Typing Training Through Gamification

A dissertation presented to the Computer Science Department

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By

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To God be all the Glory.

Declaration

I know that plagiarism is wrong. Plagiarism is to use another's work and pretend that it is one's own.

I have used the IEEE (Institute of Electrical and Electronics Engineers) convention for citation and referencing. Each contribution to, and quotation in, this dissertation from the work(s) of other people has been attributed, and has been cited and referenced.

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Date 5 September 2017

Abstract

Our study investigated the effectiveness of gamification on typing training for novice computer users. We used typing speed and accuracy as the measurable quantities in order to gather empirical evidence to support our conclusion. .The fact that most assessments at tertiary institutions require students to be computer literate and have good typing skills motivated us into carrying out this study. Research show that skills are essential and contribute to the success of students. Students who lack basic computer skills, especially typing skills, often struggle to complete and submit their tasks timeously, resulting in penalties. In some cases, the quality of work is not satisfactory.

The participants in this study were grade 11 learners from a township school in the Western Cape Province, South Africa. Mixed methods were used to collect both qualitative and quantitative data. The study is predominantly quantitative in nature. The idea of triangulation was used so as to validate data collected. Different research tools were used during data collection, including questionnaires and semi-structured interviews. Statistical methods were used to analyse data and draw conclusions. Findings from our study show that game elements motivate and encourage participation. The sample group showed high interest in engaging, spending more time on computers than the control group. The improvement of participation of the sample group in turn resulted in improvement of both the typing speed and accuracy. We therefore concluded that gamification is an effective way of improving typing speed and accuracy for novice computer users.

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Chapter 1: Introduction and justification of the study

1.1 Introduction

Gamification is claimed to be a successful way of improving motivation, engagement and overall achievement for a desired behaviour [1] [2]. While the primary objective of games is entertainment, game elements and techniques may be customized to suit various learning platforms. A lot of young people participate[1] in digital games on a daily basis. It is therefore beneficial to use game elements and techniques in order to improve learning experiences [3] [4].

Some tertiary institutions offer a basic computing course which has various names across different departments. The most common one is End User Computing (EUC), which is aimed at equipping students with basic computer skills needed to carry out their day-to-day assignments on computers during their study period and subsequently at work-places. The majority of students recruited lack the basic computer skills required to succeed at tertiary institutions, with some being practically computer illiterate. However, not all institutions offer computer skills courses for students.

1.2 Problem Statement

Information and Communication Technology (ICT) play a very important role in modern lives. It is social belief that people who make use of ICT have better opportunities for professional and academic success [5]. Schools around the world have embraced the use of computers in education, with some offering Computer Application Technology (CAT) as subject, while others offer computer literacy classes to all learners. CAT is the study of computer components, and the effective use of computer applications to solve problems. However, there are some poorly equipped schools that do not have the resources to equip their learners with such skills.

At tertiary institutions, lecturers and students make use of ICT to perform their day to day activities. Assignments at most tertiary institutions are submitted electronically, while those submitted as hard copies are typed and formatted appropriately. While the content of the assignments is the most significant contributor to the final mark, poor quality and ill-formatted assignments attract penalties. In order for a student to

[1] Participate in this context refers to either being a direct participant (play), or an observer.

complete assignments timeously, they need to be able to type rapidly and accurately. Students who cannot, often pay either professional typists or other students to have their assignments typed and printed for them. This adds an extra burden to students, some of whom cannot truly afford such services. These students may end up missing submission deadlines while waiting for their assignments to be typed, or while slowly and erroneously typing.

1.3 Research purpose

Students face challenges in attempting to cope at tertiary institutions. These challenges come from a number of perspectives, ranging from social, emotional, psychological and financial. This study seeks to explore a possible solution to one of their challenges: typing skills. Gaining computer skills, especially typing, can lead to social acceptance, and less emotional stress and frustration [4] [6], as well as better academic performance [5].

1.4 Research Question and Objective

Our objective is to conduct research on the effectiveness of gamification on typing speed and accuracy among novice computer users. Typing has become a very significant skill for students. How to train and improve students' typing skills is therefore a critical issue. The null hypothesis for our study states that gamification is not effective in improving typing skills.

To achieve the objective of this research, the following research question should be answered:

> *How effective[2] is gamification in improving typing skills for novice computer users?*

To facilitate a detailed exploration of the overall research question, it should be broken down into manageable questions as follows:

1. *What gamification design methodologies exist?*
2. *How can gamification be used in typing training?*

[2] Gamification effectiveness will be measured by comparing the number of success to the number of failures. More success indicates that gamification is effective.

3. *What are the responses of students to gamified typing training?*

1.5 Motivation and Justification

Typing skills are critical to student success these days and hence it is important that they gain this essential skill early. A significant number of first year students at tertiary institutions cannot operate a computer due to their backgrounds. This is often overlooked by many lecturers who assume that every university student should be computer literate. There is no particular subject that stipulates that students should be able to type fast and accurately, but this skill enables students to complete their assignments timeously. Addressing this skills deficiency will be beneficial to all parties concerned, and consequently to the development of the community.

Typing is a skill. Skills are gained through consistent practice. It is therefore important to find a way of motivating and encouraging students to frequently practise typing so as to gain this crucial skill. One way of motivating and encouraging engagement is through gamification. While drill based methods may achieve the same result, psychologically students do not find them attractive, since there is no element of playing. Gamification takes away the focus from the final goal to overcoming the current obstacle. By gamifying, practise will be frequent, since games have been known to improve engagement and motivation. There is remarkable research done on gamification of education, with the majority of them focusing on students' engagement with content. However, this research is unusual in the sense that there is no content involved, and focus is on a common but very important skill needed for success at university as well as in everyday life of anyone who uses a computer. Furthermore, the context in which this research is done is uncommon. Schools in Cape Flats are unique and face uncommon challenges. Crime hinders development of schools, with many having experienced burglaries and lost ICT equipment. Computers, data projectors and printers are the targets for burglars. It therefore becomes almost impossible to equip schools in these areas with computers for multiple computer labs, since more resources will be needed to ensure the labs are secure.

We select this particular field of study due to our interest to use ICT to develop communities, as well as for personal interest.

1.5 Limitations

The ideal situation would be to use a sample from a very poor community where all members of the sample have neither access to computers nor prior experience. Unfortunately, the schools where such a sample could be obtained have no computer labs. It would be impossible for us to proceed under such circumstances since there would be no nearby place with a computer lab available for use. We wanted to use Google forms for the questionnaire. Unfortunately, this could not be done due to the fact that the majority of participants had no access to computers and internet, and at the beginning of the training, most were computer illiterate and could not access and complete the forms on their own. Furthermore, the school does not have a reliable internet connection. This resulted in loss of valuable time capturing the responses. The sample used for this study could have been larger than the 52 used. However, due to the shortage of computers, only a limited number of learners could be accommodated at a time. There are other projects utilizing the same computer laboratory, and therefore the time and sessions allocated for this study were limited.

1.6 Delineation of the study

Our study focuses on novice computer users within, or from poor communities. CAT students cannot take part in this study. While the main objective is on the effectiveness of gamification on typing skills, the study will also introduce basic computer skills to the participants so as to enable them to use computers during the intervention. We however will not dwell much on theory. The study does not consider factors that contribute to lack of computer skills of the participants.

1.7 Overview of the Chapters

This report is organised in a sequential way that follows the order of activities which were carried out during the study.

This report is subdivided into five chapters.

Chapter 1: This chapter gives the introduction of the study. It covers the background, problem statement, purpose as well as the research questions and objectives.

Chapter 2: A review of literature related to the study is done. It focuses on previous research on gamification methodologies, and the current state of gamification in different contexts.

Chapter 3: A thorough discussion of the research methodology used in the study is presented in this chapter. The description details the approach used and techniques for data collection and analysis. Ethical issues and reliability and validity concerns are addressed.

Chapter 4: A presentation of the results of the study is given. Results are analyzed and discussed in detail, relating to the research questions.

Chapter 5: Key findings of the research are highlighted. Recommendations for further research are done.

Chapter 2: Literature Review

2.1 Introduction

Games have been considered as a way of relaxing and entertaining users and model the way they perceive the world and perform tasks in everyday life [7] [8] [9]. Games have led to the emergence of some trends and behaviours which indicate that society is becoming playful [10] . Despite the belief that play is a voluntary moment of waste, and is separate from productive tasks [11] [12], Malaby [13] cites that it is becoming increasingly difficult to separate play with everyday life since there is no empirical evidence to support this belief. Furthermore, games and game elements are used to help learning and perform desired activities [7].

Gamification refers to "the use of game design elements and game mechanics in non-game contexts" in order to achieve a desired outcome [14] [9]. Research suggests that the use of game elements increases user participation [15]. In presenting their findings on their study "*Using Gamification in an Online Community"*, Bista et al [15] concluded that gamification makes the interactions fun and appealing. However, it is important to ensure that focus is not given to fun and appealing interactions, but rather use them as means of achieving the desired behaviour. Gamification is evolving as a discipline [16], gaining significant academic interest after 2010 [17], and has been successful in many fields including Marketing, Education and Training [14] [18]. In education, many teachers have used game dynamics and strategies to improve learner participation and academic performance [19] with recorded great success.

2.2 Success in Education

Success in education is not merely measured by academic performance. Academic achievement is determined by a number of factors. Ibanez et al [20] and McMahon et al [21] agree that the guiding principles for success are motivation, engagement and taking ownership of content and the whole learning process. Ibanez et al [20] further state that engaged students are persistent with their studies regardless of the challenges they may face. Such students have gain intrinsic motivation by rewards, exploring new challenges or achieving the best scores, and derive satisfaction from overcoming and accomplishing their tasks [20]. Intrinsic motivation occurs when one performs an activity because they enjoy it, whereas extrinsic motivation is driven by some external outcome of performing a task [22].

Muntean [7] claims that user engagement in e-learning can be increased by gamification. In education, the use of game elements can substantially improve the final results of the students [19]. Games give the user freedom to choose. Likewise, gamification should give students the choice between passing and failing. “Winning” a game comes after successfully completing a series of small tasks, allowing the player to progress to the following level. Second chances are often given and immediate feedback as a way of encouraging the player to successfully complete a task and progress [8]. Of importance to note is the fact that users are encouraged to fearlessly experiment by giving them “extra lives” or second chances. The focus is therefore shifted from the final result to the task at hand [19]. Gamifying education leads to success, if such elements as second chances are afforded to the student.

Although primarily considered as leisure activities, games shape our everyday lives and help in the evolution of culture [10]. Culture by definition is a way of life of a group of people which makes them different from others. It is cultivated behaviour which is gained through social learning and passed over generations. Games have led to people changing the way they accomplish tasks, socialize and hence influence social learning, resulting in revolving culture. In addition, games are good for teaching. Children develop some skills and abilities during play; they acquire digital literacy through playing and exposure [23]. Prensky [24] stated that students generally spend more time to play games than they take reading. It is therefore imperative to harness the power of playing in achieving effective engagement, increase motivation and consequently success in education.

In order to reap the full benefits from gamification, good game design principles should be used [18]. For effectiveness, a game should be addictive and motivate and encourage the user [10] to keep playing. However, Gros [23] argues that although games can be both engaging and motivating, that is not enough for educational purposes. He further emphasizes the need for proper design for encouraging engagement so as to benefit from gamification in education. Design should be informed by student types [25], required outcomes and the situation where it will be applied [26], so as to decide whether to gamify or to use educational games.

2.3 Gamification and Educational Games

Educational games are games designed to assist in the learning process [27]. They reinforce development and expand concepts, while at the same time assist players learn certain skills as they play. Kapp et al [28] and Isaacs [27] believe that educational games have clearly defined learning objectives [29]. On the contrary, gamification involves a collection of tasks with some form of rewards [26]. The table below shows the similarities and differences between gamification and educational games.

	Educational games	Gamification
Similarities	• Motivate students to participate and learn. • Losing may or may not be possible: normally multiple chances are given so that students keep trying and learning in the process.	• Motivate students to participate and learn. • Losing may or may not be possible: normally multiple chances are given so that students keep trying and learning in the process.
Differences	• Normally designed to support one player at a time. Players take turns. • Playing is intrinsically rewarding. • Content is usually re-designed to fit the scenes and story of the game. • Usually hard and expensive to develop.	• Players may engage simultaneously. • Rewards often add motivation although it is intrinsically satisfying. • Game like features and elements are added, rather than making the content fit into the game. • Usually cheaper and easier to build.

Table 2.1: Comparison of Gamification and Educational games (adopted from K. Kapp, Understanding Games and Gamification)

2.4 Goals of gamification

The ultimate goal of any gamification is to achieve a desired outcome [30]. In education, this may be improving the overall pass percentage or the quality of passes (using class averages) [7] [31], improve participation, lecture attendances, and engagement with content. In some cases, gamification may also be used to encourage team work among students or competition. Gain et al [10] portray learning as an on-going process with the ultimate goal at the very end of the game, after conquering all quests. This is further supported by Filsecker et al [32] who claim that it is often discouraging to focus on the ultimate goal, and many students may lose interest [10] [32] along the way and give up (drop out). To build towards the ultimate goal, short term goals can be set, which act as progress indicators [20]. These short term goals depend on the ultimate goal, as well as the education platform for which the game is designed. However, the most common cross platform goals include:

- Increase engagement:
  - This focuses on the frequency at which a user interacts with the content, or participates in given activities.
- Increase motivation:
  - Gamification aims at giving the user a reason or reasons to take part in particular activities, or behave in a particular way.
- Increase access to content and hence understanding and application:
  - It is believed that the more frequently one accesses content, the higher the chances of understanding. Gamified content generally will be accessed more by users than normal content.

2.5 Types of gamification

Different personalities exist in games. Some student want competition, others challenges, adventure or socializing [31]. Identifying the most prevalent personality for the target group is crucial to the success of gamification, according to Zhuo et al [11]. Contextual application of gamification is key to its effectiveness. Motivational and engaging affordances of a given gamification do not necessarily apply between different contexts [10] [30]. Gamification may be effective in motivating and improving engagement in one context, but when the same gamification is applied in

a different context, it may not be as effective. There are two types of gamification to consider when designing [28]. The chosen design depends on the context for which the design is done.

2.5.1 Structural Gamification

In structural gamification, the structure is altered so that it becomes game-like, while the content remains unchanged. Structural gamification is effective for motivation and engagement in the learning process. It may be applied in scenarios where a new skill should be acquired, since it influences behaviour and habit-building, leading to intrinsic motivation. Rewards are often used to enhance motivation [26]. Commonly used game elements in structural gamification include badges, rewards, points and levels [28]. As a way of encouraging participation and engagement, leader boards may be included, and a platform where participants share their achievements. It can be argued that structural gamification wears off with time, but the intrinsic motivation gained is enough to counter this risk.

2.5.2 Content Gamification

Content gamification focuses on making content game-like in nature. Game activities and situations are added to content to make it more fun and enjoyable. Content gamification motivates students through engagement with content. This type of gamification is best suited for teaching new content or knowledge [28].

