# Mobile devices in a blended learning environment in higher education

**by**

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**Supervisor: Prof L van Ryneveld**

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# Ethical Clearance Certificate

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## Declaration

I, Mari van Wyk, student number 98280857, declare that the thesis, which I hereby submit for the degree PhD (Computer Integrated Education) at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

I further declare that I had multiple co-authors in the first article on blended learning. I conceptualised the research, critically reviewed the literature, and drafted the article myself. The co-authors contributed to some of the literature and acted as critical readers. The remaining articles were co-authored with my supervisor. Her contribution was mainly in an advisory and editorial capacity.

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Mari van Wyk

7 June 2018

## Ethics statement

High ethical standards were maintained in this thesis. After the participants had given written consent, data was collected electronically and is currently stored on a password-protected device. The raw data can only be accessed with permission from the Ethics Committee of the Faculty of Education at the University of Pretoria in South Africa. This study was guided by the University rules and regulations with regard to ethics (University of Pretoria, 2018).

## Dedication

I dedicate this research to my husband, children, friends and family who supported and encouraged me throughout this research.

**Acknowledgements**

To have achieved this milestone in my life, I would like to express my sincere gratitude to the following people:

- Prof L van Ryneveld, research supervisor, for her positive attitude, guidance and encouragement as she walked this journey of academic growth with me.

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- Also, I thank the participating students of the Faculty of Veterinary Science for their commitment to the project, their valuable time and their thoughtful input.

**Abstract**

The use of mobile devices, in the South African context, has not yet been fully exploited. There is a need, in higher education, for mobility between places of study. This is especially true for students busy with their veterinary studies at a faculty of veterinary science at a South African university. Therefore, the purpose of this study was to explore how mobile devices and applications could be used to benefit teaching and learning practices in this blended learning environment.

In line with the qualitative nature of the study, a series of case studies were explored and data were collected from student experiences as they worked with mobile devices in their various educational environments. Through analysing responses to questionnaires, feedback in group interviews, and observations, two themes emerged, namely the practice of taking notes with mobile devices, and the use of an application called Vetbox to book, log and assess students' practical exposure to veterinary cases.

The results were in line with the Technology Acceptance Model (TAM) where the usefulness and ease of use when working with mobile devices and applications, not only had an influence on the attitude of the students using the devices to take notes and to work with educational software, but also on their behavioural intent and actual use of these mobile devices and applications.

This study contributes to the existing body of educational technology research in the sense that it shows note-taking as one of the key affordances of mobile devices. In addition, it highlights the functionalities that a mobile device and its associated applications require for effortless note-taking. Also, the study highlighted the importance of the student's voice in all phases relating to the use of mobile devices and applications in teaching and learning in higher education.

Therefore, if any research about the use of educational technology or development of applications is planned, the importance of user input though all the phases of development or adoption must be considered. It is also recommended that further research be done on the development of note-taking applications that incorporate the suggestions expressed in this thesis.

**Key Terms:** Action camera; blended learning; cognitive demanding note-taking; educational technology; educational software; higher education; mobile devices; note-taking; perceived ease of use; perceived usefulness; student generated educational videos; student voice; veterinary education; video; video note-taking

## Preface

My observations in lecture halls over more than 20 years as a lecturer formed my perception of the world of higher education. It also ignited a fire and passion for teaching in me whilst forming my research interests. For example, when I started teaching in 1995, I immediately observed the immense poverty of students entering higher education. Also, the lack of computer literacy and the lack of access to educational resources and support became evident. A year later, in 1996, I obtained my first mobile phone.

At that time, the most prominent advantage of the mobile phone was its mobility and thus its convenience. As the years went by, mobile phones became a common sight in South Africa. The capabilities of the mobile phone evolved from only a device to call and send text messages, to a device that can also connect to the internet and provide access to a variety of resources and services. As I observed this evolution, I became increasingly aware of the potential of using such a device in an educational context. This was when my interest in mobile devices and their advantages for higher education, in particular, was born. The way in which mobile devices such as smartphones can be used in education fascinated me. It dawned on me, early in this journey, that it is important to get students' acceptance and buy-in for using their mobile devices for learning purposes, and that I would not be able to make unilateral decisions about the way forward.

As students embrace the omnipresence of mobile phones in their personal life, I would like to see them embracing it in their academic life. Thanks to my observations and my passion for mobile technologies, I was curious about how mobile devices could be used in a blended learning environment in higher education. Determining the way in which students use these devices in their learning environment, and obtaining their suggestions for teaching and learning with technology, thus formed the foundation of this study.

This thesis is structured and formatted as a series of journal articles. During this study, three of these articles have been published in accredited peer-reviewed journals, namely the *Medical Education Online, Progressio: South African Journal for Open and*

*Distance Learning Practice*, and *Education and Information Technologies*. Another one of the articles was published in the double-blind peer-reviewed ACM International Conference Proceedings Series.

In view of the blended learning context of the study, I first focused on blended learning, blended learning tools and how those tools could be used to improve the student success rate. From this literature review, the article *The effective use of blended learning tools that promote success among South African undergraduate students* was written. This article forms the basis of Chapter 2 in this thesis.

As I was specifically interested to see how Veterinary students use mobile devices in a blended learning environment, I spent some time informally observing them in a number of contexts, including formal lectures, in- and outdoor practicals and in a various clinical environments. I came to the conclusion that there was a marked difference between the learning environments of the pre-clinical students (Year 2, 3 and 4) and the clinical students (Year 5 and 6). Therefore, the rest of my study focused on these two groups of students separately.

In terms of the pre-clinical group (Year 2 - 4), the focus was originally on the way these students used their mobile devices in class and in practicals. Although not expected, it became clear during the data analysis of the initial questionnaire and the subsequent group interview, that the veterinary students used their mobile devices mainly to take notes in the different learning environments. As a result, the focus of this part of the study changed slightly, from the broad perspective of mobile usage in a blended learning environment, to a more narrowed focus on the use of mobile devices for note-taking purposes, in particular. From this part of the research four articles were prepared, namely *Taking notes with mobile devices: a university case study*, *Exploring videos as note-taking tools*, *Exploring the use of an action camera in veterinary science education,* and *Affordances of mobile devices and note-taking apps to support cognitively demanding note-taking.* These four articles form the basis of Chapter 3.

The other group of veterinary students (Year 5 & 6) no longer attended formal lectures and practicals, but rather performed supervised clinical duties in the veterinary academic hospital and in multiple other clinical settings, such as private veterinary

practices and government departments. Informal observations showed that most of these clinical students did not use their mobile devices for any other purposes than for accessing Vetbox.

Vetbox is a custom-made educational software programme that was developed by the veterinary faculty in order to provide a way for students to log specific procedures, and to enable formally trained clinicians to assess the clinical students' new-found skills. However, despite the obvious advantages that Vetbox offered, and the potential value it could add to the education of these clinical students, it seemed as if they were not keen to use the programme.

The article that came from this component of the study was *Listening to the student voice to improve educational software*. Because the students' feedback was so constructive, several of their suggested changes were made to the software program. One of these suggestions, included the fact that they wanted the program to be available as a mobile application (app). The newly developed app addressed three key aspects namely the booking of clinics, the logging of the students' procedures and the assessment thereof by clinicians. Therefore, a second journal ready article, namely *Investigating perceived usefulness as a measure of acceptance for a veterinary mobile application,* followed. The two articles mentioned above, form the basis for Chapter 4.

To complete this research study, the final chapter of this thesis contains the conclusion and recommendations.

# Language editor

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**TO WHOM IT MAY CONCERN**

This is to confirm that the thesis titled ***"Mobile devices in a blended learning environment in higher education"*** by Mari van Wyk was proof read and edited by me in respect of language.

I verify that it is ready for publication and / or public viewing in respect of language and style.

Please note that no view is expressed in respect of the subject specific technical contents of the document or changes made after the date of this letter.

Kind regards

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## List of abbreviations

| | |
|---|---|
| APPS | Application on a Mobile Device |
| HESA | Higher Education South Africa |
| ICT | Information Communication Technology |
| ICT4RED | Information Communication Technology for Rural Education Development |
| IDC | International Data Corporation |
| LMS | Learning Management System |
| NMC | New Media Consortium |
| OER | Open Educational Resource |
| PEU | Perceived Ease of Use |
| PU | Perceived Usefulness |
| TAM | Technology Acceptance Model |
| UCT | University of Cape Town |
| UK | United Kingdom |
| USA | United States of America |
| UVIS | Universal Veterinary Information System |
| VAH | Veterinary Academic Hospital |

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# CHAPTER 1: GENERAL ORIENTATION

## INTRODUCTION

The popularity of mobile devices is not only a reality for people in everyday life, but is also reflected in the lives of students in higher education (Shepman, Rodway, Beattie & Lambert, 2012; Sooryamoorthy, 2014; Walace, Clark & White, 2012). To validate this statement, researchers claim that a mobile device ownership rate of 80% to 90% applies to students in many institutions of higher education (Alfawareh & Jusoh, 2014; Deloitte, 2016; Farley, Murphy, Johnson, Carter, Lane, Midgley, Hafeez-Baig, Dekeyser & Koronios, 2015; Poll, 2015; Potgieter, 2015). In an attempt to take advantage of the popularity of mobile devices, many colleges and universities are redesigning their learning spaces to adopt new educational practices to achieve the goals of education, namely to prepare students to acquire the skills they need to be successful in their workplace and to enable them to bring about change in the world of today (Next Generations website). These innovations often take place in a blended learning environment where technology and traditional classroom settings are combined to create new learning spaces (Next Generations website). According to the researchers who drew up the New Media Consortium (NMC) Horizon Report of 2017, blended learning is still a key technology driver in higher education (Adams Becker, Cummins, Davis, Freeman, Hall Giesinger & Ananthanarayanan, 2017).

How, and to what extent, mobile devices can be used in a blended learning environment in higher education still needs to be investigated thoroughly. Therefore, to further such investigation, the focus in this thesis will firstly be on blended learning and then on how students use mobile devices in the learning environment, specifically in the traditional lecture hall and in the clinical settings of health science students, such as the veterinary students who participated in this study.

## INTRODUCTION TO FIELD OF STUDY

In the next section, the affordances of mobile devices will be discussed, with the focus on how they can be used in a higher education context. A description will follow of the Generation Y students in relation to blended learning. Finally, the way in which the

world of the lecturer is blended with that of the student through the use of technology, will be explored.

**Affordances of mobile devices in higher education**

In the context of mobile devices, the term ‘affordance’ refers to the fundamental properties of the device that determines how it can be used (Norman, 2013). Affordance therefore refers to how mobile devices can be used, rather than to the specific features of the device (Parsons, Thomas & Wishart, 2016). Kordt (2018) explained that an affordance occurs through the interaction that take place between an individual and a device. For example, different affordances can be experienced by individuals when using the same technology (Kordt, 2018). Over the years, researchers have indicated various affordances of mobile devices for education purposes, and some of them will be highlighted in more detail below (Bull, 2013; Parsons et al., 2016; Sung, Chang & Liu, 2016; Willemse & Bozalek, 2015; Yi, 2016).

Although the term “mobile” in the context of mobile devices refers to the portability of these devices and to the ease with which they can be taken from one place to another, the concept of mobility also suggests that the devices and their operating technologies have been designed for personal use rather than shared use (Naismith, Lonsdale, Vavoula & Sharples, 2004). However, Bhargava, Lackey, Dhand, Moshiri, Jambhekar and Pandey (2013) point out that mobile devices like smartphones and tablets are increasingly being used for training students. Because these devices are fast, mobile and conveniently available, they seem to be the prefered device for content-related, technical and administrative tasks (Bhargava et al., 2013).

Furthermore, mobile devices are excellent for both interactivity and connectivity (Bhargava et al., 2013). With each upgrade, mobile devices now offer more powerful communication tools, allowing for calls, texts, video messages and data transfers, to name but a few (Ventola, 2014).

Smartphones and tablets also provide fast access to information of all kinds through the use of podcasts, applications, books, journals and recent research (Gomez-Iturriaga, Bilbao, Casquero, Cacicedo & Crook, 2012). In addition, they enable the

completion of tasks anytime and anywhere, and are generally more affordable than personal computers and laptops. Because they weigh very little, they are portable and can easily be taken anywhere (Gomez-Iturriagaa et al., 2012).

The increased use of mobile devices with their innate ability to connect to the Internet, allows students to use their mobile devices for self-paced and self-directed learning. In doing so, this individuality allows student to work independently from others (Sung et al., 2016; Yi, 2016).

Although mobile technologies were not originally designed for educational purposes (Traxler, 2010), their omnipresence challenges lecturers and researchers to develop applications so that they can be used in education. For example, Bogossian, Kellett, and Mason (2009) report that the use of tablets has improved time management, enhanced communication and allowed more flexibility for students who want to prepare before attending lectures. In addition, Ifenthaler and Schweinbenz (2013) emphasise the tools and functionalities of mobile devices where students have access to cameras, microphones (multimodal interaction) and eBook readers, and can receive instant feedback through messaging applications (Ifenthaler & Schweinbenz, 2013). Alvares, Brown and Nussbaum (2011) add that tablets can be used to improve the sharing of ideas when students work in groups (collaborative work). It is noteworthy to mention that while using mobile devices, the boundaries of the classroom fade, and that the learning environment then moves with the student (Martin & Ertzberger, 2013).

The use of mobile devices in education has infiltrated the school classrooms and university lecturing halls. For example, in 2015 one of the provinces in South Africa launched a paperless education pilot project where students from selected schools received tablets (Oxford, 2015; Bendile, 2015). In the following years, these students will become first-year students at the universities of South Africa. In addition to the school project, universities in South Africa have also embarked on similar projects where they either provide students with a mobile device or expect students to bring their own devices (Alfreds, 2013; Fripp, 2013; University of KwaZulu-Natal, 2013). It is thus evident, that the potential value that mobile technologies can add to the higher education environment, is increasingly recognised.

## Blended learning

One of the distinguishing qualities of the current generation of students, known as Generation Y (typically born between 1982 and 2003), is that they grew up with technology and internet access freely available. As such, the world as they see it, and the world of their lecturers (typically born much earlier) are not necessarily synchronised (Berk, 2010; Traxler, 2010). In an attempt to blend these two contrasting worlds, technology can be introduced in the formal learning environment.

Although a lot has been said about the Generation Y students currently attending classes (Caruso, 2014; Hurst & Good, 2009; Oblinger & Oblinger, 2005; Wheeler, 2013), there is no clear indication of a specific teaching and learning strategy to match their characteristics, except for students' natural and intuitive inclination towards the use of technology (Berk, 2010). However, these students exhibit a variety of characteristics that include the following: they flourish in circumstances that involve technology, rely on search engines to find information, communicate visually, multi-task in everything, require rapid response and feedback, are flexible, connected and interactive, are team-orientated and encourage collaboration (Berk, 2010; Black, 2010; Howe & Strauss, 2003; Reilly, 2012).

Taking all of the above into consideration, traditional teaching methods do not seem to match the preferences of this generation, and therefore new technologies could help to engage these students, who are already comfortable using this ever-changing technology in their daily life as well as in their educational life (Berkowitz, Kung & Eisenberg, 2013). This combination of classroom teaching and the use of technology is defined by many researchers as blended learning (Bailey, Ellis, Schneider & Van der Ark, 2013; Graham, 2004; Köse, 2010; Owston, Wideman & Murphy, 2008; Poon, 2013).

The existing literature shows that researchers have different opinions about what exactly is meant by the concept of blended learning. For example, Osguthorpe and Graham (2003) refer to blended learning as a combination of the benefits of face-to-face methods with online methods. In this definition, the elements of the blended

learning environment include both online and face-to-face learning activities, as well as students and their lecturers.

Driscoll (2001) also concludes that blended learning has different meanings for different people. She distinguishes between four variations of blended learning, namely the combination of web-based technologies, the combination of pedagogical approaches with or without technology, the combination of face-to-face training with any kind of instructional technology, and the combination of technology with actual work-based tasks (Driscoll, 2001).

Owston et al. (2008) state that, when adapting a blended learning approach, blended learning provides more flexible access to learning because it allows students to work online at their own convenience. In a similar vein, the definition of blended learning could be seen as the integration of appropriate technologies in the curriculum to support and deliver successful learning (Traxler, 2010), with the co-presence of a teacher and students (Friesen, 2012), where both the practices of traditional teaching and e-Learning are exploited (Aleksić & Ivanović, 2013).

As indicated above, it is clear that mobile devices are popular among higher education students and that they are readily available to students, even in a developing country such as South Africa. The fact that mobile devices are available creates opportunities for use in higher education that cannot be ignored. Moreover, the students, who are currently registered at universities, are more technologically inclined than any other generation before them, and therefore the incorporation of the use of technology in the classroom should be thoroughly investigated. The literature points towards this use of technology being presented in a blended learning environment where contact sessions meet technology.

## PROBLEM STATEMENT

In spite of living in a society where many people are resource-deprived and where statistics show that only 20% of the households own a computer, 95% of all South Africans own a mobile device (Statistics South Africa 2013, 2014). The availability of mobile devices therefore create enormous opportunities for education. Access to

information, which was previously limited to well-off registered students, is now available to everybody through mobile devices. Service providers provide free internet or WiFi hotspots to their customers in shopping malls, coffee shops, libraries and airports, to name a few (Odendaal, 2016), and many large cities in South Africa, like Tshwane and Cape Town, have embarked on projects to provide free WiFi spots at various locations (Alfreds, 2016). This trend was also extended to some schools and universities where registered students have easy access to the internet.

In the South African educational context the value of the use of mobile technology has not yet been fully exploited. There is a strong need, specifically in higher education, for mobility between classrooms, places of study, and the workplace. Furthermore, in some study fields like medicine, engineering, science and education, students have to move between classrooms, laboratories and the clinical workplace, and they do not have access to networked computers at all those places, yet.

Although the title of the study implies that the research was done in a blended learning environment in higher education, this particular study took place at a faculty of veterinary science at a South African university where student veterinarians and veterinary nurses attend class. These students start with pre-clinical studies where they typically attend lectures and demonstrations in a combination of theoretical and practical classes.

After completing the theoretical component of their studies, students work in veterinary clinics and in veterinary hospitals, for a minimum of 18 months, as part of their experiential training. In that context, they have to book their clinics as they rotate from one section to another throughout the year. They also need to keep records of all the patients they see and the skills they master. Historically, this information was recorded in paper-based logbooks, which were easily lost or damaged. At the faculty of veterinary science, where the veterinary students who participated in the study were based, a new software program (Vetbox) was launched to enable students to capture and record evidence-based case logs online, as well as book their clinical rotations.

This online system had a number of advantages. For example, students were able to upload photos or videos of the cases that they observed or treated. They were also

able to upload video evidence of the procedures that they carried out independently, or under the supervision of a qualified clinician.

However, in reality it was noticed that even though the Vetbox system was available, it was underutilised. This lead the researcher to wonder if it could be that the end-users of the program, namely the clinicians and the clinical students, did not perceive the program to be useful, as indicated in Davis' (1989) Technology acceptance model, or did their unwillingness to actually use the program relate to its ease of use (Davis 1989).

As mentioned by previous researchers such as Kobus, Rietveld and Van Ommeren (2013), Gikas and Grant (2013) and Traxler (2010), many students at higher education institutions already own a mobile device, and the actual challenge is to determine how these technologies can be integrated into the students' learning environment. Because this research was approached from an interpretivist viewpoint, the manner in which these devices could be used by students in their authentic learning environments was explored, and an investigation into how they experienced the use of mobile devices in the different learning realities mentioned above (Mackenzie & Knipe, 2006) formed a central part of this research.

## PURPOSE OF THE RESEARCH

The purpose of the study was to determine how mobile devices and mobile applications are currently used in a blended learning environment in higher education and to explore ways in which their use can be expanded to benefit higher education teaching and learning practices.

## RESEARCH QUESTIONS

This leads to the overall question:

*How can mobile devices be used in a blended learning environment in higher education?*

To answer this question, the following two sub-questions were considered:

1. How can blended learning tools be used to enhance student success (Chapter 2)?
2. How can mobile devices be used to support the learning experience of veterinary students in
    (a) the pre-clinical component of the study (Chapter 3), and
    (b) the clinical component of the study (Chapter 4)?

Because this research was documented as a series of journal ready articles, more in-depth questions had to be asked. Each of these additional questions will be addressed in a related section, but to show the full picture, an overview of all the questions can be seen in Figure 1.

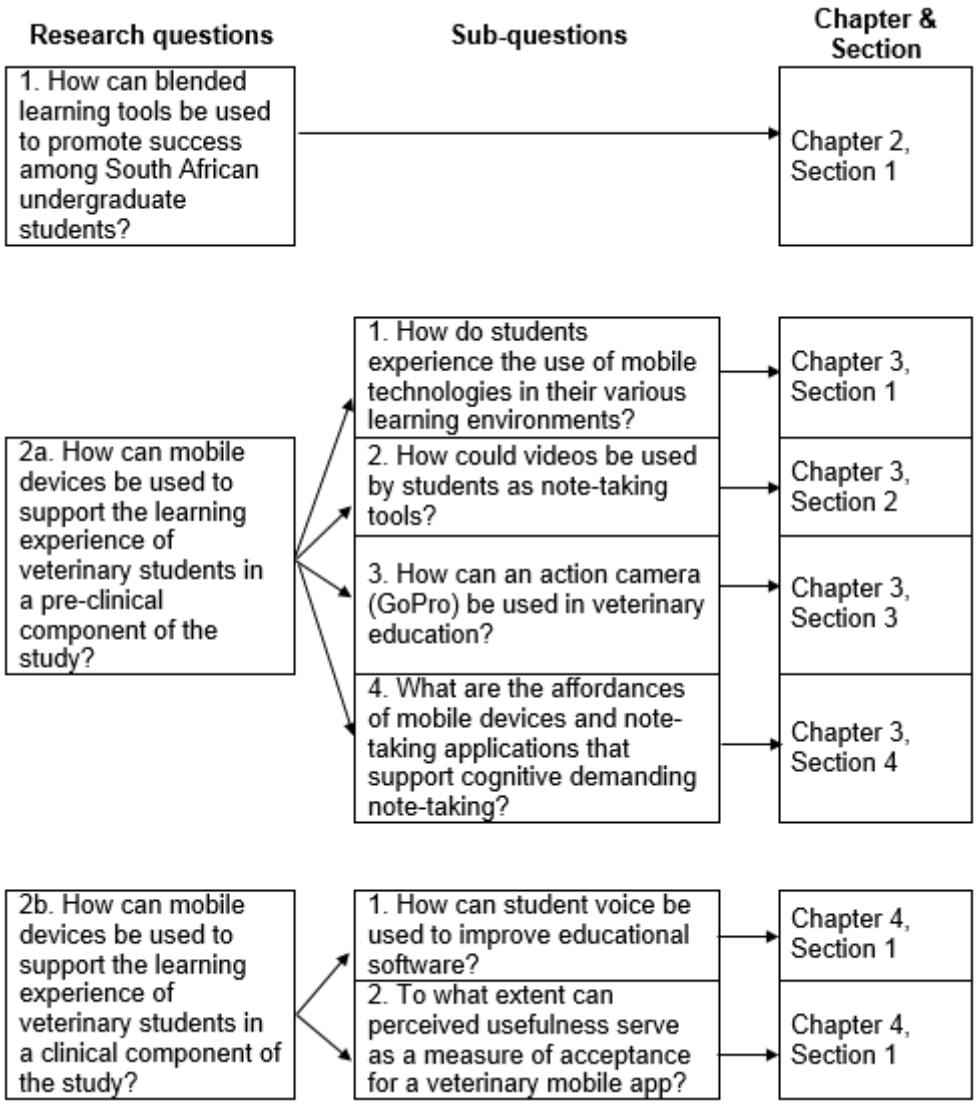


**Figure 1: Overview of all the research questions**

## NATURE OF THE STUDY

This study was exploratory by nature and, therefore, this research was mostly *interpretive*. According to Cohen, Manion and Morrison (2007), interpretivist research begins with individuals and how they understand and make sense of the world around them. In this study, the researcher interpreted the realities of the veterinary students as they worked and studied in a blended learning environment. How the research participants constructed their own meaning of the use of mobile technology in the blended learning environment, was therefore, the focus of the study. The way in which the participants used and experienced technology was studied in their authentic learning environment and in the everyday situations in which they found themselves during their studies. In addition, the participants in this study constructed their own meaning (Hammersley, 2007) from what they experienced (Mackenzie & Knipe, 2006) while functioning in different realities such as the activities and events that take place inside the classroom, as well as their individual experiences away from the classroom and laboratories, such as studying in private and preparing for classes.

After studying the work of authors like Myers (1997), Creswell (2012) and White (2005), the researcher realised that this study would be mostly *qualitative* by nature, supported by limited quantities of quantitative data in the form of descriptive statistics. Creswell (2012) states that qualitative research is best suited for exploring a particular phenomenon, as was the case in this study. Myers (1997) and White (2005) confirm that the focus in qualitative research is on understanding the social events or experiences from the participants' point of view, while quantitative research is engaged in establishing the existence of statistically meaningful relationships between variables, by making use of data in its numerical format (White, 2005).

This research was conducted in the natural learning environment of students where the views of the participants were central (Creswell, 2007). The assumption was that because of the omnipresence of mobile devices, students were already using them in their natural learning environment. Although the use of mobile devices in class was not encouraged by all the lecturers, the researcher believes that when students are given the opportunity, they explore and find ways to use mobile devices in their learning environment to their advantage without any external prompting. Therefore, in

this study, students were invited to use their mobile devices for educational activities in a natural learning environment and to then reflect on their experiences. These reflections constituted a large proportion of the data that was analysed for this study.

The reflections and feedback were *analysed* in patterns, themes were identified, and suggestions were made on how mobile devices could be used. This is in line with the Creswell's (2007) definition of qualitative research as well as the characteristics he derived from the work of other researchers. He mentions that qualitative research is done in the natural setting where the researcher plays a key role in the collection of multiple forms of data. Inductive data analysis is done where the meanings of the participants are the focus, and the research emerges and changes so that the focus stays on the participants' views. The inquiry is fundamentally interpretive and, therefore, a holistic view of the phenomenon emerged.

When describing qualitative research methods, authors such as Myers (1997), Creswell (2012) and Collins, Joseph and Bielaczyc (2004) list various methods like action research, case study research, ethnographic research, narratives, grounded theory, and design research. While each of these methods has a role to play in qualitative research, the overarching research strategy for this study fits the qualities of a *case study*. In this case students' and clinicians' views and experiences, while they worked in their natural learning environment, were the focal points of the research.

The focus of this research was also on how mobile devices can be used in a blended learning environment in higher education, this case study was exploratory in nature. Yin (2009) states that when "how" questions are asked, the research probably leads to the use of case studies. In order to explore the possibilities of using mobile devices and applications in both pre-clinical and clinical environments, a series of case-studies was done. This followed the train of thought of Yin (2009), Creswell (2007), Olivier (2009) and Stake (1995), who reason that in a case study the researcher is interested in either one event, or a series of related events, and therefore, case study research includes both single and multiple case studies (Yin, 2009). As it was important to record the experiences of the students in their various places of study, they were asked to give feedback on how they used the mobile devices while attending lectures and

when doing practical work in a clinical learning environment. This is confirmed by Yin's (2009) statement that a case study explores an event in the real-life context. Although the data included in case study research can be qualitative, quantitative or both (Eisenhardt, 1989), the aim of this research was to collect valuable insights in the experiences of the participants in the pre-clinical and clinical environments, and therefore mostly qualitative data was collected.

