success. But, should practical and logistical considerations be properly addressed then DGBL, in the view of this sample, certainly does show potential as an educational innovation.

Scale	Composite Statement	Question Numbers	Computed Mean	Number of Items
Perceptions of initial ability	I was proficient in Computer use before coming to High School.	1 to 6 (exc.4)	4.38	5
Perceptions of the Scratch Interface	I feel comfortable and secure learning to code using Scratch.	7 to 22	4.65	16
Perceptions on using Games in T&L	I enjoyed learning this way and felt motivated.	23 to 32	4.88	10

The Role of the Teacher during class time	My teacher affirmed and supported me.	33 to 41	5.11	9
Perceptions of a Constructivist approach (DGBL)	I was comfortable working and learning collaboratively.	42 to 51	4.94	10
Perceptions of IT (and ability) after intervention	I now know more about the nature of IT and CS.	56 and 57	4.65	2
<b>Overall Attitude</b>			4.77	52

Table 4.5: Coding Sheet Overview with Composite Statements

#### 4.4.3 Overview of Educator Perception of DGBL

Three educators were contacted, post-intervention, and invited to discuss their views regarding DGBL. In making the appointments, it was re-emphasised to each educator the objectives of the study. Upon meeting with the educators, the researcher reassured them that all ethical considerations would be considered regarding the manner in which the interviews would be conducted. The duration of the interviews was, on average, 60 minutes in which 5 focal questions (see Table 4.6 below) and 26 related other questions (see Appendix C) were asked. Apart from taking structured notes during the interviews, all interviews were digitally recorded, subsequently analysed, and compared with the written notes. Although the interviewees sometimes appeared disconsolate, by the state of education (specifically IT) across the country, they were generally appreciative of the fact that this research looked to address a small part of great problem. That said, the most prominent findings from the structured interviews are presented below.

- 1) Is there a benefit to using DGBL (Scratch) as a technological tool for teaching complex Computer Science concepts in high school Information Technology classrooms in KwaZulu-Natal schools?
- 2) What are your feelings about using DGBL as an approach to learning?
- 3) Do you feel DGBL can be used to teach and learn in other subjects?

- |  |
|--|
| <p>4) <b>How do High School IT teachers perceive their teaching? What is their predisposition toward the adapting of 'new' technologies such as DGBL?</b></p> <p>5) <b>What are their views on the challenges they face in terms of ensuring success based on the contingencies of their local social context?</b></p> |
|--|

**Table 4.6 One-on-One Educator Interview: Open-ended questions**

The first issue addressed in the interviews, involved the perceived educational benefit the literature associates with DGBL. During the initial stage of the interviews, insight into educator understanding of key terms, used loosely throughout the study, was sought: technology, innovation, pedagogy, and methodology. In order to understand how DGBL can be used to enhance teaching and learning, it was deemed important to address educator interpretations of the aforementioned jargon. Without exception, all showed an astute understanding of DGBL and how it fits into the extended framework of pedagogy. All of the interviewees were of the opinion that, DGBL using Scratch could be used to enhance both teaching and learning. One interviewee seemed acutely aware of the relationship between developing logical thinking and learning how to code; adding that Scratch can, *"simply achieve (logical thinking development) by using blocks to assemble code, instead of text"* (ED1). Furthermore, he added, Scratch allows educators to *"keep the focus on the logic of programming rather than the syntax which normally frustrates learners"* (ED1). It would appear apparent also, that all interviewees see value in integrating technology into the teaching of IT. On that note, the interviewees indicated that technology could be used to aid content delivery, pedagogy, and learner motivation to complete tasks. One interviewee indicated that, *"learning can be supported by simulation and visual content; which helps learners to see content from a different perspective"* (ED3). Another interviewee indicated that, *"learning gets better as learners get involved and take over the*

*responsibility of learning*" (ED2). This finding supports the feelings of the learners, in that they too feel empowered by the prospect of being responsible for their own learning. In response to a follow up question regarding the issue of learner motivation, interviewees generally felt that learners develop intrinsic motivation if they can "*touch, feel, visualise or relate to*" the subject content (ED3). In support of this view, one interviewee stated that the Scratch platform, "*gives immediate feedback during interaction*" (ED2). An additional and direct consequence being that, an intuitive and engaging learning environment can aid educators with assessing while, simultaneously, alleviating test anxiety for learners. This is especially true, for learners who have access to computers outside of school. As one interviewee put it, "*technology can absolutely help grow knowledge and aid content delivery but, unless all children have access to the technologies necessary to reinforce concepts outside of the classroom; what we are doing is disadvantaging the kids who are poor*" (ED2). Another interviewee was not entirely convinced that DGBL could be used to address "*the issue of multiple intelligences*" (ED1). Stating in a follow-up question, that "*not all children learn the same way*" (ED1). Indeed, there is a need for DGBL research to investigate the conditions in which games work best and how learner activities relate to the benefits of the game (Huizenga, 2017b).

Another pivotal issue, addressed in this part of the interviews, was the educators' view of their learner's perception of DGBL. There is definitely, some sense that the educators' view corroborates that of the questionnaire data in that DGBL was well received at a junior high school level. But, one interviewee, mentioned that he predicts making mini-games will have a short life span since many learners will want to "*solve more complicated real-life problems*" (ED1). Interviewees therefore argue that unless game developing, using a DGBL approach, can evolve rapidly within the classroom environment to include serious games (most especially for

the mobile market) its longevity might well be limited. It is consequently evident then, that mini-game developing may not be entirely practical in the long term. Yet another important issue addressed by the interviewees in this regard, is that there exists a limitation in the memory management of large Scratch applications which tend to glitch as they grow in size. This means, of course, that Scratch would not be ideal for developing serious games. To address the issue of serious games, as has been stated, the use of Unity 3D, Unreal Engine or similar game engines is necessary. But, introducing high level software is not without a great deal many more related issues and would require even more effort from already over-worked educators. Even though this suggestion was well received by the interviewees, at present, this would not be viable short-term solution to DGBL game developing.

In as far as garnering an understanding, of the context and conditions under which the interviewees conduct regular classes, several questions were asked. The idea being, to get insight into the degree to which technology is normally integrated into their classrooms. Clearly it could easily be argued, that this insight gave bearing to interviewee perceptions of DGBL; in that their propensity towards existing technology integration could directly affect the adoption of new innovations. So, while all interviewees use visual aid materials (MS PowerPoint, YouTube Videos, Simulation Software) for content delivery, not all are sold on replacing traditional teaching methods. As one interviewee put it, technology "*should embrace not replace teaching*"(ED1). In response to a follow up question regarding the issue of constructivists teaching, one interviewee suggested that it was impractical to "*use it all the time*" (ED1). So, clearly not everyone is overly optimistic about the practical integration of DGBL into the existing curriculum. In addition, another interviewee suggested that technology be used for half the allotted lesson time — once instruction using traditional methods is

complete. The weight of this evidence seems to suggest, that while some educators do see value in using DGBL there remain concerns about its use. Not least among these concerns, is the issue of classroom management; which flies in the face of some research that suggests the contrary (Rosas et al., 2003). All of the interviewees felt, that even if all the practical and logistical considerations involving DGBL implementation were properly addressed, they would still remain wary of using it exclusively. They cite learner focus, or lack thereof, as being the primary cause for concern and find that learners "*become easily distracted if the content or material used is ineffective*" (ED1). But, while this view contradicts the view of their learners, it comes as no surprise — since people only ever become comfortable with new technologies when they have acquired enough experience using them. So, unless educators are properly trained on '*how to*' teach effectively using DGBL, they face a mighty challenge. And, furthermore, unless the curriculum supports this kind of teaching style — pure constructivist teaching and learning will wither and die in schools, along with creativity. In the immediate future, it is more important to interviewees that the state make more of an effort to support them and their existing teaching practices. "*On the one hand*", as one interviewee put it, "*we are required to complete a near impossible load of content; and on the other we are simply left alone to figure out how to do so*" (ED1). One way to address this issue, they suggest, is to hold in-situ teacher training rather than annual group workshops. It is therefore clear, that even though educators may see value in using DGBL many may well opt out of using it, until its use is better supported at a governmental level. Indeed, it is evident from the interviews, that IT educators embrace the use of technology albeit to varying degrees. It is apparent, furthermore, that should the correct structures be put in place to support its use more educators would be inclined to adopt new innovations. Until this happens though, educators feel they are forced to "*follow the syllabus religiously*" (ED2).