2.6 Gamification design- Desirable game elements

A motivational gamification should focus on aspects that make games appealing to players [14], such as their impact on the players' cognitive load, emotional state and social status and level/ progression [14]. Lee and Hammer argue that gamification should therefore focus on these areas. A Gamified learning platform should consist of a series of short term tasks [32] [20] along with rules to guide players complete the tasks at the same time as mastering the rules [8] [14].

Players should be given some freedom in accomplishing tasks. However, Kapp et al [28] argue that giving students the freedom to complete tasks in any order they wish may not be the best way to learn. Completing the task successfully gives the player a feeling of achievement and conquest of a challenge [8]. Reward system may be used to enhance this feeling [14]. Gamification should offer a balance

between the skills of the players and the difficulty of the game. As the skills increase, the level of difficulty should also increase so as to lead players on in a motivating way [23]. Highly skilled players get bored by easy games, while unskilled players get anxious when playing difficult games. A good game design flow provides a balance between boredom and anxiety for the players [33].

Failing to accomplish a task leads to anxiety. If not carefully design, it may subsequently lead to frustration [8] [14]. For gamification to be effective, small penalties may be incurred and repeat chances given. In extreme cases, hints may be provided as a way of assisting the player to move on.

Some players get satisfaction from achieving the best results or score. Players who enjoy competition appreciate and give recognition to competitors who have better or comparable scores to themselves. Recognition gives a feeling of belonging [8]. Multi-player games allow the interaction of players; as competitors trying to outplay one another, as a team to work towards a common goal, or social interaction, talking about games and conniving, in cases where the game is not competitive in nature.

Players enjoy the freedom of choice when playing. If the game has meaning and the players have the ability to master it, mastering it will give satisfaction in the form of meaningful accomplishments and a sense of discovery [31]. While some claim that in a classroom situation, giving students the freedom to complete tasks as they please may not be the best way to learn, Kapp et al [28] suggest that players should be given some freedom in accomplishing tasks. Most games give players multiple “lives” (chances to successfully complete a task), which provide players the freedom to fail [19] and try again. This translates to a real classroom environment, where a student can be given a second chance. Freedom to fail boosts confidence, and encourages the player to take risks and experiment without fear. This shifts the focus from the final goal to the task at hand [8]. Therefore, gamification design should consider such ways of giving the student freedom.

To maintain the motivation and engagement of players, rapid feedback is necessary. Kapp [26]affirms that targeted, frequent feedback results in effective learning, and is supported by Scott and Naustaedter [19] and Dichev et al [34]. Game design often incorporates such rapid feedback, at the end of each level and in summary. Constructive feedback will encourage players to use various skills that

they gain during the process [35]. Apart from the feedback, there are a number of game elements that may be applied in gamification. The table below gives a brief summary of some of these elements [25] [36].

Element	When to use it
On-boarding	To introduce the students to how things work.
Sign posting	Direct the students to the next activity.
Loss aversion	Provide a way of minimizing losses so as to keep student motivated.
Rewards	To keep students motivated. Can be random, fixed schedule or time-based. These may be physical, real life rewards or virtual rewards, to use only in the gamified context.
Competition	Encourage engagement through the quest to be the best/ win.
Branching choices and customization	Provide students with the autonomy, by providing options for completing a task.
Levels/progression	To provide a way of tracking one's progress.
Progress/ Feedback	To provide a performance measure for each level, so as to inspire students to perform better in subsequent activities.
Teams/ Guilds and social networking	To encourage teamwork, and students working together to complete a task, or share ideas.
Collect and trade	Provides motivation to collect rewards and use them in the game context.
Sharing/ Gifting	To encourage engagement so as to collect rewards to share, or give as gifts. Subsequently, reciprocating will be a driving factor to encourage engagement (Some people feel good by giving others so they will be motivated to collect rewards and give. However, after one receives a "gift" they will have the urge to reciprocate.

Table 2.2: Game elements to use in gamification design (adopted from K. Kapp, Understanding Games and Gamification)

2.7 Challenges

Gamification of education has many challenges. To begin with, it may be costly to design and implement and maintain a gamified course [7] [31]. Some extremists are still opposing the idea of Gamifying education, citing fears of the adverse effects. Hanus et al [37] in their research paper "*Assessing the effects of gamification in classroom: A longitudinal study on intrinsic motivation, social comparison and*

academic performance" highlighted that gamified course's students become less engaged, less motivated over time and scored lower exam grades than students from non-gamified course. However, there is currently no scientific support for their arguments.

2.8 Rewards

External rewards have been considered to affect user discipline and engagement. Studies show that incentives support achievement [7], motivation and appropriate behaviour. Repeated interaction with content through games leads to continual improvement. However, if not implemented properly, rewards may be detrimental to an individual's intrinsic motivation [32]. This will significantly affect engagement, as it may undermine their autonomy [32] and shift the source of motivation to external objects. Some researchers argue that rewards can be misleading. Students may have the impression that they only have to learn if there is some extrinsic motivation [7]. Rewards have to be used with caution, lest the whole focus will be shifted from the goal of the process to the external rewards. Rewards should be incorporated in a way that adapts to the target group.

2.9 Gamification in Education

Gamification has been successfully implemented in marketing and produced desired influence on the customers [15]. A variety of online applications have been gamified. In education, Gain et al [31] and Ibanez et al [20] concluded that gamification can improve pass percentages. There is a general belief that gamification yields positive results. This belief can be challenged [9]. Some researchers point out that care should be taken during design, so as to minimize the negative effects since gamification can have both positive and negative outcomes [15]. Dominguez et al in their study *Gamifying learning experiences: Practical implications and outcomes* claim that gamification improves practical skills and overall score for students, but does not improve scores on written assignments and tests [14].

Muntean focused on gamification to increase e-learning engagement and motivation [7] and agrees that rapid positive feedback can improve engagement and motivation. He went on to list and explain elements that could be used. However,

there is little information from other researchers on how effective these elements are. Therefore, there is need for more research in this area.

Gamification in education has been implemented at some learning institutions. At the University Of Cape Town, O'Donovan et al implemented gamification for a Games Development Course [31]. While they report an improvement in engagement and consequently pass rate, they observed elements of cheating and other unexpected behaviour. The design should therefore look for unexpected behaviour, and where possible, as pointed out by Filsecker et al [32], balance rewards for intrinsic and extrinsic motivation. It is of paramount importance to find out ways of integrating game elements without developing unethical behaviour in students [8] [19].

Digital games have been used in education. Gros et al [23] concluded that video games are not a solution to educational problems. In their discussion, they argued that although engagement and motivation are positive benefits of gamification, they are not enough for educational purposes. Nevertheless, despite their conclusion, these benefits help students learn better. In cases where a new skill needs to be taught, engagement may be sufficient to train the students on the new skill. Because of that, more work needs to be done on gamification so as to find ways of effectively integrating games into the learning process. Gamification of courses for experimental purposes provides evidence that engagement can be improved, and students focus on feedback on their performance so as to improve and accumulate more points when completing subsequent tasks [35].

The available commercial and free typing tutor software has been used by many to improve their typing speeds. However, not all such software offer the same affordances [38]. Lin and Liu compared drill based and game-based typing training software. They concluded that game based software improve typing speeds better than the drill based [38]. However, it can be argued that not all game based tutor software can improve typing speed. Properly designed and appropriately used game elements contribute to positive behaviours [25].

2.10 Conclusion

Games are intended for enjoyment. Some designers have created games for use in different platforms, importing desirable game elements appropriate to the target audience. There are claims that Gamifying education improves engagement, but with little empirical evidence to support the claim. While there are benefits derived from gamification, some people argue that they lead to the evolution of an anti-social and violent culture [39], but again there is no scientific evidence to support this claim. Furthermore, it is important to appreciate that gamification does not mean making the whole process a game, but appropriately using some game play elements so as to encourage engagement. Therefore, gamification does not lead to anti-social and violent behaviour like some games.

Existing research shows that gamification is effective in education and other applications. However, there are opportunities for further research into various aspects of gamification. It has been proved that gamification improves engagement, but little has been done to establish the source of motivation: is it the rewards, a sense of achievement or feedback among other elements?

Chapter 3: Research Methodology

3.1 Introduction

The preceding chapter presented a survey of existing literature on gamification, highlighting similarities, differences and identifying gaps in the existing literature. This chapter focuses on the methodology that guides our study. The research design is outlined, processes and procedures for data collection are described and justified. The main purpose of a research design is to ensure that the evidence addresses the initial research questions. The research paradigm, sampling techniques, target population and sample size determination are also explored. The research process and specific methods adopted for our study are discussed. In concluding the chapter, details of how collected data will be captured and analyzed are provided.

The following research questions have guided the choice of the research methods utilized in our study:

How effective is gamification in improving typing skills for novice computer users?

This question was then subdivided into the following:

1. *What gamification design methodologies exist?*
2. *How can gamification be used in typing training?*
3. *What are the responses of students to gamified typing training?*

Due to the nature of the questions to be answered, mixed methods are used, with different data collection techniques so as to incorporate both qualitative and quantitative data. The study is predominantly quantitative, but qualitative data is also embedded so as to fully address the research questions. Using mixed methods allows data collected from the different methods to complement each other. This elaborates, enhances and clarifies results from quantitative data through detailed analysis of the qualitative data. This idea of triangulation, whereby several research methods are combined and applied, facilitates validation of data through cross verification from multiple sources. Furthermore, a mixed method approach allows different data collection tools to be used.

The quantitative data provides answers to the main research question, while qualitative data provide an in depth understanding of the difficulties faced by computer illiterate learners, the challenges that they face in their communities as well as how best these may be addressed.

3.2 Research Design

Research design refers to a specific plan for data collection and analysis procedures, according to Yin [40] and Zikmund et al [41]. Many authors concur with Zikmund et al [41], in that the research design provides a backbone of the research, which maps and creates a structure for the research [42] [43]. It is a framework on which the research is based. Therefore, the research design can be considered as a road map that takes the study from the preliminary stages to conclusion.

3.2.1 Mixed Methods

Mixed methods research combines qualitative and quantitative research methods, techniques, and approaches in a given study [44]. The utilization of mixed methods may take place at either data collection, or data analysis stages, depending on the nature of the research question and objectives [44]. In some cases, this may take place during interpretation. We decided to use mixed methods for our study because we did not want to limit and restrict our choices of approaches and techniques in answering the research questions.

Many authors concur that there is no single best or standard research design for any specific research study [40] [41] [43], with Copper & Schindler highlighting that researchers often encounter the dilemma of selecting the best design for their studies, from the many alternatives available [43]. While a given research design may have its strengths and may be the most appropriate for a particular study, it will also have shortcomings when applied to a different study [45] [46]. This is the dilemma faced when selecting the best design for our study on the effectiveness of gamification. To overcome this challenge, we considered a number of factors before choosing the most appropriate research design, as recommended by Blanche et at [47]. Blanche et al [47] advise that a careful analysis of external factors need to done before a particular research design is chosen. We considered the availability of funds to undertake the research study, target population accessibility and time constraints, before deciding

on the research design and feasibility [47] [48] [49]. A good design minimizes bias while maximizing reliability of data collected [46]. It is recommended that novice researchers should consult experienced researchers in their field of study in order for them to have a better understanding of the research process, and consequently determine the best research [41] [47]. To ensure that the best research design is followed for our study, previous related studies were used and advice from experienced researchers was sought. We adopted a quantitative approach to our study, with a number of metrics to be measured over time.

3.2.2 Research Philosophy

Mixed methods research is fundamentally pragmatic. This philosophical underpinning arises from "actions, situations and consequences rather than antecedent conditions" [44]. Our research is guided by functional pragmatism, with the belief that intervention (actions) will cause a change in the level of typing skills (consequences). In our study, we have freedom of choice as to the methods, techniques and procedures to use. Furthermore, multiple approaches are used for data collection and analysis. These are characteristics of pragmatism. The use of both quantitative and qualitative data allows us to understand best the research problem and interpret the results. Pragmatists believe that the best method to use in a research study is one that solves the problem. In our study, we believe that both quantitative and qualitative data are needed, and therefore combine the methods for the best results, hence making this an application of pragmatism.

Denscombe [50] posited that research should be aware of its underlying philosophical underpinning. A paradigm is a *"cluster of beliefs and dictates which … influences what should be studied, how research should be done and how results should be interpreted"* [50]. Three research paradigms are common:

1. Positivist, which is at times referred to as conventional or scientific;
2. Interpretive, which is also likened to constructivist paradigm; and
3. Critical theory

The paradigm followed in a study depends on the research questions and the nature of the problem under study [51]. Therefore, different researchers adopt different paradigms and choose methods they may consider suitable for particular research

[51]. Just like research methods, each paradigm has its own strengths and weaknesses. Some researchers argue that combined paradigms in a single research may bring new and creative ideas [52].

Positivist research deals with quantifiable variables or data, and assumes reality is objective. It is deductive in nature, based on empirical data. Some researchers argue that positivist approach is derived from natural science. The researcher assumes neutrality, and separates themselves from events and looks at actions without being subjective [51].

Interpretive research focuses on gaining an understanding of the human thought and action in social and organizational contexts. It adopts a subjective approach, which helps the researcher in achieving a realistic outcome, which may be interpreted in different ways, subjectively [51] [53]. It therefore does not have predefined variables, but instead focuses on human behavior. Some claim that interpretive research is necessary since natural science methods are insufficient and unsuitable to address social events [44].

The objective of Critical theory research is human empowerment and development [53]. This paradigm acknowledges human potential and opportunities. [44] [49]. Some researchers claim that social reality is historically established and keeps changing with changing social and economic conditions. However, others acknowledge human potential, but argue that opportunities to improve their conditions may be restricted by social, cultural, political conditions, among others [54]. Critical theory claims that reality is created and shaped by society. It further highlights that we cannot separate ourselves from what we know, and this affects the way we do research.

The purpose of this study is to determine the effectiveness of gamification through exploring gamification methodologies, apply them in typing training and by gathering learners' responses to gamification. Research studies are classified as experimental or non-experimental. While experimental research uses information obtained from random, controlled trials with variables (independent) manipulated, non-experimental research is used where variables may not be manipulated due to the nature of variables, or ethical considerations [45].Our research collected data from user experiment, making it an experimental study. However, quantitative data collected was evaluated and interpreted qualitatively.

3.3 Research Process

A research study is a sequential process of interrelated activities that together constitute a research process [41]. This has to be carefully planned before one can undertake a research study. The research process guides the order in which the events should occur [53] [49]. Figure 3.1 below depicts the steps for our study, adopted from “My Market Research Methods” [55]

3.4 Research approach

The method of data collection: Our study makes use of self-administered questionnaires and informal interviews, making it a communication study. Cooper and Schindler [43] define a communication study as a study in which participants respond to questions asked and the researcher then collects responses either by personal or impersonal means [43]. In addition to questionnaires, a self-directed engagement using specific computer software is used. Subjects register themselves with pseudonyms, and engage with the software package. The package has a database where all data is recorded. Observations are made during the intervention.

Researcher control of variables: Cooper and Schindler [43] assert that an ex-post facto design does not probe but allows respondents to answer questions usually in predetermined responses. The authors further states that the researcher should observe and report. The researcher did not probe the participants for answers while answering questions. Furthermore, during intervention (typing training), the participants were given freedom to complete activities in a manner of their choice. The researcher only observed and reported based on the data collected. This reduces bias in the results, yet it is helpful in understanding the behavior. For example, facial expressions were coherent with difficulty level and performance on tests and games.