In this study, various *data collection methods* such as questionnaires, interviews, group interviews and observations were used. This is in line with an observation by White (2005), namely that case study research offers opportunities to use a variety of data collection methods. Oliver (2009) also confirms that, in his opinion, interviews and direct observations are two of the popular data collection methods in case study research.

The remaining part of the nature of the study will be discussed in relation to the two sub-questions asked, as the data collection methods and research populations differed for the various themes.

To answer the first research sub-question, namely *how blended learning tools can be used to promote success among South African undergraduate students*, a **literature review** was done about the blended learning tools that can be used to address the key factors that influence student success. Searches were conducted in academic databases and the internet, using keywords such as "blended learning", "blended learning tools", "blended learning in higher education", "motivation", "critical thinking", "under-preparedness", "assessment" and "higher education". The articles found were then grouped according to identified success factors, and analysed. To relate the research done with practical applications, blended learning tools were examined to determine whether they could assist in addressing the identified success rate factors either inside or outside the classroom. The result of this relationship between blended learning tools and success rate factors was tabled at the end of the discussion of each one of the success rate factors. Further particulars are provided in Chapter 2.

In an attempt to answer the second research sub-question on *how mobile devices can be used in pre-clinical and clinical learning environments*, a **case study** methodology

was followed. Because the pre-clinical and clinical learning environments, and the way students in each of these environments use their mobile devices differ substantially, the groups were separated into two related, but separate case studies.

**In the first case study,** also called the MobiTech Project (see Chapter 3), the *target population* included second-, third- and fourth-year pre-clinical students studying for a bachelor's degree in veterinary science at a traditional university in South Africa. No first year students were considered for participation, as these students complete their foundational science modules on a different campus, before moving over to the faculty of veterinary science in their second year.

Convenience *sampling* was done, as students who were willing and available to participate were selected (Creswell, 2012). The *data collection instruments* included an online questionnaire, five group interviews, and direct, informal observations made by the researcher herself.

In the online questionnaire, closed- and open-ended questions were asked. Closed-ended questions typically limit participants' responses to one or more of the given options, while open-ended questions allow participants to supply any suitable answer (Oliver, 2009).

The results of the questionnaire were tallied and summarised using spreadsheet software, and the responses to the open-ended questions recorded. The feedback from both the closed- and open-ended questions then guided the researcher to determine themes for the group interviews. These themes broadly showed that the respondents used their mobile devices to take notes (Group interview 1) and to search for Open Educational Resources (Group interview 2). They also used their devices to capture photographs and video/audio clips (Group interview 3), that they then integrated with their own class notes, the notes they received from the lecturer, the electronic presentations that the lecturers used in class and any other information that they had gathered on a particular topic (Group interview 4). As indicated above, these themes were used to guide the discussions during the weekly group interviews.

In this study, a group interview was seen as the interaction between group members to generate responses in an environment where students are free to respond to questions as they see fit. The group interview is therefore similar to what Harrel and Bradley (2009) describe as a semi-structured interview.

The feedback from the group interviews was recorded, transcribed and analysed by coding, categorising and identifying themes and drawing meaning from those ideas or themes that occurred repeatedly (Babbie & Mouton, 2005; Henning, Van Rensburg & Smit, 2004). This was not done with specific themes in mind, but rather, the themes were derived from the data. This method is called *grounded analysis* (Easterby-Smith, Thorpe & Jackson, 2012). From this analysis three main themes emerged, namely student note-taking, video note-taking and the affordances of mobile devices and note-taking apps. These three themes are explained in more detail in Chapter 3.

In addition, observation was also used to collect data (Harrel & Bradly, 2009). Observation is used to gather information while observing students, as happened in this study where students were continuously observed in the classroom while using their mobile devices (Creswell, 2012).

**In the second case** (see Chapter 4), the *target population* included the hospital director, clinicians and students in their clinical year of study who were working in a real life workplace, for example, at a veterinary hospital or a veterinary clinic. The *sample* selection was both purposeful and convenient. Purposeful sampling is used when a researcher wants to understand a specific phenomenon, as in the case of the hospital director. The idea to develop a software program such as Vetbox, was originally his, and he also oversaw the training of the students during the clinical year. The rest of the participants were clinicians and clinical students in their 5th and 6th year who were willing and available to participate (Creswell, 2007).

*Data was collected* from a one-on-one interview with the hospital director. During the one-on-one interview predefined questions were asked, and Harrel and Bradley (2009) describes such an interview as a structured interview. The interview with the director shed some light on the current status with regards to the acceptance of Vetbox, but it

was clear that more information needed to be gathered from the end-users, namely the clinical students and the clinicians themselves.

As such, the researcher organised a group interview with a small number of clinical students and clinicians, with the purpose to identify the issues that merited further investigation. During the group interviews the students and clinicians were free to respond in any appropriate way to the questions posed. Harrel and Bradley (2009) describe this process as semi-structured interviewing.

Based on an analysis of the data from the interview with the hospital director, and the group interview with the clinical students and clinicians, an electronic questionnaire was set up and distributed to all the clinical students in their 5$^{th}$ and 6$^{th}$ years of study. In the questionnaire, both open-ended and closed-ended questions were asked (Oliver, 2009). The results of the closed-ended questions were counted and summarised with spreadsheet software and the open-ended questions were analysed by grouping, as it is done in a hybrid approach (Easterby-Smith et al., 2012). Further particulars are provided in Chapter 4.

Table 1 below provides a breakdown of the data collection methods and the approach used to *analyse* the data. It also highlights the population sampled and the techniques used.

**Table 1: Methodology summary**

| Section | Environment | | Population | | | | Data collection | | | | | Analysis | | | Sample | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-clinical | Clinical | Pre-clinical veterinary students | Clinical veterinary students | Hospital director | Clinicians | Online questionnaire | Interview | Group interview | Observations | Literature review | Excel | Content analysis | Grounded analysis | Convenience | Purposeful | Opportunity & voluntary |
| **Chapter 2** | | | | | | | | | | | | | | | | | |
| 2.1 | | | | | | | | | | | ☑ | | | | | | |
| **Chapter 3** | | | | | | | | | | | | | | | | | |
| 3.1 | ☑ | | ☑ | | | | ☑ | | ☑ | ☑ | | ☑ | | ☑ | ☑ | | |
| 3.2 | ☑ | | ☑ | | | | ☑ | | ☑ | ☑ | | ☑ | | ☑ | ☑ | | |
| 3.3 | ☑ | | ☑ | | | | ☑ | | ☑ | ☑ | | ☑ | | ☑ | ☑ | | |
| 3.4 | ☑ | | ☑ | | | | ☑ | | ☑ | ☑ | | ☑ | | ☑ | ☑ | | |
| **Chapter 4** | | | | | | | | | | | | | | | | | |
| 4.1 | | ☑ | | ☑ | | | ☑ | | ☑ | | | ☑ | ☑ | ☑ | ☑ | | |
| 4.2 | | ☑ | | ☑ | ☑ | ☑ | | ☑ | ☑ | | | | | ☑ | | ☑ | ☑ |

The data collection methods, analysis approach, population and sampling methods for each one of the sections will be further discussed in Chapters 3 and 4.

## TECHNOLOGY ACCEPTANCE MODEL

There are many technology acceptance models, each with a variety of different sets of acceptance determinants. In one such study, Venkatesh, Morris, Davis and Davis (2003) compared eight acceptance models namely the Theory of reasoned action (Legris, Ingham & Collerette, 2003), the Technology acceptance model (Davis, 1989), the Motivational model (Davis, Bagozzi & Warshaw, 1992), the Theory of planned behaviour (Ajzen, 1991), the Combined technology acceptance model and the Theory of planned behaviour (Taylor & Todd, 1995), the Model of PC utilization (Thompson, Higgins & Howell, 1991), the Innovation diffusion theory (Moore & Benbasat, 1991)

and the Social cognitive theory (Compeau & Higgins, 1995). These models were empirically tested to formulate a unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al, 2003).

The UTAUT (Venktesh et al, 2003) describes four direct determinants that play a role in behaviour intention and usage, namely *performance expectancy*, *effort expectancy*, *social influence* and f*acilitation conditions*. For the purpose of this study, the focus was mainly on performance and effort expectancy.

Therefore, this study was rather guided by the early version of the Technology Acceptance Model (TAM) as described by Davis (1989) and Davis, Bagozzi and Warshaw (1989). Researchers frequently apply this model when they try to explain users' acceptance and usage of technology (Venkatesh & Davis, 2000). Davis (1989) adapted his theory from the Theory of Reasoned Action (Legris, Ingham & Collerette, 2003) and suggests that two elements are central to determine whether users will commit to using technology, or not.

Firstly, researchers claims that *external variables* such as age, gender and education, to name a few, have an indirect influence on beliefs and attitudes (Davis et al., 1989; Durodolu, 2016; Hubona & Whisenand, 1995). Then, Davis (1989) further describes the *perceived usefulness* of a technology intervention. Perceived usefulness refers to prospective users' personal belief that using a specific application system will improve the job (Davis et al., 1989). Secondly, although users sometimes see the value of adopting a specific technology, they question the degree to which they expect the target system to be "free of effort" (Davis et al., 1989:320). In this case, the perceived usefulness (PU) is influenced by the perceived ease of use (PEU) (Davis, 1989). This corresponds to the opinion of Saade and Bahli (2005) that the amount of effort needed to use a system, will have an influence on the belief that the system makes users' work better or not.

In Figure 2 below, the relationship between the different elements in the TAM is indicated, showing clearly that the *perceived usefulness* and *perceived ease* of use directly influence the *attitude* towards using the system. The attitude then has an

influence on whether the users will consider using the system (*behavioural intention* to use), and will eventually determine whether, or not, they will *actually use* the system.

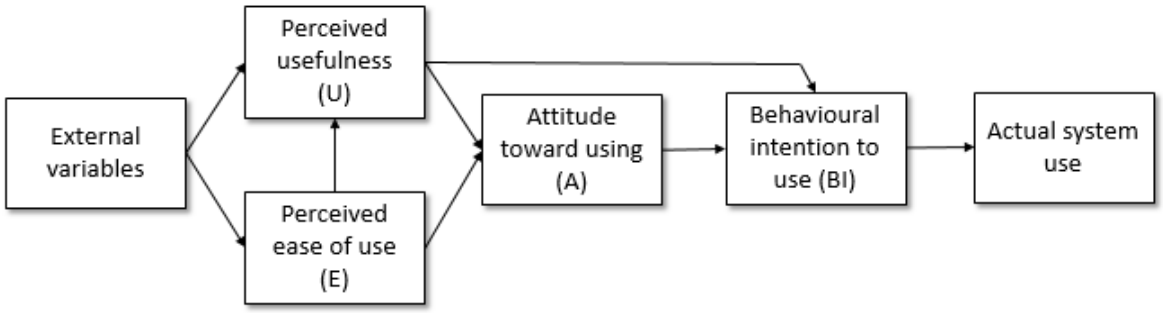


**Figure 2: Technology Acceptance Model (Davis, Bagozzi & Warshaw, 1989)**

Although later researchers improved TAM and added determinants such as experience, output quality, computer anxiety and perceived enjoyment (Venkatesh & Bala, 2008), the original TAM was deemed sufficient for the purpose of this study.

## DEFINITIONS

Defining key concepts is important to make sure that there is a mutual understanding of the important terms (Goes & Simon, 2015). Therefore, to explain the terminology used in this thesis, a few core definitions are given in Table 2 below.

**Table 2: Definitions**

| Concept | Definition or Explanation |
|---|---|
| **Affordance of an application or device** | The qualities or properties of an application or device that make it possible for a user to use it in a specific way, thus it refers to how it can be used (Norman, 2013; Parsons, Thomas & Wishart, 2016). |
| **Apps** | For this study, apps will not be seen merely as the abbreviation of applications but as an application that run on a mobile device. Initially, applications were designed to run on computers, while apps were designed to run on devices with smaller screens such as smartphones and tablets. Although, this is not entirely true anymore, there is still a |

| Concept | Definition or Explanation |
|---|---|
| | difference between the two. For example, many software that were designed to solely run on a computer, also now have an app that run on a smartphone. However, the difference between the two is that the applications functionality is much more than the app that run on the smartphone (Collins, 2016). |
| **Blended learning** | The integration of appropriate technologies in the curriculum to support and deliver successful learning (Traxler, 2010), with the co-presence of a teacher and students (Friesen, 2012), where both the practices of traditional teaching and e-Learning are exploited (Aleksić & Ivanović, 2013). |
| **Clinical students** | Students who have completed the theoretical component of their studies and are busy with compulsory experiential learning at, amongst others, an academic veterinary hospital or private veterinary practice. |
| **Clinicians** | Qualified veterinarians who do clinical work in an academic veterinary hospital. |
| **Cognitive demanding note-taking** | The actions students take to simultaneously pay attention, organise information, and record it in an understandable manner before it is forgotten (Bui & Myerson, 2014). |
| **Generation Y** | Student that are born into a world where information technology plays an important role (most Generation Y students are born between 1982 and 2003) (Berk, 2010). |
| **Group interview** | Similar to a focus group in the sense that it is used for data collection and the group interaction is used to generate responses. However, it differs from a focus group in the sense that only one group of students was interviewed in a number of successive sessions (Harrell & Bradley, 2009). The group interviews were not repeated with other groups of participants. |

| Concept | Definition or Explanation |
|---|---|
| **Intrinsic motivation** | Behaviour that students display when they engage in activities for their own sake, without any external reward or punishment (Malone & Lepper, 1987). |
| **Mobile devices** | In this study, a mobile device refers to a device that can easily be carried around when moving from one setting to another, such as, but not limited to, laptops, smartphones, tablets or action cameras (Viswanathan, 2017). |
| **MobiTech** | Case study 1 was based on data that was gathered as part of an exploratory project, called MobiTech, in the faculty of veterinary science. The MobiTech project explored how students use mobile devices in various teaching and learning environments. |
| **Pre-clinical students** | Second-, third- and fourth-year students studying for a bachelor's degree in veterinary science at the faculty of veterinary science of a traditional South African university. Typically attending lectures, practical classes and workshops. |
| **Lecturer** | Employed by a university and teach undergraduate and or post graduate students, Master degree is required. |
| **Vetbox** | Educational software developed to record students' clinical exposure and skills acquired when they work in a real-life setting such as a veterinary academic hospital or a private veterinary clinic. Furthermore, students use the software to book their clinics and request clinicians to assess them. |

## ETHICAL CONSIDERATIONS

After the participants had given written consent, data was saved electronically and is currently stored on a password-protected device. The raw data can only be accessed with permission from the Ethics Committee of the Faculty of Education at the University of Pretoria in South Africa. As ethics approval was obtained from the above

committee, this study was guided by the University Rules and Regulations (University of Pretoria, 2018).

## SUMMARY

As mentioned earlier, a literature study confirmed that the students who are currently attending universities grew up with access to technology. However, according to various researchers, the use of mobile devices for educational purposes is limited and has not yet been fully utilised, especially in the South African higher education context. In addition, researchers in the field of technology education still claim that blended learning will play a big role in education in the next few years (Adams Becker et al., 2017; Schaffhauser, 2017). In view of the above, and taking into consideration the needs of veterinary students with regard to recording information electronically, the purpose of this study was to show how mobile devices can be used in a blended learning environment in higher education. Veterinary students not only have to record information when attending lectures; they also have to keep records of the patients they examine while working in the academic hospital, among others. Therefore educational software, and especially software that is compatible with mobile devices, is also of importance for this study.

As this research was conducted as a series of journal articles, the rest of the chapters will address each one of the themes. See a schematic layout (Figure 3) of the following three chapters below.

In the last chapter (Chapter 5) a few concluding remarks are made about the contribution of this research to the blended learning higher education. The chapter also contains recommendations for further research and some personal reflections from the point of view of the researcher.

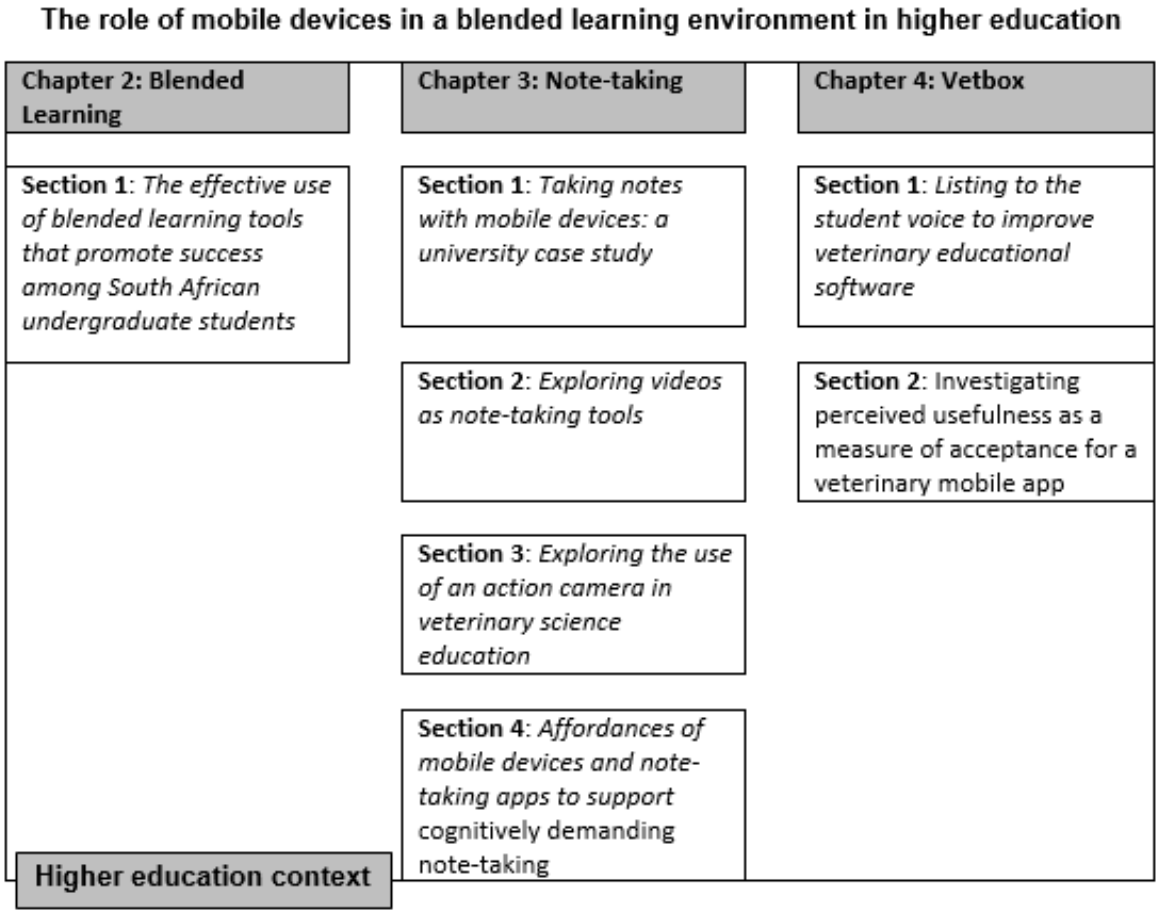


**Figure 3: Schematic layout of the sections**

# CHAPTER 2: BLENDED LEARNING

## Executive summary

The overarching question guiding this study is: *How can mobile devices be used in a blended learning environment in higher education?* To answer this question, the following two sub-questions were considered:

1. How can blended learning tools be used to enhance student success?
2. How can mobile devices be used to support the learning experience of veterinary students in (a) the pre-clinical component of the study and (b) the clinical component of the study?

This chapter aims to answer the first sub-question by reviewing existing literature. The focus is on blended learning and blended learning tools, and how students and teachers can benefit from such a learning environment. In doing so, the importance of blended learning is underlined as well as possibilities of teaching and learning in a blended learning milieu. In this literature review, the focus is on higher education in general and not on a specific student population. The review identifies a number of blended learning tools, and contributes some recommendations with regards to its use in higher education.

The results of this research is documented in an article as indicated in Table 1.

**Table 1: Blended learning – Chapter 2**

| Section nr | Title | Research question |
|---|---|---|
| Section 2.1 | The effective use of blended learning tools that promote success among South African undergraduate students | How can blended learning tools be used to promote success among South African undergraduate students? |

To answer the question How can blended learning tools be used to enhance student success a list of proposed blended learning tools, with suggestions on its use, to address the factors that influence students' success by enhancing the learning process, is given.

**Section 2.1**

# The effective use of blended learning tools that promote success among South African undergraduate students


## ABSTRACT

A major problem in higher education in South Africa is the low success rate and high dropout rate of undergraduate students. The high dropout rate could be the result of socio-economic factors, academic shortcomings or merely the fact that the current way of teaching do not meet the needs of the 21st century student. In this literature review paper, the aim was twofold. Firstly, existing literature was reviewed to identify research conducted on blended learning tools that can promote student success and the relationship between the research conducted and practical applications of these blended learning tools were indicated. Secondly, five key success factors were selected and the role of blended learning, as well as its tools, were discussed in relation to the key success factors. The result and contribution is a list of proposed blended learning tools, with suggestions on its use, to address the factors that influence students' success by enhancing the learning process. It is recommended that further research be conducted to determine by means of a pilot approach, the extent to which the use of these blended learning tools is successful in enhancing student success.



**Keywords:** Assessments; blended learning; blended learning tools; critical thinking; higher education; student success; lack of prior knowledge; motivation; problem solving; under-preparedness


## INTRODUCTION

Higher education in South Africa is currently facing high student dropout rates (HESA (Higher Education South Africa), 2009). HESA's working group suggested to the South African Parliament to advise the higher education sector to find better ways of teaching and learning that could improve outputs (HESA, 2011), as it is clear that the current teaching approaches are no longer effective.

For students living in the information age the current model of teaching, which involves direct transfer of knowledge from a lecturer to a student in a classroom setting, is no longer relevant (Aleksić & Ivanović, 2013; Slabbert, De Kock & Hattingh, 2011). Everything we do is influenced by information communication technology (ICT). Therefore, it is no longer feasible to use current teaching and learning strategies only, but more interactive approaches are required.

Students are increasingly engaged in technology-related activities, except when they are in the classroom. According to Berk (2010), Black (2010), Howe and Strauss (2003) and Reilly (2012) the current generation's students flourish in situations that involve technology, that are visual, require rapid response and feedback, and that are flexible, connected, interactive and encourage collaboration. Traxler (2010) observed that the formal university system is currently not synchronised with the world that students experience and live in, and thus suggests that changes need to be considered to align the universities with the use of mobile technology.

Proulx (2012) mentions five ways in which technology could impact higher education. Firstly, it could ensure that online learning would keep on growing in future. Secondly, technology can be used to provide information so that classroom time can be reserved for discussion and group exercises (flipped classroom). Thirdly, the blended learning model, providing more flexibility to adult and working students, would be fully embraced by students. Fourthly, a new instructional model is needed to create a more in-depth experience, preparing the students for industry and personalising courses to students' needs. Lastly the cost of higher education might decrease if universities could find a new approach that incorporates online learning, flipped classrooms and new assessment models.

Therefore, new strategies for teaching need to be investigated and incorporated in our approach to teaching and learning. One of these teaching and learning strategies is blended learning, and the focus of this article is to answer the question:

*"How can blended learning tools promote success among South African undergraduate students*"?

## METHODOLOGY

To answer this question, a literature review was done. According to Mouton (2001), a literature review study provides a good understanding of the research done in a specific field. Hart (1998) also mentioned that the purpose of a literature review is to identify relationships between ideas and practice, relating ideas and theory to applications and to establish the context of a problem. In this literature review, literature and empirically based research studies that have been conducted on blended learning were identified by searching academic databases and the Internet. Keywords such as blended learning, blended learning tools, blended learning in higher education, motivation, critical thinking, under-preparedness, assessment, and higher education were entered in the search engines. These articles were then grouped according to identified success factors and analysed. To relate the research done with practical applications, blended learning tools were examined to determine whether they could assist in addressing the identified success rate factors either inside or outside the classroom. The result of this relationship between blended learning tools and success rate factors was tabled at the end of the discussion of each one of the success rate factors. This was done to indicate how blended learning tools could possibly promote student success.

## BLENDED LEARNING AND BLENDED LEARNING TOOLS

While authors have various opinions on what the definition of blended learning is, Pankin, Roberts and Savio (2012) describe blended learning as learning opportunities that use more than one learning method, either inside or outside the classroom. Driscol (2001) mentions four variations of blended learning, namely (a) a combination of various web-based technologies, (b) a combination of various pedagogical approaches, (c) a combination of any form of instructional technology with face-to-face instruction, and (d) a combination of instructional technology with actual job tasks. Similarly, Staker and Horn (2012) describe blended learning as part online learning and part learning in a supervised environment where these two parts are connected to provide an integrated learning experience. Within the boundaries of this description, blended learning can be implemented in one of four models, namely:

1. rotation model,
2. flex model,
3. à la carte model,
4. enriched virtual model.

However, Graham (2004), Köse (2010) and Owston, Wideman and Murphy (2008), prefer to refer to blended learning as a combination of face-to-face instruction and online learning. Therefore, part of the delivery in a blended learning environment is online so that students and lecturers as well as institutions become more productive, both academically and financially (Bailey, Ellis, Schneider & Van der Ark, 2013). To establish a blended learning approach, lecturers need to redesign their courses and course material to integrate the use of technology with the traditional face-to-face model (Poon, 2013) of teaching and learning. Blended learning is defined as the "range of possibilities presented by combining the internet and digital media with established classroom forms that require the physical co-presence of a lecturer and students" (Friesen, 2012:1), because blended learning is a combination of face-to-face teaching and e-Learning that best exploits both these approaches (Aleksić & Ivanović, 2013).

Tayebinik and Puteh (2012) reviewed the literature on the advantages of blended learning in comparison with pure on-line or face-to-face instruction. They suggested, that blended learning improves communication, provides a sense of community, improves academic performance, allows for collaborative tasks, creates opportunities for active participation, enables adequate feedback, and constitutes a fun and practical way of teaching and learning.

The positive effect of blended learning on teaching and learning has been reported by various authors. For example, studies by Bawaneh (2011), Delaney, McManus and Ng (2010) and Hiralaal (2012) revealed that the availability of online learning material in addition to face-to-face classroom sessions in a blended learning environment resulted in improved exam results, led to a deeper understanding of learning material, and improved the comprehension of subject knowledge, procedures, terms and principles. In the blended learning environment, additional material is available online

to everyone through hyperlinks to various websites (Hiralaal, 2012), which increases flexibility in terms of learning (Dziuban, Hartman & Moskal, 2004).

In addition to better examination results in some cases, the levels of motivation and attitude of students towards the subject also improved when learning in a blended learning environment (Delaney et al., 2010; Hiralaal, 2012; Sucaromana, 2013; Tseng & Walsh, 2016). Students were also satisfied with the learning climate, which resulted in significantly higher levels of intrinsic motivation (Sucaromana, 2013).

Dziuban et al. (2004) and McKenzie, Perini, Rohlf, Toukhasati, Conduit and Sanson (2013) state that the use of repeated online formative assessments results in significantly higher summative assessment scores. Although the systematic use of formative assessment would have a positive effect on summative assessment, the use of blended learning probably facilitates more frequent and different forms of formative assessment. With online assessments, students also receive immediate feedback (Delaney et al., 2010; Hiralaal, 2012).