Of noteworthy importance, is that interviewees cited certain difficulty in transitioning learners from Scratch (visual, block-based coding) to high level (text-based coding) programming as being a key underlining factor limiting DGBL's potential. But, a common and widespread approach to teaching programming has always been to first teach the basic principles, as a means of forming a basis for building more advanced skills, before guiding learners towards the necessary intricacies linked to high level languages (Ala-Mukta, 2003). Furthermore, there exists enough research that suggests Scratch is perfect for use since it provides with a great introduction to programming (Resnick et al., 2009). The results of the educator survey indicate, that while educators are keen to try new innovative ways to disseminating information there are still many negative factors affecting their predisposition towards innovations like DGBL.

With that revelation, the researcher looked to gain more of an insight into interviewee views on the challenges they face as educators in the contexts of their schools. All of the participants cited a positive impact made by their teachers, when they were at school, as having an influence on the way they teach. One interviewee suggested, that the negative experiences from her school days motivated her to make more of an effort today. In regard to the availability of technological tools to aid teaching today, one interviewee suggested that while *“information and an unlimited amount of collective knowledge and resources are available, at your fingertips”*, the danger comes in not knowing how to effectively channel age-appropriate content and resources (ED3). *“Even though,”* as one interviewee put it, *“the integration of technology into my classroom has had an impact on my approach to teaching, a huge challenge is being able to accommodate mixed abilities”* (ED2). This view was shared by another interviewee, who stated that he found that top achievers repeatedly became bored during the course of the intervention; even though they were invited to help those who were falling behind.

Another interesting view that came up involved the issue of reliability. It was noted, by some of the interviewees, that “*technological innovations can sometime be temperamental*” (ED1). Power outages, being the number one cause of frustration, oftentimes left educators having to modify lessons on the fly. Thankfully, there were no issues with computers during the intervention. Still on the subject of reliability, all of the interviewees (except the one at the private school) cited a lack of curriculum support, resources, funding, and relevant teacher training as being a major source of frustration and a direct reason for them being resistant to the idea of experimenting with new technologies. “*It would be ludicrous*”, one stated, “*to imagine a future without technology*” (ED3). “*However, as educators we need to plan, progress and move forward in our accessibility to technology. Government needs to wake up and realise they are negatively affecting our future economy by not providing the necessary tools for our children to succeed*” (ED3). Passionate views, one may argue, are a sure-fire way of identifying fervent educators. Based on the results shared herein, it would seem as though the greatest challenge, at least in the view of the interviewees, is not so much bringing games — or any technology for that matter — into the classroom, but rather the real challenge is changing the culture of our schools; to be organised around the manner by which children learn, instead of what they learner. While the possibility of developing low cost games is tempting in terms of the lesser expense, when compared to buying development bespoke software, they may still be expensive in terms of the time taken to develop (Whitton, 2012). It is critical, therefore, that educationalists understand not just *how* games work but how different *types* of games work and; how game taxonomies align with existing learning taxonomies (Van Eck, 2006).



#### **4.5. Discussion of above Results**

This study investigated the perceived teaching and learning benefits associated with DGBL by assessing the attitudes, of junior high school participants and their educators, toward IT and, the relationship of participants' attitudes to a selected set of independent variables. The study took place at three schools. In education, peoples' attitudes have been universally recognized as an important factor for the success of technology integration (Daggett, 2010; DW Govender & Dhurup, 2014; Rogers Everett, 1995). Findings from this study, suggest that participants have positive attitudes towards the use of DGBL in education. The participants' positive attitudes are evident across a wide range of associated domains. Such optimism cannot simply be attributed to the novelty of using games in teaching and learning. The participants seem, to have wholly accepted the importance of developing an understanding of the underlying principles associated with Computer Science. This acceptance seems to have had a direct, positive effect on participant motivation. The majority of respondents (92%), therefore, regard DGBL as a viable and effective educational tool that can be used to either change or reinforce perceptions. Participants' positive attitudes, show their initiation into the innovation-decision process (Rogers Everett, 1995). Developing a positive attitude, it can safely be argued, affords learners the ability to make a more informed decision as whether they wish to pursue a future in this field. This cements the view, that there is a direct relationship between peoples' attitudes toward DGBL, its use in the classroom and success (Barab et al., 2005). Furthermore, some have even found that while games can be used to support learning (S. I. De Freitas, 2006; Egenfeldt-Nielsen, 2011); the reason why they are so successful, with both educators and learners alike, lay in the innate motivational and excitement value their use commands (Huang, 2011; Papastergiou, 2009a; Woo, 2014). These findings confirm a very definite positive correlation between participants' attitudes towards engaging with content in IT and DGBL.

In the end, the participants demonstrated an explicit willingness to meet deadlines in regard to both class work and homework. The data appears to suggest, a direct relationship between participant perceptions of DGBL and attitude towards completing work. It would seem as though; the findings are consistent with Roger's Diffusion of Innovation theory. An examination of discussion forums on the Wiki site, shows that participants are mostly positive about the relative advantage of DGBL as an educational tool. Participants' perceptions on the compatibility of DGBL with current classroom practices, seemed also to be positive with the majority indicating that learning to code, using DGBL, suited their learning preferences and level of computer knowledge. Interestingly, it would seem that many of the participants seem certain that DGBL fits well into the curriculum goals for all learning areas. This conclusion, points to the need for extending this study so as to expand upon the generalizability of its findings. Be that as it may, the majority of participants regarded computer technologies, as well as the content taught in IT, as pertinent to both South African schools and society. Furthermore, many saw value, from a career perspective, in knowing how to manipulate computer technologies through programming. As has already been stated, research identifies a lack of competence as the main barrier to people accepting and adopting new technologies (DW Govender & Dhurup, 2014). The majority of participants in this study, reported proficiency in both computer competence and coding using Scratch. This of course, flies against the findings of research that speaks to a largely impoverished society with limited access to computer technologies. Overall however, each of the subscales tested showed a positive reaction from participants. This finding supports the hypothesis, albeit, so long as the sample demonstrates a basic computer competency. To a degree, this finding supports the argument made for the importance of computer competence in predisposing participant attitudes toward computer

technologies. As a result, it can be said, that there is a direct relationship between attitude and competence. This suggests that an increase in competence may cultivate a positive attitude and vice-versa.