3.5 Population and Sample

3.5.1 Population

Gravetter and Forzano [56] define population as the entire set of individuals of interest to a researcher. The population of the study is within the confines of the research study geographical location, and is determined by the research question and objectives. In most cases, a sample of the population is used to represent the population, and the

results are generalized to the entire population. Our target population is novice computer users who are in high school from impoverished communities.

3.5.2 Sample and Sampling method

Zikmund et al. [41] define probability sampling as a technique whereby every member of the population has a known, non-zero probability of selection. In most cases, especially where selection is random, all members have an equal probability of selection. Non-probability sampling is a sampling technique whereby members of the sample are selected from the population based on the researcher's personal judgment or convenience. In non-probability sampling, the probability of any particular member of the population being chosen is unknown.

The sample for our study is grade 11 learners at Manzomthombo Secondary School. The school is located in Mfuleni, a poor community in the Cape Flats. The idea is to generalize the findings of this study to all novice computer users, especially high school learners from impoverished communities, attending underprivileged, under-equipped schools in the Cape flats. The Cape Flats refers to poor townships within the Cape Metro.

The sample size for our study is 52. Both probability and non-probability sampling were used. Non-probability sampling was used to select the school where the study was done. Manzomthombo Secondary school was chosen for convenience by the researcher. The researcher taught at the school previously, and still works with some of the learners as part of his community involvement projects. Furthermore, proximity to the researcher's residence was considered. All grade 11 learners have a non-zero probability of being selected, hence probability sampling. Random sampling was done, with the number of computers being the limiting factor for group sizes.

3.6 Pilot testing

Before engaging with participants, a pilot study was done with five volunteers, two of whom were computer literate. This enabled the researcher to identify weaknesses in the data collection methods. Moreover, it gave comparable results which were used to determine the effectiveness of the questionnaire and software package. Their responses helped the researcher to modify some of the questions. Pilot testing was also used as a way of testing the feasibility of the study.

3.7 Research Instruments

In order to be able to answer the research questions, the following data collection tools were utilized. Each tool has its strengths and weaknesses, as discussed below. Utilizing different methods for our study enabled us to combine strengths of the methods, hence reducing the weaknesses since the strengths of one method overcomes the weakness of the other.

3.7.1 Statistical data collection instrument - Typing training software

To meet the objectives of the study, quantitative data had to be collected and analyzed statistically. Typing master, a typing training software system was used to collect data. All participants used pseudonyms to register, login and complete activities. Pseudonyms allow us to track the progress of each participant and were only used for that purpose. Data collected involved engagement statistics and performance. We intended to design, develop and use our own typing training software which would meet our requirements. However, Typing master was used to replace the initially proposed software due to high costs and time constraints. The specifications of the software is given in appendix A

Typing master is a game- based commercial typing tutor. It incorporates a number of game elements, which made it a suitable tool to use for our data collection. Desirable game elements include the freedom to choose. Participants have the freedom to choose the activities they want to engage with, and in any order. These activities are:

- Studying- made up of three courses, each one with lessons. The courses are Touch Typing, Speed Building, and Numbers, Special Marks and 10-Key Pad.
- Typing Tests, where participants are given text to type.
- Games- three games could be played. These games are Bubbles, Clouds and WordTris.

Figure 3.1: Screenshot of Typing master user interface.

Typing master comes with a database which records all data concerning users and their activities. It allows the administrator to register or delete participants, as well as track the progress of each participant and access their statistics.

3.7.2 Survey Instrument – Questionnaire

The researcher used a questionnaire to collect information about each participant's computer skills and exposure. Positivist studies draw conclusion from large quantities of data, and questionnaires are a good instrument for such data [44]. Questionnaires are also good for descriptive studies [53]. Our study is both positivist and descriptive, and hence the use of a questionnaire. To ensure that an effective questionnaire is designed, questions asked should be relevant and precise [41]. Questions asked are in line with the research objectives and address the research questions. In designing the questionnaires, we checked to ensure that all important questions were asked, participants were stimulated to respond and the wording was properly done so as to avoid bias.

The questionnaire for this study is structured in a way that minimizes ambiguity. The questions are precise and short. Multiple choice, true or false, yes or no and Likert scale questions were asked. A Likert scale measures participants` degree of agreeing or disagreeing. Most questions are derived from past studies so as to ensure reliability and validity, as recommended by Zikmund et al [41]. Questions were interpreted for

the participants on request. This helps reduce the risk of misinterpretation, which is one of the weaknesses of questionnaires. Personal information is also collected, so as to enable the researcher to classify the participants and generalize some conclusions based on gender, and background.

3.7.3 Interviews

In research, interview is the verbal conversation between two people with the objective of collecting relevant information [44]. It involves asking questions and getting answers from participants in a study. It can be a valuable source of qualitative data. Informal, unstructured interviews were used in our study. This methods is chosen for its flexibility. Moreover, formal interviews complement observations [56]. Participants may provide an explanation for certain observed behavior when asked during interviews. Open ended questions were asked, so that the researcher could get a better understanding of the participants' behavior.

3.8 Data analysis

Data analysis involves a number of steps, from preparation where collected data may be reduced to a manageable size, to interpretation of data [49]. During preparation, incomplete data is discarded, and editing is done on questionnaires where necessary. Google forms were used for questionnaires, which were printed out due to lack of computer skills among participants. Collected data was captured and prepared for analysis. Microsoft excel 2013 was used to analyze data. Summaries were developed, patterns identified, tables, graphs and charts were generated, which were subsequently used for interpretation and drawing conclusions. Data is displayed in graphical and tabular form, with descriptions, explanations and interpretations of the patterns given.

3.8 Validity and Reliability

The worth of a research study is determined by its validity and reliability [44]. A valid and reliable study contributes to the body of knowledge, and is considered to be of value. A measurement is said to be reliable if it is consistent and stable when repeated. It should measure exactly the same way whenever it is used [49]. Validity refers to the ability of a measuring tool to measure what it claims to measure [44] [49]. To ensure reliability, a pilot test was done. The software system used proved to be reliable. In

addition, it measures typing speed and accuracy, which are the metrics required for our study. As such, it is a valid tool to use for or study. Google forms, used for data collection (questionnaire), is designed to ensure only valid data is entered. Since collected data is captured onto Microsoft excel, range and type checking techniques are used to validate quantitative (numerical) data. Correlation coefficients and p-values are calculated and interpreted. Furthermore, the questionnaire used was designed by deriving questions from past studies in the same field, and further scrutinized by peers and other researchers.

3.9 Ethical and confidentiality concerns

The most important aspect considered before undertaking research is the potential harm, directly or indirectly, to participants. It is expected of researchers to take cognizance of moral values and norms before undertaking a research study [47]. Upholding research ethics is the researcher's responsibility [56]. Gravetter and Forzano [56] emphasize the need for the researcher to be honest and respectful to all affected parties.

Several measures are taken to ensure the protection of participants against any possible harm, physical, social or psychological, as outlined below. Furthermore, the integrity of data collected is given utmost importance. Data collected is safeguarded to avoid unauthorized access.

Ethical clearance is sought before any data is collected. Our study was approved by the UCT Faculty of Science Ethics Committee. This included the introduction letter, consent form and the procedure for data collection (see appendix). All participants signed consent forms before taking part in the study. Participation was voluntary, and no individual was compelled to disclose any personal information. All participants were well informed of their rights, emphasizing that they could withdraw at any time if they wanted to. In addition, the data collected is used for the purpose of this study only. Pseudonyms were used, and no personal information usable to identify a person was collected during data collection.

Consent forms with personal details were kept away from the data collected. All data was treated with strict confidentiality, and no third part had access to the raw data. To

avoid giving participants different affordances, the control group was later given the same intervention as the control group.

In summary, the following specific ethical guidelines were observed:

a) **Institutional approval** –The University of Cape Town Faculty of Science Ethics Committee gave ethical clearance for the research to be done.
b) **Institutional Permission to conduct the research** – Manzomthombo Secondary school gave permission, and granted access to their computer laboratory and access to the learners (participants).
c) **Informed consent** – All participants were informed of the research, and that participation was voluntary. The consent form had a covering letter, the content of which was explained to participants. Participants signed consent forms to participate in the study.
d) **Confidentiality** – No access to data was or will be given to any third part.
e) **Anonymity** – Pseudonyms were used to ensure anonymity of all participants.
f) **Discontinuance** - All participants were informed of their right to discontinue at any time without having to explain.

3.10 Conclusion

This chapter gave full details of the methods and procedures used in conducting our research study. Explanations as to why certain methods or techniques are chosen over others is given and justified by making references to literature. It is worth mentioning that our study uses questionnaires, interviews, observations and Typing Master, a computer-based typing training software system, for collecting data. A pilot study was done to ensure feasibility, reliability and validity. Microsoft excel was then used for data analysis and presentation, which will be discussed in the next chapter.

Chapter 4: Data presentation and analysis

4.1 Introduction

A quantitative research inquiry was used in an endeavour to determine whether or not gamification can be effectively used to improve typing skills. A sample of 52(n=52) participants was drawn from the Manzomthombo Secondary School, an under-equipped school in the impoverished Cape Flats in South Africa. Participants were involved over a period of 3 weeks, and data was collected after every session. Two sessions were conducted per week. The data was then captured and analysed statistically.

4.2 Speed and accuracy training

Participants were exposed to a structured, introductory session. The aim was to give them an introduction to computers, as well as improve their typing skills. It is believed that ICT skills can only be gained by people who are computer literate [57] [58].To make the program more beneficial to the participants, an introduction to end-user computing content was added for both the sample and control group.

The sessions for the sample population were divided into three parts, with the first part being some theory and practice on computer literacy. This comprised an introduction to computers and Microsoft Word 2010. The second part was left to participants to choose what they wanted to do. They could choose among exercises, games, tutorials, and courses. Courses have three categories: Touch typing, Speed building and Numbers, Special Marks 10-number key pad. This freedom to choose motivates most participants to engage more with the typing training software, as suggested by Kapp et al [28]. Most students enjoyed games more than other activities. The satisfaction of being in the top 10 (competition) on the leaderboard (in line with literature, [59] [60] is the reason that most participants play games more often. The leaderboard acts as a yardstick for many, comparing their performance with others. The least performed activities were tutorials and touch typing training. Touch typing training is a drill method, which is considered by many as monotonous.

Courses are structured, step by step details of how to achieve desired outcomes. For example, touch typing course start by teaching participants how to position their

fingers on the keyboard. Participants are encouraged (but not obliged) to complete the courses sequentially.

Tests display text in a paragraph form, and participants are expected to type the text as it appears. The time taken to complete the test is noted, and used to determine the typing speed. All wrong keys pressed are noted and then used to determine typing accuracy.

Games differ in design. Clouds, the most played game, had clouds flying across the screen, with names written on them. Points are accumulated by capturing the cloud. To capture a cloud, one has to type the name before the cloud passes through the screen. Missing a certain number of clouds leads to losing the game.

For the control group, the sessions were well structured, with all participants working under instruction and doing exactly the same activities at any given time. The sessions started, like the sample, with an introduction to computer basics and Microsoft Word 2010. This was followed by a drill touch typing course. Participants were not given the freedom to choose what they wanted to do. There was no competition, since there was no leaderboard to inform them of how others were performing. This group was restricted to exercises, touch typing course (studying) and tests. Participants were not allowed to generate certificates and reports for themselves, so that they did not have feedback other than their typing speed and accuracy.

The final part of the session, for both groups, was to test the participants and collect statistics. Each participant undertook tests, both timed and free. At the end of each test, each participant from the sample group was given immediate feedback, together with their net[3] and gross[4] typing speeds as well as the typing accuracy. Immediate feedback was indeed embraced by many, and used to better prepare themselves for the next test. For example, where feedback would highlight problematic keys, participants will focus and practice more on the keys they made mistakes on before taking the next test. Interviews conducted at the end as post-training evaluation reveal that feedback served as a motivating factor to many [59] [61]. Statistics were not shared among participants, out of concern that it would demotivate and embarrass

[3] Calculated by considering only correct characters.

[4] Calculated by considering all keystrokes, regardless of whether they are correct or not

those not performing well [59]. The only statistics shared were the top 10 performers, who would appear on the leaderboard. For the control group, the only statistics which were given to participants were their own personal statistics.

The sessions were 90 minutes long for both groups. However, for the control group, the time was viewed as too long, and participants mostly left the computer lab early, after spending between 45 and 60 minutes on tasks. Most participants in the control group said the course was boring, and they only participated because they wanted to be computer literate. Participants from the sample had to be forced to leave the computer lab, after spending more than the stipulated time. Some spent up to 150 minutes, citing that they are enjoying themselves, and had targets to meet before leaving.

Data collected was tested using graphical methods for both speed and accuracy and show a normal distribution, and statistical tests were done based on this. A t-test was done for both speed and accuracy, so as to justify accepting or rejecting the null hypothesis that gamification is not an effective technique for typing training for novice computer users.

4.3 Participants

Participants were selected from Manzomthombo Secondary School in Mfuleni, an impoverished community in the Western Cape. The school has an enrolment of over 1 532 learners[5], 45.23% of whom are male and 54.77% female. The school has two computer labs. The first one is strictly used for Computer Application Technology (CAT) lessons, offered as a subject to few learners at the school. CAT is the study of the computer hardware, ergonomics, and the effective use of computer applications to solve problems. The number of learners who take CAT is limited due to insufficient resources to accommodate large numbers. Non-science classes are divided into two: CAT and Consumer studies. The highest number of CAT student per class is 25. The second computer lab, which has 23 computers in working order, is used for mainly by Maths Educators. This lab is responsible for servicing the whole school, giving an estimated computer-learner ratio of 1:65. To regulate lab usage and minimise vandalism and damage to the computers, the labs are out of bounds to learners,

[5] According to CEMIS.

unless under supervision by teachers. This leaves the majority of learners with no access to the computer lab.

The second lab, with 23 working computers, was used for this project. Learners were trained two separate groups of 26. The groups were engaged for three weeks each, in parallel. The researcher had to provide 3 extra computers for the duration of the project. Ideal participants were grade 12 learners who were about to exit high school and enter tertiary level at the beginning of the following year. Instead, grade 11 learners were selected since the grade 12 learners were preparing for their final examinations when data was collected. Learners who take CAT as a subject were not eligible to participate. Due to time constraints and challenges faced during data collection, some learners who were willing to participate could not be accommodated. Although the school has a higher proportion of females, more males participated in this study than females. This may be because Science learners participated, the majority of whom are males. Table 1 below shows gender distribution for the school, Science classes, as well as of the participants.

Gender	School	Science Classes	Sample	Control Group
Male	693	68	26(50%)	24(49%)
Female	839	52	20(38%)	18(38%)
Unspecified	0	0	6(12%)	7(14%)

Table 4.1 Gender distribution.

88% of the participants do not own computers either personally or within their households. Furthermore, the majority of them do not have access to computers. This likely impacts them negatively in life according to Schmitt and Wadsworth [62]. However, this made them ideal participants for this study. In addition, participants' self-evaluation shows that the majority of them lack basic computer skills, with some admitting to being computer illiterate. In a pre-session, participants were requested to switch on and off their monitors, as well as to switch on/off their computers. Very few participants managed to perform these tasks without assistance.