Students need to be actively involved to develop critical thinking skills. Dziuban et al. (2004) and Hiralaal (2012) found that students show increased interaction among themselves as well as with lecturers when working in a blended learning environment. The use of a wiki (website where a group of people work together to add and edit content) in a blended learning environment was investigated by Snodgrass (2011). Snodgrass (2011) found that combining the wiki with face-to-face activities could improve collaboration between students, which further enhances their ability to apply critical thinking skills and reasoning.

To expose students to real-life examples of the subject matter being studied, Siegel, Omer and Agrawal (1997) experimented with a series of videos. These videos were created to provide students with an indication for what actually happens in a real work situation. Siegel et al. (1997) reported that the students' performance improved after they had watched the videos in class.

Based on the case presented above, it appears that students benefit from a blended learning environment. They have access to additional material, are more motivated,

and are encouraged to collaborate and gain a better understanding of the workplace. Moreover, they have repeated access to online assessments, which results in better examination results.

While blended learning is seen as a combination of classroom teaching, the internet and digital media (Friesen, 2012), instructors of the Intel Corporation believe that blended learning cannot be established without online technology tools (Intel Corporation, 2012). Based on the work of Devedzic and Jovanovic (2015), Gwaltney (2012), LaBanca, Worwood, Schauss, LaSala and Donn (2013), Lesser (2016), Staker (2011), Tenkely (n.d.), Thomson (2014), Walsh (2012) and researchers at Intel Corporation (2012), the authors drew up the list of possible blended learning tools shown in Table 1 below.

**Table 1: Examples of blended learning tools**

| Category | Blended learning tool | Use |
|---|---|---|
| Learning management system (LMS) | Blackboard<br>Moodle<br>Edmodo | Upload course content like study guides, exercises, memorandums and videos<br>Create online assessments<br>Create discussion forums/blogs<br>Share files |
| Cloud storage | DropBox<br>Google Drive<br>4Shared | Host course content and share files |
| Social media tools and networks | Schoology – social network for learning<br>Facebook<br>WordPress<br>Twitter | Discussions<br>Upload information<br>Feedback<br>Reflection |
| Video and audio creation | VoiceThread<br>Audacity<br>Camtasia | Produce instructional videos and podcasts |

| Category | Blended learning tool | Use |
|---|---|---|
| | Screencast-O-Matic<br>ShowMe<br>PowerPoint animated slideshows<br>Educreation<br>Flicker | Record a presentation, voice and audio<br>Also record whiteboard<br>Record slideshow |
| Existing video platforms | YouTube Education<br>TED<br>Khan Academy<br>Academic Earth | Provide videos on large variety of topics |
| Interaction | Kahoot<br>Socrative<br>Clickers<br>Survey Monkey<br>Blackboard<br>Mentimeter | Voting or polling tool, audience response system (asynchronous or synchronous) |
| Collaboration | Wikispaces Classroom<br>Google docs<br>Skype<br>ProofHub<br>MindMeister | Work together to create and edit documents<br>Communicate online<br>Share files<br>Live chat feature |
| Slide shows | PowerPoint<br>Prezi | Create multimedia or animated slideshows |
| Video and web conferencing | Blackboard Collaborate<br>Skype<br>PalBee<br>Scribblar<br>Twiddla<br>BigMarker | Bring human resources into the class<br>Discussions |
| Back channel | TodaysMeet<br>Twitter | Students post questions while lecture is on |

| Category | Blended learning tool | Use |
|---|---|---|
| Access to existing courses | MOOC | Students can access training courses of other institutions |
| Electronic incentives | Class Badges<br>Mozilla Open Badges<br>Open Badges | Students can be rewarded for sections completed |

In view of the positive results of blended learning research and the various uses of blended learning tools, the question arises how these blended learning tools can be used to promote success South African undergraduate students; specifically to address the identified key factors that influence student success. This paper could never address all the identified success factors, and therefore only focuses on a few that can be accommodated within the teaching and learning environment of education in a developing country.

## KEY FACTORS THAT INFLUENCE STUDENT SUCCESS

A plethora of international and national study findings is available on the factors influencing academic success. The scholarly literature on this topic contains common factors such as attitudes, problem-solving skills, values, emotional intelligence, socio-economic status, ethnicity, community support, interest in the course, cognitive competencies, time management, language and communication skills, previous academic performance, quality of teaching, cultural expectations, peer culture, status of residential area, access to technology, interaction between students and the academic and social systems of the university, and financial support (De Clercq & Venter, 2009; De Hart, Doussy, Swanepoel, Van Dyk & Venter, 2005; Foxcroft & Stumpf, 2005; Gardiner, 1994; Greg, 2009; Kim, Newton, Downey & Benton, 2010; Ngidi, 2007; Radford, 2010; Roos, 2009; Van Eeden, De Beer & Coetzee, 2001; Zewotir, North & Murray, 2011).

Under-performance, especially in South Africa with its history of unequal schooling, often reflects the negative impact of educational shortcomings rather than a student's potential to succeed in higher education. Therefore, this article focuses on success

factors which lecturers and students in developing countries deemed important. In a study conducted by Sadler and Erasmus (2005) on distance learning honours students, the students provided these factors in order of priority: timeous and regular examination preparation, logical reasoning, consistent effort, and effective examination techniques. In a similar study on success factors, Steenkamp, Baard and Fick (2009) found that poor class attendance, a lack of subject knowledge, insufficient time and insufficient knowledge of the English language are the main contributing factors that lead to poor student performance.

Another challenge for higher education is that the employer expectations have changed considerably over the years and students do not always meet these expectations. Kavanagh and Drennan (2008) found that employers expect students to have problem-solving skills, as well as real-life experience of the workplace. Polyacskó (2009) also found that the skills most lacking in many graduates are language proficiency, the ability to apply knowledge in practice, and individual motivation. Furthermore, their motivational levels and commitment were questionable, which had an influence on their attitude to their work. Polyacskó (2009) also mentions the relation between motivation and attitude.

For the purposes of this paper, the following five key factors were identified as the most prominent:

1. Understanding the basic principles of the subjects.
2. Attitude and motivation of students towards teaching and learning.
3. Additional exposure to pre-testing and preparations for examinations.
4. Critical thinking skills (applying knowledge, problem-solving and logical reasoning skills).
5. Applying theory and authentic work experience.

These five factors will now be discussed in relation to blended learning tools that could positively influence them.

## BLENDED LEARNING TOOLS THAT CAN POSITIVELY INFLUENCE THE KEY SUCCESS FACTORS

For each of the five factors, blended learning tools will be identified from the literature. Furthermore, examples will be provided of how blended learning tools could be used to assist lecturers and students in these activities.

### Understanding the basic principles of the subjects

One of the most commonly identified indicators of the low success rate of students in tertiary institutions is under-preparedness, which is caused by a mismatch between students' skills and academic background, and what the university expects from their students. Research studies over the past 30 years indicate that under-preparedness is not a new phenomenon worldwide, and South Africa is no exception (Conley, 2010; Council on Higher Education, 2013). Pitts, White and Harrison (1999) state that under-preparedness is a dilemma facing universities and lecturers and that many lecturers do not know what individual skills and knowledge their students have. Moreover, they often lack relevant strategies and support to handle the challenges embedded in under-preparedness.

Du (2011) developed a blended learning university introductory course to introduce students to the basic principles of a first-year subject. The students had to work through the content before they came to class so that the limited class time could be used for more complicated discussions. Du (2011) found that this course improved students' final performance through in-depth class activities. Since the majority of the first-year students grow up with technology and prefer multimedia above printed media, blended learning tools can be used to address the lack of knowledge of basic subject principles (Berk, 2010). To give all the students access to the same information and to address the possible lack of knowledge without sacrificing class time, a list of tools is provided (Table 2). These tools can be used to host course content, share files and create online activities using digital media.

**Table 2: Blended learning tools to assist students to better understand the basic principles of subjects**

| Lecturer and/or student activity | Use of blended learning tool |
|---|---|
| Lecturer makes content/information available for student use.<br>(Tip: Short, manageable chunks of information). | • Use a learning management system (LMS) to upload information such as basic principles or assumed knowledge, activities, or case studies.<br>• Use cloud storage to save information that students can access from any device.<br>• Use social media to share announcements and information.<br>• Use existing video platforms to identify videos that students can watch.<br>• Use video creation software to create short videos about key concepts in a subject.<br>• Create slide shows to present the necessary information.<br>• Create electronic incentives (badges) to reward students for sections completed. |
| Students interact/engage with content before, during and after class. | • Let students create videos on how to do examples of practical work and new examples.<br>• Online quizzes can be created to test knowledge.<br>• Online quizzes and/or clickers can also be used as an engagement tool during class.<br>• Blogs can be used to discuss topics of the day, or as platform where students can ask questions.<br>• Students can use collaboration software to create a wiki where they work together in building the content of a topic. |

By using blended learning tools, additional information can be made available to students to read, discuss, and engage with. In the next section, blended learning tools in relation with attitude and motivation of students towards teaching and learning will be discussed.

**Attitude and motivation of students towards teaching and learning**

Student retention and success are major concerns, because student populations have become more diversified and non-traditional in nature and are generally less prepared for higher education studies (Jeffrey, 2009; Visser & Van Zyl, 2013). Literature identified attitude and motivation as prominent success factors.

At the University of Winchester (Marriot, 2009), a lecturer implemented a series of online summative assessments in a first-year course with the aim of soliciting student engagement, facilitating evaluation, feedback and motivation, and providing both the lecturer and the students with performance indicators. Marriot (2009) concluded that students perceived a positive impact on motivation, learning and engagement. Another study was conducted in Hungary, where it was also found that one of the skills most lacking in many graduates is motivation (Polyzcskó, 2009).

This finding that students often lack motivation, is supported by Sucaromana (2013) who also concludes that motivation is an important part of learning. Motivation determines how involved students will be in their learning as well as the effort they are willing to put in to achieve their goals. Al-Ani (2013) claims that there is a positive correlation between student achievements and their learning motivation when implementing blended learning. The students concerned indicated that the use of blended learning approaches helped them to maintain a positive attitude towards learning because they could follow lecturer notes and do additional reading. Malinina (2013) found that students are more motivated and encouraged to study because the use of web-related technologies enables them to personalise their studies (for example, students can learn at their own pace, whenever and wherever they want to). In addition to the above, Malinina (2013) observed that activities that were more relevant to the real world gave students an additional incentive to study.

To summarise, as indicated by the above research, in order to be motivated and have a positive attitude, students need to be assessed, experience achievement, have access to learning material, and use technology to personalise their studies, and the examples they use must be relevant (discussed in more detail later). To assist with these summarised factors, a list of blended learning tools that could be used is provided in Table 3.

**Table 3: Blended learning tools and motivation**

| **Lecturer and/or student activity** | **Use of blended learning tool** |
|---|---|
| Lecturer creates regular online formative assessments. | • Use an LMS assessment option to create regular online assessments. |
| Students see and track their achievements and have a choice to improve achievements. | • The use of LMS provides options for immediate feedback, therefore students can track their progress, redo assignments and be aware of their achievement.<br>• Use badges to reward students on completion of tasks/tests. |
| Lecturer makes notes and additional reading available online. | • Use software to create<br>a. Documents (MS Word)<br>b. Slide shows (PowerPoint, Prezi)<br>c. Videos<br>of your lecture and upload on an LMS<br>• On the LMS, upload links to websites where students can get additional information.<br>• Use QR code generator to embed links in QR format so that students can access it from mobile device or print it and they can scan it. |
| Students can personalise their studies. | • LMSs allow students to work through the weekly topics that are uploaded. This is done at their own pace at any time anywhere. |

| Lecturer and/or student activity | Use of blended learning tool |
|---|---|
| Lecturer provides relevant examples. | • Complement the course with customised videos that you make for the class of real-life examples or applications of your subject matter.<br>• Use existing videos from educational platforms or the Internet to show students the real-life scenarios.<br>• Arrange video conferencing sessions with people in the industry/other universities. |

The Table 3 above illustrates how blended learning tools such as videos, badges and video conferencing can assist in addressing students' attitude and motivation. In the next section, how blended learning tools can be used to increase opportunities for additional tests as well as assist students in examination preparation, will be discussed.

**Additional exposure to pre-testing and preparation for examinations**

Balduf's (2009) study reveals that first-year students find themselves underprepared for examinations in higher education because high school success needed less effort and they were never taught how to work through challenging issues. Students tend to have poor time management skills, and they do not know how to pace their studies and prepare in advance for assessments. Francis and Shannon (2013) found that the integration of student engagement and online activities such as assessments positively correlates with improved student learning outcomes. Therefore, blended learning can also be used to increase students' access to questions before examinations.

To engage students in class, Caldwell (2007) and Wang, Chung and Yang (2014) used audience response systems. Audience response systems permitted students to answer anonymously and to see immediately how their response compares to those

of the rest of the class. Caldwell (2007) and Wang, Chung and Yang (2014) found not only that the use of these audience response systems resulted in better test scores, but also that it motivated students to study topics in greater detail before coming to class so that they can participate in discussions in class.

Hadsell (2009) created online quizzes and suggested that timely, consistent completion of online quizzes in an introductory course improves exam scores. However, these quizzes were only available in class, and to gain access students needed to attend classes. Therefore, online quizzes were not only used as preparation for exams, but also as a way to increase class attendance. In addition to the above research Baleni (2015) claims that the repetitive nature of online assessments gives students the opportunity to study numerous times, which results in good results, especially under low achievers.

To engage students, expose them to pre-testing and address factors affecting students' performance before and during tests and examinations, various blended learning tools can be used. A list of some of these tools is provided in Table 4.

**Table 4: Blended learning tools that enable pre-testing and preparation for examinations**

| Lecturer and/or student activity | Use of blended learning tool |
|---|---|
| Lecturers create mock examination questions. | • Use an LMS to upload mock examination questions.<br>• Provide a forum like a discussion board to discuss student questions that arise from the mock examination questions. |
| Lecturers create online quizzes.<br>(Tip: Can be answered repeatedly). | • Use an LMS to create online quizzes that are marked automatically.<br>• Use the online quizzes for pre-testing or after testing, in or outside the class.<br>• Use the online quizzes as an engagement tool during the lesson. |

| Lecturer and/or student activity | Use of blended learning tool |
|---|---|
| Lecturer sets up questions to be used with an audience response system. | • Use audio response systems such as Clickers or others that uses a mobile device to do quizzes in class and actively involve students. |
| Lecturer creates assignments | • Upload these assignments on the LMS.<br>• Create an assignment link on the LMS where students can upload scanned answers or PDF versions of their work wherever they are.<br>• Discuss answers using a discussion forum. |

As indicated in Table 4 above, learning management systems and clickers can be used successfully for continuous assessment to give immediate feedback to the lecturer and students regarding their knowledge levels. In the next section, how blended learning tools can be used to allow students to apply knowledge and practice problem-solving and logical reasoning skills, will be discussed.

**Critical thinking skills (applying knowledge, problem-solving and logical reasoning skills)**

Problem solving skills were identified as one of the top three skills expected by employers from new college graduates (Adams, 2014). An extensive literature review by Kavanagh and Drennam (2008) indicated that critical thinking skills that involve the ability to apply knowledge in order to solve problems are essential for all new employees and that these skills should be developed with the assistance of educators. There is, however, a lack of agreement on the methods to be used to best incorporate and assess critical thinking in the curricula (Wolcott, Baril, Cunningham, Fordham & St. Pierre, 2002).

Educational research suggests that active learning strategies must be used to develop critical thinking skills, as the current classroom setting, where only passive learning takes place, is not a conducive environment (Cunningham, 1996). One of the active learning techniques that Young and Warren (2011) suggest is that students should be

allowed to apply acquired knowledge of real-life scenarios and to solve unfamiliar problems.

Weill, McGuigan and Kern (2011) explored the value of case study online discussion forums in an intermediate course. They found that students perceived the use of case studies to improve their ability to “identify the relevant data in the case” and “to think critically about issues”, amongst others. In addition to the above, MaKinster, Barab, Harwood and Andersen (2006) found that the use of online discussion forums creates an opportunity to socially construct knowledge. To create real-world experiences, Stanley (2012) explored the use of videos. He found that using videos to simulate real-world experiences is an exciting way to teach students high-level thinking skills (Stanley, 2012).

Totten, Sills, Digby and Russ (1991) and Bruner (1985) state that students working in a group setting are confronted with different interpretations of a given situation. While the students engage in discussion they improve their problem- solving skills and consequently become critical thinkers (Bruner, 1985; Totten, Sills, Digby & Russ, 1991). Gokhale (1995) agrees with the above and found that students who participated in collaborative learning performed significantly better in a test taken to assess critical thinking skills than students who worked individually. Researchers also confirmed that when blended learning is applied as a learning strategy, the problem-solving, decision-making, critical thinking and clinical skills of students are improved (Makhdoom, Khoshhal, Algaidi, Heissam & Zolaly, 2013).

Jou, Lin and Wu (2016) found that when interactive technologies were used, students’ critical thinking skills improved. They further proposed a blended learning environment to encourage critical thinking skills amongst students (Jou, Lin & Wu 2016). To address the development of critical thinking skills, a number of blended learning tools were identified, as shown in Table 5.

**Table 5: Blended learning tools to develop critical thinking skills**

| Lecturer and/or student activity | Use of blended learning tool |
|---|---|
| Students need to apply knowledge to real-life scenarios to solve problems. | • Use an LMS to upload examples of case studies, articles about real-life cases or existing videos.<br>• Let the students continue with the in-class discussions online, either individually or in groups, through a blog or reflective journal, discussion forum or social media.<br>• Use these discussions as starting point in the next class. |
| Students need to construct their own knowledge. | • Create and upload case studies on the LMS and let students discuss them on discussion forums. After discussions, let them reflect and then submit their ideas online. This could help the lecturer to find new discussion topics for the next class.<br>• Use, for example, Wikispaces Classroom or Google docs for students to share their problems and find solutions together to solve the problems, based on their case studies, articles, or what they have learned. |
| Students need to participate in collaborative settings | • Group work can either be done purely online or after the work done in class. Students can collaborate through Skype sessions or Blackboard Collaborate with students in other environments to solve given business problems.<br>• Case studies and real-life problems can be uploaded on LMS so that solutions can be found in the group setup and discussed |

| Lecturer and/or student activity | Use of blended learning tool |
|---|---|
| | through blogs, discussion forums or social media. |
| Lecturers need to expose students to real-world learning. | • Record videos of real-life issues or scenarios that can either be discussed in class or online.<br>• Use Skype or other video-conferencing software to show real-life examples, or use live streaming of business settings.<br>• Use existing videos from other universities or videos published on YouTube or TedTalk to expose students to real-life examples. |

Table 5 above indicates how blended learning tools can also assist with developing critical thinking skills. In the next section, how lecturers can use blended learning tools to show students how to apply theory to real-life situations, will be discussed.

**Applying theory and authentic work experience**

According to Kolb (1984), learning is the process whereby knowledge is created through the transformation of experience. The emphasis is on adaptation and learning in contrast to content and outcome, and therefore it requires the immersion of a learner in real-life experiences, solving real-life challenges. In a study conducted in Hungary, the researcher claims that people's inability to apply knowledge is a result of the overly theoretical nature of their education (Polyacskó, 2009).

A pilot study in South Africa showed similar results. In a study conducted by Griesel and Parker (2009), it was found that graduates' understanding of the real world did not meet employers' expectations and that they lacked the ability to learn quickly from workplace experience. Employers claimed that higher education did not prepare the students well enough to apply their knowledge in the workplace or to meet employer expectations (Griesel & Parker, 2009).

Slabbert et al. (2011) suggest that students should get practical exposure rather than only theoretical and secondhand knowledge, which leaves students overwhelmed and without contextual and conceptual understanding of the work. But how can we marry these two concepts: learning in the classroom vs. work-intergrated learning, especially when lecturers are challenged by teaching large classes?

Rowe, Frantz and Bozalek (2010) conducted a literature review to determine the impact of blended learning on the teaching of practical courses. They found that blended learning can bridge the gap between theory and practice, and also improve reflective skills, reasoning and clinical competencies. To bridge this gap between theory and practice, the University of Cape Town (UCT) initiated a video project after it had been established that many underprepared learners did not have a frame of reference for the examples mentioned in large classes when explaining the subject-related concepts, and consequently a blended learning approach was adopted (Jawitz & Perez, 2014). This resource material made a significant contribution to enhancing both students' experience and their engagement with the real-world environment (Jawitz & Perez, 2014).

Blended learning tools can also assist students to gain real-life experience in the workplace. Additional blended learning tools that can expose students to real-life experience in the workplace are listed in Table 6.

**Table 6: Practical/workplace examples and blended learning tools**

| Lecturer and/or student activity | Use of blended learning tool |
|---|---|
| Lecturer provides opportunities to experience real-life scenarios. | • Video-conferencing tools can be used to listen to board meetings or "live" real-life business interactions, and experience them at first-hand. |

| Lecturer and/or student activity | Use of blended learning tool |
|---|---|
| Lecturer creates real-life challenges that students need to solve. | • Videos uploaded on the Internet can be identified and accessed and then discussed.<br>• Case studies can be uploaded on the LMS and discussed through blogs or discussion forums.<br>• Videos can be created that simulate real-life challenges and solutions discussed on LMS.<br>• Videos can be made of real-life situations, and used in assessment of students. |

Work-integrated learning does not form part of all courses, and if it does it is usually during the last year of the qualification, which limits students' exposure to the real-life workplace. Blended learning tools such as videos could play a major role in filling this gap.

## CONCLUSION AND FURTHER RECOMMENDATIONS

A primary problem currently encountered in South Africa's tertiary education system is students' low success rate and high dropout rate. In some cases current teaching methods are no longer relevant because it has not kept up with modern times. We need a change in our (current) teaching approach. This paper is the result of a review of previous research on how a blended learning approach and tools could contribute to the improvement of the success rate of undergraduate students in South Africa.

Based on this review, we argue that a blended learning approach, through the use of various tools, could address the key success factors identified in this paper. With blended learning tools, one could address the lack of basic subject knowledge, motivate students to participate, allow students to test and re-test their knowledge and to apply critical thinking skills, and bring real-life examples and scenarios into the class.

It is important to realise that technology should not only be used as a means of teaching, but should also form an essential part of the learning process itself, established within the current classroom environment with the physical co-presence of the lecturer and students. The tools that have been suggested here could assist with student interaction, engagement in the classroom, discussions and reflection, all of which form part of a student-centred learning process. Blended learning tools could provide students with access to information for further reading, additional exercises, case studies, videos and web links that could improve their contextual and conceptual understanding. It should also be noted that the blended learning tools mentioned in this paper are not the only tools and devices that are available. However, they could act as a springboard for the use and further development of blended learning in higher education. Because a literature review cannot produce new empirical insights (Mouton, 2001), it is recommended that further research be conducted to determine by means of a pilot approach, the extent to which the use of these blended learning tools is successful in promoting student success.

# CHAPTER 3: NOTE-TAKING

## Executive summary

The overarching question of this study is: *How can mobile devices be used in a blended learning environment in higher education?* To answer this question, the following two sub-questions were considered:

1. How can blended learning tools be used to enhance student success?
2. How can mobile devices be used to support the learning experience of veterinary students in (a) the pre-clinical component of the study and (b) the clinical component of the study?

This chapter attempts to answer the second sub-question, part (a). Because the learning environments of the pre-clinical and clinical students differ distinctly, only the pre-clinical students participated in this case study (also known as the MobiTech project). In chapter 3, the target group is 2nd, 3rd and 4th year pre-clinical students (n=365) and convenience sampling was used to select the participants.

An **electronic questionnaire** (see Appendix A), with closed- and open-ended questions, were distributed to all the pre-clinical students who attended class on a specific date (n=179). In the responses to these questions, participants indicated that they intuitively use their mobile devices in a variety of ways, for example they search for information, take notes, take photographs and videos, and in some cases, even do assignments and write tests.

Based on the information gathered through the analysis of the questionnaires, and the **informal observations** made by the researcher, the following themes needed further scrutiny, namely note-taking in class and in practicals, searching for Open Educational Resources (OERs) on a particular topic, incorporating students' own media such as video clips, audio and/or pictures into notes on a topic, and integrating all the information students had on a topic, including items such as lecturer slides, class notes, video clips and photographs into an Open Educational Resource (OER) for their own subjects.

To explore the abovementioned themes in more depth, student volunteers were invited to participate in a further component of the MobiTech study. The participation entailed five weekly contact sessions (one introductory session and four group interviews) to discuss how the participants used mobile devices in their various learning environments. Each of the contact sessions focused on one of the themes mentioned above.

Eight students (n=8) volunteered and participated in the weekly group interviews that was kick started by an introductory session during the first week. During the next four group interviews, participants reported back on the devices and apps that they tried out in relation to the theme of the week, and gave feedback on what worked and did not work for them. The feedback was, however, not restricted to the participants' experiences during the preceding week only, as participants were encouraged to share all their intuitive experiences and opinions with regards to the theme of the week, even if these occurred in the past.

After analysing the data from all four the group interviews, note-taking emerged as a key affordance of mobile devices. Not only did the participants intuitively use their mobile devices to take notes in class in a variety of ways (typing, writing, and drawing, session 1), but they also used the connectivity affordance of the mobile devices to search for additional information in the form of OERs. Once they found helpful OERs, they used them to enhance their own notes on a particular topic (session 2). Participants also used their mobile devices to take pictures, record audio clips and take videos (session 3) which they similarly incorporated into their notes on the topic (session 4). It seemed as if the participants perceived their mobile devices as *useful* for note-taking purposes, and that some of the functionalities and applications was *easy* enough *to use*, thus encouraging *behavioural intent* and *actual use* of these devices, as it is described in Davis' TAM (1989).

The first article in this chapter reports on the participants' experiences as they used their mobile devices for note-taking purposes. The article culminates in a number of recommendations with regards to the minimum requirements that note-taking apps need to exhibit in order to enhance this type of activity in higher education.

Researchers claim that when taking notes, students need to be actively involved (Piolat, Olive, & Kellogg, 2004) and not only typing or writing verbatim, or taking a video or photo (Mueller & Oppenheimer, 2014). Despite these claims, the use of videos and action cameras for note-taking purposes, is presented in the second and third articles. Participants in this study reported that they made extensive use of the ability of their own mobile devices to take video and audio clips as well as static photographs, which is often regarded to be a shallow cognitive activity on the part of a student (Mueller & Oppenheimer, 2014). However, in this study the participants actively engaged with their learning content when they organised and integrated the self-obtained media with their existing notes. This engagement was regarded to be on a cognitively demanding level that is generally associated with a higher order of thinking. By adding their personal meaning to the content, the participants enhanced their learning processes (Russell, Caris, Harris & Hendricson, 1983).

This type of activity, which was made possible by their mobile devices, however also stimulated opportunities for reinforcement and recall, and is in line with what Van Scoter (2004) and Lias & Thomas (2003) observed. While taking the videos or pictures, students needed to decide what and how they wanted to record it, whilst simultaneously making provision for individuality in their learning process (Ekanayake & Wishart, 2014).

The affordances of mobile devices are closely interlinked with the affordances of the note-taking applications used. Therefore, the final article in this chapter mostly focused on the affordances of a note-taking application that allowed students to take notes that are cognitively demanding and have the ability to positively contribute to their learning process. According to Norman (2013) and Salomon (1993), the concept of affordance refers to the perceived and actual properties of an application or a device that determines how it can be used.