#### **4.6. Concluding remarks**

This chapter looks to analyse and discuss the results of each of the research questions in greater detail. Research question one was stated as follows: *What are learners and teacher's perception of DGBL?* The data gathering methods for this research question were an instructional plan, a questionnaire, and an interview. All data for this research question were analysed both qualitatively and quantitatively were applicable. The dataset was coded using *Google Apps* for factors associated with the research question. Overall, based on the collection of data from the questionnaire and interviews with three focus-groups (six learners each), it was found that the implementation of DGBL was successful. The findings showed that using a DGBL approach did lead to more engagement and cooperative learning among the participants. Literature suggests that learners do become more actively involved in the learning process, when they can establish a relationship between content and method (Berg Marklund, 2015). Notwithstanding learner-educator relationship, once a sense of ownership was established a vested interest was created. The participants presented with, an eagerness akin to the prospect of sharing the role of both master and commander in the teaching and learning process.

The second research question was stated as follows: *Why do learners and teachers perceive DGBL the way they do?* Again, the data collecting methods were an instructional plan, a questionnaire, and an interview. All data gathering methods for this research question were analysed for both qualitative and quantitative data. The dataset was coded using *Google Apps*

for factors associated with the research question. Overall, it would seem, the effectiveness of DGBL on influencing learner perceptions of IT were mostly positive. Based on the data gathered, learners either changed their perception or had an already positive perception endorsed. There were, but a few learners who remained unmoved in their negative perception of IT. Even fewer remained uncertain, however these participants did concede that they saw value in IT being taught at schools. They were, nonetheless, resolved in their view that they did not see a future in it for them. It would appear that most, see future value in IT and are able to correlate success in IT with success in future careers. For many, game developing represents a fun, accessible and high-paying profession. For educators, game developing presents with a fun, engaging and niche method of teaching key Computer Science concepts. The plausibility of incorporating DGBL into other subject areas, was another key positive factor for the entire sample.

The third research question was stated as follows: *How can DGBL be used to enhance the teaching and learning of IT?* For this research question, the data collecting methods were an instructional plan and several interviews with both educators and learners. All data gathering methods for this research question were analysed exclusively for qualitative data. The dataset was coded using *Google Apps* for factors associated with the research question. Overall, it was determined that there exists a definite, almost intangible excitement factor associated with DGBL. Learners seemed particularly motivated by the fact that they could, through collaboration, be a part of the teaching and learning process. Throughout the study, learners seemed to relish the process of developing original games or providing an original idea. It would seem that there is a certain, perhaps not quantifiable allure, associated with making games that gives rise to a tremendous sense of achievement in realizing successful application.

Indeed, all of the learners remained, throughout the intervention, intrinsically motivated to completing their game projects. The next step, as one of the participants so poignantly stated, is "*to start developing mobile games; so (they) can get rich*" (Participant 1). Perhaps it is this sense of direction, purpose and vision that sums up why DGBL is so successful. Learning real-world skills that can equip you with the tools essential for success in a workplace, remains an undeniable and uniquely IT-related trait. Learning these skills while still at school, is a feat no other high-school subject can dare boast. In the end, this mixed-method research mostly proved what the current literature states (that there is value in choosing to adopt or adapt new teaching innovations, that there are benefits in using DGBL and that learners want teaching and learning to be relevant). The fact that no research exists, detailing the use of DGBL within a South African high school environment speaks well to the relevance of this study. In this regard, this study will perhaps provide stimulus for future works of this kind.

So, was DGBL responsible for the positive responses, from learners, towards both teaching and learning? Did DGBL have a positive effect on the learners' perceptions towards IT? And if so why? These and other, related, and pertinent questions were addressed herein. It would seem, beyond a reasonable doubt, that there is an unconditional benefit in using varying teaching approaches in the pursuit of making learning relevant, modern, and accessible to learners. Yes, the success of any teaching approach, as with so many things, is oftentimes related to the attitudes of all stake holders. However, bear in mind that a motivated educator certainly is a force to be reckoned with and a motivated educator, almost always, equals a motivated learner! The purpose of this study was two-fold. First was to determine whether the literature concerning DGBL was true. Second, and perhaps even more important, was to

provide the researcher with the impetus to continue the path of a life-long learner. In both these regards, one could easily argue, this research has been successful.

#### **4.7. Conclusion of chapter**

Learning environment research, has a broad range of applicability in diverse educational issues (Nix et al., 2003). This mix-method research provided with another example of the use of learning environment variables in the evaluation of learning environments. Indeed, the overall results validate the use of games to support teaching and learning within a constructivist learning environment. What remains to be seen, is whether or not these results speak to an inter-disciplinary transferability. According to Nix et al (2003) a move from a traditional, teacher-centred, pedagogical approach can be difficult to realize in the classroom (p.16). Thankfully, as was found to be the case, the motivation behind the implementing of this research aided the successful implementation of the constructivist epistemology. The Constructivist Learning Environment Survey (CLES), provided with a complementary means of assessing the degree to which participants saw value in the principles of constructivism. Especially when one considers a comment made, during one of the interviews, wherein a participant mentioned that he "*sees a relationship between the things we learnt about*" and "*the real world*" (Focus Group 3). In relation to the way participants are taught in other subjects, some found that DGBL enhanced the effectiveness of their teaching and learning experience. Even though computer game development has, in the recent past, required a high proficiency level in programming skills (Whitton, 2012). The data seems to suggest, that using the Scratch platform negates this shortcoming — thus allowing for hindrance free adoption of new learning innovations such as DGBL (Egenfeldt-Nielsen, 2011; Michael & Chen, 2006).

## **Chapter 5 : Conclusion and Future Work**

Over the last 20 years much has been done, by government, to stall the Apartheid driven chasm between the haves and the have-nots. This is true for every sector in society. However, there are still many mountainous issues that plague our education system. Not least among these, are the issues surrounding the varying quality of education being delivered at schools in South Africa. This coupled with the, widely, accepted perception that there is a very definite and direct relationship between money and the eminence of the education one receives, goes the distance in reinforcing the current status quo. That is to say, as long as education continues along a privatised path to excellence, government schools will be hard-pressed to keep up the challenge of achieving educational equilibrium. This is most especially apparent when one considers the disparities in classroom sizes, resource availability, staff development, curricula training and support. And, since it would be capitalistically unrealistic and retrograding to suggest any capping or restrictions on private schooling; thought must be given to workable solutions to the many exigent issues plaguing modern education. It follows then, when considering the disparities bred by educational inequality, that one must consider the following question: if we cannot unilaterally, and with immediate effect, improve on the standard of education across the board, can we instead standardize the quality of the delivery mechanism, that is to say teaching and learning?