4.4 Computer Ownership by gender

It is widely believed, and supported by research [62] that gender, age and computer ownership and computing experience have a direct influence on an individual's attitude towards computers. To understand learners' attitudes and performance in this study, computer ownership was analysed by gender. Since all subjects are in the same age group, age therefore becomes a constant. Ownership gives the privilege of gaining computer experience [63]. Theoretically, in poor communities, females are more affected by poverty than males [64]. This may be attributed to society and cultural beliefs that disadvantages women, denying them opportunities that men are exposed to, like education. This is supported by the results of our study, depicted in the table below (table 4.2), which shows that more male learners own computers as compared to female learners. Of the learners who own computers, 65% are male with only 35% being female.

Gender	Ownership (%)	Non-Ownership (%)
Male	13	87
Female	7	93

Table 4.2: Percentage Computer ownership by gender

4.5 Variation of typing accuracy with typing speed

Empirical evidence points out that for novice and intermediate computer users, typing accuracy decreases with increasing typing speed [65]. To type accurately, a novice computer user has to focus on the keyboard and be sure of the keys before typing. This adversely affects typing speed. It is claimed that at very high typing speeds, the accuracy is severely compromised. It is therefore necessary to find the optimum typing speed so as to find the best trade-off between speed and accuracy.

4.6 Baseline performance

Learners were tested for their speed and accuracy prior to engagement. This was done so as to be able to compare the differences between performance before engagement and after, leading to a viable conclusion. Baseline performance is in line with theoretical claims that accuracy reduces with increase in speed, according to Franks et al. [66]. Both control and sample groups gave very strong negative correlation coefficients between speed and accuracy, of 0.995 and 0.997 respectively.

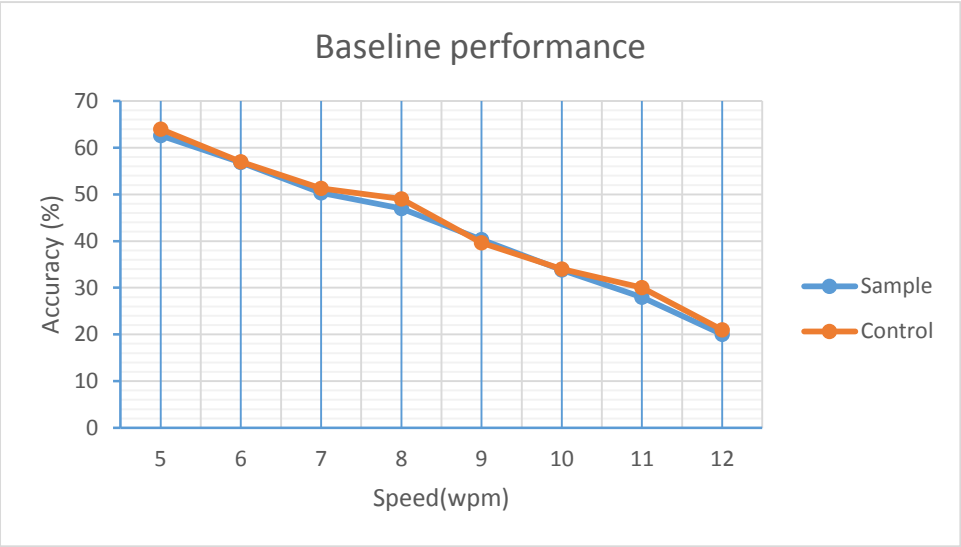


Figure 4.1 Baseline variation of average accuracy with typing speed for both the sample and control groups

Generally, the performance before engagement was comparable between males and females, with very small differences. After determining that data collected was normally distributed by using graphical methods, running an unpaired t-test results in p=0.91, indicating that the differences in the mean values for speed are not statistically significant.

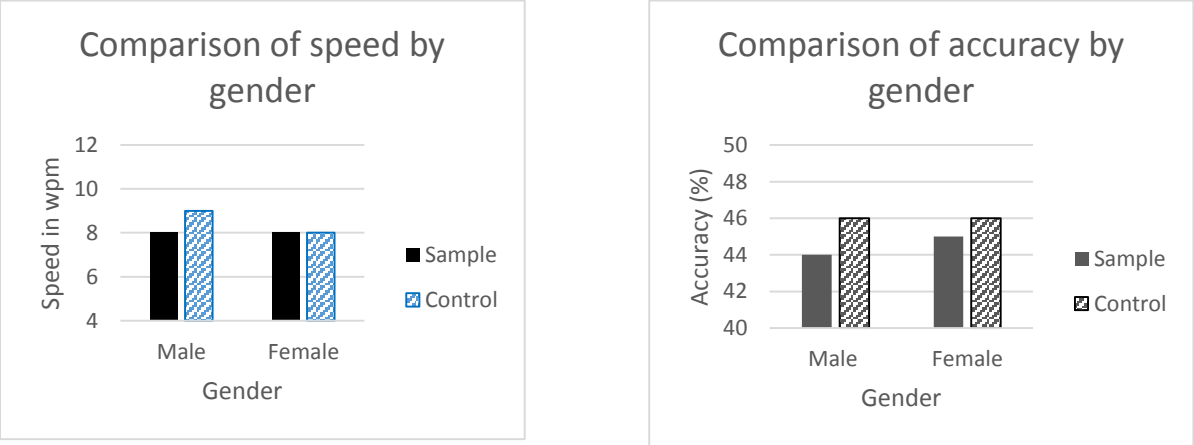


Figure 4.2 Comparison of (a) speed and (b) accuracy by gender

4.7 Speed

Results show that typing speed can be improved by using gamification techniques. Since typing is a skill, there is little knowledge that is required to develop it. The most important aspect is getting the basics, then gaining the skill through consistent practice.

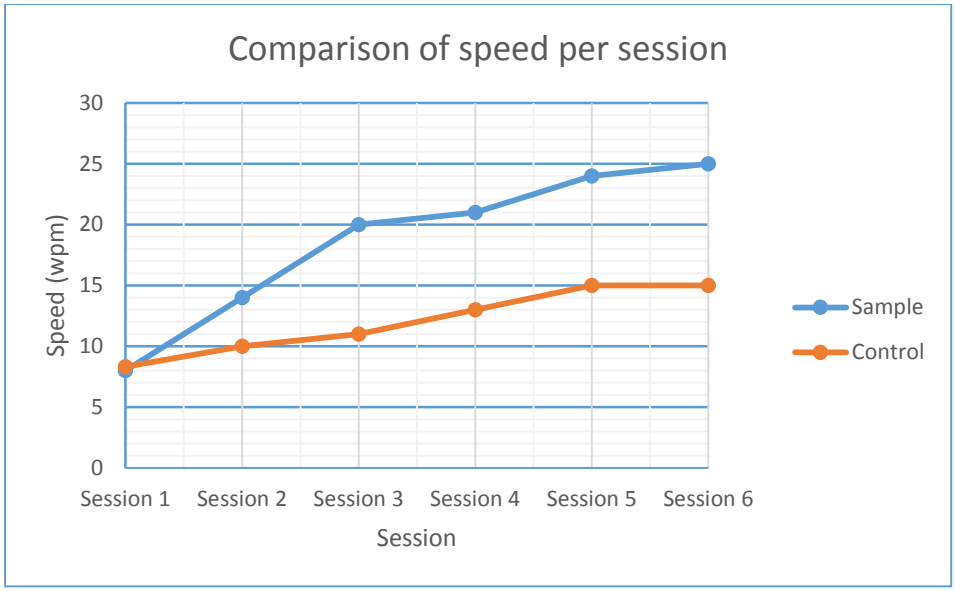


Figure 4.3 Comparison of average typing speed per session for both groups

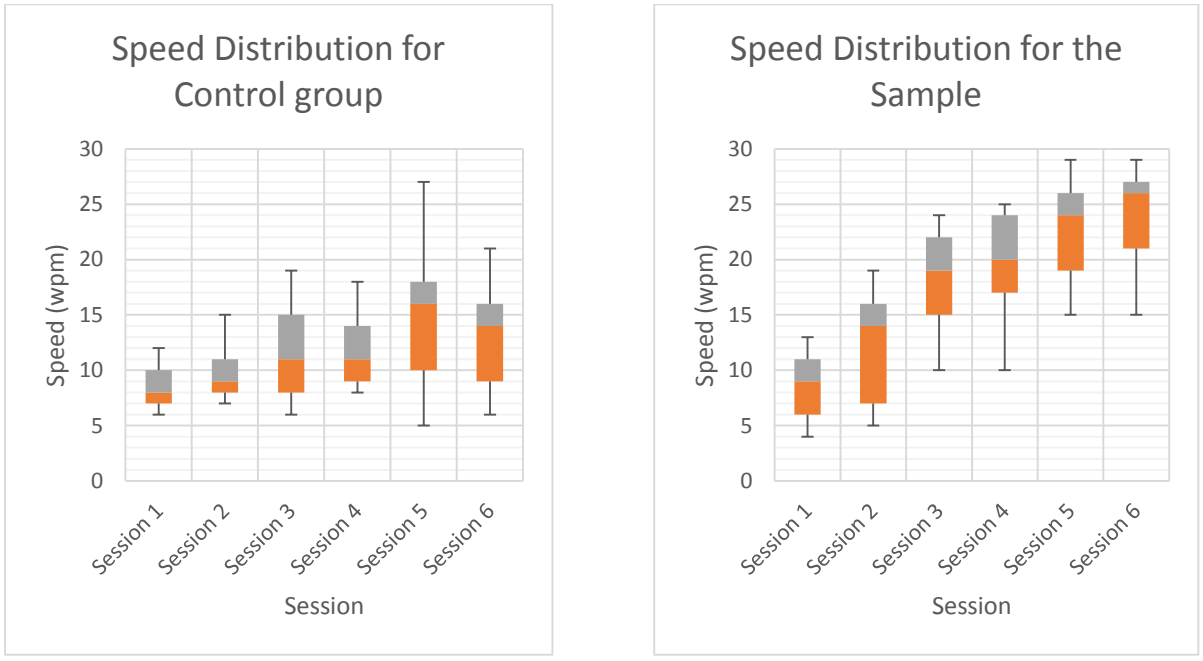


Figure 4.4 Speed distribution per session for (a) control group and (b) sample.

Over the 3 weeks, the mean typing speed of the sample increased, from a mean of 8wpm to a mean of 25wpm, a 213% increase. The same cannot be said for the control group, whose mean typing speed increased from 8wpm to 15 wpm, an 87% increase. As shown on the figure 1.7, there is an increase in the mean speed with frequency (number of sessions) for both groups. This increase came through regular practice. The graph levels out gradually, showing smaller increases. This may suggest that the

participants are tending their highest speeds, and therefore more practice can no longer improve it, but simply maintain. However, due to limited time and other challenges, the researcher could not carry out more sessions to verify this claim. While the graph comparing the mean speed shows that the mean for the sample group was always above that of the control group, one should appreciate that there are outliers in both groups. For the sample group, in most sessions, the lowest mark is far lower than the lower quartile compared to that of the control group. The maximum is very much comparable for both groups. Of interest to note is the outliers on the control group during session 5. The test for session 5 was challenging, with randomly generated, meaningless text which made it impossible for participants to predict. Therefore, those who had poor skills scored very low marks, while those competitive (only one) attained a very high score. The high scorer has previous computer experience, and owns a computer. Analysis shows that participants from the control group who attained comparable speeds to those in the sample group had previous, basic computer exposure or came from a household that owns a computer. Unpaired t-test for comparing the speed of the two groups, with n=52 and n=49 for the sample and control respectively gave a p value ($p= 0.045$), with a difference in the mean of 6.67wpm. 95% confidence interval of this data lies between 0.22wpm to 13.12wpm. The probability of rejecting the null hypothesis is statistically significant, hence the difference in speed for the two groups is not a mere coincidence, but can be attributed to gamification.

4.8 Accuracy

While speed is considered an important aspect of typing, and many end-user computing professionals are required to have a certain minimum typing speed, very seldom do people talk about accuracy. It is a common assumption that, when people talk about speed, accuracy is assumed to be 100%. However, having a high typing speed but with a lot of errors is problematic, since time will be wasted on editing and correcting the errors. Results obtained in this study shows that, like speed, accuracy can also be improved by practice. The average accuracy for the sample improved from

43% (baseline) to 93%, an increase of 116% (by a factor of more than 2), while that of the control group improved from 44% to 70%, an increase of 59%.

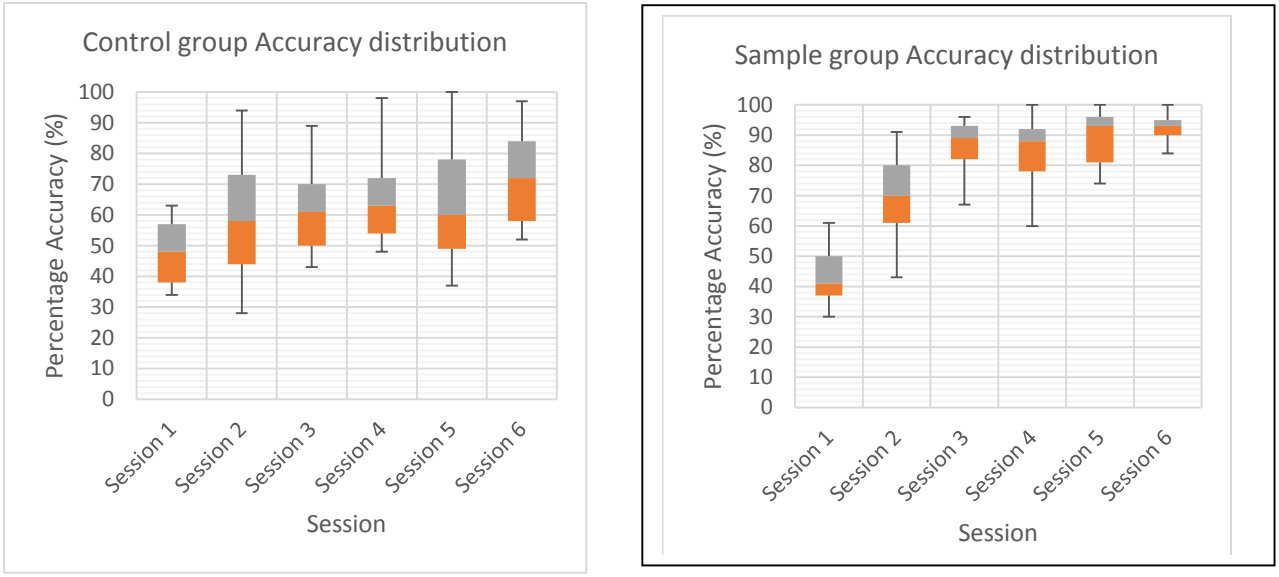


Figure 4.4 Speed distribution per session for (a) control group and (b) sample.