Because the participants each owned and used their own mobile device, the affordances of mobile devices made it possible for participants to take notes. For example, in terms of *portability* the participants were able to take their devices with them to take notes in all their learning environments. The *connectivity* affordance of mobile devices allowed participants to download their lecturer's notes and related

OERs to enhance their existing notes. Participants were able to share resources with their peers as a result of the *interactivity* affordance of the mobile device. In terms of *individuality* participants were able to work at their own pace and create their own personalised notes. Finally, the *multimodal interaction* affordance of mobile devices allowed participants to enhance their notes with a variety of different media and to put it all together in one 'package'.

This study concludes that note-taking can be seen as a key affordance of mobile devices. Secondly, it can also be argued that students put a high value on the use of videos in their learning process, specifically with regards to the use of an action camera like a GoPro that can be used to record procedures especially when they need their hands to be free. Lastly, based on the feedback of the participants, a list of functionalities is proposed in order to inform developers of mobile note-taking applications of requirements associated with the affordances of mobile devices and cognitively demanding note-taking. The research outcomes were documented as indicated in Table 1.

**Table 1: Note-taking sections- Chapter 3**

| Section nr | Section title | Research question |
|---|---|---|
| Section 3.1 | Taking notes with mobile devices: a university case study | How do higher education students experience the use of mobile technologies in a variety of different learning environments? |
| Section 3.2 | Exploring videos as note-taking tools | How can students' own videos be used for note-taking purposes? |
| Section 3.3 | Exploring the use of an action camera in veterinary science education | How can a mobile action camera (such as a *GoPro*) be used in veterinary education? |
| Section 3.4 | Affordances of mobile devices and note-taking apps to support cognitively demanding note-taking | What are the affordances of mobile devices and note-taking applications that support cognitive demanding note-taking? |

In response to the question, “H*ow can mobile devices be used to support the learning experience of veterinary students in the pre-clinical component of the study?”, the following is offered*: The note-taking affordance of mobile devices can be used to support the learning processes of pre-clinical students. From this research study it is clear that the omnipresence, and several other affordances, of mobile devices make it possible for higher education students to take cognitively demanding notes that contribute to their learning. Students seems to be able to take such notes if they perceive the mobile device and associated apps as e*asy to use* (Davis, 1989), and if they find the device or app *useful* (Davis, 1989), e.g. when they have access to a single application that is scalable to multiple devices, and if they are able to effortlessly share and store their notes with others.

## Taking notes with mobile devices: a university case study


### ABSTRACT

In recent years there has been a sharp increase in the number of students who have access to mobile devices such as laptops, tablets and smartphones. Many of these students are already experimenting with mobile devices in their particular teaching and learning environments. But do educators really grasp the full potential of these devices in an educational environment? In this case study, a group of students from the Faculty of Veterinary Science at a South African university was approached to explore, amongst others, the note-taking possibilities of mobile devices in various educational settings. No prior knowledge was assumed, and no training was given. The researchers were interested in the students' authentic experience without external interference of any kind. Data were collected through a questionnaire, a series of group interviews and observations where the researchers received valuable feedback on how students used their various mobile devices for note-taking purposes. The research findings include insights into the software and applications used, as well as the students' perceptions about what worked well and what did not. Finally, recommendations are made about the capabilities note-taking applications and devices need to have for effortless note-taking.


### INTRODUCTION

The growing popularity of mobile devices amongst the youth of today cannot be ignored. Numerous researchers have shown that the use of mobile devices has increased dramatically over the years (Schepman, Rodway, Beattie & Lambert, 2012; Sooryamoorthy, 2014; Wallace, Clark & White, 2012). To put this growth in perspective, a breakdown of the international connected smart device market share in 2014 showed that 70.7% of devices sold were smartphones, 12.5% tablets, 9.5% laptops and 7.3% desktop computers (IDC (International Data Corporation), 2015). The astounding popularity of mobile devices is further illustrated by the fact that Tim

Cook, CEO of Apple, announced in October 2014 that the company had already sold 237 million iPads at that stage (Dilger, 2014). In the first four years since the launch of iPads, more devices had been sold than any other product in Apple's history (Dilger, 2014). Furthermore, the results of a worldwide survey showed that mobile subscriptions reached 4.7 billion in 2015, which is a penetration rate of 63% of the world population (Abbassi, 2016).

In South Africa, a general household survey completed in 2013 showed that 95% of households had a mobile phone while only 20% had a computer (Statistics South Africa 2013, 2014). Not only have South African citizens access to mobile phones, but 37% of them indicated in 2015 that they owned a smartphone as well (Poushter, 2016). From the above it is clear that mobile devices, albeit laptops, smartphones or tablets, are popular and readily available for day to day use. One can now question how these devices can be used in education, especially in a learning activity as important as note-taking.

Over the years researchers have emphasised the benefits of note-taking. Anderson and Armbruster (1986); Morrison, McLaughlin and Rucker (2002); Ward and Tatsukawa (2003) and Kobayashi (2006) all found that, when taking notes, students learn and remember information and are able to retrieve the information at a later stage. Furthermore, students take personal notes even if lecture notes are handed out before the lecture (Morrison et al., 2002), which indicates the importance of note-taking to students. Taking the popularity of mobile devices worldwide and the importance of taking notes in all the educational environments and realities of the students in consideration, the focus of the literature will be on note-taking and the use of mobile devices in education.

## LITERATURE REVIEW

In the literature review, the importance of note-taking for students will be discussed as well as the processes they follow to do so. However, note-taking is not only done by hand, electronic devices are also used. Therefore, the importance and use of mobile devices will also be mentioned.

## Note-taking

It cannot be denied that note-taking is to the advantage of students (Anderson & Armbruster, 1986; Cohen, Kim, Tan & Windelmes, 2013). As far back as 1925, research was done to determine the correlation between the number of facts recorded during note-taking in class, and the scores on a follow-up quiz (Crawford, 1925). Crawford (1925) found that the more information a student recorded and the more comprehensive the notes were, the better the student's scores were.

Students often complain about the balancing act they need to perform in class by simultaneously trying to read from slides, actively listening to the lecturer, critically thinking about new constructs, and writing legible notes. This is confirmed by Piolat, Olive and Kellogg (2005) and Bui, Myerson and Hale (2013) who state that the process of note-taking is cognitively demanding. How to capture and recall the flow of information in traditional lecture periods has been a dilemma for university students, and first-year students in particular, for many years (Piolat et al., 2005). This may be because students who take notes need to pay attention, organize the information, and then record it in an understandable manner before it is forgotten (Bui & Myerson, 2014).

Note-taking students also need to listen selectively to distinguish between what is important and what is less so (Kirkgöz, 2010). Bui et al. (2013) add that the more notes a student records, the stronger the influence it has on the learning, as more information is processed. Boyle and Forchelli (2014) agree and state that if good quality notes are taken, learning and comprehension of material increase. It is furthermore argued that students will need to carry on taking notes, despite the fact that many lecturers embrace innovative teaching methods such as peer teaching and flipped classrooms, because most lecturers still spend most of their time in class, lecturing (Bui et al., 2013).

If this process is so demanding, the obvious question is why lecturers do not simply provide students with full sets of notes. Russell, Caris, Harris and Hendricson (1983) found that if notes are provided, it is better to give students partial outlines only, as opposed to full sets of notes, as that enables them to add their own experience, and

thereby expand on the existing information. Also, Anderson and Armbruster (1986) claim that note-taking assists the student to learn and remember information, and to store it for later use.

Bui et al. (2013) did a study where they, amongst others, compared handwritten note-taking with taking notes on the computer. They found that although there was no difference in recalling information, the computer is better for transcribing notes than for organizing them. In that particular study, transcribing referred to typing or writing as many facts as possible, while organizing involved summarizing facts before typing or writing them. Furthermore when students were tested immediately after they had taken the notes, the students who transcribed the notes achieved better scores than those who first organized the notes. However, when there was a time delay, students who first organized their notes were more successful. When they allowed students who had only transcribed the notes to study them as well, the advantage that the students who had organized the notes had over time fell away. From the above, the conclusion is made that computers can be used for note-taking with some success.

Two ideas for further research that emerged from the research of Boyle and Forchelli (2014) were that researchers needed to investigate the use of notes in different content areas in the real world of the student, and that the impact of technology on note-taking skills should be examined. To respond to the impact of technology on note-taking skills, Mueller and Oppenheimer (2016) explored note-taking in four different settings and concluded that the effectiveness of note-taking and the technology used differ from situation to situation. For example, in the classroom the primary goal is to facilitate learning, therefore, students will summarize and synthesize, while in another scenario it might be merely to record ideas. In order to engage the student's mind, note-taking needs to be cognitively challenging, with technology playing a supporting role (Ward & Tatsukawa, 2003), rather than being a distracter in class (Mueller & Oppenheimer, 2016). Accordingly, they claim that a system that simulates pen-and-paper note-taking would be the best technology for the classroom. While simulating pen-and-paper-based note-taking, the note-taking process still demands deeper processing while providing students with the advantages of having electronic notes.

Since lecturing seems to remain a popular way of teaching amongst lecturers, the challenge is to make note-taking as effective as possible. With the abovementioned literature in mind, this article focuses on the use of mobile technology in note-taking.

**Mobile devices in education**

Although mobile technology was not originally designed for educational purposes (Traxler, 2010), their omnipresence challenges lecturers and researchers to develop applications so that they can be used in education. Students seem to use their mobile devices often and regularly. Laurillard (2012) affirms that students use their digital devices frequently, for example more students use their mobile phones to find information than their physical university libraries. Nowadays, mobile technologies such as tablets and smartphones seem to offer lecturers and their students a wide variety of tools and functionalities with educational potential. For example, students can use cameras, microphones and ebook readers for learning purposes, and can receive instant feedback through a variety of messaging applications (Ifenthaler & Schweinbenz, 2013). Alvares, Brown and Nussbaum (2011) mention that tablets can be used to improve the sharing of ideas when students work in groups. Furthermore, the classroom's boundaries disappear when mobile devices are used, and as an added bonus, this boundary-less learning environment moves with the students wherever they go (Farley, Murphy, Johnson, Carter, Lane, Midgley, Hafeez-Baig, Dekeyser & Koronios, 2015; Martin & Ertzberger, 2013).

While the educational use of mobile technology is a relatively new research field, many studies have been conducted on mobile technology application over the past few years. For example, in a study done by four universities in Canada, Boruff and Storie (2014) found that because of the portability and increasing processing power of mobile devices, medical students regularly use their mobile devices when searching for information, doing calculations and taking notes. Similar results were reported from research done at an Australian university, where students confirmed that although no formal use of mobile devices were encouraged, they used their mobile devices for educational activities (Farley et al., 2015).

Also, at universities like Stanford's Medical School, students use iPads to assist them with note-taking and studying (Stringer & Tobin, 2012). Da Silva, Marques and De Oliveira (2014) and Johnson, Adams Becker, Cummins, Estrada, Freeman and Ludgate (2013), note that tablets are emerging as powerful tools to be used inside as well as outside the classroom. Their mobility, ease of input, and new screen format enable lecturers to present learning material in new ways (Clark & Svanaes, 2014).

In addition to the above-mentioned research, between 70% and 80% of the junior doctors and medical students that participated in a study in the United Kingdom indicated that they own a smartphone and that their average educational apps usage is 79% (Payne, Wharrad & Watts, 2012). In a more recent study, Thomas and Muñoz (2016) found that more than 70% of high school students confirmed that they use mobile phones and applications for educational purposes. It is noteworthy that this group of high school students will be the future students of universities.

In South Africa, the use of mobile devices in education is also increasing. For instance, over 1 400 students of the College of Health Sciences at the University of KwaZulu-Natal in South Africa received tablets during 2013 to be used in a learning project (University of KwaZulu-Natal, 2013). Similarly, the University of Johannesburg announced at the end of 2013 that it was compulsory for all first-year students to have a mobile device like a laptop or tablet/iPad (Fripp, 2013). Some private universities have also embarked on a tablet project, for example first-year students at CTI Education Group (a private higher education institution in South Africa) received tablets with all their study material already uploaded (Alfreds, 2013).

In 2015 the Gauteng province's department of education in South Africa launched a paperless education system pilot project. As a start, seven schools in the province received tablets and internet connection (Oxford, 2015). Six months later the department rolled out another phase of its project and provided tablets to Grade 12 learners at about 300 schools in the province (Bendile, 2015). Also during 2015, three schools in the Eastern Cape Province reported that, as part of the Information Communication Technology for Rural Education Development (ICT4RED) project, they used tablets with great success in the rural areas (Wild, 2015). As a result of the

above, many first-year students at South African universities will already have been exposed to the use of tablets when they arrive at university.

As mentioned by previous researchers, such as Gikas and Grant (2013); Kobus, Rietveld and Van Ommeren (2013) and Traxler (2010), many students at higher education institutions already own a mobile device, and the challenge is now to explore how these devices can be integrated with student note-taking.

## RESEARCH QUESTIONS

Taking into consideration both the popularity of mobile devices and the value of note-taking, the question arises how students experience the use of mobile technologies in the various learning environments (Mackenzie & Knipe, 2006). To do so, the following two sub questions are asked:

1. How can mobile devices be used to take notes in a typical health science course?
2. What functionalities do mobile devices need to have to ensure effective note-taking?

## RESEARCH METHOD

This research study was exploratory and qualitative in nature and the design is in line with that of a case study. The unit of analysis was BVSc students who were busy with their degree studies at a Faculty of Veterinary Science at a university in South Africa. All the data was collected by means of class observations, a questionnaire and group interviews.

On a particular day, 179 pre-clinical training students who attended classes on that day, completed an electronic questionnaire about their mobile device ownership, mobile device usage and internet access. This questionnaire was administered by the researchers and after the purpose was explained and consent asked, clickers were used to collect their responses. These responses were counted and summarize using Microsoft Excel.

In the last question of the questionnaire, student volunteers were invited to participate in this study. Eight of the 179 pre-clinical training students who attended their second- third- and fourth-year classes on a specific day volunteered to participate in the study. They were one second-year student, five third-year students and two fourth-year students. Three of the students stayed off campus, three in the residence on campus and two did not disclose their residency, but all of them had adequate Internet access.

This study explored how students used their mobile devices in their authentic learning environment. However, not all the lecturers in that particular faculty allowed students to use their mobile devices in class. Therefore, for this project, we had to inform the university lecturers involved when one of the students would be using a device. Students were only allowed to proceed with the written consent of the lecturer in question.

As part of the study, specific assignments were designed so that the participants could integrate mobile technology into their learning practices, particularly when taking notes in typical educational environments like lecture halls, laboratories, and clinical settings where practical sessions are held. These clinical settings included indoor facilities, such as the academic hospital and pharmacy, as well as outdoor facilities, for example, the sheep pens and horse stables. After exploring a particular aspect of mobile note-taking, participants had to report back on their experiences during a group interview.

The group interviews were held once a week for six subsequent weeks, and the participants' inputs were recorded during these sessions, after giving written consent. Participants were asked to report every week on the specific device and applications that they used for taking notes, and whether they felt it worked for them, or not. The types of devices that participants could choose from were tablets, smartphones and laptops, and their choice depended on which device(s) they already owned themselves. The group interviews were recorded and transcribed and the text was analyzed according to the method described by Henning, Van Rensburg and Smit (2004) to determine trends and recurring patterns.

Lastly, observations were made when the researcher visited an anatomy practical class to observe whether, and how, students used mobile devices. After permission was asked from the lecturer and students, the researcher took photos of how the students take notes with and without their mobile devices.

## RESULTS

First the mobile device ownership of the students is presented. After that, the results of the analysis of the group interviews and observation are presented in the form of four themes, namely students' current note-taking practices, their perceived value of note-taking, the mobile devices and applications used, and suggestions to simplify future note-taking.

### Mobile device ownership and use

To confirm the usage of mobile devices at this university, the participants were asked to indicate what mobile devices they were using at that time. In the electronic questionnaire 96.6% of the students indicated that they were using a mobile device for either social or academic purposes. As seen in Figure 1, the various mobile devices that students used, are indicated.

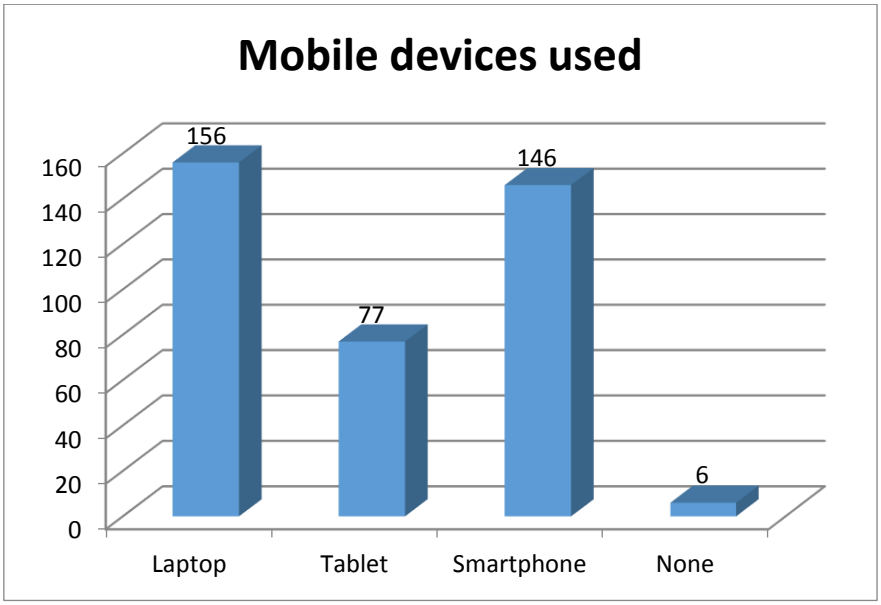


**Figure 1: Mobile devices used by students**

Students also specified, that they use their mobile devices for both social and academic purposes. This is shown in Figure 2 (social purposes) and Figure 3 (academic purposes), respectively.

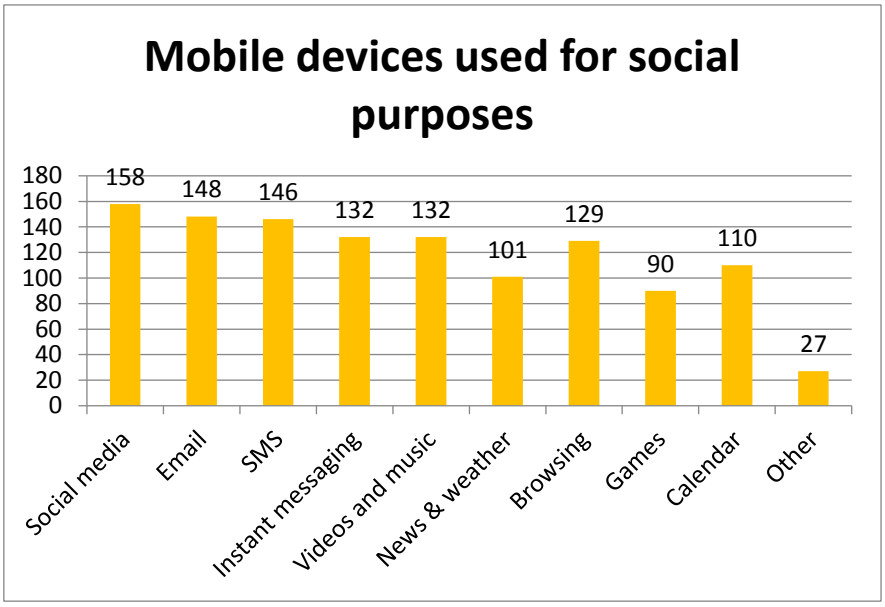


**Figure 2: Mobile devices used by students for social purposes**

Students are already using their mobile devices for, amongst others, note-taking purposes. From the students that participated in this study, 31% indicated that they used their mobile devices for taking notes during classes, 61% of the students used their mobile devices for taking photographs during class, while 22% of the students had recorded a lecture in the past.

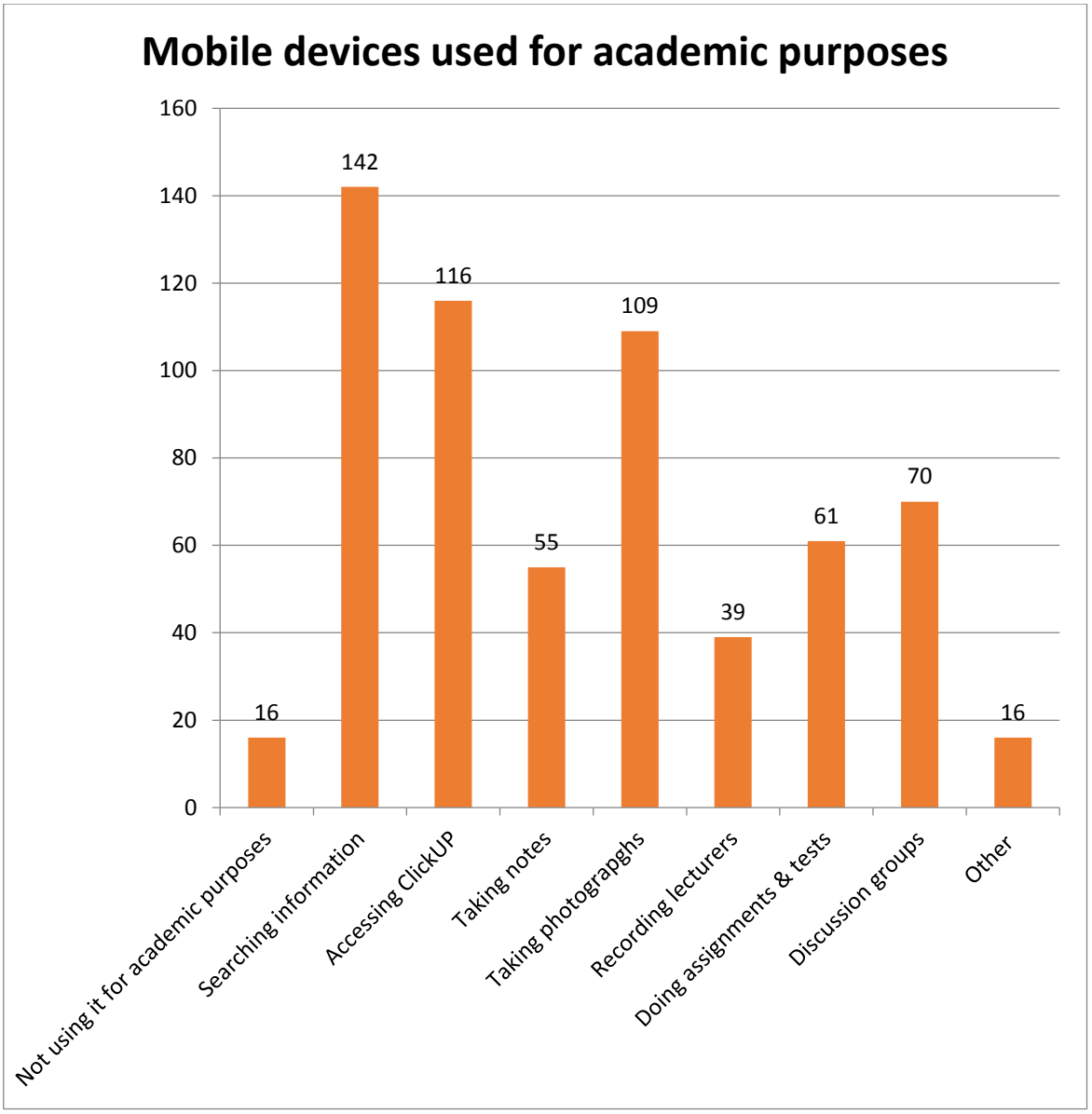


**Figure 3: Mobile devices used by students for academic purposes**

The data from the questionnaire confirmed that the majority (96.6%) of the pre-clinical students owned a web-enabled mobile device and this finding encouraged further exploration in the use of mobile devices. The eight students who participated in the group interviews indicated that they all (100%) own a mobile device, whether it was a laptop, smartphone or tablet. Furthermore, the results also shown that students are using mobile devices for note-taking and or capturing of information during classes. Therefore, it became evident that the focus of the study will be on the use of mobile devices for note-taking purposes.

## Current note-taking practices

During the first group interview participants were asked to indicate their current note-taking practices (Figure 4).

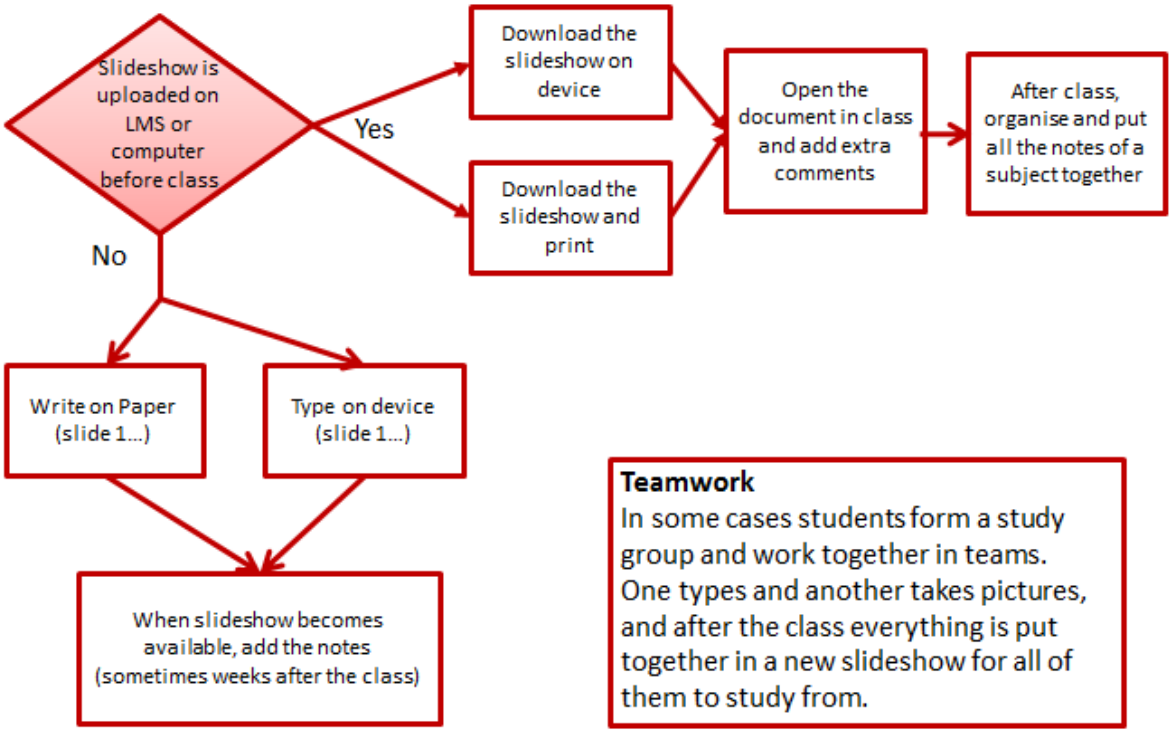


**Figure 4: Current note-taking practices**

Participants' explanations of their current note-taking practices confirmed that students were already making use of their devices without the interference of lecturers or the university (Laurillard, 2012; Naismith, Lonsdale, Vavoula & Sharples, 2004). The examples below show how some students in a practical anatomy session preferred the traditional pen-and-paper way of taking notes (Figure 5) while they dissected and isolated specific anatomical structures, whereas some other students used their mobile devices (Figures 6 and 7). Some students who attended that session printed out all the notes beforehand and came to the practical armed with an array of colored flags, pens and highlighters, as can be seen in Figure 5. They then did the dissection and took notes on their paper-based handouts as they went along.