For the educators involved in this study, education has become a mechanical system, whose sole purpose in society, it seems, is to churn out groups of young indoctrinated individuals ill-prepared for life outside of school. Furthermore, it is felt that the curriculum being used to teach, in both private and public schools, continues to be a stagnant, convoluted, limited

experience of mastering a pre-defined set of objectives, mostly through listening or participating in structured activities with pre-determined outcomes (Sqire, 2005). Certainly, this is not the case in every school and the view of every educator. Nevertheless, it is a widely accepted view that more could be done in high schools to individualize teaching and learning so as to engage learners at a level where curiosity is stoked rather than stifled. Couple this with an approach that regards learners as equal stakeholders in the teaching and learning process, and what you might end up with is a Petrie dish of creativity where anything educational is possible. Subsequently, a direct result of giving learners agency as co-conspirators in the education process, as was described in Chapter 1, is an experience that best represents, what some may regard as, the antithesis of traditional educating. Moreover, as soon as one regards this view it becomes apparent that the real challenge, is not so much in bringing games, or any technology for that matter, into schools; but rather being able to organise schools around learning instead of as institutes of social control (Sqire, 2005). Truly, it may not be realistic to expect every educator to proactively engage, as was required by this study, in trying to realise a truly constructivist learning environment through DGBL. Remember, DGBL requires a pedagogical approach that will almost certainly be unfamiliar to many educators. Furthermore, many issues need to be addressed before DGBL can successfully be implemented. Not least among these issues, is that of policy. Unless policy makers attribute a higher status to educators and educating, inequities in the distribution model of poorly trained educators to poor and minority learners will continue to return an imbalanced result set. But, how do we develop guidelines, technology, routines and resources that will support those less technologically savvy than others? Especially when one considers the financial ramifications involving infrastructure, hardware, software, updates and patches normally associated with all things related to IT. Moreover, in order to understand how games work, and how different types of



games work, an understanding of how game taxonomies align with learning taxonomies is warranted in order to fully inform policy development (Van Eck, 2006). Furthermore, in order for widespread success to be realised using a DGBL approach, policy makers must understand how to align the game with the curriculum and with content (Van Eck, 2006). Continual pressure on policy makers, through on-going research, into determining how best to properly effect and support the introduction of new, dynamic methods of instruction is key if we are to unilaterally increase the quality of education on offer in this country. It goes without saying then, that until educators have absolute, clear and concise parameters from which to inform their teaching paradigms and are well supported and trained then they cannot be expected to embrace change. Of course, while a complete overhaul of the curriculum is encouraged it is not mandated for DGBL to work. Quite the contrary in fact, since DGBL presents with a means to bridge any potential gap in the teaching being deployed without regard for any possible gaps in educator competence (Stigler & Hiebert, 2009). In any event, a complete overhaul of the curriculum is not possible at schools where the ratio of learners to educators is as high as 60 and where there is no access to computer technologies. Achieving these changes, will certainly require the concerted and combined efforts of educators, school management, university heads, community leaders, corporate heads and government. To be sure, this study has shown that DGBL can play a role in supplying quality education without complete dependence on the educator.

However, education remains socially driven, and quality education will continue to be associated with quality educators (Noor-UI-Amin, 2013) since there is no school who bears results that are better than the sum quality of the educators teaching there (Robinson, 2012). It would be naive to think that every school comes equipped with equally passionate and forward-

thinking educators. There will always be old, and perhaps even new, educators opposed to the idea of change. Teaching methodologies that encourage learner-centred instruction, when employed using constructivist learning technologies like DGBL, require educators who are willing to take the risk and try something different. Placing the learner at the epicentre of the teaching and learning process encourages collaboration and significantly increases learner motivation. Yet, even though DGBL does enhance the effectiveness of teaching and learning, it will take some time before DGBL proponents witness widespread adoption by educators and educationalists. One plausible way in which to get educator investiture could involve a rewards program to encourage educators to up-skill their abilities. Another strategy could be not limiting the learning experience in the classroom to the media educators deem worthy. In other words, a child who loves playing *Civilisation* (strategy game) should be allowed to bring this into his/ her formal learning — perhaps by creating a similar simulation for assessment (Squire, 2005). In this way DGBL allows for assessments, to be treated primarily as opportunities to support learning rather evaluative structures. Yet another strategy, would involve updating existing standards for entry into the teaching profession. Or setting accountability measures for colleges and universities that prepare educators for their lives at school. Or maybe the answer lay in instituting recruitment and reward programs to attract the best educators to poor performing schools (Hanushek, 1986). Whatever the case, central to successful administration is a basic tenet — schools need to be given more control over how their educators teach and government needs to support this process.

Electronic games have come a long way since the 8-bit era, and game studios have successfully developed, over the last two decades, one of the most financially astute industries. Today, people the world over have evolved into digital natives, thanks, in no small part, to electronic

socialization through gaming. Children, today more than ever, have become intuitively proficient in digital literacy through play and have easily adapted to new technologies; sometimes absent adult instruction. It is no surprise then, that many of these digital natives have become disengaged with traditional means of instruction. With information such as it is, readily available to anyone with an internet connection, it is no wonder many archaic educators are at odds trying to remain relevant. Indeed learners, nowadays, require multiple streams of information, prefer inductive reasoning, want frequent and quick interactions with content and have exceptional visual literacy skills. In this regard, DGBL does support both motivation and cognitive success. Moreover, DGBL has provided the means to allay the performance outcome fears normally associated with computer programming. A positive attitude by all stake holders, regardless of how it is obtained, will always have a positive impact on the adopting and advancing of new learning technologies.

In a world where the margins between developed and developing nations draw ever closer, great pressure exists in ensuring all learners can compete, equally, in a global and competitive market. As educators, we are responsible for developing the great thinkers of tomorrow. To ensure an accomplished passing of the baton, great effort must be made to decrease the commonplace poor success in CS related subjects. The key lay, one could easily argue, in exposing our learners to CS concepts — the earlier the better. Using the Scratch platform provides people access, even those who have a limited knowledge of computers, to powerful tools with which to create intuitive virtual environments for the incorporation of game elements into the teaching syllabus. The result of this '*gamification*' of curriculum content does undeniably provide, as was shown in this study, an opportunity to address problems involving learner motivation and engagement.

## **5.1 Summary of chapters**

In Chapter 1, was presented the primary purpose for this study. The resulting research questions were discussed at length, the background for the study was presented, along with the motivation behind its implementation. Next, was discussed the contributions to the board of knowledge this study looked to make, along with the setting wherein the study would take place. Chapter 1 closed with a conclusive discussion and presented with a roadmap for the rest of the study. In Chapter 2 was presented a large array of literature involving, a) the use of games in education; b) digital game-based learning or DGBL; c) understanding the challenges to using DGBL; d) constructivism as a theoretical framework within computer science education and; e) theoretical frameworks used to gauge responses in this study. Chapter 2 closed, with a discussion into the proposed manner by which to implement DGBL thereby providing a link to Chapter 3; wherein was outlined the methodology for this study. With the methodology dealt with, Chapter 4 provided findings from the research. In Chapter 5 was provided, an analysis and discussion of the results and in Chapter 6 was outlaid the conclusive views of the researcher.

## **5.2 Answers to the research questions**

In answer to the each of the following research questions it was found that:

1. Teachers and learners, within a junior high school setting, reported an overall positive perception of DGBL.
2. The reason why DGBL affects the above is due to, among other things, the innate excitement value it brings to any classroom.

3. DGBL has shown potential for improving learning outcomes, engagement, and motivation for learning.

Although this research has shown that DGBL has the potential to improve upon learner engagement and motivation to learn, there is a definite need for more investigation into the framework required to ensure unilateral success in implementation. Without a doubt, there are many elements that can play a role in DGBL, but more research needs doing to fully comprehend what games have to offer teaching and learning in the modern classroom from a cognitive, motivational, affective, and socio-cultural perspective. Most especially, considerably more research is still needed to establish which approach to DGBL will have the most academic success across a wide range of subjects on offer at high schools. The domain of educational games today is profoundly interdisciplinary but great effort is required to ensure successful implementation and return. Especially when one regards the unambiguous detachment from fun that can come, when the relationship with the game takes on the format of that of the developer rather than player.