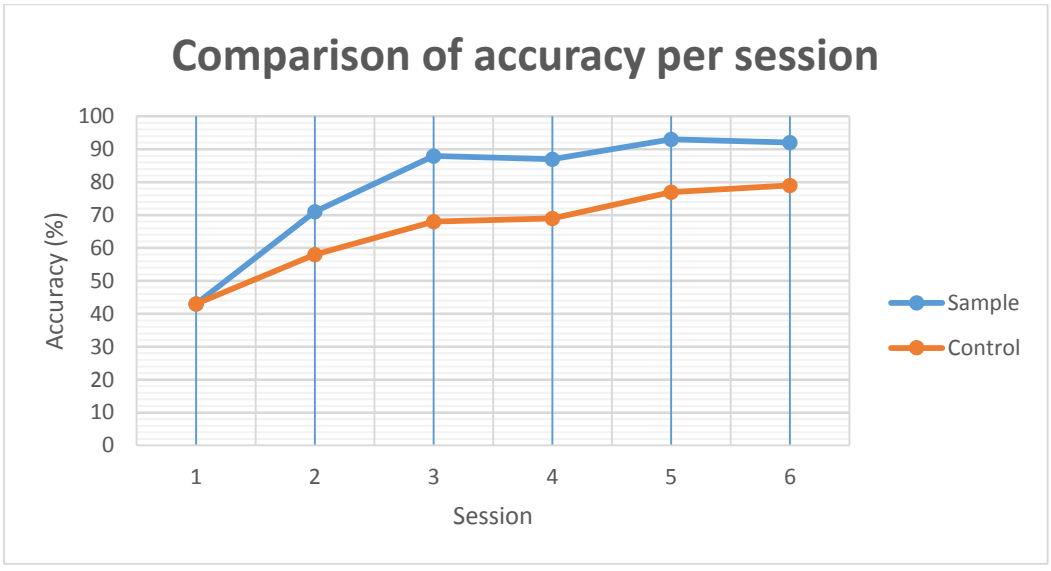


Figure 4.5 Changes in average accuracy with frequency of practice.

In this case, the probability of rejecting the null hypothesis that gamification cannot be effectively used for typing training is p=0.048, which is statistically significant. The difference in the mean of the two groups is 20.0, with 95% confidence interval between 0.42 and 39.58. Statistics thus support the rejection of the null hypothesis.

The trend shows that there is a strong correlation between changes in both accuracy and speed with frequency of practice. For the sample, the Pearson product-moment correlation coefficient between frequency (in hours) and accuracy is 0.85 (r=0.85) and 0.97 for the control group. Between frequency and speed r=0.95 for the sample, and 0.98 for the control. Interesting to note is the fact that in instances where speed drops, accuracy also drops. This could be accounted for by the level of difficulty of the exercises in these instances.

4.9 Speed versus accuracy

Research proves that for novices in any field, increasing the speed of execution results in a decrease in accuracy [66]. Baseline results in this study support this claim. However, during typing skills development training, both speed and accuracy increase. A graph of accuracy against speed shows a direct proportionality, with a positive regression coefficient of 2.88. Therefore, it can be concluded that regular practice improves typing skills.

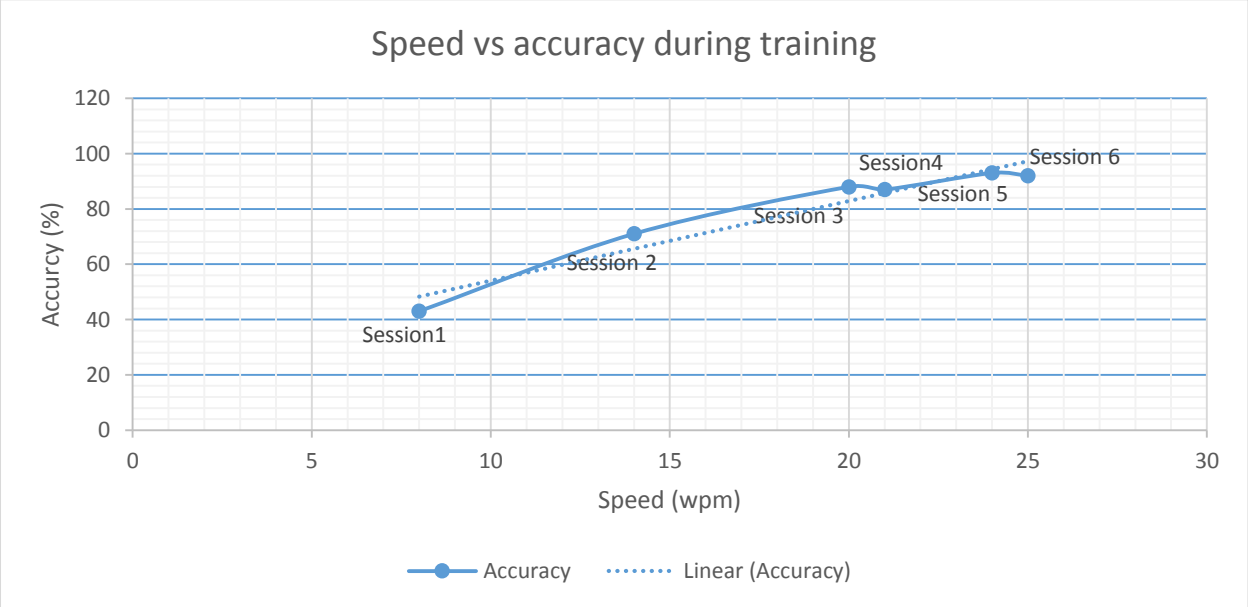


Figure 4.6 Relationship between speed and accuracy during training

4.10 Motivational aspects

The knowledge that computer skills are vital in the modern world, and increasingly dominate daily activities was the greatest motivator for learners in their volunteering to take part in the study. In addition to this, a number of gaming elements encouraged and motivated participation.

4.10.1 Leaderboard and competition

Naturally, all human beings strive to be the best. At the end of every game, a leaderboard was displayed to the player, showing the top 10 scores. Although only pseudonyms were used, players kept playing to try and ensure they are on the leaderboard. To avoid embarrassment to the bottom participants, the leaderboard only focused on the top achievers. Competition is within human nature, directly or indirectly. Most students enjoy competing, even if it is a blind competition [61] [28]. In this case, they were competing with someone they did not know, since pseudonyms were used. However, often the participants will recognise their competitors. Post training interviews reveal that the target for most of the students was to perform better than the class average, lowest or highest score. This resulted in ever-increasing scores for speed and accuracy.

4.10.2 Feedback

At the end of every activity, feedback was given. Post evaluation interview responses show that immediate feedback encouraged participants to keep practising, utilising the feedback to improve their performance. Furthermore, participants were motivated by the idea that feedback was personal, specific and they did not have to wait for it.

4.10.3 Branching choices

Completing activities had no sequential requirement. Participants were given the autonomy to choose how to complete activities, and which activities they would like to do. The freedom to choose was welcomed by all participants, citing in their responses that it gave them responsibility and accountability over their performance. Unlike academic activities where teachers dictate what should be done and when, participants found branching choices exciting and it motivated them to keep practicing. However, this led to some challenges (see section 4.10).

4.10.4 Achievement Awards

Participants could generate and view or print certificates for successfully completing certain activities. A certificate is considered a sign of achievement, and therefore each participant wanted to have as many certificates as possible. Most students admitted to being encouraged and motivated to practice by the need to have many certificates.

4.11 Challenges

4.11.1 Simulation

During data collection, a particular software system, Typing Master, was used. While the software used has most of the game elements required, it is not exactly what the researcher had intended initially. However due to time and finances required to develop the software to requirements, software available on the market had to be purchased and used. Typing Master does not offer badges and ranks, which were initially proposed to be incorporated.

4.11.2 Access to computer lab

The school where the study was done has its own internal challenges, in addition to being under-equipped. The school has an enrolment that is above its capacity. As such, there is a shortage of classrooms, and the computer lab is used as a classroom in a bid to alleviate this problem. There are a number of intervention programs, some of which use the computer lab, causing inconvenience and disruptions. Communication from the school was very poor, in some cases meetings would be arranged and clash with the scheduled times for typing training. The researcher would only find out once at the school, and no communication would be done to inform him of such cancellations. School times are not fixed, and at many times there would be disturbances, leading to learners being dismissed early, and the researcher would find all learners gone. In some cases, other activities ran late to such an extent that it was not be possible to engage the learners, since some use organised transport. These disruptions affected both groups, and to compensate for the time lost and ensure a fair comparison, lost sessions were rescheduled.

4.11.3 Sample size

Due to limited number of functional computers and limited time allocated to the researcher, the sample size was adversely affected. The ideal was to engage more than 200 participants. Unfortunately, only 52 participants could be engaged fully, which constitutes only one and a half classes, out of the seven classes. While learners from all classes wanted to take part, the shortage of computers was the limiting factor. The researcher had to bring to the school his own personal computers so as to maximize the number of participants.

4.11.4 Branching choices/freedom

While giving participants the freedom to choose which activities to do and how to complete them encouraged and motivated them to participate more, it introduces some challenges. The repercussion of this was an unbalanced trend in activities attempted. Participants ended up focusing on certain activities to the expense of others. The most attempted activities were games and tests. Lessons (studying) were the least attempted. Participants who attempted lessons would skip most of the drill courses, and focus on the touch typing course, and games, which were part of the lessons.

4.11.5 Trend of completion of activities

Games had the highest frequency of engagement compared to other activities. Research shows that most players play until they either complete a level, win the game, or reach their target score [67]. As such, when participants started playing games, they would play repeatedly until they achieved their goals. Words were generated randomly, to avoid cheating and to ensure that participants do not memorize the words. Of the games available, Clouds was the most appealing to participants, and had the highest average frequency.

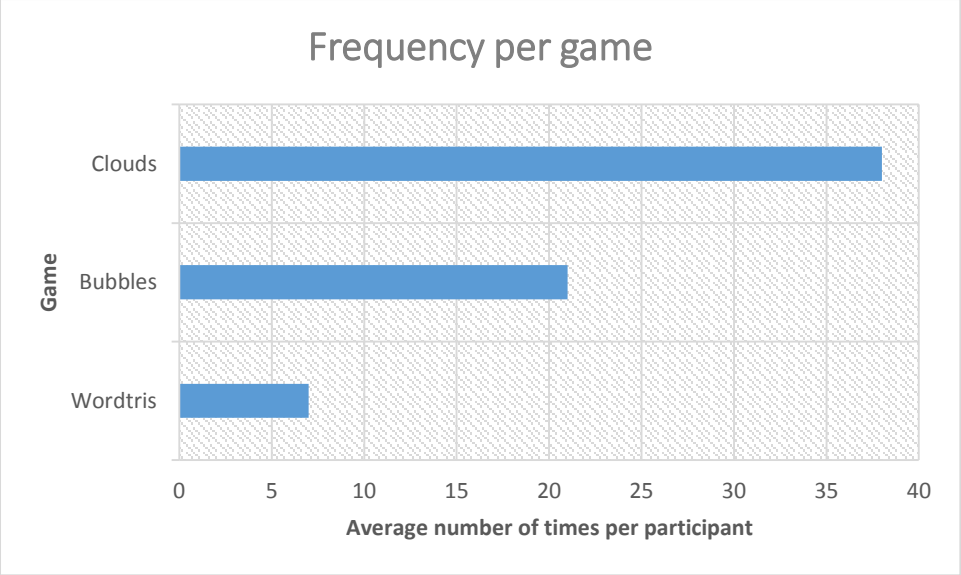


Figure 4.7 Comparison of frequency of playing games.

Tests were a compulsory part of the training. Although there was no strict rule as to the number of times a test could be attempted, the average number of attempts per test was 1.7, with a standard deviation of 0.88 and variance of 0.77. Most participants would retake a test only once, with some never retaking a test. The highest frequency per participant for a given test was 5. This was done by a participant who has no computer in their household, and has no access to a computer, does not own a cell phone, making the keyboard relatively new to her. This is in support to research evidence claiming that home computer ownership has an effect on a student's performance [68]. This participant was eager to improve her performance, and was embarrassed by her statistics. The trend shows that participants who do not own computers and do not have regular access to computers generally score less than those who have access [68]. The same participants have a tendency to repeat tests.

Lessons were the least completed activities. Initially, participants took time to go through the lessons and drill methods. However, as they gained knowledge and skills, they admitted that lessons and drill methods were monotonous and they preferred to learn through playing instead of following and completing a drill. Therefore, the first lessons have a higher percentage of completion than the subsequent ones.

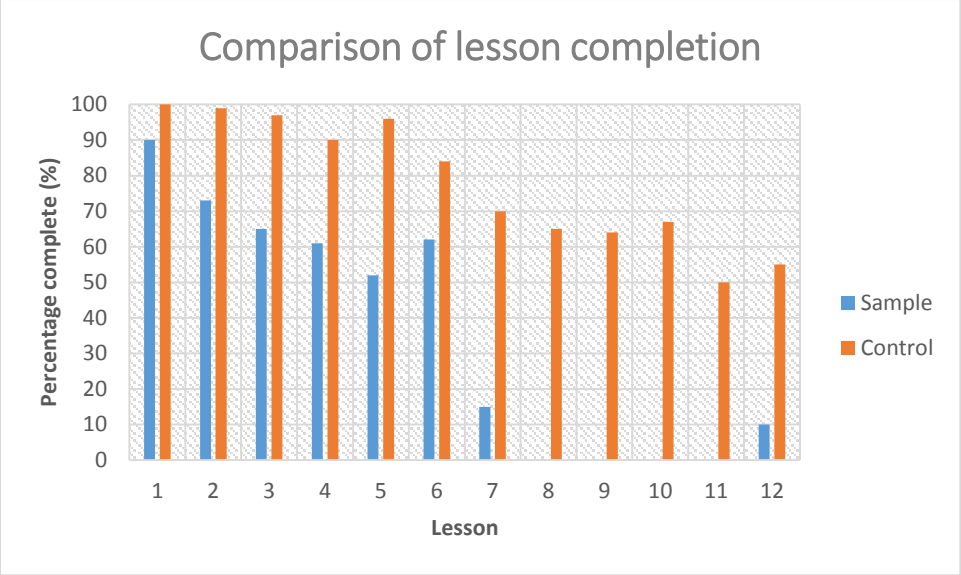


Figure 4.8 Percentages of lessons completed

A few students went on to complete the last lesson, skipping the other ones. This could be because they wanted to find out if there are any differences between the initial and subsequent lessons. However, for the control group, all lessons were attempted. This is mainly because the sessions were structured in a way that all control participants were directed to attempt all the activities by the researcher.

4.12 Discussion

This section discusses the major research findings. The meaning and importance of results of the study are explained. Links between findings are established, and similarities and differences are explained and justified, and recommendations are made. Relation to previous researches is established. To clearly discuss the results and findings, this section is sub-divided in such a way that each finding is stated and discussed separately.

1. ***Typing speed and accuracy can be increased by regular practice and gamification.***

Regular practice helps novice computer users familiarise themselves with the keyboard. This results in, initially, having a rough idea of the general location of each key on the keyboard. This reduces the time it takes to locate the required key and type, as well as the eye movement between screen and keyboard. With more practice, one gains knowledge of the actual position of each key, and skills in how to position fingers of the keyboard so as to easily access all keys without having to look. As practice results in one looking at the keyboard for a shorter period of time, it leaves more time for the monitor. Focusing on the monitor allows one to immediately identify and correct mistake, giving a higher accuracy. However, for most novices, it is easy to give up due to "computerphobia", lack of confidence, and poor computer skills. Therefore, to ensure regular practice, game elements may be incorporated. Gamification leads to a higher frequency of practice, which in turn improves both typing speed and accuracy. This finding shows that gamification is effective in improving typing skills for novice users.