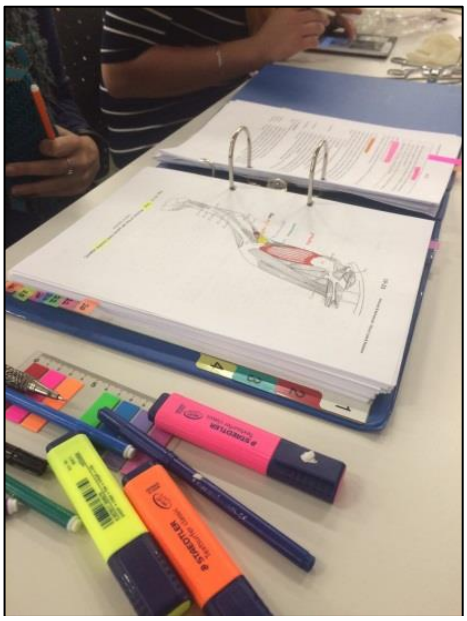

**Figure 5*:* Taking notes the traditional way**

Other students chose to use their smartphones or tablets in these sessions (see Figure 6).

**Figure 6: Taking notes with a smartphone**

These students downloaded the notes on their devices beforehand, and came to class without having to carry heavy lever-arch files and masses of stationery. They opted to take photographs of their own dissections as they discovered the various anatomical structures, and used an app with digital pens in a variety of colors to draw and highlight the various features on their picture.

Some students found it frustrating to divide their attention between their notes and the photographs of their dissection, and opted to use their tablets as well (see Figure 7).

It seemed as if these students alternated effortlessly between the various devices, using each one in a slightly different way and for a different purpose, depending on their need at the time.

**Figure 7: Taking notes using a combination of hard-copy notes, a tablet and a smartphone**

The authors observed that it seemed to be irrelevant whether or not lecturers give students copies of their presentation slides, or even lecture notes, before the class, as students take notes regardless of handouts. They also use the capacity of their devices to the maximum permitted by the lecturer or the department. When taking down notes, students either type or write on top of the electronic format of the notes, or they print the notes in hard copy and write on them in the traditional way. If the notes are not available beforehand, they either type the notes on their mobile devices, or they write on a piece of paper. Furthermore, in some environments where it is not practical to use bigger devices like laptops or tablets, students seem to use their mobile phones or other small handheld devices such as video cameras or camcorders to record segments of the class.

**Value of note-taking**

A significant theme that emerged from the feedback was the value of note-taking as experienced by the participants in the study. One of the participants made the following comment about the value of making proper notes:

> "… for me personally, sitting and putting the time into … making comprehensive notes for myself is almost two-thirds of the learning experience…" [G3P2]

Based on the feedback, it was concluded that the veterinary students seem to have two specific opinions about note-taking. Firstly, note-taking was perceived as important because it was seen as an integral part of their own learning process. But it was, secondly, interesting to note how these participants also regarded it as important to record and save information for future students (those currently in lower classes), especially in the form of visual notes like pictures with captions of specific diseases, and videos with voice recordings and explanations of real case procedures.

The importance of sharing notes with one another, and of using notes that students from previous years supplied, also become clear as indicated by the following student remarks:

> "… in Pathology it really helped going through what other students have made of each of the organ systems" [G3P1]

> "Having a bank/stash of those … would be valuable because sometimes you miss a practical and they did a specific condition that you've missed now. You are not going to be seeing it again because it [that type of case] might not be one coming in again …" [G3P2]

One participant commented that they appreciated it when final-year students recorded the real-life cases that they were exposed to in the clinical setting and then made the information available to students in the pre-clinical years. The student said:

> "… it is a lot easier to remember diseases like that if you actually have memories of the pictures, … what it looks like, … what you saw and different variations of the same type of disease" [G3P1]

**Devices and applications used**

Note-taking refers to the typing or writing of information in a systematic way, which can include the recording of images, voice, or both during a lecture or a discussion (Schneider, 2014). To allow the participants to further explore the use of mobile devices for note-taking, they were asked to make use of different types of mobile devices and applications to take notes during the week in question. The participants had to use applications of their choice to type notes and take pictures and videos, and were then requested to organize and integrate the notes and images with the lecture notes they received from the lecturer. In the group interview they were requested to give feedback on the devices they chose to use (tablet, smartphone or laptop), and the educational setting (classroom, practical or laboratory) where they used it. They were also questioned about the specific applications that they used, as well as which of these worked best in their particular environment. The participants also reported on those devices and applications that did not work well.

The mobile devices the participants experimented with were tablets (Samsung tablet, Samsung Galaxy 2 and an iPad), smartphones (Sony Xperia Z2, Lumia and Zest) and laptops. The mobile devices that have dedicated stylus recognition worked well and participants could write, highlight, and insert videos, audio and pictures using that application. In contrast with that, participants who used devices without a dedicated stylus downloaded a stylus application that did not work well and they had to revert back to typing instead of writing.

Participants also used various Office applications such as King Office, Polaris Office, Office Suite 7, Documents Office and Microsoft Office. Some worked better than others, depending on what the participants tried to do, and on which mobile device they used it. Typical actions were to highlight, format text and add objects like pictures. Although they attempted drawing on existing slideshows, they could not use that function on a laptop. Participants also complained that not all Office packages were user friendly and that they had struggled to create new documents, especially on the smartphones.

The participants also experimented with dedicated note-taking applications such as Evernote, OneNote and S-Note, with mixed results. Although all these applications worked, documents could sometimes not be opened and edited, and in other cases documents could not be shared. The majority of participants explored Adobe, since the slides used in class were in PDF format. They mentioned that Adobe worked on all the devices and that documents could be moved between devices. However, they were unable to select a specific page to print.

With some mobile devices participants could use a USB adapter, which allowed them to move documents easily between devices and applications. This gave them access to more functionalities. In some cases participants could split the screen so that they could see two documents at the same time and also move content from the one document to the other.

In order to put together all the information collected during note-taking, participants used more than one device and more than one application. Therefore, to make their note-taking effective, their devices had to be able to sync with one another. This is confirmed by Mueller and Oppenheimer (2016), who concluded that the note-taking devices and applications used will differ from situation to situation, and that note-taking needed to be more effective rather than merely easier.

## DISCUSSION

During the research, participants experimented with word processing applications, mobile note-taking applications, digital experience applications, and some of the apps that come with specific smartphones. A comparison of the available note-taking applications did not seem to meet all the expectations of the participants. It is therefore clear that there is a need for applications that make the note-taking process as seamless as possible, whether it is for self-learning or for the benefit of other students. With the pace of technology development increasing (Columbus, 2015; Roser, 2016), more sophisticated note-taking applications are expected to be developed in the near future.

Students need to be able to access the application readily and without difficulty. Although they did not prefer to use a specific mobile device above another one, the students should be able to move information seamlessly between their devices and should be able to pick up easily where they left off. Therefore, if one app is used, it should be scalable across devices.

Participants expressed the need to have all the functionalities in one application. They also indicated that they would like to be able to take notes and to access their textbooks in the same application. Ideally, students should be able to manage all the modules they are enrolled for in one centralized app. The app should make provision for students to open and take notes on any of their learning material, which could include, amongst others, a prescribed e-book, a slide presentation, a website and a hand-out (typically in PDF format). They should also be able to create a completely new document or note independently in a variety of formats, such as text, video and audio.

With a view to using the notes and subsequent summaries again at a later stage, the app should have the functionality to save the notes in a format that is small enough to be transferred between devices. Students should be able to organize their saved notes in a folder on the device, or in cloud storage. This is particularly important because the participants emphasized the importance of making their work available for future students. Therefore, this application should be able to allow students to share their information with others. For example, the information could be shared through social media like Twitter and Facebook, or through email. If it is saved in the cloud, it would also be available on other devices. It seems that some students still find it important to be able to print their notes, and therefore that functionality should also be considered.

And, finally, if one centralized app should be developed, it should preferably be able to integrate seamlessly with whichever learning management system is used by an institution of learning. Therefore, it would be interesting to know if it is possible to develop such an app that students at universities can use to take notes.

## CONCLUSION

It was evident from the literature that the majority of students own mobile devices and use them on a daily basis (Gikas & Grant, 2013; Kobus et al., 2013; Traxler, 2010).This trend was confirmed through informal observations in the South African higher education context and in particular at the Faculty of Veterinary Science at a South African University through the current study. It appears that South African students, and particularly those studying veterinary science, are already intuitively using these mobile devices in their educational environment, specifically for note-taking purposes.

Because note-taking is seen as a valuable educational activity on which students already spend a lot of time, this study aimed to explore the current practices and experiences of students when they take notes using their mobile devices. The aim was to explore what functions students see as important when taking notes. It also aimed to propose guidelines that should be considered when an app is selected for note-taking purposes. This guidelines could be of great importance to creators of online applications aimed at institutions of higher education.

As mentioned in the literature review, many studies have been done on note-taking, electronic note-taking and on hardware and software needed for note-taking. Therefore, this article contributed by looking at the type of activities students would like to be able to do when taking notes in the twenty-first century, taking into consideration the sophisticated technology that is available, as well as students' higher levels of computer literacy. It remains to be seen whether all of these actions need to be done on a single device. Because students often own more than one device, it might be more appropriate for students to work with the device of their choice, depending on the particular environment and context, and for applications to integrate seamlessly. It will be interesting to observe how the new age of cloud storage impacts the note-taking activities of the future.

**Section 3.2**

## Exploring videos as note-taking tools


### ABSTRACT

The popularity of watching and downloading videos from the internet cannot be denied. Videos have also been used for some time in an educational context to provide access to information, and especially to technical skills. However, mobile devices have now become increasingly popular, and therefore the use of videos on mobile devices is of particular interest. In this qualitative study, a group of eight volunteer students were asked to experiment with mobile devices to which they had access and to record theoretical and practical lectures for note-taking purposes. The students experimented with an action camera, tablet, mobile phone video camera, and handheld video camera. The students not only indicated the benefits of working with video when taking notes, but also made suggestions on how it can be used best in the practical classes. To conclude, participants agreed that there was no one-size-fit-all device that would work well in all educational settings. Some devices are obviously more suitable for a classroom-based environment, whilst others would work better in a practical environment.



**Keywords:** Action camera; mobile phone; note-taking; tablet; video


### BACKGROUND

"You may want to take notes," is an opening remark that university lecturers often make at the beginning of a class, even though it is not necessary to tell students because they seem to take notes (Bui, Myerson & Hale, 2013; Morrison, McLaughlin & Rucker, 2002), even if not prompted to do so. The way in which students take notes differs from student to student, and from one educational setting to another (Badger, White, Sutherland & Haggis, 2001; Boyle & Forchelli, 2014, Bui et al., 2013; Mueller & Oppenheimer, 2016, Ward & Tutsukawa, 2003). In the past decade or so researchers have been advocating the use of computers, (Bui et al., 2013) and electronic note-taking systems (Kim, Turner & Pérez-Quiñones, 2009; Ward & Tatsukawa, 2003) for

taking notes in class, but it is worthwhile to explore to which devices higher education students in South Africa currently have access for that purpose.

## LITERATURE REVIEW

In the next section, the value note-taking have for students will be discussed. However, as mobile devices become more popular and available, students started to take notes with these devices. Therefore, the importance of the use of mobile device in education will also be discussed. But, student do not only take written or typed notes, they also make video recordings, so, lastly the use of videos in educations will also be investigated.

### Note-taking

It is a well-known fact that note-taking is prevalent in an academic context. Researchers have found that, when taking notes, students learn and remember information and are able to retrieve the information at a later stage (Anderson & Armbruster, 1986; Kobayashi, 2006; Ward & Tatsukawa, 2003). Morrison et al. (2002), mention that students take notes even if lecture notes are handed out before the lecture. This is explained by Bui et al. (2013), who are of the opinion that the more notes a student records, the stronger the influence it has on the student's learning, as more information is processed during the note-taking process. Boyle and Forchelli (2014) confirm this finding by stating that learning and the comprehension of material increase if notes of a good quality are taken.

Students often complain about the balancing act they need to perform in class when they simultaneously have to read from slides or watch a demonstration, actively listen to the lecturer, critically think about new constructs while determining what is important and what not, and write legible notes (Kirkgöz, 2010). Researchers have confirmed that the process of note-taking is cognitively demanding and a complex skill, (Bui et al., 2013; Piolat, Olive & Kellogg, 2005) because when students take notes, they need to pay attention, organise the information, and then record it in an understandable manner before it is forgotten (Bui & Meyerson, 2014).

It is, therefore, not surprising that students still carry on taking notes in the 21st century. Despite the fact that many lecturers are embracing innovative teaching methods such as peer teaching and the flipped classroom, some lecturers still spend most of their time in class on lecturing (Bui et al., 2013). However, students do not only take handwritten notes, as Bui et al. (2013) found in their research that electronic devices can also be used to some extent for note-taking.

Two ideas for further research that emerged from the research of Boyle and Forchelli (2014) were that researchers needed to investigate the use of notes in different content areas in the reality of the student, and that the impact of technology on note-taking skills should be examined.

In answer to a question about the impact of technology on note-taking skills, Mueller and Oppenheimer (2016) explored note-taking in four different settings and concluded that the effectiveness of note-taking and the technology used differ from situation to situation. For example, in the classroom the primary goal is to facilitate learning, while in another scenario it might be to record ideas. Thus, research should be done on the use of technology in various educational settings. In this study the focus is on mobile devices and how they can be used in students' theoretical and practical classes.

**Mobile devices in education**

In the past decade a sharp increase in the use of mobile devices was observed. For example, smartphone ownership has increased with 25% since 2013 (Poushter, 2016), while the mobile device subscription rate worldwide reached 63% in 2015 (Abbassi, 2016). This trend of owning a smartphone also seems to apply to university students. For instance, 86% of students surveyed in the United States said that they used a smartphone on a regular basis (Poll, 2015) while 91% of the young adults in the United Kingdom owned a smartphone (Deloitte, 2016). A similar trend has been observed at other universities, such as in Australia where 86% of the students owned a smartphone (Farley, Murphy, Johnson, Carter, Lane, Midgley, Hafeez-Baig, Dekeyser & Koronios, 2015). Similarly, 94% of the students at a Saudi Arabian university (Alfawareh & Jusoh, 2014) and 84% at a South African university (Potgieter, 2015), indicated that they owned a smartphone. Although smartphone ownership

statistics for South Africa indicated that only 37% of South Africans owned a smartphone (Poushter, 2016), in comparison to the 95% that owned a mobile phone (Statistics South Africa 2013, 2014), Potgieter (2015), showed that the percentage of smartphone users at some universities tended to be higher. One can, therefore, assume that students tend to have access to mobile devices and therefore the educational possibilities of using these devices in teaching and learning should be explored.

Although mobile devices were not specifically designed with education in mind (Traxler, 2010), they create untold opportunities and possibilities for education (Traxler & Vosloo, 2014). Currently, many fierce debates are focussed on whether mobile phones should be banned or embraced in the classroom. Some lecturers are not in favour of using mobile phones in the class because they say the phones distract the students, rather than assisting with their learning (Beland & Murphy, 2015; Thomas & Munoz, 2016), while others recognise the benefits and therefore support the presence of mobile phones in class (Farley et al., 2015; Smith-Stoner, 2012). Be that as it may, it is an undeniable fact that mobile devices do have capabilities that could encourage teaching and learning (Ifenthaler & Schweinbenz, 2013; O'Bannon & Thomas, 2015; Traxler & Vosloo, 2014).

Previous studies have shown that many students are already experimenting with mobile devices and applications in their particular teaching and learning environments (Alfawareh & Jusoh, 2014; Kim, Ilon & Altmann, 2013; Payne, Wharrad & Watts, 2012). Laurillard (2012) claims that students probably use their mobile devices more often than they use university libraries. But do educators really grasp the full potential of these devices in an educational setting? Since lecturing remains a popular way of teaching with higher education lecturers, the challenge is to use these devices effectively. One possible way is to assist students with the recording of information while they are actively engaged in their various educational settings. Because mobile devices are nowadays equipped with good quality cameras and video cameras, the use of videos could be one way to record, store and share lectures, practicals and demonstrations.

## Videos in education

Why videos? The popularity of watching and downloading videos from the internet cannot be ignored. According to researchers from the Cisco Group (Cisco Website, 2017), video traffic comprises 70% of the global internet traffic. To confirm this popularity, Internet Live Stats (2017) reported that 71 016 YouTube videos are being watched every second. In this new age, where students grew up with technology, it is perhaps not surprising that millennials watch more videos than the average person (Heltai, 2016). Not only do they watch videos; they are also guilty of video binging (watching multiple videos non-stop over an extended period). A similar finding was made by Morrison (2016), who determined that millennials watch between two and thirty one hours of videos per week. Humphrey (2016) also supports the notion that millennials characteristically watch a lot of videos.

After an eight-year literature review (from 2002 to 2011), Kay (2012), supported by Lee, Chae, Kim, Lee, Min and Park (2016); and Dong and Goh (2015); summarised the benefits of using videos for education. He mentioned that the use of videos allowed students to control their own learning because they could learn at their own pace, anywhere and at any time, could revisit a particular section of the video, slow it down or speed it up, and so forth. Also, students described the use of videos as useful, helpful, effective, enjoyable, motivating and stimulating (Kay, 2012). Students' study habits gradually changed because they accessed those videos more frequently, especially before a test (Roshier, Foster & Jones, 2011).

The use of videos also has valuable application potential in the health sciences. For example, Frentsos (2015) and Dong and Goh (2015) found that the use of videos in patient education was flexible and a medium that people were used to. Delivery can also take place via mobile devices, which give patients easier access to the information because they do not need to be in front of a computer. In cases where certain procedures are scarce, difficult to illustrate, or staff intensive, Schwerdtfeger, Wand, Schmid, Roessler, Quintel, Leissner and Russo (2014) showed that videos can be used with great success. By recording specific procedures, the video material can be used repeatedly. However, videos are not only used in the education of students or patients, but studies also show videos to be a valid and feasible option in the

assessment of students, in both a formative and a summative context (Bowles, Harries, Young, Das, Saunder & Fleming, 2014).

Much of the research done to date revolves around topics such as access to information, assessing skills, and video notes. When discussing access to information, researchers focus mostly on using videos to provide students with access to content to reinforce concepts, provide support, and supplement education (Frentsos, 2015; Lancellotti, Thomas & Kohli, 2015; Ljubujevic, Vaskovic, Stankovic & Vaskovic, 2014; Roshier et al., 2011; Van Wyk & Van Ryneveld, 2016). These videos are usually recorded by the lecturer, but in some cases videos from popular channels such as YouTube, Khan Academy and Linda.com were used (Dong & Goh, 2015; Jang & Kim, 2014; Kay, 2012; Lee et al., 2016; Schwerdtfeger et al., 2014).

In other cases, videos were used to assess students, for example in terms of their communication skills (Kiehl, Simmenroth-Nayda, Goerlich, Entwistle, Schiekirka, Ghadimi, Raupach & Koenig, 2014; Ram, Grol, Rethans, Schouten, Van der Vleuten & Kester, 1999; Roshier et al., 2011), patient encounters (Epstein, 2007), technical skills (Bowles et al., 2014; Dunne, Brereton, Bree & Dallat, 2015), self-assessment (Framp, Downer & Layh, 2015; Vara, Wu, Shin, Sobol & Wiater, 2016; Yoo, Son, Kim & Park, 2009), feedback (Perron, Louis-Simonets, Cerutti, Pfarrwaller, Sommer & Nendaz, 2016) and decision-making (Webb, Davis, Muir, Lissauer, Nanduri & Newell, 2012). In these cases the videos were either pre-recorded cases that were used repeatedly, or the students were recorded and assessed (Bowles et al., 2014; Nyström, Pålsson, Hofsten & Häggström, 2014; Webb et al., 2012).

Another topic of interest is taking notes from educational videos, especially to create an experience similar to taking notes on paper, where notes can be added to a video. This is typically called video annotation. Various video annotation tools are discussed and in some cases suggestions are made about the characteristics video annotation tools should have. In these cases students used the video annotation tools after they had watched the videos that had been recorded by the lecturer (Chatti, Marinov, Sabov, Laksono, Sofyan, Yoesef & Schroeder, 2016; Lawson, Bodle & McDonough, 2007; Mu, 2010). Video annotation tools could also be used to review teaching practices (Rich & Hannafin, 2009).

As seen above, research about videos in education mostly involves information sharing, assessing students and video notes. The videos involved were mostly made by the lecturers or subject specialists or they were made of students while they did certain tasks. Limited research is available on videos that are made by students and are then used as a tool for note-taking. Therefore, the question asked is how videos could be used as note-taking tools by pre-clinical health students in higher education. In this research, the focus is therefore on students' recording of videos to be used as note-taking tools in both their theoretical and practical classes.

## METHODOLOGY

This qualitative research study is explorative by nature and in line with the qualities of a case study. The study was based on the MobiTech project which aimed to explore the use of mobile devices in higher education. The study was conducted in two separated phases in the natural learning environment (Creswell, 2007) of students at a South African university that offers a bachelor's degree in veterinary science. In phase 1 of the MobiTech project, the total group of 2$^{nd}$ – 4$^{th}$ year pre-clinical veterinary science students (n = 365) was approached to participate in the study. From this group, 179 students completed an electronic questionnaire about their current access to, and use of mobile devices for learning purposes.

The final section of the questionnaire invited students to participate in the 2$^{nd}$ phase of the study and provided them with the necessary background information regarding the MobiTech project. This 2$^{nd}$ phase was qualitative in nature and consisted of a series of group interviews that was intended to provide qualitative insights to the quantitative results obtained through the questionnaire in phase 1. Phase 2, therefore, consisted of five 1 hour long group interviews, spread over a period of 6 weeks. The time commitment beyond the group interviews, was restricted to approximately 2 hours per participant.

The researchers were keen to engage with approximately 10 students, all of whom had to self-identify as being passionate and enthusiastic about the use of their mobile devices in their various learning environments. It was explained that the ideal group of participants would be diverse in terms of their cohorts, social backgrounds and gender.

Apart from personal contact details, interested students also had to indicate whether they owned any mobile devices (e.g. mobile phones, tablets, laptops, digital cameras). They were also requested to motivate their interest in mobile technologies in one sentence. In response to this call, eight students self-selected (Daniel, 2012) to participate and since they all complied with the requirements and were sufficiently diverse in nature, all were accepted as voluntary participants.

After an initial introductory briefing the participants were tasked to explore different angles each week. For example, during the first week they had to experiment with their mobile devices and a variety of applications to take notes in their various educational environments. No guidance or instructions were given with regards to the specific devices they had to use, or how they were supposed to use them. The following week, they were asked to explore using their mobile device to find and use open educational resources (OER) that related to one of their modules and to report on their impressions at the next group interview. During the third week, the participants had to use the multimedia features of their mobile devices to take pictures and to record audio and/or video clips as part of their note-taking activities in class, albeit lectures or practical sessions. Next, the participants had to create their own open educational resource by combining their class notes with the OERs that they found earlier on, as well as with the multimedia recordings that they made the week before. During the last week the participants had to upload their resources to an electronic platform and explore ways to share the resources with their peers.

An example of the activities for Week 3, as well as the question guide that were used in the group interview that followed, is shown below in Figure 1.

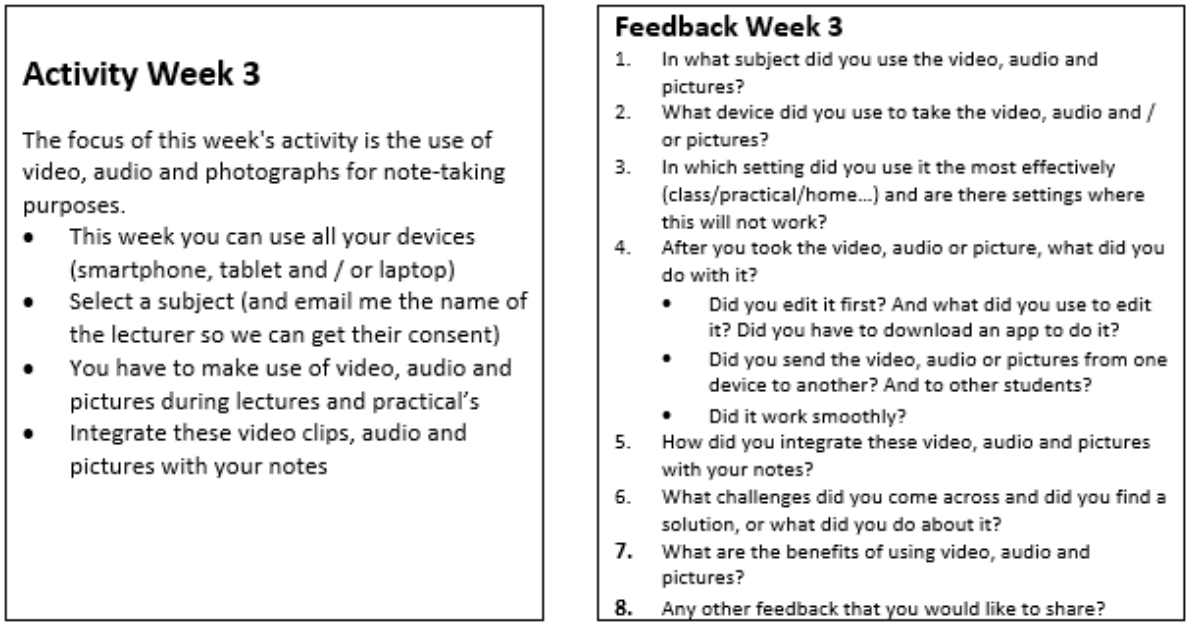


**Figure 1: Week 3 activity and feedback**

To ensure that all the participants contribute to the discussions, each one of them was given the opportunity to give their initial feedback. However, participants were allowed to interject and add their own experiences to the reflections of their fellow students. The session ended when no further feedback was offered and the researchers had also exhausted all their probing questions.

Although the use of mobile devices to record videos only formed part of the activities of the third week, participants regularly referred to the way in which they used videos in the group interviews in other weeks as well. Therefore, participant feedback on the use of videos were extracted from all of the five sessions.

The researchers' representation of the use of videos as note-taking tools, were built from the rich reflections of the participants after they explored the use of mobile videos as note-taking tools in a variety of their educational settings (Creswell, 2007; Miles & Huberman, 1994). No prior knowledge about the use of mobile devices was assumed, and neither was any training given to the participants, because the researchers were specifically interested in the participants' authentic experiences using their mobile devices to take video notes, without external interference of any kind.

To determine how the participants made meaning from taking videos on their mobile devices, the usefulness of the video notes that they took, and their opinions about the mobile devices they used, the group interviews were recorded and transcribed. The text was analysed by determining trends and recurring patterns as described by Henning, Van Rensburg and Smit (2004). This was not done with specific themes in mind, but themes were derived from the data (Easterby-Smith, Thorpe & Jackson, 2012). The participants' feedback was coded according to a group and participant number. For example, the code G1P5 represents feedback given by participant number five in the first group interview.