### **5.3 Reflections**

It goes without saying that learners in 'previously disadvantaged' environs deserve the same level of education on offer at schools where money is not an object. At the risk of sounding socialist, it is presented herein that this should absolutely be the case. It is suggested that every child, in every country deserves an equal opportunity and access to every possible resource available so as to ensure a brighter future for both themselves and their country. It is contested herein that every parent should demand nothing less than the best for their children. Computer Science education (CS) and Information Technology (IT) share many epistemological traits. Many educationalists have seen value in developing these traits in learners. This study has

shown, that while DGBL can positively affect both teaching and learning; much research is still needed to investigate the conditions necessary to ensure successful implementation regardless of the school and in spite of the educator. It is the view of this researcher that IT, as a high school subject area, stands head and shoulders above all others — due to its inherent ability to remain relevant in a world bursting with futuristic fictions. No other subject can boast more self-trained experts or self-made millionaires. Nor can any other subject profess to have established an equilibrium, within the minds of all who regard the inter-disciplinary prowess of IT practitioners, between reverence and austerity. Without a sliver of a doubt, IT has the most to offer both educators and learners. What DGBL provides with, is a means to incorporate everything good associated with games into an already derelict and out-dated educational framework. Giving everyone the experience of being a part of what has always been regarded as an exclusive process, can only bode well for the future of society at large.

#### **5.4 Contributions**

As has already been stated, literature abounds in the areas of; a) the use of games in education; b) digital game-based learning or DGBL; c) understanding the challenges to using DGBL; d) constructivism as a theoretical framework within computer science education and; e) theoretical frameworks used to gauge responses in this study. Before this study there existed no literature, concerning the mixed-method investigation into the implementation of DGBL, within a junior high school environment, by way of developing games. This study looked to fill a gap in the research and proposes further investigative studies, by like-minded researchers, as a means of encouraging debate in what must certainly be *the* most multifaceted and exigent issue of our age — education. The recommendations for future research, this study makes, would be to increase the generalizability of the findings presented herein. As has been stated,

mixed-method research is not without its fair share of limitations. It would be encouraging to look forward to a more expansive, perhaps even more collaborative study, involving a broader, representative sample.

## **5.5 Future work**

A key element omitted, due to the restrictive nature of this study, involved the assessing of any academic benefits associated with DGBL. Time and pragmatic application did not allow for an investigation into what might well prove to be the linchpin trait of an already beneficial innovation. Further studies could avenge the effects this omission may have had, on how readers view the findings discussed herein. Moreover, according to Bertram and Christiansen (2014), researchers can habitually become, albeit unknowingly, inclined to see things from a singular perspective — their own. Although this may well be true, since the researcher is himself a proponent of DGBL, it could very easily be argued that careful data collection and analysis counteracted this apparent limitation.

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## APPENDIX A

### DGBL TECHNOLOGY SURVEY

The questionnaire referenced below was implemented online using Google Forms. All the Linkert-Scales shown below were adapted from Vagias (2006).

An analysis of perceived benefits linked to the deployment of a Digital Game Based Learning into the Information Technology syllabus at a high school level.

A foreword of thanks:

Thank you so much for taking the time to complete this survey. In doing so you are effectively contributing toward on-going research concerned with the developing and integration of effective, engaging, and exciting teaching methods. It is hoped that this research will shed light on the plausibility of using games in education. Thank you. Mr. Johnson.

**\*Required**

a. **Email address**

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### **Personal Information**

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Before you get started with the meat of it please take some time and tell us a little more about yourself:

**b. What grade are you currently in? \* Mark only one oval.**

- Grade 8
- Grade 9
- Other

c. Which gender group do you belong to? \* Mark only one oval.

- Female
- Male
- I'd rather not say

d. To which ethnic population group do you belong? \* Mark only one oval.

- Black
- Coloured
- Indian
- White
- I'd rather not say

## Background Information

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Next, we would like to an idea of your background in computers.

**1) Before registering for IT, here at your school, how would you rate your Computer Literacy ability?**

...."Computer Literacy" - can be defined as the knowledge and ability to utilize computers and related technology efficiently.  
Mark only one oval.

	1	2	3	4	5	6	7	
Extremely Poor.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Extremely Confident with Computer Technology.

**2) Did you enjoy working at the computer? Searching Google, doing PowerPoint's etc. Mark only one oval.**

	1	2	3	4	5	6	7	
Nah, not really.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	I was a Primary School Computer Ninja. Loved it!



**3) How would you rate your Computer Programming ability?**

.... Using Scratch or any other Platform. *Mark only one oval.*

1   2   3   4   5   6   7

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NO Programming Experience at all Chief.                        Extremely Confident with Coding.

**4) How would you best describe your view of IT, before being introduced to programming using Scratch?**

.... You may choose more than one answer. *Check all that apply.*

- I had no idea what IT entailed.
- I thought programming was only for 'geeks' or 'nerds'.
- I thought IT was only for 'smart' people.
- Even though I enjoy playing games I didn't think I would be able to make them myself.
- I saw value in learning IT.
- I dreamed of joining Google someday.

**5) How would you rate your inclination toward choosing a career in IT, before being introduced to programming using Scratch?**

*Mark only one oval.*

1   2   3   4   5   6   7

---

No interest in any IT related career.                        Absolutely sure I wanted to work in the IT field.

**6) Did you, or have you ever, felt as though there is no relationship between what is being taught in school and the "real - world"?**

*Mark only one oval.*

1   2   3   4   5   6   7

---

No, not really.                        All the time, every day, every subject.

**Learning with Scratch**

Now we would like to gauge your feelings on learning to code using Scratch. Please be honest with your answers. Remember not to over think this next part - there are NO right and wrong answers, only your views.

**7) Do you see value in learning how to program at school? *Mark only one oval.***

1   2   3   4   5   6   7

---

No, not really.                        Yes, absolutely.

**8) Do you see value in using Game Developing as a 'cool' or 'exciting' way to learn how to code? *Mark only one oval.***

1   2   3   4   5   6   7

---

No, not really.                        Yes, absolutely.

9) While you were interacting with Game Developing, were you thinking about how much you enjoyed it. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

10) Did you ever feel really distant from the content being taught? *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

11) Did you ever feel at all nervous about being taught to code using Game Developing in Scratch? *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

12) Did you ever feel like you had choice about being taught in this fashion? *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

13) Would you describe interacting with the IT course content as very enjoyable? *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

14) I didn't put much energy into interacting with the content. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

15) How would you rate your inclination toward registering for IT in Grade 10? *Mark only one oval.*

	0	1	2	3	4	5	6	7	
No way Jose'	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	More determined than ever.

16) I really doubt that I will ever be interested in IT. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

17) I found IT to be very interesting. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

18) I enjoyed learning to code using Scratch very much. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

19) I felt tense while completing tasks using Scratch. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

20) I really feel like I could come to see value in using Scratch, learning to code. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

21) Using Scratch was fun. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

22) I feel like I didn't really have a choice about learning to code using Scratch. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

## Games and Learning

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Now we would like to gauge your feelings on using Games in Teaching & Learning. Please be honest with your answers. Remember not to over think this next part - there are NO right and wrong answers, only your views.

23) I tried hard to make the most of the time spent learning to code using Game Developing. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

24) I'd really prefer not to learn content in this way. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

25) I was anxious while learning in this way. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

26) I thought Game Developing was very boring. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

27) I felt like I was allowed to do what I wanted to do while making games. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

28) I tried very hard while learning using Game Dev. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

29) I thought interacting with content was very interesting using Game Dev. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

30) I felt pressured to do well. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

31) I think it's likely that I could become a computer programmer. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

32) I have seen an improvement in my IT ability. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not at all true.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, absolutely true.

## Learner Centered Instruction

---

For this last bit we really would love to gauge your views on having control over "how" you learn the things you are forced to learn.