2. ***Gamification can be used to motivate and encourage engagement.***

In line with the research question *"How can gamification be used in typing training?"* results reveal that activities with a high frequency of attempts are the gamified ones, with most drill-based methods not being attempted at all by the sample population. High frequency of engagement may be explained in terms of motivation and encouragement. While some activities basically have the same objectives, these objectives can only be achieved through engagement. Since the activities use different methods but have the same objectives, and in some cases are the same, the difference in engagement can therefore be attributed to the methods used. Gamified activities are therefore more interesting for participants. Thus, gamification can be used to motivate and encourage engagement. This conclusion is supported by empirical evidence, done in a variety of contexts [15] [25] [30] and supported by our study

3. ***Computer ownership has an effect on a pupil's ICT confidence, performance and self-esteem.***

Participants who have limited or no access to computers felt they were social misfits. This comes due to the fact that their peers from other schools and communities always talk about computers, technology and social networking, which they have no access to. The majority of participants had no email addresses, did not know how to create an email account, had no social networks accounts and could not operate a computer. Results show that the majority of participants live in households that do not have computers, and they do not have access to computers, which is in line with previous research findings [62]. During sessions, their confidence levels were very low, with most of them admitting to not knowing how to switch on/off a monitor. One of the participants was sceptical as to whether or not to participate or not. When asked why he was undecided, his response was:

> "I would like to take part in your lessons, but I am scared that others will laugh at me because I do not know how to use a computer. I have never used a computer before."

The response given by the participant may be interpreted as lack of confidence, fear of being a social misfit and low self-esteem. Schmitt & Wadsworth [62] carried out a study to find out if there is a relationship between a child's household computer ownership and academic performance. Their results show that computer ownership increases the probability of performing better. Based on Schmitt and Wadsworth's conclusion [62], the low computer ownership levels revealed in this study may be stretched to partially explain poor academic results at most underprivileged schools in the Cape Flats.

4. ***Males are more likely to own computers than females.***

Responses to the questionnaire show that males have a higher percentage of computer ownership than females. Imhof et al [6], in their study "Computer use and the gender gap: The issue of access, use, motivation, and performance" found out that males have higher computer access than females. They further ascertained that more males visit public facilities to get access to computers than females and females were less likely to own computers than males. The results of our study supports the claims made by Imhof et al, although the two studies were done in different contexts

and environments. In a separate study, Sanalan [69] found that females are less interested in computers than males. Although his population comprised teachers, his findings can be generalised. Sanalan's results may therefore be a useful explanation for less computer ownership in females than in males. On the contrary, it can be argued that lack of interest in computers in females is due to precollege computer access, and hence low confidence levels [70]. Furthermore, it is attributed to the fact that, in many poor communities, women are more affected by poverty than males due to the cultural beliefs in opportunities. Men are often given better economic opportunities than females.

Chapter 5: Conclusion and recommendations

This chapter presents a conclusion to our study into the effectiveness of gamification on typing training for novice computer users. Limitation are highlighted, challenges faced are stated and recommendations for further research are made. As part of the conclusion, key findings are stated, and the extent to which they answer the research questions.

5.1 Key Findings

The objective of this study was to find the effectiveness of gamification on typing training for novice computer users. In endeavouring to meet this objective, research questions were posed, data collected was analysed and the questions were answered.

Research Question:

What gamification design methodologies exist?

This question was answered by reviewing literature on gamification. Gamification is a methodology, where either content or the structure of an activity may be gamified. In some cases, it may be worthwhile to gamify both content and structure. For example, one may consider starting a lesson with a challenge instead of s list of objectives(content gamification), and awarding points to learners for attempting or completing tasks(structural), which may not necessarily be gamified. However, gamification design should be carefully done to ensure that users' interest is captured, so as to yield desired results.

Research Question:

How can gamification be used in typing training?

Our study reveals that gamification increases engagement through motivation and encouragement. By allowing failing and learning, as well as improving engagement, gamification helps novice computer users' gain typing skills without getting bored. Gamification gets participants' attention using the emotions of pleasure, competition, and other game elements, thereby motivating them to learn new things. However, poor gamification design may be detrimental to admired behaviour. Literature and theory suggest that skills may not necessarily be gained through observation, but

regular, consistent engagement. Since typing is a skill, it therefore means it may be gained and perfected by regular practice. Results show that gamified activities had highest frequency of attempts. Gamifying all or most of the activities will be a sure way of increasing engagement.

Research Question

What are the responses of students to gamified typing training?

Post training review showed that participants enjoyed the training sessions. A common theme that stood out among the responses is that gamification makes exercises interesting, even the ones that are normally "boring". One participant openly declared the wish for "teachers to adopt and use the same methods" for teaching tough and boring content, instead of them being "sleeping tablets to us". Although the sessions were 1hr 30 min, participants said they felt the sessions were short, since the time passed without them realising it. This, together with the results, shows that participants enjoyed gamification, and they welcomed it with a wish for it to be expanded to other academic learning areas.

Research Question:

How effective is gamification in improving typing skills for novice computer users?

Preliminary data shows that there is a strong negative correlation between typing speed and accuracy for both the control and sample groups ($r = 0.995$ and $r = 0.997$ respectively). Novice computer users struggle to find a trade-off between typing speed and accuracy. Both their typing speed and accuracy are below acceptable levels, with a speed of as low as 5 words per minute, and an accuracy of less than 20%. However, due to gamification of the structure and some of the content, participants became motivated and engagement increased. This resulted in an improvement in both typing speed and accuracy. Both speed and accuracy are directly proportional to frequency of engagement. By the end of the training, the average speed had improved from 8 wpm to 25wpm, while accuracy had shot up from 43% to 93% for the sample group. For the control group, speed improved from 8.3 wpm to 15wpm, and accuracy from 44% to 70%. A comparison of the two groups' speed and accuracy gave a p values of 0.045 and 0.0461 ($p=0.045$ and $p=0.048$) respectively, which are both statistically significant differences. Therefore, it can be

concluded that gamification of typing training is an effective way of improving typing skills for novice computer users.

5.2 Recommendations

This section presents practical recommendations usable by all stakeholders in education: schools, government, charitable organisations and parents. Recommendations for further research are also highlighted in this section. These recommendations are areas that need attention but were out of the scope of this study.

Investing in computers

- Literature points out that home computer ownership has a direct effect on academic performance. An analysis of South African public school matric results reveals that most underperforming schools are also under-equipped. These are schools in poor communities. The existence of a correlation between academic results and level of facilities/equipment at schools is not necessarily a cause-effect relationship. Nevertheless, parents should consider investing in computers to help their children perform better academically.

- Schools should invest in computers so as to give advantage to their learners and prepare them for tertiary studies and professional life. Students from schools that gave access to computers easily adapt to tertiary studies [71] [72]. Furthermore, schools should consider incorporating computer literacy as part of their curriculum (part of Life Orientation).

- Education specialists, curriculum developers and teachers should consider gamifying their content so as to improve engagement. Gamifying their teaching methodologies and using ICT in classrooms may also improve their academic results.

5.3 Recommendation for further studies

The limitations stated above suggest the need for further research so as to ensure more reliable results. It would be appropriate to choose a sample from more than one school in poor communities. For comparative purposes, this may be extended to other

provinces so as to further validate the results. Furthermore, it we be recommend to incorporate more gamification elements, for example, badges and ranks, as well as in-game purchases.

Based on the results of our study, we recommend follow-up research so as to determine the causes and effect of some of the answers given. It would be interesting to get an understanding of the attitudes of computer illiterate youths towards computers, and their knowledge of the importance of computer skills.

5.4 Conclusion

This descriptive study looked at the effectiveness of gamification methodologies for typing training of novice computer users. A questionnaire was administered so as to gather background information about participants. Analysis of the participants' responses revealed that the majority of them were computer illiterate, did not own computers in their households and did not have regular access to computers. In addition, it was found that computer ownership has an effect on a learner's self-esteem, confidence and performance. After an in-depth analysis of results, a conclusion is made that gamification is effective in typing training for novice computer users since it improves engagement and allows to fail and learn without any risk.

Bibliography

[1] Bunchball, "Gamification 101: an introduction to the use of Game Dynamics to influence behaviour," Bunchball, October 2010. [Online]. Available: http://www.bunchball.com/sites/default/files/downloads/gamification101.pdf. [Accessed 19 March 2016].

[2] M. I.C, "Raising engagement in e-learning though gamification.," in *6th International Conference on Virtual Learning (ICVL)*, Bucharest, 2011.

[3] B. Gros, "Digital Games in Education: The Design of Games-Based Learning Environments," vol. 40, no. 1, 2007.

[4] P. M., "Digital Natives, Digital Immigrants," vol. 9, no. 5, 2001.

[5] N. Elshemy, "Impact of Gamification strategy on academic achievement and achievement motivation toward learning.," in *Proceedings of Teaching and Education Conferences (No. 4907055). International Institute of Social and Economic Sciences*, Venice, 2017.

[6] M. Imhof, R. Vollmeyer and C. Beierlein, "Computer use and the gender gap: The issue of access, use, motivation, and performance.," *Computers in human behavior,* vol. 23, no. 6, pp. 2823-2837, 2007.

[7] I. C. Muntean, "Raising engagement in e-learning through gamification. In Proc. 6th International Conference on Virtual Learning ICVL (pp. 323-329).," in *Bucharest University Press*, Bucharest, October 2011.

[8] I. Blohm and J. M. Leimester, "Design of IT- Based Enhancing Services for Motivational Support and Behavioral Change," *Business and information Engineering,* vol. 1, no. 4, pp. 275 - 278, 2013.

[9] Bunchball, "Gamification 101: An introduction to the Use of Game Dynamics to influence behaviour," Bunchball, October 2010. [Online]. Available: http://www.bunchball.com/sites/default/files/downloads/gamification101.pdf. [Accessed 19 March 2016].

[10] H. Vermeulen, J. Gain , P. Marais and S. O'Donovan, "Reimaging gamification through the lens of Activity Theory," 2015.

[11] J. Zhuo and G. Salvendy, "Human aspects of IT for the aged population: Design for everyday life.1st International Conference ITAP 2015, held as Part of HCI International 2015," in *Springer*, Los Angels, CA, 2015.

[12] K. Kwastek, Aesthetics of Interaction in Digital Art, Cambridge: MIT Press, 2013.

[13] M. T. Malaby, "Beyond Play: A new approach to Games," *Games and Culture,* vol. 2, no. 2, pp. 95 - 113, 2007.

[14] A. Dominiguez, J. Saenz-de-Navarrete, L. De-Marcos, L. Fernandez-San, C. Pages and J. Martizen-Herraiz, "Gamifying learning experiences: Practical implications and outcomes," *Elsevier: Computers and Education,* vol. 63, pp. 380-392, 2013.

[15] K. S. Bista, S. Nepal, N. Colineau and C. Paris, "Using Gamification in an Online Community.," *Collaborative Computing: Networking, Applications and Worksharing (CollaborateCom), 8th International Conference,* pp. 611 - 618, 2012.

[16] M. Korolov, "Gamification of the Interprise: How to successfully add game features to coperate pocesses," 10 september 2012. [Online]. Available: http://aspnet.cob.ohio.edu/matta/mis2020/HotTopics/8.0%20Gamification%20of%20the%20enterprise.pdf. [Accessed 20 Marh 2016].

[17] H. Sarsa, J. Koivisto and J. Hamari, "Does Gamification work?- A Literature Review of Emperical Studies on Gamification. 47th International Conference on System Sciences(HICSS)," in *IEEE*, Hawaii, 2014.

[18] K. Squire and H. Jenkin, "Harnessing the Power of Games in Education," *Insight,* vol. 3, no. 1, pp. 5 -33, 2003.

[19] A. Scott and C. Naustaedter, "Analysis of Gamification in Education," School of Interactive Arts and Technology, Simon Fraster University, Surrey, 2013.

[20] I. M., D.-S. A. and D.-K. C., "Gamification for Engaging Computer Science Students in Learning Activities: A Case Study," *IEEE Transactions on Learning Technologies,* vol. 7, no. 3, pp. 291 - 301, 2014.

[21] B. McMahon and J. P. Portelli, "Engagement for what? Beyond popular discourses of student engagement," *Leadership and Policy in Schools,* vol. 3, no. 1, pp. 59 -76, 2004.

[22] R. M. Ryan and R. L. Deci, "ntrinsic and extrinsic motivations: Classic definitions and new directions. Jan 1;25(1):54-67," *Contemporary educational psychology.,* vol. 25, no. 1, pp. 54 - 67, 2000.

[23] B. Gros, "Digital Games in Education: The Design of Games-Based Learning Environments," *Journal of Research on Technology in Education,* vol. 40, no. 1, pp. 23 -38, 2007.

[24] M. Prensky, *Digital Natives, Digital Immigrants,* vol. 9, On the horizon, 2001.

[25] S. Deterding, M. Sicart, M. Nacke, K. O'Hara and D. Dixion, "Gamification: Using game design elements in non-gaming contexts: ACM CHI'11. Extended abstracts on Human Factors in Computing Systems," in *ACM CHI'11*, Vancouver, 2011.

[26] K. Kapp, "Understanding Games and Gamification," 5 March 2015. [Online]. Available: www.slideshare.net/kkapp/understanding-games-and-gamification/. [Accessed 10 May 2016].

[27] S. Isaacs, "The difference between gamification and game based learning," 15 January 2015. [Online]. Available: www.inservice.ascd.org/the-difference-between-gamification-and-game-based-learning. [Accessed 10 May 2016].

[28] B. L. M. R. Kapp K.M., The Gamification of Learning and Instruction Fieldbook: Ideas into Practice, Wiley and Sons, 2013.

[29] Unknown, "elearning infographics," 5 October 2015. [Online]. Available: www.elearninginfographics.com/games-vs-game-based-learning-vs-gamification-infographics/. [Accessed 10 May 2016].

[30] J. Hamari and J. Koisisto, "Why do people use gamification services?," *International Journal of Information Management,* vol. 35, no. 4, pp. 419 - 431, 2015.

[31] S. O'Donovan, J. Gain and P. Marais, "A Case Study in the Gamification of a University- level Games Development Course. In Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference (pp. 242 - 251)," in *ACM*, East London, 2013.

[32] M. Filsecker and T. D. Hickey, "A multilevel analysis of the effects of external rewards on elementary students' motivation, engagement and learning in an educational game," *Computers and Education,* vol. 75, no. 1, pp. 136 -148, 2014.

[33] S. Baron, "Cognitive Flow: The Psychology of Game Design," Gamasutra, 22 March 2012. [Online]. Available: http://www.gamasutra.com/view/feature/166972/cognitive_flow_the_psychology_of_.php. [Accessed 3 May 2016].

[34] C. Dichev, D. Dicheva, G. Angelova, Agre and G, "From Gamification to Gameful Design and Gameful Experience in Learning," *Cybernetica and Information Technologies,* vol. 14, no. 4, pp. 80 - 100, 2014.