## RESULTS

The students reported that they did not only take notes by typing or taking photos with their mobile devices during lectures, but that they also made sound and video recordings. In this study the focus is on video note-taking only. The participants indicated that they either recorded a whole lecture, or made shorter video clips of practical demonstrations. To make the video recordings, the participants explored a variety of video-enabled devices to see what worked best in the different educational settings they were exposed to, namely lectures, practicals and laboratory demonstrations.

### Mobile devices students experimented with during video note-taking

To take video notes during lectures, practicals and laboratory demonstrations, students use action and video cameras as well as the video functionality of their tablets and mobile phones. The section is, therefore, grouped according to action cameras, video cameras, tablets and mobile phones.

*Action cameras (GoPro)*

To take videos, some students explored the use of a popular type of action camera [G1P1]. The action camera is designed to make recordings of activities such as extreme sport and activities where participants' hands need to be free, and therefore it is typically built so that it can be mounted on bicycles, helmets or surfboards

(Furchgott, 2014). In this study, the action camera worked better than other cameras in situations where students needed to use their hands for writing or other practical or laboratory activities. Furthermore, one participant reported that his/her action camera linked up with a mobile phone application where the exact image that was being recorded could be seen, which allowed the student to readjust the focus where necessary [G3P1]. Students were also able to control the action camera remotely from the application on their mobile phones, as indicated by the comment of one student [G1P1].

> "I've got an app on my cellphone … I am looking on my phone while I am using this the whole time. Then I can readjust it and move it around. So you can actually see are you seeing the right thing or are you not. I can pause, stop and play instead of trying to push the button when it's on your cap."

Because the primary purpose of the action camera is to record video footage, the quality of the videos was better than that of most other mobile devices such as smartphones or tablets that also have a camera functionality. Another advantage the action camera had in comparison with the other mobile devices used was that it came with a waterproof casing that allowed students to use the camera outdoors in the field and in wet learning environments, for example, a wet laboratory. This created opportunities to take notes in an environment where the traditional pen-and-paper method of note-taking would not have been possible. Students also found that the battery of the action camera lasted longer than the battery of the mobile phone or tablet [G3P1] and this was regarded as a bonus in longer practical and laboratory sessions.

The participants agreed that the action camera was not ideal for recording theoretical classes because the venue was typically too big, and the camera could not zoom in and out [G3P1]. Presentation slides seemed too small through the lens of the action camera, and therefore students were of the opinion that the action camera was best suited for taking video notes in a practical environment [G3P1]. However, they confirmed that the action camera was easy to use and that video notes taken with this type of device could be downloaded and distributed on the learning management system [G3P3].

*Handheld video cameras*

While handheld video cameras were not as popular as the action cameras or mobile phones, one student mentioned that she had used a handheld video camera to record a theoretical class. She experienced that the video quality was good enough, but the audio quality was not very good [G3P2]. Interestingly enough, she added that recording a whole lesson would only have value if one had not attended the class [G3P2]. In a similar manner, it was reported that there were students who recorded all the lectures instead of taking notes [G3P1]. However, this was not common practice, as many students realised that they simply never watched a recorded lecture [G3P2, G3P4]. One student jokingly commented that she had slept through a lecture once, and that she had no intention of putting herself through that one more time [G3P4].

*Tablets*

Another device students used for taking video notes was the tablet. In their opinion, the tablet had much better video recording functionalities than a laptop. They highlighted the fact that a tablet had a back and front camera and a good battery life, and that it was more portable than a laptop. The tablet was also smaller in size and participants felt confident that they could track the device if it got lost or stolen on campus [G1P2].

One participant reported that she took videos with her tablet in a practical pathology class and that she found it extremely valuable to watch the video again at a later stage to recap what they did in class on that specific day. She also watched the video again in preparation for tests and exams. Another reason participants gave for watching their video notes again was that they needed to understand certain techniques better and that this learning process was made possible by their video notes [G1P2].

*Mobile phones*

The mobile phone was another popular device the students used to take video notes. Participants indicated that one of the main advantages of using a mobile phone rather

than a bigger device, like a tablet or laptop, was that you could watch the video clips at anytime and anywhere because of the omnipresence of a student's mobile phone.

The participants indicated that the video notes they took with their mobile phones could easily be downloaded to a laptop or desktop computer and shared with their fellow students, for example, through email [G1P6]. When students used the mobile phone in practical classes the quality was good and the video sizes manageable, in comparison with other video cameras where the files were perceived as excessively big [G3P2]. Not only did the participants take video notes with their mobile phones, but the device also came in handy when students wanted to record audio notes. Even if the audio files were big, participants reported that they could easily store these notes on their mobile phones [G3P1].

Two participants reported on working together to take notes in their practical class. The one student had a mobile phone with a good quality camera, whilst the other one reported that she could type very fast. So while the one student took responsibility for taking photos and videos, the other one used a note-taking app to type notes using her mobile phone. At night they would then put all their notes together as the evidence of their practical class that day [G1P6]. This student indicated that she preferred using her mobile phone to take the written notes, because typing on a tablet or laptop meant she needed to sit down, whereas with the mobile phone she could do it standing. However, the participant also mentioned that different devices have different strengths, and that the environment she was in influenced the type of mobile device she chose to use. For example, she would actively choose whether she wanted to take notes on a laptop, a mobile phone or an action camera, depending on the environment. Participants reported that the challenge was to juggle the use and integration of all these devices, because it was regarded as impossible to select only one type of device to meet all their learning needs [G1P6].

**Video as a note-taking tool during practical classes**

Student-generated videos seemed to have a valuable impact, even beyond video note-taking. The participants reported that they sometimes had to assist with surgeries, watch specific medical procedures performed by a skilled clinician, or attend

practical demonstrations on live animals. Because the groups that observe a particular procedure are often big, students who are short, or stand at the back, often miss out on the details simply because they cannot see the procedure that is being carried out. Or, in some cases, the procedure performed by the clinician is so delicate that it is not possible to observe all the details unless you have a close-up view. The participants therefore suggested that it might work best if a camera were mounted on the body or the forehead of a clinician or surgeon [G3P2], so that the best possible view could be captured.

However, some participants disagreed and said that students needed to take responsibility and therefore they should also made the video recordings themselves [G3P3]. The participants did agree that the environment should determine the person who takes the videos, because, for example, in surgery it was better that the surgeon make the video, while in pathology the students could possibly rather take their own photos and videos during a demonstration [G3P4]. The participants suggested that students take their own videos, but that, instead of all participants buying their own video cameras, they be allowed to book the necessary equipment from the various departments to make their own video clips [G3P5]. One suggestion was that each group appoint their own videographer and that such a student then be responsible for making the video clips available to the rest of the group.

The participants also suggested that students be trained in making good quality video recordings. For example, when a video was taken by someone without training the focus of the camera was often too wide, and important details were sometimes not clearly visible. However, some participants reported that, even when students were trained to take proper video notes, many of the videos were still “terrible” [G3P2]. Without a dedicated videographer, each student could potentially want to record his or her own video, and in the process other challenges would be created. For example, all students would then try to get a good spot from where they could see the procedures, and therefore they would actually stand in front of other students and possibly adversely affect the quality of their learning experience [G3P1].

Not all the participants were in favour of using videos. One student felt very strongly that the use of videos was pointless and she stated that she never recorded any

videos. However, she indicated that if there were a camera that could be used inside the animals when the students needed to examine them that would change her opinion [G2P4]. Inexperienced students often do not know what they are supposed to see and feel with internal examinations, and so students were of the opinion that they would be able to learn better if they could see, internally, where they were at any given time [G2P4].

The participants reported that their use of videos was not without technical challenges. Some students struggled to save the videos on their mobile phones, while other participants reported that the storage space on their mobile phones was not enough. One of the participants indicated that if a video clip could be sent through WhatsApp, they could all watch it [G2P4].

**Benefits students experienced**

In the group interviews, the participants mentioned various benefits of using videos. For example, they indicated that students who had a video would be in a position where they could watch the video clip of a procedure repeatedly and that this had the potential to help reinforce what they had learned [G2P4]. Another student said that they used existing videos to prepare for examinations. Participants furthermore confirmed that they still took regular notes as well even if they recorded parts of a class. However, they stated that they very seldom watched a video of the entire lecture again. They would rather refer back to the video if there was something that they did not understand, or details that they could not remember [G3P1, G3P4].

The participants mentioned that the mobile phone was not as effective [G3P6] as the action camera, or even a handheld video camera [G3P1] when recording a lecture. But this still shows the value of having videos available and of students being able to use them as needed (just in time) [G2P8]. One of the students mentioned that their modules had pre-recorded videos which he routinely first watched, before starting to study [G3P3]. In that way the student obtained an overview of what was presented in the text.

The participants also emphasised the value of short videos, rather than longer ones. Students tended to only watch short videos when they needed information, rather than struggling through long sections [G3P2]. It took them less time to watch a short video than to read through their notes again [G3P2]. Sometimes students could not understand the written text, but when they watched the video of the work before studying, it explained the work better and the picture in their mind became clearer [G3P5]. Sometimes students wanted to go back to work that had been done in previous years, and the videos that had been made earlier made it possible to do so [G3P2]. After creating the video, one particular student uploaded it on YouTube and distributed the link to his or her fellow students to view. Students already seemed to share their video notes through Dropbox [G5P1], while others uploaded their video notes to YouTube and used Facebook to share the link with their friends [G5P3].

Videos were also valuable when students were working in their free time. In one example provided by the participants in the study, a student worked at a veterinary practice over weekends and after hours. On a particular day, an interesting and unique case was treated and while the veterinary surgeon talked her through the procedure, the student took video notes in order to refer back to it at a later stage [G3P2].

However, the importance of taking video notes in practical classes was central, and it was mentioned that students needed to use devices that allowed them to integrate or share their videos notes when they juggled their learning with the support of more than one device [G1P6]. It seems as if creating a seamless integration between various mobile devices was essential in order to avoid wasting time. For one participant, the quality of the mobile device such as a smartphone was essential, because an image or video of a sick animal could be shared immediately, especially when expert knowledge was needed and the correct treatment had to be given right away [G1P6].

As seen in the literature, the main benefit of note-taking is that it actively involves students in the learning process (Anderson & Armbruster, 1986; Bui & Myerson, 2014; Biu et al., 2013; Cohen, Kim, Tan & Winkelmes, 2013). The same is true for video note-taking. When students create their own videos, they also need to incorporate them with their other notes where they then summarise, add information and create links. One participant mentioned that when she was asked to create videos and

organise her notes as part of this research project, it was the first time ever that she went back to the videos she had previously taken. She then incorporated the video notes and pictures she had taken into a PowerPoint slideshow and this process formed a significant part of her studying. So, for this student the video notes suddenly formed part of the study methods that she intended to use in the future [G5P2]. The use of the videos together with her other notes, and the integration of the different components, forced her to spend more time on her work, which eventually resulted in higher marks [G5P2].

Finally, participants reiterated that the benefit of good quality video notes is not only for the student who takes the video, but also for future generations of veterinary students, since interesting notes can be shared with other students.

**Suggestions when making videos**

In some subject fields, detailed video clips of a good quality are already available. Participants indicated that they often find that existing video clips that are available on the internet are either too basic [G3P2] or too advanced for what is needed in a particular module. It can also happen that different practices and clinicians use different techniques. It was suggested that lecturers might want to identify and quality assure existing video clips to make available to students, as that would save students a lot of the time that they currently spend on sifting through videos that are neither relevant nor directly applicable [G3P2].

However, students still preferred videos to be made from their own subject material; either by them or by students of previous years or by lecturers who know what work is relevant and what the students need to know [G3P5]. It was also mentioned that if the lecturers were to make customised videos, they would have to be prepared to update them regularly because the information they contain may become outdated soon, for example, if the drugs used in the video were to be discontinued [G3P5].

## RECOMMENDATIONS FOR FURTHER RESEARCH

During the discussions it was mentioned that some ethical concerns might arise from recording certain practical cases. If videos were made of teaching staff, clinicians and patients, would it not be possible that they could have a negative impact on the individual's right to privacy? What would be the ethical issues around video notes and how could the identity of lecturers and patients be protected [G4P5]? It might be worthwhile to investigate the ethical issues pertaining to the making of videos in classes as well as ways in which video notes can be taken without necessarily revealing the identity of teaching staff, owners and patients.

Another prominent issue is the possible decrease in class attendance when all lectures are eventually recorded. Why would students still want to attend any lectures at all? It would be interesting to know whether the fact that contact sessions have been pre-recorded has a negative effect on class attendance. However, in this study, one participant did made the following remark with regard to class attendance.

> "You can never recreate the class environment. It is never as effective as class … so I would not skip class because there is a video available." [G3P4]

## DISCUSSION AND CONCLUSION

To conclude, the participants agreed that there is no one-size-fit-all device that would work well in all educational settings. Some devices are obviously better suited to a classroom-based environment whilst others would work better in a practical environment. This finding is not unique to this study, as Mueller and Oppenheimer (2016) came to the same conclusion when they investigated note-taking in various environments. What is noteworthy, though, is the possibilities that are created by the use of the action camera. Procedures can be recorded while doctors are busy with operations or while lecturers and clinicians are demonstrating delicate procedures that would otherwise not be visible to all students.

Another device that is valuable for its note-taking capabilities is the mobile phone. When students take video notes with their mobile phones, those videos are always available and can be viewed at any time, since students are very seldom very far from their mobile phones. This finding was also confirmed by Roshier et al. (2011) and Lee et al. (2016). But, for students to take and quality assure their own video notes, they need to get training, and that is in line with the findings of Roshier et al. (2011) that lecturers should not assume that students know how to take good quality videos. Measures also need to be in place so that students do not stand in front of one another in their attempts to make videos (Jang & Kim, 2014).

To make sure that the video notes are of good quality, the best view should be captured by the person in charge of making the video clips. It was, furthermore, recommended that teaching staff make customised videos to support student learning.

The students also confirmed that they did not ever choose to watch lengthy videos. This is in agreement with what McNulty, Hoyt, Gruener, Chandrasekhar, Espiritu, Price and Naheedy (2009) found, namely that medical students watched online videos made by teaching staff sparingly. However, if video clips are short, students use them to reinforce information, revise before an examination, and refresh their memory about work done in previous years. Roshier et al. (2011) obtained similar results when they found that there was an increase in the number of times a video was accessed before a test, or when students needed to practise their practical techniques.

Lastly, the participants emphasised the importance of videos to provide a clear picture in their mind before they attempt to go through the written text. In view of the fact that the students of today are bombarded with visual material, this is not surprising. Roshier et al. (2011) agree and state that the use of videos improves the visualisation of specific techniques.

Although this study was conducted from a student perspective, the ideas and suggestions obtained could also be of value to lecturers, in that the length of a video, its quality and its interactivity should be taken into account. Furthermore, the researchers believe that the discussions in this research will not only be of value to the medical education sector, but also to other fields of study in higher education.

However, the results might have some bias, as the majority of the students who participated in this study had shown an interest in using mobile devices and therefore volunteered for the project. Only one student volunteered to participate because she knew nothing and wanted to learn.

## Exploring the use of an action camera in veterinary science education


### ABSTRACT

Millennials are known to spend multiple hours watching videos on their digital devices in the form of movies and series, but whilst there are many educational videos available online, it is not yet clear whether, and how, they use these videos for educational purposes. In this research, the focus is not only on how existing videos are used in the teaching and learning process of eight veterinary science undergraduates, but also on how these students benefitted from student-made footage taken with an action camera in various educational settings. The participants in this study were volunteering veterinary students who explored the use of various mobile devices to take notes. Their feedback was obtained during a set of five group interviews. Apart from a number of different mobile devices and applications, the participants also used an action camera in their traditional lectures as well as during practical demonstrations in laboratories, theatres and outdoors. The study discovered that participants found it easy to use the action camera for note-taking purposes. They also commented on its usefulness and recommended that it be used for recording information during practical classes on a regular basis.


**Keywords:** Action camera; GoPro; self-directed learning; student-made videos; veterinary education; video.

### INTRODUCTION

The popularity of watching and downloading videos from the internet cannot be ignored. In 2017, Internet Live Stats (2017) reported that 71 016 YouTube videos are being watched every second. The new generation students grew up with technology and it is therefore not surprising that they (millennials) watch between two and thirty one hours of videos per week, (Morrison, 2016), which is more than what the general public watch per week (Heltai, 2016).

Students grapple with multi-tasking during class while they have to pay attention, listen, process and record information accurately (Bui, and Myerson, 2014; Piolat, Olive & Kellogg, 2005). In addition, in a practical environment, students have to compete to get close enough to the demonstration so that they can see exactly what is demonstrated. When they are close enough that they can observe what is demonstrated, they need to pay attention and write down the steps fast and accurately enough so that they will be able to refer back and use it to prepare for their exams. In an effort to record their information accurately, students started using the video camera functionalities of their mobile phone and/or tablets.

Researchers claimed that the way students record information in the various educational settings they find themselves in, differ from educational setting to educational setting (Badger, White, Sutherland & Haggis, 2001; Boyle & Forchelli, 2014; Bui, Myerson & Hale, 2013). These differences are also evident when students use technology to record information during class (Mueller & Oppenheimer, 2016).

The use of videos has valuable application potential in the health sciences, by recording specific procedures and the video material can then be used repeatedly in a variety of contexts. When the opportunity arises to observe uncommon cases that are scarce or limited, difficult to illustrate, or staff intensive, Schwerdtfeger, Wand, Schmid, Roessler, Quintel, Leissner and Russo (2014) indicated that videos can be used with great success. Whilst videos can be used effectively in the education of students and patients, studies also show videos to be a valid and feasible option in the assessment of students, in both a formative and a summative context (Bowles, Harries, Young, Das, Saunders & Fleming, 2014).

Although the focus of this article is to explore how an action camera such as the GoPro[1] can be used in veterinary education, the study is also grounded in the Technology Acceptance Model (TAM) (Davis, 1989). When explaining the Technology Acceptance model, Davis (1989) states that if a user perceived technology as useful and easy to use, the user will most likely be willing to experiment and use the technology in the long run. Therefore, if the participants in the study found the action

[1] GoPro is a registered trademark of GoPro, Inc. in the United States.

camera useful and easy to use, it may be worthwhile for either students or institutions to consider using such a device in veterinary education.

When the veterinary students attend a theory lecture, it might be appropriate to write down or type notes, while when they are observing skills, it might be easier to video record it as it may be difficult to write down all the detailed steps on how to execute a particular procedure. In this study, students not only explored hand held video cameras, cell phone cameras and tablet cameras, but also the action camera. Although, not designed for education, the action camera allows for users to make recordings of activities such as extreme sport and activities where participants' hands need to be free, and therefore it is typically built so that it can be mounted on bicycles, helmets, surfboards, or the body of the participant (Furchgott, 2014). It is because of this handsfree recording ability, that the action camera is seen as a favourable device to be used for recording demonstrations during class.

Therefore, to explore the question *how an action camera (such as a GoPro) can be used in veterinary science education*, the following sub questions were asked:

1. Why are the students recording video?
2. Who are using the action camera to make the recordings?
3. What are the students recording?
4. When are the students using the action camera?
5. Where are they making the videos?

## METHODOLOGY

This qualitative research study is explorative by nature and in line with the qualities of a case study. Yin, (2009) advocates that to answer a "How" question such as "How the action camera can be used in veterinary science education", a case study can be useful. The study was conducted in the natural learning environment by Creswell (2007) of students at a South African university that offers a bachelor's degree in Veterinary Science (BVSc).

A group of eight pre-clinical students volunteered to explore the use of mobile devices such as smartphones, tablets and laptops to record information while attending classes in the different educational settings. No specific device was prescribed therefore the students were free to experiment with the devices that they already owned. The outcome was that participants found that some devices worked better in one environment (eg. laptop were more popular when used in a lecture hall) than in another (eg. video camera were more popular in a laboratory). From this group of eight students, two explored, amongst others, the use of an action camera in a variety of educational settings. The researchers' interest was specifically in the students' authentic experience of using their action camera to take video notes, without external interference of any kind.

Data was collected through a series of group interviews. The sessions were recorded, transcribed and the transcriptions were analysed by determining trends and recurring patterns as described by Henning, Van Rensburg and Smit (2004) to isolate the experiences of the participants who experimented with the action camera.

**RESULTS**

In an attempt to capture all the important information that is shared in class, participants first explored with the video camera functionality of smartphones and tablets only to realise that these do not work as effectively as expected. Therefore, some participants explored the use of the action camera, specifically the GoPro action camera, to record information in the different educational settings they were exposed to, namely lectures, practical classes and laboratory demonstrations.

The GoPro worked particularly well when students needed to use their hands for writing or other practical or laboratory activities. Furthermore, the GoPro linked up with a mobile phone app where the exact image that was being recorded could be seen, which allowed the student to readjust the focus, where necessary. Participants were also able to control the GoPro remotely from the app on their mobile phones, as indicated by the comment of one student.

> "… media that I for instance have is a GoPro and then you can get the App and link it to your cell phone … the GoPro you can mount to your chest or your cap or something then you can see on your cell phone what exactly you are recording." [P5]

Because the primary purpose of the GoPro action camera is to record video footage, the quality of the videos was better than that of most other mobile devices, such as smartphones or tablets that also have a camera functionality.

**Why are the students recording video?**

Participants mentioned various reasons why they make video recordings. For example, they indicated that students who had a video would be in a position where they could watch the video clip of a procedure repeatedly and that this had the potential to help reinforce what they had learned. Another participant said that they used existing videos, provided by lecturers, to prepare for examinations.

> "I will only go over it while I am studying for a test or an exam if I feel like I have missed something in the class." [P1]

Students were inclined to watch videos only when they needed additional information. For example, some students could not understand the written text, but when they watched the video of the work before studying, it explained the work better and the picture in their mind became clearer.

Although, numerous training videos are available on online platforms, such as YouTube or iTunesU, students preferred to produce their own videos. The participants explained that in the majority of the online videos, the content is not on the required level, and that the techniques demonstrated differ from what they were taught. They also indicated that when interesting cases are presented, it should be recorded, saved and kept for future students to watch. One participant mentioned:

> "…having the video material available that the students and lecturers made, makes it relevant and on the level that is required from you…" [P2]

**Who are using the GoPro to make the recordings?**

Students need to observe and pay careful attention to demonstrations during their practical classes. Because the groups that observe a particular procedure are often unavoidably large, students who are short, or stand at the back, sometimes miss out on the details, simply because they cannot see the procedure that is being carried out. It happens that the procedure performed by the clinician is so delicate that it is not possible to observe all the details unless you have a close-up view. The participants, therefore, suggested that it might work best if a camera was mounted on the body or the forehead of a clinician or surgeon who is doing the demonstration, so that the best possible view could be captured.

> "…give it to the lecturer and let him record what he is doing it is the absolutely best view." [P2]

Although some participants suggested that the students need to take responsibility for the recordings themselves, they did agree that the type of procedure should determine who should be taking the video. However, when all students try to make a video recording, the implication is, that students would try to get a good spot from where they could see the procedures, and then actually stand in front of other students which might adversely affect the quality of their learning experience. Participants suggested that if students are responsible to make the recordings, it might be a solution that one student in a group is elected and assigned the best vantage point for recording the video.

**What are the students recording?**

Students made recordings of a theory lecture as well as demonstrations during practical classes. However, they stated that they very seldom watched a video of the entire lecture again.

> "If I sleep through most of the lectures in class then I will definitely sleep again in my room." [P4]

Participants said that they would rather refer back to the video if there was something that they did not understand, or details that they could not remember. Therefore, participants emphasised the value of short video clips, especially of procedures, rather than longer ones such as lectures.

Other than attending classes, the participants reported that they sometimes had to assist with surgeries, watch specific medical procedures such as fecal examination, abdominal ultrasound or urinalysis performed by a skilled clinician. They also attend practical demonstrations such as taking temperatures, checking mucous membranes or pregnancy diagnosis on live animals. Therefore, they made recordings of these opportunities to either use when they are studying or for future reference purposes.

**When are the students using the GoPro cameras?**

Participants reported that they made videos both during class, as well as after hours. They also commented that they wore the action camera when they were busy with their clinical rounds, so that they could record these learning experiences for reflection later, or future reference purposes.

Videos are valuable when students work in their free time, for example, at a veterinary practice over weekends and after hours. During one of the after hour sessions, one of the participants reported that the veterinary surgeon talked her through an interesting and unique case while she took video clips for future reference.

> "I also worked part time in a clinic … they had quite a few interesting procedures, and I video recorded that." [P2]

**Where are they making the videos?**

The participants indicated that they made recordings both indoors and outdoors. For example, they made recordings in the theory classes as well as the practical classes and laboratories. However, they agreed that the action camera was not ideal for recording lectures and auditorium-style classes because the venue was typically too big, and the camera could not zoom in and out. Presentation slides seemed too small

through the lens of the action camera, and therefore participants came to the conclusion that the action camera was indeed best suited for making video clips in their practical learning environments.

In addition, the GoPro action camera came with a waterproof casing that allowed students to use the camera outdoors in the field and in wet learning environments, for example, a dirty laboratory. This created opportunities to record information in an environment where the traditional pen-and-paper method of note-taking would not have been possible.

> "The video was very useful for the practical sessions especially because the GoPro comes with a waterproof casing." [P1]

## DISCUSSION

During this study, the focus was on the recording of information for later use, and not on the benefits and mental processes of note-taking. However, participants were spontaneous and intuitively used technology to capture and record information during class. Participants indicated that for an action camera to be used in veterinary education, the following need to be in taken in consideration:

- A Mobile app on the cell phone need to be available so that the footage of the action camera is visible to the user.
- Short videos are important and will be made rather than longer ones.
- Both clinicians and students can use the action camera to make videos.
- The action camera is best suited to be used in practical venues where close-up recordings are made than recordings of full lectures.

As mentioned before, this study was grounded in TAM principles where Davis (1989) stated that perceived usefulness and ease of use will have an influence, whether users will adapt to using the technology or not. With regards to the usefulness and ease of use of using the action camera, the students indicated the following:

- It is easy to mount the action camera on your own body, so that you can use it at all times during your training.
- It can be worn the whole day long.
- It saves video footage on a SD card which can be downloaded to the computer.
- It has a good battery life.
- It can be used in dirty and wet environments.
- When recording footage, it includes a wide view.
- Although the video footage is of high quality, you can set it to lower settings in order to reduce the file size.

Because the action camera is designed for adventure sports, its casing is robust and can be used in indoor as well as outdoor environments.

> "It's really sturdy, robust; it's easy to hold in your hand, if you want you can mount it …" [P1]

However, students suggested that it would have been more valuable if it had a flashlight so that it can be used in environments where the light conditions are low. Participants even stated that they would consider using the action camera for internal examinations, for example with the pregnancy diagnosis of a cow, if it came with a flashlight functionality.

**CONCLUSION**

As mentioned earlier, the use of videos in the everyday lives of millennials are very popular. Furthermore, students move between various educational settings, and how they capture information in each of these settings, differ. Therefore, to explore how they capture information through video recordings, students explored, amongst others, how they can use action cameras in their day to day educational lives.