33) During this study, I asked my peers about their ideas. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, never ever.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, very often.

34) During this study, the teacher helped me to think about what I learned in past lessons. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, never ever.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, very often.

35) During this study, the teacher gives me problems to investigate. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, never ever.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, very often.

36) During this study, I didn't ask other learners about their ideas. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, never ever.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, very often.

37) During this study, I did investigations into solving problems in my own way. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, never ever.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, very often.

38) During this study, the teacher did NOT insist that my activities be completed on time. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, never ever.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, very often.

39) During this study, the teacher shows the correct method for solving problems. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, never ever.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, very often.

40) During this study, I talked with other learners about the most sensible way of solving a problem. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, never ever.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, very often.

41) During this study, the things I learned about were NOT really interesting. *Mark only one oval.*

	1	2	3	4	5	6	7	
No, never ever.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Yes, very often.

## Working with Games

---

Just a few questions detailing your experience working through this module.

42) How satisfied are you with the quality of Learning involving Games? *Mark only one oval.*

	1	2	3	4	5	6	7	
Not satisfied at all.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely satisfied.

43) How dissatisfied are you with problem solving process involved in this study? *Mark only one oval.*

	1	2	3	4	5	6	7	
Completely satisfied.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Completely dissatisfied.

44) How would you rate your "understand-ability" of the content taught during this time? *Mark only one oval.*

	1	2	3	4	5	6	7	
I understood very little.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	I completely understood everything.

45) How do you feel about the classroom discussions? *Mark only one oval.*

1    2    3    4    5    6    7

---

I hated them.        I loved having them.

46) How do you feel about interacting with your classmates? *Mark only one oval.*

1    2    3    4    5    6    7

---

I hated having to work with them.        I loved being able to bounce ideas off them.

47) Did you find interacting with the content to be frustrating? *Mark only one oval.*

1    2    3    4    5    6    7

---

Yes, very much so.        No, not at all.

48) Did you find the Scratch system to be rigid and inflexible to interact with? *Mark only one oval.*

1    2    3    4    5    6    7

---

Yes absolutely.        No, not at all.

49) Did you find it easy to get the system to do what you wanted it to do? *Mark only one oval.*

1    2    3    4    5    6    7

---

No, not at all.        Yes absolutely.

50) How easy was it to recover from mistakes when using the technology? *Mark only one oval.*

1    2    3    4    5    6    7

---

Not at all easy.        Yes, absolutely easy.

51) How easy was it to explore all of features of the technology? *Mark only one oval.*

1    2    3    4    5    6    7

---

Not at all easy.        Yes, absolutely easy.



52) Did you learn new ways of using the Scratch from a classmate? *Mark only one oval.*

- Yes.
- No.
- Maybe.

53) Did you change your way of using Scratch based on what you learned from a classmate? *Mark only one oval.*

- Yes.
- No.
- Maybe.

54) Did you learn new ways of learning content from working with a classmate? *Mark only one oval.*

- Yes.
- No.
- Maybe.

## Closing thoughts

---

The absolute last part. Thank you so much for your time and effort in both completing this Survey and participating in class.

55) Has this experience changed, or altered, your view of Information Technology and Computer Science at large?  
*Mark only one oval.*

- I still don't like it.
- I think it's interesting but it's not for me.
- I have changed my view and am considering a future in IT.
- I am indifferent (do not care).
- I love it now more than ever.

56) How likely are you to continue with IT into the near future? \* *Mark only one oval.*

	1	2	3	4	5	6	7	
No, not all likely.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Definitely, consider it a done deal.

57) Do you feel as though you understand what IT entails a little more? *Mark only one oval.*

	1	2	3	4	5	6	7	
No, I'm still confused.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	I got it, absolutely.

58) Is there anything you like to add?

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## APPENDIX B

### DGBL STUDY INSTRUCTIONAL PLAN

#### GRADE 8's

**Subject:** Information Technology

**Section:** Collaborative Game Developing

**Time Frame:** First Term/ Quarter

**Learning Outcome 4:** Programming and Problem Solving

#### Outcome Overview:

During this intervention learners will have the opportunity to develop mini Scratch games. They will be encouraged to work collaboratively with other members of their class. They will have to, by the end of the intervention, produce a working 'Scratch Product'. Remember to emphasize that this is a Collaborative Project and NOT a Group Work one. Ensure learners understand the difference!

#### Section Goals:

- Each learner needs to research and replicate one, or more, of the core roles prevalent in the Game Developing Industry.
- Apply knowledge of coding so as to design and build a fully functional mini-game using the Scratch Platform. Genre of game is open-ended however the theme for this Term is "Educational Games".
- Catalogue the process using the Wikispaces Team Project page.

### **Programming Components:**

- Sequence: order of steps.
- Iteration: forever and repeat.
- Conditional statements: if and if-else. Event handling: when key pressed and when sprite clicked.
- Coordination and synchronization: broadcast and when I receive to coordinate actions of multiple sprites.
- Keyboard input: ask and wait prompts for input and answer stores keyboard input.
- User interface design: use clickable sprites.
- Levels: Minimum two.
- Screens: Home, About, Credits, Score etc. Including correct hyper-linking between screens.

### **Key things to look out for:**

- Learner propensity toward working collaboratively: over the timeframe (how often each learner updates/ interacts with the Wiki is easily tracked thanks to an embedded Assessment Tool).
- Learner work ethic: has the learner fulfilled their role within the team effectively and efficiently?
- Game quality: please deploy the Scratch Project Draft Rubric.

### **Proposed Games:**

- Learner propensity toward working collaboratively: over the timeframe (how often each learner updates/ interacts with the Wiki is easily tracked thanks to an embedded Assessment Tool).
- Learner work ethic: has the learner fulfilled their role within the team effectively and efficiently?
- Game quality: please deploy the Scratch Project Draft Rubric.

## APPENDIX C

### **SEMI-STRUCTURED INTERVIEW SCHEDULE FOR JUNIOR INFORMATION TECHNOLOGY LEARNERS - FOCUS GROUP SESSIONS**

**1) Describe your experience with IT before participating in this study.**

Have you made games before using Scratch or any other software tool?

Do you feel DGBL can be used to enhance the teaching and learning of Information Technology?

Please explain your answer.

**2) What are your feelings about using DGBL as an approach to learning?**

Was the experience fun?

Was it challenging?

**3) Do you feel DGBL can be used to teach and learn in other subjects?**

Why do you feel that way?

## APPENDIX D

### STRUCTURED INTERVIEW SCHEDULE FOR INFORMATION TECHNOLOGY EDUCATORS

**1) Is there a benefit to using DGBL as a technological tool for teaching complex Computer Science concepts in high school Information Technology classrooms in KwaZulu-Natal schools?**

What is your understanding of the word 'technology'?

Can DGBL be used to enhance the teaching and learning of Information Technology?  
Please explain your answer.

What role does technology play in the teaching of IT in terms of the following?

- i) Content delivery
- ii) Pedagogy (theory and practice of education)
- iii) Learner motivation and willingness to complete tasks

**2) Have teachers noticed a change in their learner's attitudes towards teaching and learning?**

How did your learners perceive DGBL?

Why do you think they perceived it that way?

**3) What does your planning and preparation for lessons normally entail?**

What factors do you consider when planning for the teaching of a section in IT?

What do you think is a good balance between 'traditional' teaching and making use of technology?

Please describe in as much detail as possible the process you follow when planning to teach a lesson.

Please include when the decision to use technology is made.

What resources do you have access to?