[35] P. Be Byl, "Can Digital Natives Level-Up in a Gamified Curriculum?," *Future Challanges, Sustainable Futures,* pp. 256 - 266, 2012.

[36] A. Marczewski, "Gamification Elements, Mechanics and ideas," 4 February 2015. [Online]. Available: www.gamified.uk/2015/02/04/47-gamification-elements-and-ideas/. [Accessed 10 May 2016].

[37] M. D. Hanus and J. Fox, "Assessing the effects of gamification in the classroom: A longitudinal study on intrinsic motivation, social comparison, satisfaction and academic performance," *Computers & Education,* vol. 80, no. 1, pp. 152 -161, 2015.

[38] C. H. Lin and E. Liu, "A comparison between drill-based and game-based typing software. III, pp.48-58," *Transactions on Edutainment,* vol. 3, pp. 48 - 58, 2009.

[39] M. A. De-Alguilera M., M. De-Algeilera and A. Mendiz, "Video Games and Education (Education in the face of a " Parallel School")," *Computers in Entertainment,* vol. 1, no. 1, p. 1, 2003.

[40] R. K. Yin, Case study research: Design and methods. Thousand Oaks, CA: Sage., Sage, 2013.

[41] W. G. Zikmund, B. J. Babin, J. C. Carr and M. Griffi, Business research Methods, Cencage Learning, 2013.

[42] A. Bryman and E. Bell, Business Research Methods, USA: Oxford University Press, 2015.

[43] D. R. Copper, P. S. Schindler and J. Sun, Business Research Methods, Mcgraw-hill, 2003.

[44] J. W. Creswell, Research design: Qualitative, quantitative, and mixed methods approaches., Sage, 2013.

[45] S. D. Lapan and M. T. Quartaroli, Research Essentials: An Introduction to Designs and Practices, San Fransisco: Jossey-Bass, 2009.

[46] C. R. Kothari, Research Methodology and Techniques, New Delhi: New Age International, 2009.

[47] M. T. Blanche , K. Durrheim and D. Painter, Research in practice: Applied methods for the social sciences. Juta and Company Ltd., Cape Town: UCT Press, 2006.

[48] C. Seal, G. Gobo, J. F. Gubrium and D. Silverman , Qualitative Research Practice, Wiltshire: Sage, 2007.

[49] S. L. Jackson, Research Methods: A Modular Approach, Belmont: Thomson Wadsworth, 2008.

[50] M. Denscombe, "Communities of practice: A research paradigm for the mixed methods approach," *Journal of mixed methods research,* vol. 2, no. 3, pp. 270 - 283, 2008.

[51] W. J. Orlikowski and J. J. Baroudi, " Studying information technology in organizations: Research approaches and assumptions.," *Information systems research,* vol. 2, no. 1, pp. 1 -28, 1991.

[52] K. Peffers, T. Tuunanen, M. A. Rothenberger and S. Chatterjee, "A design science research methodology for information systems research.," *Journal of management information systems,* vol. 24, no. 3, pp. 45 - 77, 2007.

[53] U. Serakan and R. Bougie, Research Methods for Business: A skill-Building Approach, Chennai, India: Willey, 2014.

[54] H. K. Klein and M. D. Myers, "Klein, H. K., & Myers, M. D. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems," *MIS quarterly,* pp. 67 - 93, 1999.

[55] "My Market Research Methods," [Online]. Available: http://www.mymarketresearchmethods.com/the-market-research-process-6-steps-to-success/. [Accessed 30 03 2017].

[56] F. J. Gravetter and L. B. Forzano, Research Methods for the Behavioral Sciences, Wardsworth, 2009.

[57] E. Lee and J. Park, "Challenges and Perspectives of CS Education for Enhancing ICT Literacy and Computational Thinking in Korea," *Indian Journal of Science and Technology,* vol. 9, no. 46, pp. 1 -13, 2016.

[58] J. D. De Hart and B. Stergois, "Simulations, Literacy, and Learning," *Journal of Adolescent & Adult Literacy,* vol. 60, no. 4, pp. 485-487, 2017.

[59] E. Kim, L. Rothrock and A. Freivalds, "The effects of Gamification on engineering lab activities," in *Frontiers in Education Conference (FIE), 2016 IEEE*, 2016.

[60] F. Bruhlmann, K. Opwis, A. N. Tuch and E. D. Mekler, "Do points, levels and leaderboards harm intrinsic motivation?: an empirical analysis of common gamification elements," in *In Proceedings of the First International Conference on gameful design, research, and applications, ACM.*, 2013.

[61] J. Chapman and P. Rich, "Identifying Motivational Styles in Educational Gamification," in *In Proceedings of the 50th Hawaii International Conference on System Sciences*, 2017.

[62] J. Schmitt and J. Wadsworth, "Is there an impact of household computer ownership on children's educational attainment in Britain?," *Economics os Education,* vol. 25, no. 6, pp. 659-673, 2006.

[63] K. Hans and B. Hemker, "The impact of computer use at home on students' Internet skills," *Computers & Education,* vol. 49, no. 2, pp. 460 - 480, 2007.

[64] Z. Oxaal, Education and poverty: A gender analysis, Sussex: Institute of Development Studies at the University of Sussex, 1997.

[65] Y. Monotori, M. J. Crump and G. D. Logan, "Speed–accuracy trade-off in skilled typewriting: Decomposing the contributions of hierarchical control loops," *Journal of Experimental Psychology: Human Perception and Performance,* vol. 2013, no. 3, p. 687, 2013.

[66] N. R. Franks, A. Dornhaus, J. P. Fitzsimmons and M. Steven, "Speed versus accuracy in collective decision making," in *Proceedings of the Royal Society of London B: Biological Sciences*, London, 2003.

[67] J. L. Sherry, "Flow and media enjoyment," *Communication Theory,* vol. 14, no. 4, pp. 328 -347, 2004.

[68] J. Schmitt and J. Wadsworth, "Is there an impact of household computer ownership on children's educational attainment in Britain?," *Economics of Education review,* vol. 25, no. 6, pp. 659-673, 2006.

[69] V. A. Sanalan, "Computerphobia in Preservice Teachers," *International Education Studies,* vol. 9, no. 3, p. 217, 2016.

[70] L. Shashaani, "Gender differences in computer attitudes and use among college students," *Journal of Educational Computing Research,* vol. 16, no. 1, pp. 37 - 51, 1997.

[71] K. De Jager and M. Nassimbeni, "Institutionalizing information literacy in tertiary education: Lessons learned from South African programs.," *Library trends,* vol. 51, no. 2, p. 167, 2002.

[72] E. Dednam, "Away with computer literacy modules at universities, or not?," in *2009*, Proceedings of the 2009 Annual Conference of the Southern African Computer Lecturers' Association. ACM.

[73] "University Of Cape Town," [Online]. Available: https://www.cput.ac.za/...cput/.../admission_requirements_16jul2015.pd. [Accessed 24 March 2016].

[74] "Cape Peninsular University Of Technology," [Online]. Available: https://www.cput.ac.za/...cput/.../admission_requirements_16jul2015.pdf. [Accessed 23 March 2016].

[75] "Stellenbosch University," [Online]. Available: www.maties.com/admissions/admission-and-selection-requirements.html. [Accessed 24 March 2016].

[76] M. Crotty, The foundations of social research: Meaning and perspective in the research process, Sage, 1998.

[77] D. Tettelbach, L. Fields and A. M. Alvero, "Effects of performance feedback on typing speed and accuracy," *Journal of Organizational Behavior Management,* vol. 27, no. 4, pp. 29 - 52, 2008.

[78] S. L. Britner and Pajares F, "Sources of science self-efficacy beliefs of middle school students," *Journal of research in science teaching,* vol. 43, no. 5, pp. 485 -499, 2006.

[79] J. M. Harackiewicz, A. M. Durik, K. E. Barron, L. Linnenbrink-Garcia and J. M. Tauer, "The role of achievement goals in the development of interest: Reciprocal relations between achievement goals, interest, and performance.," *Journal of educational psychology,* vol. 100, no. 1, p. 105, 2008.

[80] S. Hidi, "Interest: A unique motivational variable," *Educational Research,* vol. 1, no. 2, pp. 69 - 82, 2006.

Appendix A: Software specifications

Design Brief

A significant amount of students entering university/college do not possess the typing skills (i.e. speed and accuracy) necessary in order to work comfortably with computers as their main writing tool. With the current trend of classes, assignments and educational material moving to being hosted online - on platforms such as Blackboard (an example of educational management system) - this gap in skills severely hinders students' ability to work and learn. We need the use of a typing training software to improve typing skills for novice computer users.

Goal

- To design and develop/find a typing training software that can meet the requirements below.
- To investigate whether the software can prove effective in reducing the gap in student typing skills through a combination of technical and gamified typing exercises.

Requirements

Users and their functions

The software should have users with functions/access as specified below:

Admin:

- Track all users' activities and user progress; manage and maintain the database.
- Add, remove and edit users (override password)
- Activate/deactivate password option for users

Users:

- Register and login
- Access to all training content and activities. (No administrative authority)

User experience

A student using the software is expected to be able to do the following:

1) Log on/log off

a) Pseudonym/Code name

2) View past performance

a) Speed
b) Accuracy
c) Completed activities
3) Do technique exercises - these will introduce and enforce correct typing technique
4) Play typing game(s)
a) this will provide an engaging experience for students to practice their typing techniques
5) Participate in challenges
a) Harder/timed exercises
b) View class leaderboards

Database

The software should have a database that can:

1) Gather the following metrics per session
a) User log ins (to determine frequency of use)
b) Typing speed (in words per minute, wpm) and accuracy (percentage)

Platform

The software is expected to:

1. Be compatible and accessible/runnable from Windows (7, 8, XP, 10)
2. Allow multiple users to sign-in & use the program at the same time

The software should have the following, and their specifications:

Tutorials/training

Touch typing training (drill), where users are trained through correct keyboard techniques, like positioning fingers, which fingers should punch which keys etc. This may be broken down into short tutorials to eliminate the monotony.

Rewards to be offered:

1. Points based on the time spent and speed reached
2. Badges and ranks equivalent to the speed and accuracy reached (e.g., badges or stars for speed, rank for accuracy)

Exercises and challenges (quests) should offer:

1. Practice based on training completed
2. Students should be given points and ranks for completing exercises and challenges.
   NB: Challenges (quests) are optional exercises which are ideally a bit challenging, randomly displaying text (may be meaningless), and would therefore give more points. It is expected of challenges to be much harder than the normal exercises.

   At the end of each level (games), exercise or challenge, the system should provide feedback to the user; give awards appropriately (points, badges, stars).
   The leader board must be given on a link (for those who want to view it), not always displayed. Only the top participants should be displayed on the leaderboard.

Assumptions

1. All computers are connected to the network(LAN).

Out of scope

The software is not required to do the following:

1. Data analysis - this will be performed after the data has been collected and is not a requirement of the software.
2. Non-typing instruction (e.g. familiarity with navigating Windows; using a mouse; I.T. terminology)

NOTE: Although this is out of scope, the software would ideally be designed to allow it to be extended; hopefully this kind of functionality can be added in the future.

NOTES

1. Speed is calculated in words per minute (WPM), or stokes/keys per minute. WPM is based on 5 letters as one word.

Appendix B: Ethics approval Application

UNIVERSITY OF CAPE TOWN
FACULTY OF SCIENCE RESEARCH ETHICS COMMITTEE

RESEARCHER ETHICS STATEMENT

A key function of the Faculty of Science Research Ethics Committee is to screen and approve, or otherwise refuse, all research proposals in the Faculty that relate to human subjects (see definition in section 2 overleaf), including questionnaires involving human participants; this includes proposed research involving students or staff, by UCT researchers or by outside visiting researchers. Research that does not involve human subjects does not need to be submitted to this committee for approval. Research on animals needs to be approved by the Faculty's Animal Ethics Committee; and research that uses biological materials from humans (e.g. fresh tissues, blood or body fluids) needs also to be approved by the Faculty's Biological Safety Committee.

This **researcher ethics statement form** and the appended **informed consent form** should be completed by the actual person undertaking the research ('the applicant'). Place the **tick** provided in the **Yes** or **No** box, and **type** in details where appropriate. Please read the '**UCT Code for Research involving Human Subjects**' before completing the form: http://www.uct.ac.za/downloads/uct.ac.za/about/policies/ethicscode.pdf

In the case of research that involves a number of researchers, this form should be endorsed and signed by the Principal Investigator (PI). If the applicant is a student, the supervisor must endorse and sign the form and ensure that the student is fully informed of his/her ethical responsibilities. Where the research is part of a project that is being co–ordinated from outside the Faculty of Science, the researcher should fill in the form in relation to her or his part of the larger research project. The turnaround time for a reply is approximately 7 working days.

E-mail this completed **form in** the original **MS Word format** to:
The Servicing Officer: Ms Shanaaz Smith, Faculty of Science Research Ethics Committee at shanaaz.smith@uct.ac.za

Expedited Review

Researchers who use participants only to test the **usability** of programmes and applications (typically from those in the Computer Science Department) *and* are not working with any vulnerable populations (e.g. pregnant women, minors, or prisoners) may apply for **expedited review** by ticking "Yes" for question 2. Applications for expedited review are not necessarily faster, but only require the approval of one member of the Science Research Ethics Committee. '**Usability**' in this context is defined to include learnability, efficiency, memorability, accuracy, ease of use and user experience, typically with an artefact or prototype. However, if such 'usability' research also involves the collection of any privately identifiable or sensitive personal data about participants (e.g. information on disabilities, vulnerabilities, health/medical conditions and/or treatments), then the proposal is **NOT** eligible for expedited review. Projects using human subjects other than for 'usability' purposes will be submitted for review by the full committee.

Appendix C: Ethics Approval

UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

Faculty of Science
University of Cape Town
RONDEBOSCH 7701 South Africa
E-mail: timm.hoffman@uct.ac.za
Telephone: + 27 21 650 5551

29 August 2016

Silence Chomunorwa
Department of Computer Science

Typing Training Through Gamification

Dear Silence Chomunorwa

I am pleased to inform you that the Faculty of Science Research Ethics Committee has approved the above-named application for research ethics clearance, subject to the conditions listed below. You are required to:

- In your revised application which should be submitted to Shanaaz Smith please (1) include an additional disclaimer in your consent form stating that "...choosing not to participate will not have any impact on your marks, recommendations, etc." ;
- Ensure that the application form is duly signed by all who need to do so;
- Please make sure that you get approval from CPUT to use their students in the same way that this is required of researchers working with UCT students.
- Implement the measures described in your application to ensure that the process of your research is ethically sound; and
- Uphold ethical principles throughout all stages of the research, responding appropriately to unanticipated issues: please contact me if you need advice on ethical issues that arise.

Your approval code is: **FSREC 046** – 2016

I wish you success in your research.

Yours sincerely

Prof Timm Hoffman
Chair: Faculty of Science Research Ethics Committee

cc. Supervisor: A/Prof James Gain

Appendix D: Permission Letter

MANZOMTHOMBO SENIOR SECONDARY SCHOOL

P.O. Box 161, Blackheath, 7581
Telephone No.: (021) 901 0100 Fax: 071 698 0111
admin@manzomthombo . wcape.school.za

2016-09-05

Mr. S. Chomunorwa

We have considered you application and presentation on request to conduct research at Manzomthombo and I am pleased to inform you that your request is granted.