For this study, the students used the GoPro action camera to capture information. Although it did not work well in the large lecturing halls, they benefited from the recordings made in the smaller practical venues or when working outdoors where they

could get a close-up view of what was demonstrated. Because the GoPro has a waterproof casing it did not make a difference whether they used it indoors or outdoors. Also, in order to optimise the value of the video, either the students themselves, as onlookers, or the clinicians who is demonstrating a procedure, can wear the GoPro camera, depending on the situation they find themselves in. The students find the GoPro camera easy to use and the recordings that they made useful, especially when they wanted to prepare for exams, or wanted to reinforce what they have learned. From their view it will be to the advantage of all students to have a GoPro camera that they can wear on a daily basis.

Although, only a small number of students participated, and the data collected, specifically on the use of the action camera, was limited, the participants were positive that if they own an action camera, they will be able to use it. However, it will be worthwhile to expand this study to explore the impact of using an action camera to record the procedure (while the student is passive) versus traditional note-taking by hand (while student is actively involved). In addition, valuable information might be collected when exploring the advantages and disadvantage of using various kinds of video recording devices as video note-taking tools. The use of the action camera in assessments, also, need to be investigated.

**Section 3.4**

## Affordances of mobile devices and note-taking apps to support cognitively demanding note-taking


### ABSTRACT

Note-taking is one of the more common and ever-present learning activities that form an important part of all students' daily lives. The potential of using technology to enhance note-taking activities has recently come under the spotlight. However, while mobile technologies may be applauded for their mobility and the value they can add to students' learning experience, they could easily become a distracting factor, rather than the improvement they were intended to be. In this qualitative study, eight students volunteered to experiment with various mobile devices for a period of six weeks, and to share their experiences in a series of five group interviews. Information found in the literature about note-taking, combined with the students' feedback on their experiences, provided insight into how students record and process information. The affordances of mobile devices for cognitively demanding note-taking that are regarded as useful in a teaching and learning environment were also discussed in the group interviews. All the students agreed that they would not commit themselves to using only one application or device. They emphasised the fact that they used more than one device, and in some cases multiple applications on those devices, depending on their educational setting. This article gives students, lecturers and software developers insight into the affordances of mobile devices and note-taking applications (apps), in order to support cognitively demanding note-taking.



**Keywords:** Cognitive demanding note-taking; laptops; mobile devices; mobile phones; note-taking; note-taking applications; tablets


### INTRODUCTION

Despite the fact that many university lecturers have embraced innovative teaching methods such as peer teaching and flipped classrooms, some still spend most of their time in class, lecturing in the traditional way as they have always done (Bui, Myerson

& Hale, 2013). Therefore, it is perhaps not surprising that many students still frantically take notes in class in the 21st century. Note-taking is the one activity that lecturers do not need to actively encourage, as students seem to take notes automatically (Bui et al., 2013; Morrison, McLaughlin & Rucker, 2002) without being prompted to do so. Regardless of previous research that claims that computers can be used for note-taking (Bui et al., 2013), many students still use the pen-and-paper method. Current researchers support this finding by confirming that if students take notes with a mobile device such a laptop, they mechanically transcribe what the lecturer is saying, which results in shallow cognitive processes (Mueller & Oppenheimer, 2014). The dilemma faced by lecturers is that students are constantly attached to their mobile devices (Maclachlan, 2016) and that it therefore seems worthwhile to explore ways in which those mobile devices can be used for educational purposes.

As the process of note-taking is associated with action words and phrases such as capture, recall (Piolat, Olive & Kellogg, 2005), learn, remember (Anderson & Armbruster, 1986), pay attention, organise, record, and making understandable and legible notes (Bui & Myerson, 2014), this article focuses on the affordances of mobile devices that make it possible for students to take cognitively demanding notes. For this study, “affordances of mobile devices” refers to those qualities and properties that mobile devices offer to enable cognitively demanding note-taking, while “cognitively demanding note-taking” refers to the cognitive processes that take place during note-taking, and not to the note-taking itself that is cognitively demanding. Student participants experimented with mobile devices in various educational settings and their experiences were recorded and analysed. The affordances of mobile devices that support note-taking were subsequently identified from the feedback.

## THE VALUE OF NOTE-TAKING AS A LEARNING ACTIVITY

Much has been written about the educational importance to students of note-taking. For example, the researchers Anderson and Armbruster (1986), Ward and Tatsukawa (2003) and Kobayashi (2006) found that students learn and remember information when they take notes, and are able to retrieve that information at a later stage. This phenomenon was explained by Bui et al., (2013), who stated that the more notes

students record, the stronger the influence it has on their learning, as more information is processed. As far back as 1925, Crawford (1925) found what Boyle and Forchelli (2014) confirmed in a more recent study, namely that if high-quality notes are recorded, learning and comprehension of material improve.

Students often complain about the balancing act they need to perform in class by simultaneously trying to read from slides, listen to the lecturer, critically engage with new constructs, and write legible notes. This is confirmed by Piolat et al. (2005) and Bui et al. (2013), who state that the process of note-taking is cognitively demanding. University students, and first-year students in particular, have been battling with the question of how to capture and recall the flow of information in traditional lecture periods for many years (Piolat et al., 2005). This may be because students who take notes need to pay attention, organise the information, and then record it in an understandable manner before it is forgotten (Bui & Myerson, 2014).

If the process of taking notes is so demanding, the obvious question is why lecturers do not simply provide students with sets of comprehensive and well-written notes. Russell, Caris, Harris and Hendricson (1983) found that if notes are provided it is better to give students partial outlines only, as opposed to full sets of notes, as that enables them to add their own experiences and observations, and thereby expand on the existing information. Also, Anderson and Armbruster (1986) claim that the act of note-taking assists the student with learning and remembering information, and with storing it for later use.

The way in which students take notes differs from student to student, and from educational setting to educational setting (Badger, White, Sutherland & Haggis, 2001; Boyle & Forchelli, 2014; Bui et al., 2013; Ward & Tatsukawa, 2003). Two ideas for further research that emerged from the work of Boyle and Forchelli (2014) were that researchers needed to investigate the use of notes in different content areas in the real world of the student, and that the impact of technology on note-taking skills should be examined. To respond to this call, this article looks at the affordances of mobile devices that support cognitively demanding note-taking.

## NOTE-TAKING WITH AN ELECTRONIC DEVICE

In the past decade many researchers advocated the use of computers (Bui et al., 2013) and electronic note-taking systems (Kim, Turner, Pérez-Quiñones, 2009; Ward & Tatsukawa, 2003) for recording and summarising important concepts in class. Bui et al. (2013) did a study where they compared pen-and-paper note-taking with taking notes on the computer. The authors found that although there was no difference in recalling information, the computer was better for transcribing notes than for organising them. In that particular study, transcribing referred to typing or writing as many facts as possible, while organising involved summarising facts before and while typing or writing them.

Furthermore, when students were tested immediately after they had taken the notes, the students who transcribed the notes achieved better scores than those who first organised them. However, when there was a time delay, students who first organised their notes were more successful. When the researchers allowed students who had only transcribed the notes to study them as well, the advantage that the students who had organised the notes had over time fell away. From the above, the assumption is made that computers can indeed be used for note-taking with some level of success. However, care needs to be taken, because if one wants to engage the student's mind, note-taking needs to be cognitively challenging, with technology playing a supporting role (Ward & Tatsukawa, 2003), rather than it being a distracter in class (Mueller & Oppenheimer, 2016).

In a contrasting study, Mueller and Oppenheimer (2014) wrote that when students record notes with a laptop instead of in the traditional way with a pen and paper, their immediate cognitive processing are deemed to be shallow. The authors argued that this is because students typically attempt to transcribe everything the lecturer says verbatim. Furthermore, when students in this study had to take a test, the ones using the laptop performed worse in conceptualising questions than the students who took notes with pen and paper. In another study, students also agreed that their handwritten notes led to a better retention of knowledge than when they typed their notes on an electronic device (Vincent, 2016). Nevertheless, in spite of the disadvantages of taking

notes on such devices, Vincent (2016) still argues that reading and writing online are more practical in a university environment than the known traditional methods.

## THE AVAILABILITY OF MOBILE DEVICES

Nowadays, most people seem to have access to mobile devices. Global statistics indicate that smartphone ownership worldwide has increased by 25% since 2013 (Poushter, 2016), while global mobile device subscription rates reached 63% in 2015 (Abbassi, 2016). This trend of owning a smartphone also seems to be true for university students. Research done at universities in the United States (Poll, 2015), United Kingdom (Deloitte, 2016), Australia (Farley, Murphy, Johnson, Carter, Lane, Midgley, Hafeez-Baig, Dekeyser & Koronios, 2015), Saudi Arabia (Alfawareh & Jusoh, 2014) and South Africa (Potgieter, 2015) shows that between 86% and 94% of all higher education students own a smartphone. Although smartphone ownership statistics for South Africa shows that only 37% of South Africans own a smartphone (Poushter, 2016), in comparison with the 95% that own a mobile phone (Statistics South Africa 2013, 2014), Potgieter's (2015) research shows that there seems to be more smartphone users at South African universities (86% - 94%).

Students in the 21st century are accustomed to using technology (Maclachlan, 2016). They do not own only smartphones, but also other mobile devices such as tablets and laptops, and they often choose to use these devices during class time. Together with smartphones, these mobile devices offer lecturers and their students a wide variety of tools and functionalities with educational potential. For example, students can use cameras, microphones and e-book readers for various learning purposes, and can receive instant feedback on their learning through a variety of messaging applications (Ifenthaler & Schweinbenz, 2013). In another example, Alvares, Brown and Nussbaum (2011) mention that tablets can be used to improve the sharing of ideas when students work in groups. It thus seems as if many of the brick-and-mortar classroom boundaries disappear when mobile devices are used in an educational setting, and, as an added bonus, this learning environment without boundaries moves with the students wherever they go (Farley et al., 2015; Martin & Ertzberger, 2013).

While students attend classes they have to take proper notes that capture the true essence of the class. However, they are not bound to one venue, and constantly have to move from one educational environment to another carrying all their handwritten notes with them. In some practical classes it is also not possible to sit down and write legible notes while a lecturer is busy with a demonstration. Therefore, since mobile devices such as laptops, tablets and smartphones are popular and available, their ability to support students with note-taking should be explored. It might be too optimistic to assume that all possible functionalities that students need to take efficient notes in all learning environments and for all learning purposes could be available in a single application on a single device one day. However, it may be worthwhile to explore the current affordances of mobile devices and applications that have the potential to support cognitively demanding note-taking in a variety of learning environments.

## RESEARCH DESIGN

This qualitative case study is explorative by nature and was conducted in the natural learning environment (Creswell, 2007) of students at a university in South Africa that offers an undergraduate bachelor's degree in Veterinary Science (BVSc). According to Yin (2009), when a "What" question such as "What is the affordances of mobile devices and note-taking applications to support cognitive demanding note-taking" is asked, the research can lead to the use of explorative case studies. Explorative case studies also work best when little is known about the topic, as was the case in this study where the affordances of mobile devices and applications in a variety of educational environments still needed to be discovered. A group of eight second- to fourth-year students volunteered to explore the note-taking possibilities of mobile devices in a variety of educational settings.

In order to bring about interaction between group members and to generate responses in an environment where students are free to respond to questions as they see fit (Harrel & Bradley, 2009), group interviews were used. Data was collected at a series of five group interviews. During each of the contact sessions, students were informed about the area of interest that they had to explore during the following week and were asked to identify the device and applications they intended to use for note-taking

purposes that week. It is important to note that no mobile devices were provided for the purpose of the study. The participating students all owned their own mobile devices and they only had to make a selection if they owned or had access to more than one device, for example a laptop and a smart phone. No level of prior knowledge about the use of mobile devices was assumed, and neither was any training given to the students, as the researchers were interested in the students' authentic experience, without external interference of any kind. Students were simply asked to experiment and explore ways to use their various mobile devices and associated applications to record notes, and they were free to use the device(s) of their choice, such as a laptop, a tablet or a smartphone.

The participants had to inform the researchers in which module and learning context they would be testing their technology-supported note-taking efforts. The weekly activities varied from identifying different apps to use for note-taking in a lecture to using videos and pictures for note-taking. During the last week the participants had to take extensive notes in their learning environment of choice, after which they were tasked to integrate and combine their notes in a logical manner before sharing them online for the rest of the group to access. In each of the group interviews, the participants were asked to report on their experience with the specific device and applications that they used for taking notes, and on whether or not they felt it worked for them.

The research team's representation was constructed based on the rich descriptions of the participants' feedback and views when they discussed how they had used their mobile devices and applications as note-taking tools in their day-to-day academic lives (Creswell, 2007; Miles & Huberman, 1994). The feedback received in the group interviews was recorded and transcribed and the text was analysed as described by Henning, Van Rensburg and Smit (2004), to determine trends and recurring patterns. The participants' feedback was coded according to a group and participant number. For example, the code G1P5 represents feedback given by participant number five in the first group interview.

## RESULTS AND DISCUSSION

In this study, student participants experimented with different types of mobile devices and applications in various educational settings. Between them the participants owned and used devices such as tablets, smartphones, video cameras, action cameras, kindles and laptops. These devices were used to take notes in class through typing text, inserting photographs and self-drawn sketches, recording audio and video clips, and then integrating the different components into learning notes that could be used for studying. To do so, students not only experimented with the functionalities of the various mobile devices, but also with a number of applications (apps) that lend themselves to note-taking.

### Open and edit existing notes

In order for students to take notes, they need to be able to create a blank document for entering their personalised notes. However, in some cases lecturers provide full or partial notes before the class. Russel et al. (1983) stress the value of having partial notes available when recording important information in class, and add that partial notes allow students to add their own personal experience and understanding to the notes. By doing so, they are able to increase the existing information. In this study, the participants indicated that they needed to be able to create a blank document if the lecturer's notes and PowerPoint presentations were not available electronically before class. If those notes were available, they needed to be able to open them on the devices of their choice. This need to have notes available before class and to have them available on a mobile device was confirmed during one of the group interviews where one student mentioned that:

> "… and it would really be more efficient if we could have them with us in class available …I really like using my tablet so that I don't have to print all the colour pictures because it gets really costly. So I would like to have it on my tablet. Download it the night before and be able to type extra notes on there." [G1P1]

**Input mode**

To take notes on these mobile devices, the participants used either a stylus or a keyboard to capture information. The ones who explored note-taking with a stylus had mixed success. For example, the mobile devices with a dedicated stylus seemed to work better for writing notes and drawing sketches than those that required students to install a specific application to enable them to write with. This mixed success is demonstrated in the comments of two student participants:

> "Whereas now with the Samsung and its stylus it is one of the first ones they have actually brought out where the palm recognition is correct and it does not make lines all over the page and that really has made it a lot easier." [G1P5]

> "I did download a stylus beta app to try and use the stylus but your finger recognition is a lot better than the stylus. Then when it tries to convert the handwriting to text its one big mission so I just decided to rather type." [G2P1]

For those participants who were able to type fast, the keyboard seemed to have worked well. They reported that the keyboard allowed them to capture a large number of notes.

> "I've got a little memo pad app on my cell phone and I type crazy fast on my cell phone so I sit and type what the lecturer says." [G1P6]

However, according to the literature, the use of the keyboard could potentially hinder cognitively demanding processes, and only allow students to transcribe verbatim what the lecturer was saying (Mueller & Oppenheimer, 2014). Therefore, although the keyboard is the most common way of entering information on a mobile device, it might add value for cognitively demanding note-taking purposes if the mobile device could have a dedicated stylus. All the students agreed that a stylus would enable them to take notes in the way they wanted to.

> “I don’t like trying to type what the lecturer is saying as he is saying it I will write something in bullet format and then link it to something else. Whereas now with the Samsung and its stylus … I can actually take notes the way I want to.” [G1P5]

To enter the information, a number of different word processing applications were tested that allowed the participants to type text, format it and insert objects. The participants found that not all word processing applications that were available on their smartphones and tablets had the same functionalities as those that they were used to on their computers. This could be the result of students having inexpensive, entry-level smartphones. Even when working with dedicated note-taking applications, the participants found that some applications allowed them to open, edit and save documents, and that others limited them to only opening and viewing existing documents. Although Bui et al. (2013) found that the more information students recorded, the higher influence it had on learning, researchers seem to agree that it is not necessarily the ability to speedily record information that adds value to the note-taking process, but rather the way in which students need to pay attention, organise the information and record it in an understandable way (Bui & Myerson, 2014) that made note-taking cognitively demanding (Piolat et al., 2005). It seemed that some students put so much effort into working with the application that they did not spend time on the note-taking per se.

As mentioned by a participant, it would be of value if the note-taking application allowed students to draw shapes and diagrams rather than only allowing text input. These drawings could either be added to existing notes (for example, on PowerPoint presentations that are made available in a PDF format) or on a blank document. To make notes clear and legible, it might be worthwhile to also explore handwriting recognition possibilities. In addition, regular formatting functions (bold, italics, font colour, etc.) should be in place so that students can emphasise certain information. Given these affordances, the quality of the notes could be improved significantly, while learning comprehension would increase, as research has proved the correlation between the quality of notes and the degree of learning comprehension (Boyle & Forchelli, 2014).

**Using the camera**

The participants in the study used more than the typing functionality of their mobile devices when they took their notes. Some of them also used the camera functionalities of their mobile phones or tablets to take photos and/or to record audio and video clips. These photos were then combined with their other learning materials and they could write next to the photo or on it. For example, one student mentioned that she had added a screen clipping to her note-taking application and then she could type next to it, or on it, while the lecturer was lecturing.

> "Then you highlight the piece you want [and] put it in there. You can [then] type next to it, [or] you can type on top of it." [G2P6]

Initially, students were excited to video record their lectures as an alternative to taking notes in the more traditional way. However, most of them agreed that when they recorded a lecture in its entirety, they very seldom went back and watched it again.

> "I always make hand notes irrespective of taking a video. I still would more default to my own hand notes trying to understand. It is a lot quicker than sitting through another two hours through class trying to find out what he said." [G3P1]

> "If I sleep through most of the lectures in class then I will definitely sleep again in my room." [G3P4]

The only exception was if they had missed a class and could catch up by watching a video that had been recorded by a fellow student who did attend the session. However, for the participants the value of using the videos was in the videos that they recorded during the practical sessions, for example, when a clinician demonstrated a particular procedure. In these practical sessions, the participants used their smart phones to record the lesson. Although a smart phone's video quality was good enough, participants stated that the advantage of smartphone videos and photos was that they were immediately available on the mobile device and could easily be manipulated afterwards. However, good quality smartphone videos and photos were only possible

if the recording student was in a position to get a clear view of the demonstration. The participants also appreciated the fact that such videos were then available on demand, regardless of where the viewers were.

**Accessibility of notes**

Because the participants moved between different educational settings in the course of a typical week, they also indicated a need to use different mobile devices, depending on the context. For example, participants found it difficult to sit down and type while they were observing a practical demonstration with live cattle. As such, the participants found that they ended up with multiple worthwhile notes on a particular topic, but that those notes were dispersed over multiple devices. Therefore, in an attempt to combine all the notes that were recorded using the various devices into a comprehensive document that could be used for studying purposes, participants reported that they needed to share their notes and artefacts between devices.

> "So if you've got multiple resources on one single device then you have the chance to look at it immediately." [G1P6]

However, some participants seemed to find it difficult to share information between devices because they could not get the devices to communicate with one another. Some participants reported that their devices had USB adaptors with which notes could easily be shared between devices. Others were creative and came up with innovative solutions in this regard. They captured notes on one device, such as their smartphone, and then emailed the document or artefact to themselves so that they could download and access on their laptop or tablet it via their mailing system. It was not always possible to use the same device when students moved between various educational settings; therefore, it would help if the note-taking application made it easy for students to share information between devices so that they could have all the information on one device.

> "You can't really only have one device and expect to use it all the time unfortunately it is not practical." [G1P6]

**Organising and sharing notes**

To keep the notes they had taken for revision purposes and to learn from them at a later stage, the participants needed to organise the work in folders and to save the notes in a way that supported their personal learning preferences. However, the participants complained that there often was insufficient storage space on their devices. To overcome this obstacle, the note-taking application should also allow students to change the storage location to accommodate cloud or external memory card storage.

Although the participants used mobile devices and stored information on their personal devices, that stored information needs to integrate seamlessly with the learning management system used by the universities, as this is the platform on which notes for student downloading are stored.

> "So if we could have the slideshows … and then to make notes on top of that would be very valuable. So for them to upload it before class is what we are basically asking." [G1P6]

Although it was not the focus of the research, students mentioned that their notes were available anywhere and anytime because they had those notes on their mobile devices. If they also had electronic versions of their textbooks, it would be possible to have their books and notes available on one mobile device that moves with them wherever they go, whether it is a classroom, hospital or veterinary practice. As one student mentioned.

> "…to have my slideshows with me and to have mobile books and stuff all in the same convenient small little thing. Because lugging a book like that around is a nightmare, and I am somebody that if I don't understand something I want to look it up now, because you tend to forget, or you think it's not that important you end up not looking at it." [G1P6]

## NOTE-TAKING APPLICATION AFFORDANCES

In view of the above, it is evident that not all of the functions the student participants wanted to use worked seamlessly on one device or were available in one application. For example, certain aspects need to be available on such an application in order to take notes. The note-taking functionalities with which the student participants experimented and that need to be present in a note-taking application are as follows:

- Open and edit an existing document.
- Add notes via a physical or virtual keyboard.
- Add input via a handwriting functionality, possibly with handwriting recognition by means of, for example, a stylus.
- Write or draw directly on objects such as slides or PDFs with text, pictures and diagrams.
- Format text and paragraphs for example bold, italics, bullets, numerical lists
- Insert and save multimedia such as photos, animations, audio clips and videos in the notes.
- Create folders for organisational purposes.
- Save notes, either on the device, and/or on the cloud, and/or an external memory card.
- Access and share notes across multiple devices such as laptops, tablets and smartphones.
- Email notes.

The researchers realise that the affordances contained in this list might not only involve aspects that need to be addressed through software development, but that the hardware of the device also has to be suitable. For example, to be able to connect a USB device, there has to be a USB port or converter. Still, this list could be valuable to students when they need to evaluate and decide on which note-taking applications to use, as they often spend a lot of time downloading and installing an application and creating a user account, only to discover belatedly that the application does not meet their specific needs. In addition, this list could also be useful to software developers when they develop note-taking application software, whether for educational or

business purposes. Furthermore, when lecturers want to recommend note-taking applications to students, this list could give them an idea of the functionalities such an application should incorporate.

## CONCLUSION

As mentioned previously, note-taking practices are still a standard learning activity of students in higher education. The cognitive processes that form part of note-taking are sometimes regarded as being more valuable than the rote actions of simply capturing information. Additionally, contrasting research results about the use of technology in the note-taking process were published over the years (Bui et al., 2013; Mueller & Oppenheimer, 2014). Since students are seldom without their mobile devices, many lecturers are investigating ways in which these devices could be used for educational purposes such as note-taking. Despite students' apparent ease of access to and successful use of mobile devices in other contexts, the use of these devices for note-taking has been met with varied success.

Similarly to the way in which researchers value the worth of partial notes in cognitively demanding note-taking, students expressed the need to have an electronic copy of the lecturer's presentation available on their mobile devices before class so that they can open the notes beforehand and add their personal insights. In addition, students need to be able to write and type on their notes in order to be cognitively involved in the note-taking process. While all devices and applications allow keyboard input, not all of them make provision for students to write on their electronic notes.

Since the students who participated in this research moved between various educational settings, and because using the same type of device is not always practical in all kinds of environments, they used various devices. As a result, their note-taking activities varied from writing and typing in class to taking photos and videos in a practical demonstration. Therefore, to make sense of all the notes they took during the day or in one particular subject, they had to be able to merge the information they recorded. That could either be done by sending or saving all information on one device, or by combining it in one application so that the information could be accessed from all the devices used.

Although it is premature to assume that one application loaded on a single type of mobile device could give the students everything they need to take notes, the technology is developing rapidly and therefore it is anticipated that students would soon will be able to use mobile devices and note-taking applications seamlessly and intuitively to enhance their note-taking practices.

Taking the student experience into consideration, this study suggests how the affordances of mobile devices could be mobilised for the process of taking cognitively demanding notes. These suggestions could possibly be of value to students, lecturers and software developers. However, the researchers are not convinced that it is possible to have all these affordances on one application or on one device at this stage, or that it is actually necessary to have all the functionalities of mobile devices that can be used for note-taking purposes available on one application. We did, however, find that when students experimented with these devices, some devices worked better in a particular educational setting than others. Therefore, additional research should be done to determine how these identified affordances of mobile devices can be further exploited to provide students with the means to use their mobile devices for cognitively demanding note-taking purposes.

# CHAPTER 4: VETERINARY EDUCATIONAL SOFTWARE

## Executive summary

The overarching question of this study is: *How can mobile devices be used in a blended learning environment in higher education?* To answer this question, the following two sub-questions were considered:

1. How can blended learning tools be used to enhance student success?
2. How can mobile devices be used to support the learning experience of veterinary students in (a) the pre-clinical component of the study and (b) the clinical component of the study?

This chapter addresses the second sub-question, part (b) by reporting on a case study in which the use of mobile devices in a clinical learning environment was explored. Because the learning environment of the pre-clinical and clinical students are distinctly different, only the clinical students (Year 5 & 6) participated in this part of the study. Informal discussions with students and observations made in the academic veterinary hospital, suggested that students are no longer using their mobile devices for note-taking purposes when they get to apply their theoretical knowledge in a clinical environment. It seemed as if they now mostly used their mobile devices to log the skills and procedures that they were exposed to during their clinical rounds. For these logging purposes, students used Vetbox, a new computer-based application that was specifically developed for use in veterinary academic hospitals. In spite of international praise (Odendaal, Ntshabele & Rose, 2015), students seemed to be dissatisfied with the functionality and usefulness of the Vetbox application.

To explore how the voice of the clinical students can be used to improve Vetbox, the target group of the **first article** in this chapter (section 4.1), was all the 5$^{th}$ and 6$^{th}$ year veterinary students who were busy with their clinical training, as well as the clinicians who taught them in the veterinary academic hospital environment. After a *one-on-one face-to-face interview* with the manager of the academic hospital, six students were purposefully selected and invited to participate in a *group interview* to determine their

levels of satisfaction with Vetbox, and to identify topics that could be explored in more depth in a *questionnaire* that was distributed to the entire clinical cohort at the time.

After a grounded analysis of the data from the face-to-face and group interviews, themes were identified and a questionnaire with both closed- and open-ended questions, was compiled. The purpose of the questionnaire was to identify how the students' voice can be used to improve Vetbox and to address issues of *usefulness* and *ease of use* (Davis 1989). The responses to the close-ended questions was analysed with the help of MS Excel and the responses of the open-ended through content analysis in MS Word.

The results of the questionnaire was in line with what Davis (1989) promote in his Technology Acceptance Model. In this research, students did not initially find the software *useful* or *easy to use*. For example, one of the Vetbox features meant to highlight students' progress as they were exposed to, and eventually mastered, certain clinical skills and procedures. However, students did not regard this feature as *useful* to monitor their own progress due to a design flaw that required a significant number of procedures to be logged, before the indicator would display a students' progress. This lack of progress was regarded as highly demotivating and was in line with what Malone and Lepper (1987) mentioned in their taxonomy of intrinsic motivation. The students were, furthermore, dissatisfied with the manner in which they had to switch between two different sets of software (UVIS and Vetbox) as it resulted in unnecessary duplication in their opinion. Students also did not regard Vetbox as *easy to use* as they complained that access to the software were troublesome and indicated that they need additional training before they could use the application.