Where are these resources obtained from?

How are these resources incorporated into lessons?

**4) How do High School IT teachers perceive their teaching? What is their predisposition toward the adapting of 'new' technologies such as DGBL?**

Describe the resources available to Information Technology department and explain how this assists you in teaching.

What are your views about using new technologies, including learner-centred technologies such as DGBL, in teaching and learning?

Some researchers believe that integrating technology into lessons allows students to be more active learners. Do you agree with this statement? Explain.

How do you cater for differing learning styles within your classes?

How do you cater for differing learning abilities within your classes?

**5) What are their views on the challenges they face in terms of ensuring success based on the contingencies of their local social context?**

Does the way that you were taught influence the way that you teach IT now?

How has technology changed teaching in your opinion?

Do you believe that the integration of technology has had an impact on your pedagogical approach to teaching IT?

Describe some of the obstacles faced by you with regards to the integration of technology in teaching IT.

From your observations, what are some of the reasons technologies, like DGBL, are not used in teaching IT?

Do you find that learners focus more on the physical technological material rather than the content or not?

Finally, how do you see the role of technology in the future of learning and teaching?

## APPENDIX E

### CONSENT LETTER AND DECLARATION FOR HIGH SCHOOL INFORMATION TECHNOLOGY TEACHERS

Digital Game Based Learning: An Exploratory Analysis of Perceived Educational Benefits, in Information Technology, at a junior High School Level.

#### CONSENT LETTER FOR ARRANGING THE INTERVIEW

Dear High School Information Technology Teacher

I am a Masters student working on my dissertation at the University of KwaZulu-Natal Edgewood Campus under the guidance of Professor D. Govender. My research is concerned with the perceived positive impact digital game-based learning has on both teaching and learning. As one of my selected respondents, your assistance will be required in accessing information about your experiences implementing DGBL to conduct and tape-record a thirty-minute semi-structured interview during 2017 relating to my study. I will contact you telephonically to confirm the date and venue of this interview.

#### Consent Declaration

I hereby consent to participate in the above research project. I understand that my participation is voluntary and that I may change my mind and refuse to participate or withdraw at any time without penalty. I may refuse to answer any questions, or I may stop the interview. I understand that some of the things that I say may be directly quoted in the text of the final dissertation, and subsequent publications, and my name and my school name will not be associated with the text. I hereby agree to participate in the above research.

Participant Print Name: .....

Signature .....

Date: .....

Student Print Name:

Signature .....

Date: .....

Postal Address:



Telephone:

Supervisor Print Name:

Signature .....

Date .....

Telephone:

Yours sincerely,

Mr. Clay Johnson

.....

For purposes of analysis, please provide and print information about yourself:

GENDER .....

RACE .....

AGE .....

NAME .....

DESIGNATION .....

SIGNATURE .....

## APPENDIX F

### CONSENT LETTER AND DECLARATION FOR HIGH SCHOOL INFORMATION TECHNOLOGY LEARNERS

Parental consent letter

Address:

Date:

Dear Sir/ Madam

I am Information Technology educator at Eden College, in Glenwood. I am currently working towards completing my Masters in Education, through the University of KwaZulu Natal. As part of my training I am carrying out a study looking at how, if at all, Digital Game Based Learning (DGBL) influences teaching and learning. It is my hope to that this research will help suggest ways that schools can support their education. I am writing to ask if you would be willing to give permission for me to ask your child if he/ she would like to take part in my research. This will involve interviewing your child in order to find out what he/ she thinks about using DGBL to facilitate teaching and learning. This research project, supervised by Prof. Desmond Govender of the University of KwaZulu Natal, will see data collected using a questionnaire and learner interviews. The interviews will take place at your child's school, during normal school hours and will take between thirty minutes and, at most, two hours of your child's time. Your child's participation in this research will be treated confidentially and all information will be kept anonymously, meaning that no one will be able to work out what it is your child has said. If you have any comments or questions about this research please could you contact my supervisor, Prof. Govender, using the contact details provided below.

This research has been approved by the University of KwaZulu Natal's ethic committee however if you wish to confirm this, or satisfy any concern, you can contact the ethics committee by telephone on (031) 208 4557/4609 or by email [hssrecHumanities@ukzn.ac.za](mailto:hssrecHumanities@ukzn.ac.za) (for attention Prem Mohun). Many thanks in advance for your consideration of this project. Please let me know if you need more information. I would appreciate it if you could complete the attached permission slip and send it with your child, for record purposes.

Regards,

Mr. Clay Johnson - 204516038@stu.ukzn.ac.za

(Research Educator)

Prof. Desmond Govender - govenderd50@ukzn.ac.za

(Research Supervisor)

### Parental Consent Reply Slip

I understand that my child's participation in this research project will involve:

- Taking part in an interview with Clay Johnson, in which he/ she will be asked questions about his/ her views on the use of DGBL in his/ her school.
- During this interview, notes will be taken, and the interviews recorded for later transcription. The interview will be fully anonymised when it is transcribed. The audio files will be also then be destroyed.

I understand that my child's participation in this study is entirely voluntary and that he/ she can withdraw from this study at any time without giving a reason.

I understand that participation will be treated confidentially, and all information will be stored anonymously and securely. All information appearing in the final report will be anonymous. My son/ daughter will have the option of withdrawing his data from the study, up until his transcript has been anonymised.

I understand that I am free to ask any questions at any time. I am free to discuss any questions or comments I would like to make with Prof. Govender. I understand that I am free to contact the University of KwaZulu Natal Ethics Committee to discuss any complaints I might have.

I also understand that at the end of the study I will be provided with additional information and feedback about the purpose of the study. I, \_\_\_\_\_(NAME) consent to Clay Johnson proceeding with this study with the supervision of Prof. Desmond Govender.

Signature of Parent or Guardian: .....

Date: .....

Name of Child: .....

## APPENDIX G

### SCRATCH PROJECT RUBRIC DRAFT

- adapted from the Scratch Ed website. Retrieved online: <http://scratched.gse.harvard.edu/resources/rubric-assessing-scratch-projects-draft-0>

	<b>Beginning</b>	<b>Developing</b>	<b>Proficient</b>	<b>Exceptional</b>
<b>1) Content area concepts</b>	Does not include ideas about the subject area or ideas are incorrect.	Includes a few ideas about the subject, shows some understanding.	Focuses on and understands important concepts about the subject matter.	Makes important connections between subject area concepts, shows in-depth understanding.
<b>2) Project design</b>	Did not try to make own artwork. No clear purpose of project or organization. Does not provide a way for other people to interact with program.	Project uses artwork of others with some effort to change. Has some sense of purpose and structure. Includes way for user to interact with program, may need to be clearer or fit program's purpose better.	Project uses original artwork or reuses imported images creatively. Has clear purpose, makes sense, has structure. Includes way for user to interact with program and clear instructions.	Project artwork and creativity significantly support the content. Has multiple layers or complex design. User interface fits content well, is complex; instructions are well-written and integrated into design.
<b>3) Programming</b>	Project shows little understanding of blocks and how they work together. Lacks organization and logic. Has several bugs.	Project shows some understanding of blocks and how they work together. Has some organization and logic. May have a couple bugs.	Project shows understanding of blocks and how they work together to meet a goal. Is organized, logical, and debugged.	Project shows advanced understanding of blocks and procedures. Uses additional programming techniques. Is particularly well organized, logical, and debugged.
<b>4) Process</b>	Learner did not get involved in design process. Did not use project time well and did not meet deadlines. Did not collaborate.	Learner tried out the design process. Used project time well sometimes and met some deadlines. Collaborated at times.	Learner used design process (stated problem, came up with ideas, chose solution, built, and tested, presented results). Met deadlines. Collaborated appropriately.	Learner made significant use of the design process. Used project time constructively, finished early or added additional elements. Found ways to collaborate beyond class structure.