However, the permission is valid on condition that:

- You do not disrupt the smooth running of the school.
- You adhere to conditions outlined in your letter of request.
- You respect all learners who participate, and take into consideration their different abilities.
- You inform the school authorities on a regular basis on the progress of the project.
- You do your research in an ethical manner, as outlined in your letter.

Yours faithfully

J. Matiso (Mr.)
PRINCIPAL

Appendix E: Computer Literacy Questionnaire

Computer Literacy Questionnaire

Information provided in this form is needed for the research that you chose to participate in. Please note that you are free to withdraw at any time. You are not under any obligation to answer all, or part of the questions. However, if you choose to answer some of the questions, it is imperative that you provide your code name. No personal information is required, and do not disclose or share your code name with anyone, including the researcher.

Note that a computer in this questionnaire is defined as either a desktop or a laptop, not other " machines for processing data" e.g tablets, mobile phone etc.

*Required

1. **1a.Please enter your code name and Gender**

2. **b.Gender**
   Mark only one oval.
   - ◯ Male
   - ◯ Female

3. **2. Do you own a computer?**
   Mark only one oval.
   - ◯ Yes
   - ◯ No

4. **3. Does anyone you stay with own a computer?**
   Mark only one oval.
   - ◯ Yes
   - ◯ No

5. **3a. If Yes, how often do you have access/use a computer?**
   Mark only one oval.
   - ◯ Never
   - ◯ Rarely
   - ◯ Monthly
   - ◯ Weekly
   - ◯ Daily

6. **3b. If No, do you have regular access to any other computer?**
   Mark only one oval.
   - ◯ Yes
   - ◯ No

ɔcs.google.com/forms/d/1xGxYGJFBEY3UrVKlqqPzZlleN0KQbXu4LkW7aim9TEc/edit

7. **4. How confident are you with computers?**
Mark only one oval.

	1	2	3	4	5	
not confident	◯	◯	◯	◯	◯	very confident

8. **4a. I can switch on/off a computer, monitor and printer**
Mark only one oval.

- ◯ Yes, with confidence. I have done it several times
- ◯ Yes, but not confidently
- ◯ Not sure, have never done it before
- ◯ No, I can't

9. **5. How do you rate your current computer skills level?**
Mark only one oval.

- ◯ Very poor
- ◯ Poor
- ◯ Fair
- ◯ Good
- ◯ Very good

10. **6. Rate your confidence in using the keyboard**
Mark only one oval.

	1	2	3	4	5	
not confident	◯	◯	◯	◯	◯	very confident

11. **7. Rate your confidence in using the mouse**
Mark only one oval.

	1	2	3	4	5	
not confident	◯	◯	◯	◯	◯	very confident

12. **8. I know the difference between drives, folders and files**
Mark only one oval.

	1	2	3	4	5	
Strongly agree	◯	◯	◯	◯	◯	Strongly disagree

13. **9. I know how to zip and unzip folders**
Mark only one oval.

- Yes
- No

14. **10. I can confidently search for information on the internet**
Mark only one oval.

- Yes
- No

15. **11. I can attach files to an email, and do an online submission**
Mark only one oval.

- Yes
- No

16. **12. I know the parts of a keyboard**
Mark only one oval.

- Yes
- No

17. **13. If you answered Yes to question 12, name the parts of a keyboard**

_____

_____

_____

_____

_____

18. **14. I know how to use a word processor to check for grammar and spelling mistakes**
Mark only one oval.

- Yes
- No

19. **15. How do you rate your typing skills?** *
Mark only one oval per row.

	Poor	Fair	Good	Excellent
Accuracy				
Speed				

20. **16. I believe typing skills can be improved by:** *

Mark only one oval per row.

	I agree	I agree to some extend	I disagree
Playing computer games			
Being taught using drill methods			
Regular practice			
Playing computer games that use the keyboard for controls			

Appendix F: Post Intervention Questionnaire

Post Training Questionnaire

This questionnaire may only be completed by people who participated in the typing training experiment conducted at Manzomthombo Secondary School. It is not an obligation for anyone to fill i this form, but your honest feedback is very important to us.

1. **1. Enter your code name**

_____

2. **2. Gender**

Mark only one oval.

- ◯ Female
- ◯ Male

3. **3. On a scale of 1 to 5, rate your computer skills.**

Mark only one oval.

	1	2	3	4	5	
Poor	◯	◯	◯	◯	◯	Excellent

4. **4. On a scale of 1 to 5, rate your typing accuracy**

Mark only one oval.

	1	2	3	4	5
Accuracy	◯	◯	◯	◯	◯

5. **5. On a scale of 1 to 5, rate your typing speed**

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

6. **6. What did you enjoy most during the training?**

_____

_____

_____

_____

_____

7. **7. What did you like least/hate during training?**

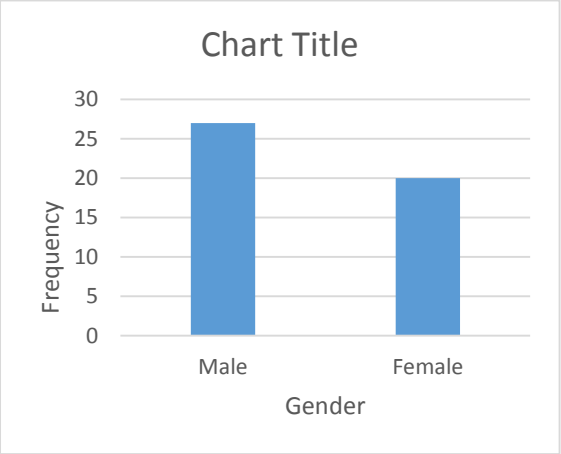
8. **8. Rate the following aspects on their usefulness and effectiveness in encouraging and motivating you to engage (0-not useful, 5-Very useful)**
Mark only one oval per row.

	1	2	3	4	5
Leaderboards					
Lessons					
Tests					
Feedback					
Awards(certificate)					
Freedom to choose					
Games					
Other(specify)					
Other(specify)					

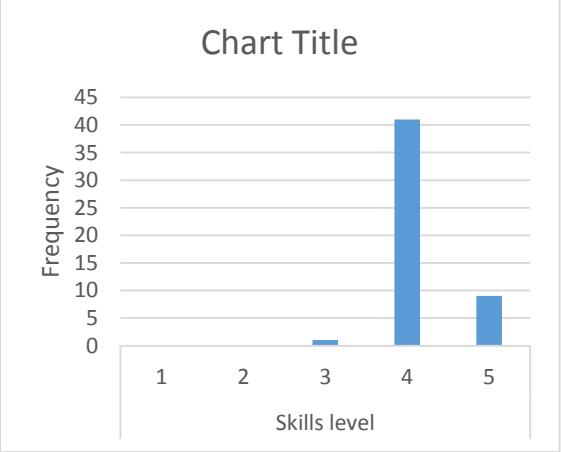
9. **9. Is there anything you would have loved to be incorporated? List such elements**

Appendix G: Post training questionnaire responses

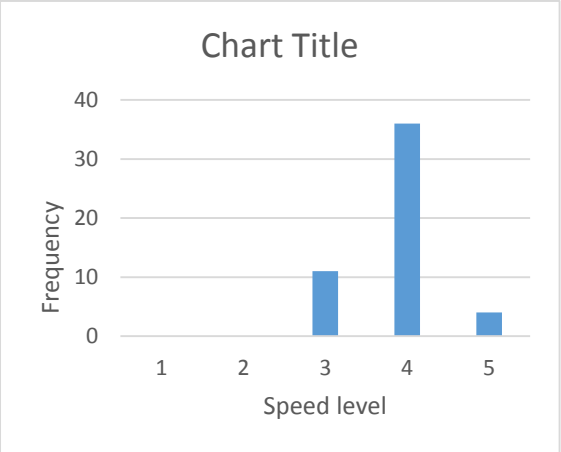
Gender



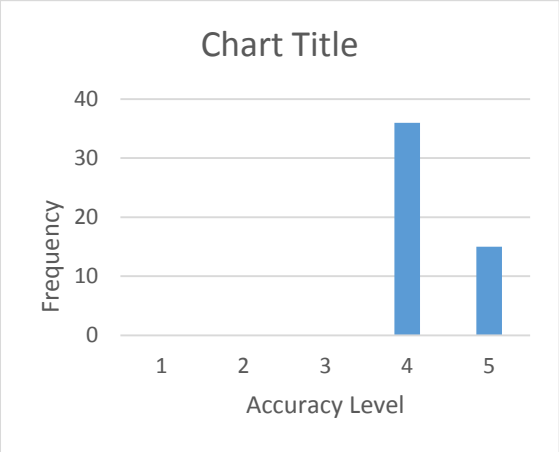
On a scale of 1 to 5, rate your computer skills. [1-Poor, 5-Excellent]



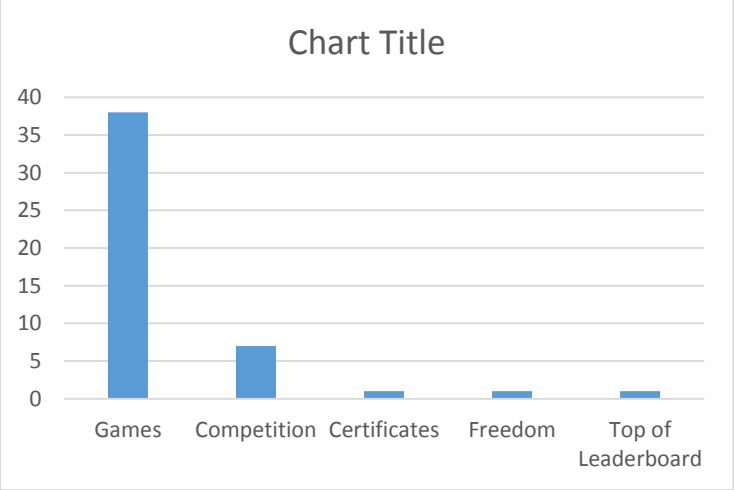
On a scale of 1 to 5, rate your typing speed. [1- Poor, 5- Excellent]



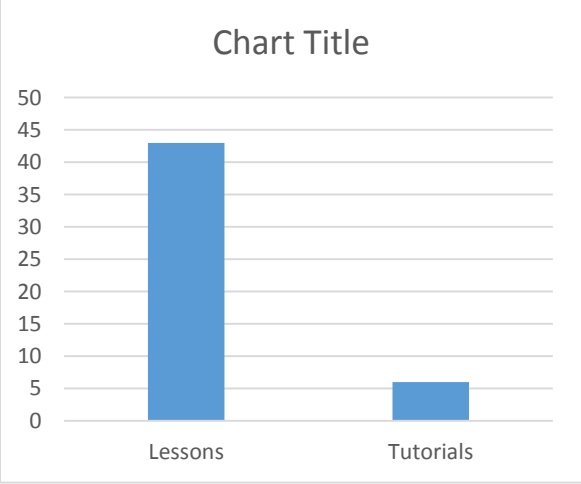
On a scale of 1 to 5, rate your typing accuracy. [1- Poor, 5- Excellent]



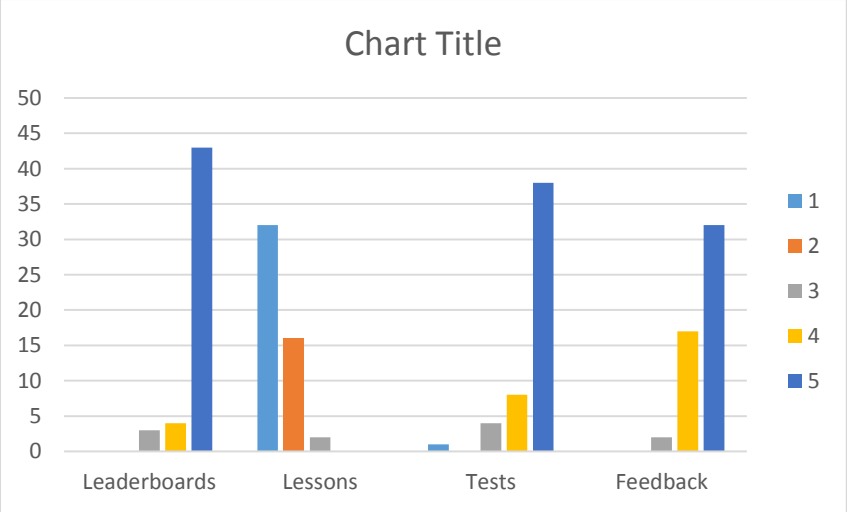
What did you enjoy most during the training?



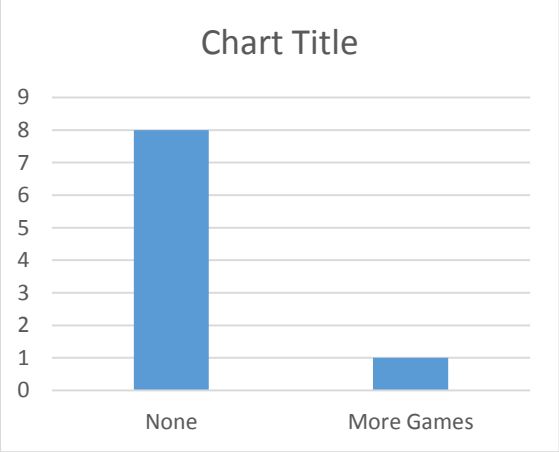
What did you like least/hate during training?



Rate the following aspects on their usefulness and effectiveness in encouraging and motivating you to engage (0-not useful, 5-Very useful)



Is there anything you would have loved to be incorporated? List such elements



Appendix H: Interview Guide

Interview responses

1. **Why did you choose to participate?**
   Mark only one oval.

   - ◯ Improve computer skills
   - ◯ For fun
   - ◯ To be with my friend
   - ◯ To learn how to use computers

2. **At the end of the sessions, you wanted to stay longer. Why?**
   Mark only one oval.

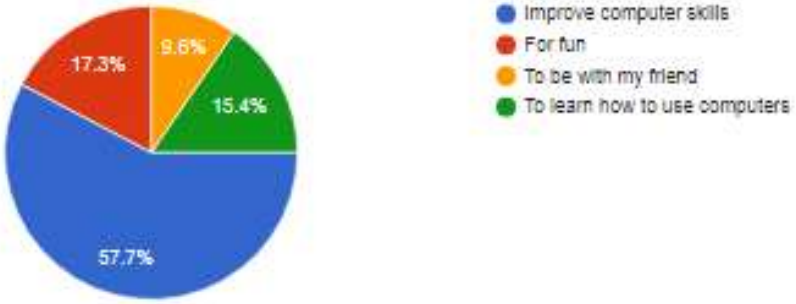
   - ◯ I wanted to score more points and be on top of the leaderboard
   - ◯ To do more tests and beat my previous score
   - ◯ To use the feedback to improve my next score
   - ◯ To keep playing games

Appendix I: Interview Responses Summary

SUMMARY | INDIVIDUAL

Why did you choose to participate?

52 responses



At the end of the sessions, you wanted to stay longer. Why?

52 responses