## APPENDIX H UKZN ETHICAL CLEARANCE

4 December 2017

Mr Clay Christopher Johnson 204516038  
School of Education  
Edgewood Campus

Dear Mr Johnson

Protocol reference number: HSS2083/017M

Project title: Digital Game based Learning: An exploratory analysis of perceived Educational benefits in Information Technology, at a junior high school level

### Provisional Approval - Expedited Application

I wish to inform you that your application received on 27 October 2017, in connection with the has been granted provisional approval, subject to the following:

***Gatekeeper permission being obtained from Department of Education***

Kindly submit your response / documents to Dr Shenuka Singh (Chair), as soon possible.

**This approval is granted provisionally and the final approval for this project will be given once the above condition has been met. Research may not begin until full approval has been received from the HSSREC.**

Yours faithfully

.....  
**Dr Shenuka Singh (Chair)**  
**Humanities & Social Sciences Research Ethics Committee**

/pm

cc Supervisor: Professor DW Govender  
cc Academic Leader Research: Dr SB Khoza  
cc. School Administrator: Ms Tyzer Khumalo



education

Department:  
Education  
PROVINCE OF KWAZULU-NATAL

## APPENDIX I DOE ETHICAL CLEARANCE

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Enquiries: Phindile Duma

Tel: 033 392 1063

Ref.:2/4/8/1459

---

Mr C.C Johnson  
80 Feilden Drive  
Glenmore  
Durban

Dear Mr Johnson

### **PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS**

Your application to conduct research entitled: **“DIGITAL GAME BASED LEARNING: AN EXPLORATORY ANALYSIS OF PERCEIVED EDUCATIONAL BENEFITS IN INFORMATION TECHNOLOGY AT A JUNIOR HIGH SCHOOL LEVEL.”** in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the  
Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 26 January 2018 to 09 July 2020.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department.  
Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Phindile Duma at the contact numbers below.

9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.

10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

Inanda Seminary  
Northwood School  
Eden College



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**Dr. EV Nzama**  
**Head of Department: Education**  
**Date: 22 February 2018**

**KWAZULU-NATAL DEPARTMENT OF EDUCATION**

**Postal Address:** Private Bag X9137 • Pietermaritzburg • 3200 • Republic of South Africa

**Physical Address:** 247 Burger Street • Anton Lembede Building • Pietermaritzburg • 3201

**Tel.:** +27 33 392 1063 • **Fax.:** +27 033 392 1203 • **Email:** Phindile.Duma@kzndoe.gov.za • **Web:** www.kzneducation.gov.za

Facebook: KZNDOE....Twitter: @DBE\_KZN....Instagram: kzn\_education....Youtube:kzndoe

## APPENDIX J

### PARTICIPANT INFORMATION SHEET AND CONSENT FORM

**What is the deal with this study?** – I am interested in seeing whether Game Based Learning (GBL) can positively affect teaching and learning at a high school level. I need to collect data from learners to see if GBL can affect your attitude towards class and homework among other things.

**What will participation involve?** - This research involves you and your classmates working through regular IT-related course using GBL learning strategies. After that you are invited to fill out a questionnaire and you might be called to have a conversation with me about your experiences as well. All information will be stored anonymously, which means no body will know who said what. Of course, some people in the school will know that you have taken part in this study.

**How long will participation take?** – The entire process should take a few weeks in the third term however the questionnaire and interviews will take between thirty minutes and two hours of your time both before and after the process.

**As an informed participant of this research study, I understand that:**

1. My participation is voluntary, and I may cease to take part in this research study at any time and without giving a reason.
2. During this interview, notes will be taken, and the interviews recorded for later transcription. This means that Mr. Johnson will write up everything that I say.
3. All data will be stored anonymously once it has been collected. This means that it will be impossible to trace information back to me. As such, if I decide I want to withdraw my data from this study I will only be able to do this up until the transcript has been anonymised. If I decide to withdraw my data, I will ask Mr. Johnson directly or via my teacher.
4. All information appearing in the final report will be anonymous. This means there will be nothing that will enable people to work out what I said.
5. This research has been approved by the University of KwaZulu Natal Ethics Committee. This means it has been approved by a panel of professionals to make sure it meets high standards.
6. All my questions about the study have been satisfactorily answered and I am aware of what my participation involves.
7. Mr. Johnson will treat my participation in this study confidentially and that anything I say in the interview will be treated confidentiality, unless it leads Mr. Johnson to believe that my safety is in danger. In this case he will be unable to keep this information



confidential. If this happens, he will inform me that he will have to share that information with my school because of his concern for my welfare.

**I have read and understood the above, and agree to take part:**

**Participant's Signature:** \_\_\_\_\_

**Date:** \_\_\_\_\_

**I have explained the above and answered all questions asked by the participant:**

**Researcher's Signature:** \_\_\_\_\_

**Date:** \_\_\_\_\_

## APPENDIX K

### **Application for Permission to Conduct Research in KwaZulu Natal Department of Education Institutions**

The Headmaster  
Inanda Seminary  
Inanda  
Durban  
4001

Dear Sir,

I am a Master of Computer Science Education Student at the University of Kwa-Zulu Natal. The title of my research is “*Digital Game Based Learning: An Exploratory Analysis of Perceived Educational Benefits in Information Technology, at a junior high school level*”.

The outcome of the research should provide valuable information which will contribute to the use of coding in the classroom at a junior high-school level. Computer programming will be taught in the Grade 8 IT classroom using a Digital Game Based approach as a means to facilitate both teaching and learning. Learners will be taught how to create games using the Scratch platform, which is in line with coursework already taught at your school. Once the week-long intervention is completed, learners will be asked, after parental consent has been attained to complete questionnaire that speaks to their experiences. After which a group of 6 learners will be asked to participate in an informal interview. The full duration of the study, including the survey, will take no more than 10 days. My presence at your school will be completely unobtrusive and I will in no way encroach upon regular teaching time, unnecessarily. Should you wish I can avail myself at any time this week to meet with you so as to allay any fears and answer any questions you may have.

I thank you in advance for your kind support in this endeavour. I look forward also to being able to help your IT teacher formulate a new junior curriculum that will bring your school in line with what is being taught abroad.

Yours sincerely,

*Clay Johnson*

---

RESEARCHER : Clay Johnson

CONTACT DETAILS : HOME : 031 2619007      CELL : 060 5421614

# APPENDIX L

## TURNITIN REPORT

Turnitin Originality Report  
DGBL by Clay Johnson  
From Draft Thesis (General)



- Processed on 29-Aug-2018 9:45 PM CAT
- ID: 994648504
- Word Count: 41434

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### paper text:

Digital Game Based Learning: An Exploratory Analysis of Perceived Educational Benefits at a Junior High School Level A research project submitted to the department of computer science and information systems education in partial fulfilment of the requirements for the awarding of an Master in Education Degree of University of KwaZulu–Natal by Clay Christopher Johnson August 2018 Abstract Digital Game Based Learning (DGBL) incorporates innovative tools that are widely recognized as having considerable potential to foster and support active learning, problem- solving and communication while providing an environment that embraces

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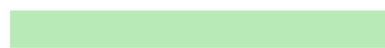
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