As Vetbox was originally developed as a web-based application, students could use it, to some extent, on their mobile devices. However, one prominent suggestion that came from the responses to the questionnaire, was that a dedicated mobile application needed to be developed. As such, the **second article** in this chapter (section 4.2) focused on the perceived *usefulness* of Vetbox as a measure of acceptance by the same set of clinical students that were targeted in the first article.

For this article, three clinical students and a further three clinicians, were sampled by means of a combination of opportunity and volunteer sampling. These volunteers were invited to participate in a *group interview* that was held to determine the extent to which the mobile application version of Vetbox addressed the issues identified in the previous round. A grounded analyses was done of the data that was gathered, and the findings of this part of the study were discussed in terms of the perceived *usefulness* of the mobile version of the Vetbox application (Davis 1989).

The findings of this research study emphasised the importance of listening to the students' voice when designing and developing software intented for learning purposes. Not only does the end-user, namely the student, need to be involved in the conceptualisation phase, but also throughout each of the subsequent development, testing and implementation phases of such a project. In this case study participants made valuable suggestions about what they regarded as important considerations when a new software application is introduced. However, as the students could not always predict their own needs accurately, their inputs had to be obtained on a continuous and regular basis throughout the design and development phases to ensure that the final product was indeed perceived as useful and easy to use.

Furthermore, this study found that the end-user of an educational application may be motivated to use an app if they perceive it to be personally *useful*, even if they don't necessarily experience it as *easy to use* (Davis, 1989). Finally, the study also stressed that there is no pre-determined list of criteria that can guarantee the *actual use* of an application (Davis 1989), but that student buy-in and a perception of personal usefulness will go a long way towards motivating students to *actually use* an educational application.

The outcomes of the research were documented as indicated below.

**Table 1: Vetbox sections - Chapter 4**

| Section nr | Section title | Research question |
|---|---|---|
| Section 4.1 | Listening to the student voice to improve educational software | How can the student voice be used to improve educational software? |
| Section 4.2 | Investigating perceived usefulness as a measure of acceptance for a veterinary mobile application | To what extent can perceived usefulness serve as a measure of acceptance for a veterinary mobile app? |

**Section 4.1**

## Listening to the student voice to improve educational software


### ABSTRACT

Academics often develop software for teaching and learning purposes with the best of intentions, only to be disappointed by the low acceptance rate of the software by their students once it is implemented. In this study, the focus is on software that was designed to enable veterinary students to record their clinical skills. A pilot of the software clearly showed that the programme had not been received as well as had been anticipated, and therefore the researchers used a group interview and a questionnaire with closed-ended and open-ended questions to obtain the students' feedback. The open-ended questions were analysed with conceptual content analysis, and themes were identified. Students made valuable suggestions about what they regarded as important considerations when a new software program is introduced. The most important lesson learnt was that students cannot always predict their needs accurately if they are asked for input prior to the development of software. For that reason student input should be obtained on a continuous and regular basis throughout the design and development phases.



**Keywords:** Ease of use; educational software; software development; student voice; user experience; veterinary education


### INTRODUCTION

One of the important competencies expected of practising veterinarians is the protection of the health and well-being of animals by diagnosing diseases and treating sick and injured animals (Sokanu, n.d.; South African Veterinary Council, 2016; World Organisation for Animal Health, 2012). Therefore, veterinary students need to be empowered with essential knowledge, skills and mind-sets in the course of their professional training (World Organisation for Animal Health, 2012). We know from the literature that students expect to be fully equipped with the practical skills required by

their profession so that they can adapt easily to the real world of work (Wharton, Goodwin & Cameron, 2014). As such, universities that offer veterinary education typically strive to provide students with extensive hands-on training in various clinical settings, including academic veterinary hospitals, laboratories, and private or state-owned veterinary practices (Murdoch University Veterinary hospital, 2016; University of California Davis Veterinary, 2016; University Utrecht, Veterinary Education, 2016). Such practical exposure gives students an opportunity to learn in a real-life context and has the potential to develop a wide array of skills, including clinical reasoning, communication and fine motor skills.

At the university where this research was done, veterinary students are exposed to a number of work-integrated learning experiences in the form of 32 clinical rotations that take place in an eighteen-month period. This practical hands-on learning follows a number of years of studying a wide range of para- and preclinical modules. Whilst it is almost impossible to guarantee standardised case exposure to all students who visit a particular station during their various rotations, the aim is always to ensure that students are adequately prepared to deal with any typical scenario they might encounter on their first day in practice (South African Veterinary Council, 2016).

For exceptional quality veterinary education, clinical training in small groups is essential (Meyers, Meyer, Stewart, Dreesen, Barrick, Lange & Farrell, 2011). Thus, students usually join a particular section or station in groups of eight to ten on a rotational basis. For various reasons not all students can be guaranteed the exact same level of exposure. For example, some illnesses, such as Parvoviral enteritis (cat flu) and Babesiosis (biliary fever), are more prevalent in a particular season, whilst the natural ebb and flow in any practice benefit those students who are attending the specific rotation when an interesting or a rare case is admitted.

In an attempt to get a comprehensive picture of an individual student's clinical exposure during his/her training, the director of a South African veterinary academic hospital (VAH) conceptualised and developed a computer-based logging system called Vetbox (Odendaal, Ntshabele & Rose, 2015). This system was intended to replace the rather inefficient, paper-based logging system that had been used in previous years. One of the aims with the introduction of Vetbox was to provide students

with an easily accessible online space where they could log the various procedures they were exposed to during their clinical rotations in real time. The online program was designed as a web-based application and although it could be used on a smartphone or tablet, it did not have a customised mobile application user interface or caching abilities. However, the benefits of such a system are self-explanatory and the concept has been internationally acclaimed for its ability to record specific curriculum outcomes (Odendaal et al., 2015). For example, if one of the outcomes is that students should be able to carry out routine diagnostic tests and procedures (such as haematology, basic clinical pathology, basic imaging) in order to make a diagnosis, the online program should provide them with the opportunity to log the specific procedure that show that certain skills are mastered against a case that they were involved in.

It is a well-documented fact that today's Generation Y students regard themselves as active participants with a strong desire to shape their own learning experiences (Bowen, Burton, Cooper, Cruz, McFadden, Reich & Wargo, 2011). Keiller and Inglis-Jassiem (2015) support this notion and state that when academics plan to implement new innovations and technology in teaching and learning, they should consider the students' voice, especially in relation to student preferences and their levels of competency with regard to the new technology. According to Phillips (Apr 23, 2015 posting by M Phillips to Edutopia, see 'Notes'), the value of including the students' voice in decision-making is that it teaches students democracy, helps them develop student leadership, increases student achievement and engagement, and increases the quality of decision-making, as the students add a different perspective than the academics.

The way in which students experience the use of an online program such as Vetbox is an important consideration. According to Law, Roto, Hassenzahl, Vermeeren and Kort (2009) the user experience of products and systems is more personal than social by nature, because it refers to how a user as an individual experiences systems and products. A user's experience of a particular program is subjective and unique, and not only impacts on his/her willingness to use such products and services immediately, but also on the possibility of prolonged use. In addition, user experience is dynamic by nature and as such it is important to explore user experience prior to developing a

product. This is especially needed in education, as education was practised in a static setting for many years (Garreta-Domingo, 2016) and was not necessarily designed to accommodate individual users' unique experiences.

The VAH director, who understood the importance of taking the student voice into account (Bowen et al., 2011) met beforehand with various small groups of students and based the initial design of Vetbox on their inputs. However, no explicit follow-up process was in place to evaluate the user experience once the program had been implemented (Garreta-Domingo, 2016).

Although Vetbox was hailed as a revolutionary product that could potentially add tremendous value to the clinical training of veterinary students (Odendaal et al., 2015) the student feedback after the initial pilot period was not overwhelmingly favourable. It was soon realised that although the initial student input was used to develop the Vetbox program, the finer details of Vetbox had to be given much more attention if student satisfaction with the product was a desired outcome. In order to refine the program, to get broader buy-in from the student community and to ensure the long-term use of Vetbox, it was necessary to listen even more closely to the voice of the targeted students and to take their full experience into consideration

## METHODOLOGY

Freeman (1997) mentioned that although researchers often ask students for their opinion, they seldom include students when developing solutions to the problems students face. Based on the realisation that the student voice had not been sought sufficiently to ensure buy-in from the veterinary students involved in clinical training, their voice was overtly sought by collecting both qualitative and quantitative data from the whole group after the completion of the pilot study. A voluntary group interview (n = 5, purposive sampling) and a structured questionnaire (n = 133) with both closed- and open-ended questions were used (see Appendix B). The voluntary group interview was attended by five female students and the intention was to get initial feedback on the students' experience of using Vetbox to log their procedures. The students were asked to describe their Vetbox experience in general, as well as the specific problems they encountered in using the program. The interview was recorded and transcribed,

after which the text was analysed to determine common concerns and recurring trends. The analysis was done according to the method described by Henning, Van Rensburg and Smit (2004), through which the process of coding, categorising and identifying themes results in the identification of recurring trends and patterns. These themes were indicative of the Vetbox issues the students experienced and were therefore transformed into questions that could be used in the questionnaire.

A structured questionnaire was then developed and distributed electronically to the 133 final-year veterinary students who were on clinical rotations at the time. In the questionnaire, students were specifically asked about their Vetbox login experience, and particularly about the process of logging their clinical procedures. Seventy-three of the 133 students, returned the survey, with the majority of them being female (73%). Although some of the students were older than 30 years, most were aged between 25 and 26 years (56%).

For the majority of the questions in the questionnaire a Likert scale response was used that ranged either from *strongly disagree* to *strongly agree*, or from *never* to *always*. In some cases, these questions were followed up with probing open-ended questions. At the end of the questionnaire, four open-ended questions were asked about students' level of motivation and their recommendations for improving Vetbox for future use. All the open-ended questions were analysed using conceptual content analysis by Babbie and Mouton (2005), which enabled the research team to derive meaning from those concepts and themes that occurred frequently.

## RESULTS

The results of the student feedback were grouped according to the themes identified in the manner described above. The students' suggestions were discussed first, and subsequently the underlying student need that was addressed by each of the suggestions was confirmed using the results of the closed-ended questions and the group interview. Individual student voices were indicated with a unique identifier where direct quotations were used.

**Ease of use and Usefulness of Vetbox**

Students felt that certain aspects needed to be in place in order for them to use Vetbox. Firstly, the login process needed to be streamlined, the number of actions they had to complete had to be reduced, and the whole experience needed to be made more user-friendly. The students' frustration was mirrored in the question where nearly half of the students (54%) said that they did not find it easy to log in to Vetbox (Figure 1).

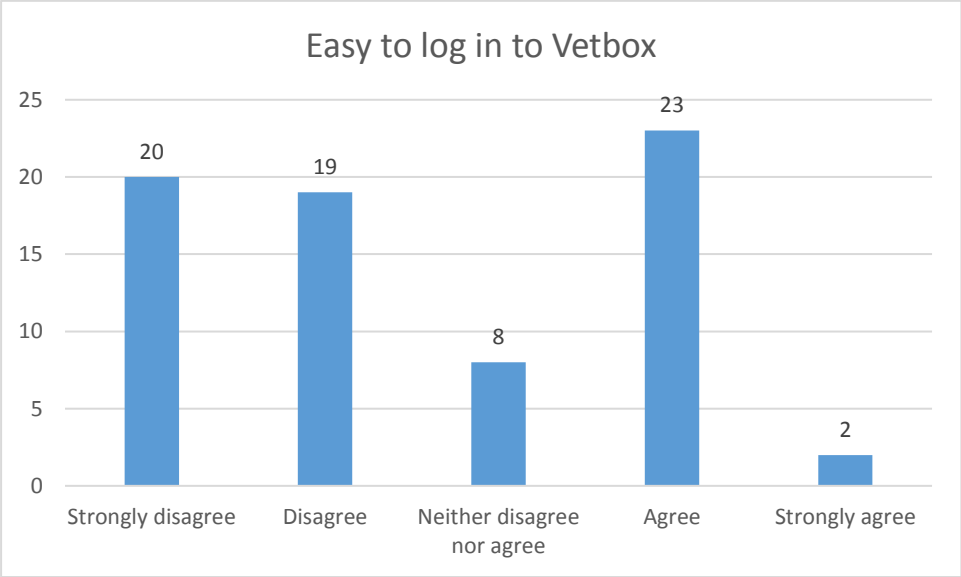


**Figure 1: Level of ease of the login process**

A similar concern was also expressed in the group interview, and in an open-ended item in the questionnaire another student expressed his/her displeasure as follows:

> "… the system did not want to accept my username and password on several occasions and after finally being logged on I was kicked off the system." [P69]

This corresponds to the finding of Davis (1989), who points out that students will only use a program if using it is perceived to be free of effort, which, among others, means that the number of clicks has to be limited to a minimum. Students seemed to have experienced the process of logging their procedures in Vetbox as cumbersome and time consuming. For example, one student commented:

> "… did try to use vetbox, but after struggling for over an hour on the first two login attempts (each) it was relegated to a waste of time (something not in big supply in final year) …" [P1]

When the students were asked whether they attempted to log all their procedures, 51% of the responses were *rarely* or *never* (Figure 2).

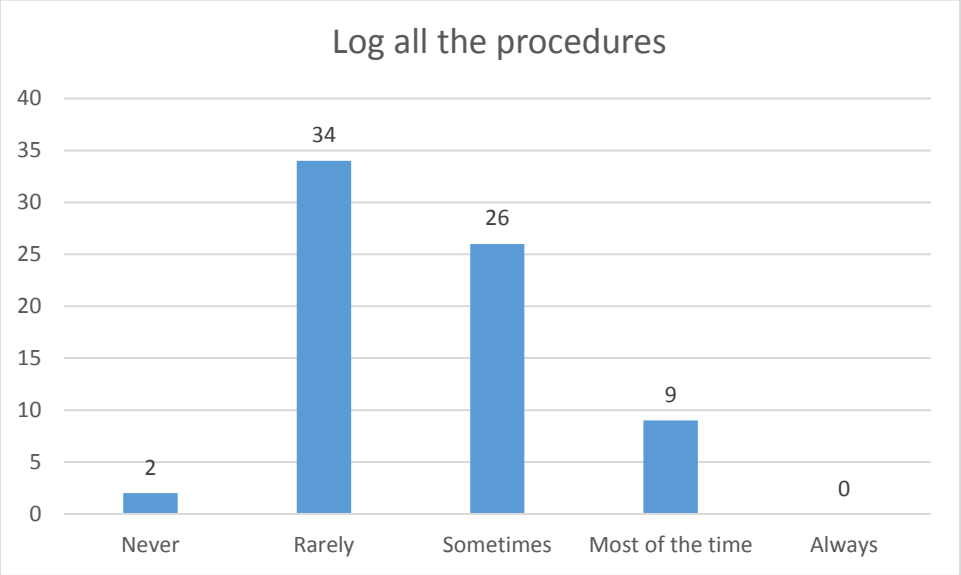


**Figure 2: Attempts to log procedures**

In an attempt to suggest ways to increase the number of logged procedures, students recommended that the list of procedures be updated to include some of the more common procedures (like making a blood smear), and that the process to find the specific procedure that they wanted to log be made much easier. For example, they suggested the use of a dropdown list, or autocomplete functionality, to look up a particular procedure. Another suggestion was that if students were busy with, for instance, an equine rotation, the Vetbox program could automatically recommend a list of possible procedures that could be logged when working on horse-related cases, so that students could tick them off as they progressed through the rotation. If they mastered a procedure that was not on the list, then an 'Other' comment box could be added, to enable them to enter the information manually. Students also indicated a need to change the number of times they were exposed to a particular procedure, rather than having to add the same procedure repeatedly in relation to different cases.

> “It was not possible to log multiple procedures at once, ie performed 50 vaccinations. To log this, every procedure would have to be logged individually ...” [P26]

This not only correlates with what Davis (1989) and Saadé and Bahli (2005) call perceived ease of use, where the amount of effort needed to operate a system has an influence on whether or not students will use it, and also on the perceived usefulness; whether or not the use of the software would make their lives easier. In this study, the students seemed to have struggled to find the procedure that they wanted to log, and therefore did not experience the program as helpful or as a tool that made their work easier. This struggle to find procedures is reflected in their responses as indicated in Figure 3.

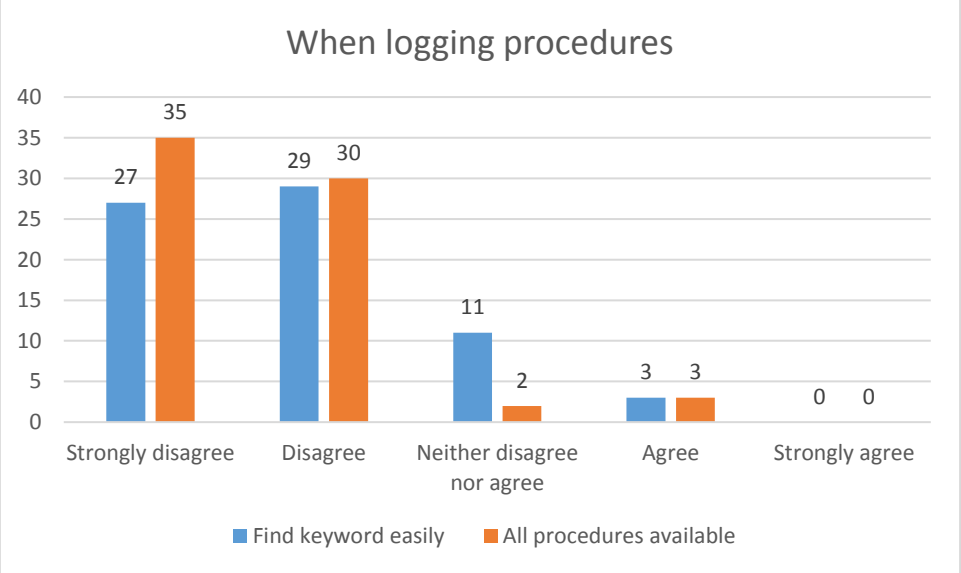


**Figure 3: Ease of use relating to the logging of procedures**

**Motivation to use Vetbox**

The students requested that the way their progress was measured be updated. They complained that even though a progress bar was available, they could not visually see their progress; not even after logging a number of procedures. The perceived slow progress seemed to be unintentionally demotivating. Students’ frustration was

reflected in their responses when they were asked if the progress bar motivated them to log their skills (Figure 4).

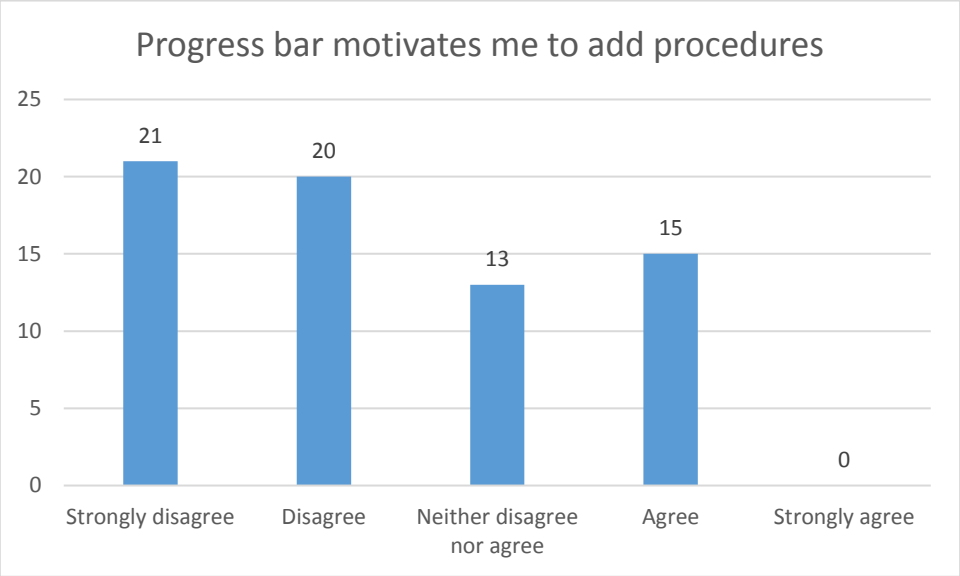


**Figure 4: Progress bar as motivator**

This led to many of them perceiving themselves as incompetent and slow, whereas a perception of personal competence needs to be present to promote intrinsic motivation (Malone & Lepper, 1987). Students were keen to see their own progress after each procedure they logged and seemed to be discouraged when they could not see immediate progress. This is voiced in the following student remark:

> "The progress bar just shows how far you are from finishing, after long hours of filling in the complicated progress of vetbox admin you are disheartened to discover you are only on 3%." [P50]

The students experienced this perceived lack of progress as highly demotivating. Malone and Lepper (1987), in their taxonomy of intrinsic motivation, refer to four factors, namely challenge, fantasy, curiosity and control. When discussing 'challenge', Malone and Lepper (1987) concluded that performance goals should always be personally meaningful before they can be experienced as motivational.

The absence of meaningfulness was also expressed in the comments of the students, as many of them stated that they could not see the value of using both Vetbox and

UVIS (Universal Veterinary Information System, a registered trademark based in Dayton, Ohio, USA) to capture the details of each individual case admitted to the hospital. In addition to the lack of meaningfulness, the much needed feedback from residing clinicians was also lacking. According to a number of researchers, feedback is an important aspect of intrinsic motivation and improved performance (Krenn, Würth & Hergovich, 2013; Mumm & Mutlu, 2011).

Students also felt that they needed an incentive to use Vetbox, as expressed in the next comment:

> "If it was compulsory for our year it would have encourage logging." [P59]

This statement by one of the students is in line with the incentive theory of motivation, which proposes that a desire for incentives motivates behaviour (Cherry, 2014). According to Bernstein (2013), the incentive theory states that students will be drawn to behaviours that involve positive incentives and will be pushed away from those with negative incentives. It is, however, recognised that these incentives might differ from student to student, and from situation to situation. The fact that students could collate a list of procedures they had been exposed to did not seem to be enough motivation for them to invest time in that task. They stated that they would be more likely to log their procedures if other assessments like portfolios and tests were reduced. A few of them believed that if a mark were allocated for the procedures logged, if they were continually assessed on their progress, or if a clinician were to evaluate them and give them feedback on their mastery of particular procedures, it would in fact have motivated them to keep on using Vetbox. Others felt that incentives could also have included the offer of an exclusive learning opportunity, for example, at a private veterinary practice or attending an unusual surgical procedure.

**Mobility and Accessibility**

The students suggested that when more than one software program is used, those programs be integrated and synergised in order to make their life easier. In this case, students felt that if Vetbox were linked to UVIS, and all the duplication, such as entering the same case number, diagnosis and treatment plan twice, were removed,

they would be more willing to log their cases regularly, as it would take up less of their valuable time.

> “Would really save time if UVIS and Vetbox could be linked.” [P16]

One way to seamlessly integrate Vetbox and UVIS would be if the students could use their mobile device (for example, a smartphone) to scan the code from the UVIS sticker (using a barcode reader or QR code) where all the patient information is already embedded. If all these details were then automatically exported to Vetbox, students would regard it as a significant improvement.

Further suggestions were made with regard to the devices used to access Vetbox. For example, students suggested that Vetbox be designed as a mobile application, where procedures can be logged immediately and not at the end when everybody has to compete for one of the few available computers in the hospital. In a case where procedures are not logged immediately, they suggest that an improved Vetbox application be developed that could be used offline and which would then automatically upload their logs when they next connect to WiFi. While Vetbox were available on the web browser and could be accessed on a mobile device, the user interface and caching abilities were not developed explicitly for use on mobile devices. The alternative to a mobile application was that more computers should be made available at the hospital.

In Figure 5, the device distribution is indicated. It is noteworthy to mention that the students indicated that they very seldom used a single device. There was a distinct preference for using a combination of devices, depending on availability and the specific context they found themselves in.

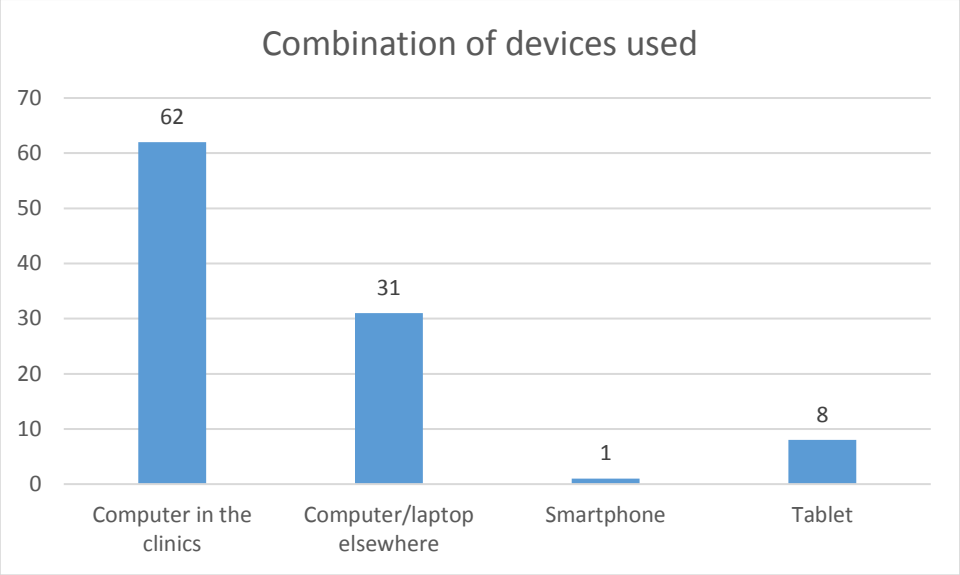


**Figure 5: Devices used to log procedures**

Although the majority of students (91%) opted to use the desktop computers that were available in the clinics or elsewhere on campus, three students indicated that they managed to use only a tablet to capture their work. Even though the number is small, this result serves as an indication that it was indeed possible to log cases using a mobile device, and therefore the possibility of using a mobile device in the clinical environment should be explored in more depth. However, some students mentioned that there might be clinical settings where it would simply not be feasible, or practical, to use an expensive device such as a smartphone or a tablet, for example, in wet labs or in the anatomy hall during a dissection practical. In such cases, the procedures would have to be logged at another location after the session.

The students expressed a need for a dedicated daily time slot during which they could log their cases and procedures, stating that they found it hard to remember details when logging their work at a later stage. The important role of time constraints in the students' lives is illustrated by the following comment:

> "It was too time consuming and there were too many cases to log, especially during the clinic year, we are well over worked with long hours and continuous assessments." [P30]

## Training

Lastly, students stressed the need for proper training for both themselves and the clinical staff on the purpose, value and use of Vetbox. During such training the basic functionalities of the program should be explained. They also indicted that they would appreciate a guide with information on the terminology used in Vetbox to refer to their particular procedures, as many of them struggled to find the specific procedure they wanted to log.

Despite students emphasising the importance of proper training, 25% of them did not attend the training session that had indeed been offered at the onset of the pilot. Of those who had attended, only 11% found it useful, whereas the rest were either neutral, or did not find it useful at all (64%). Over and above the face-to-face training, an online manual was also made available. Although more students found the manual useful (24%), the majority still did not really experience it as beneficial, despite indicating that they would appreciate a detailed guidebook (Figure 6).

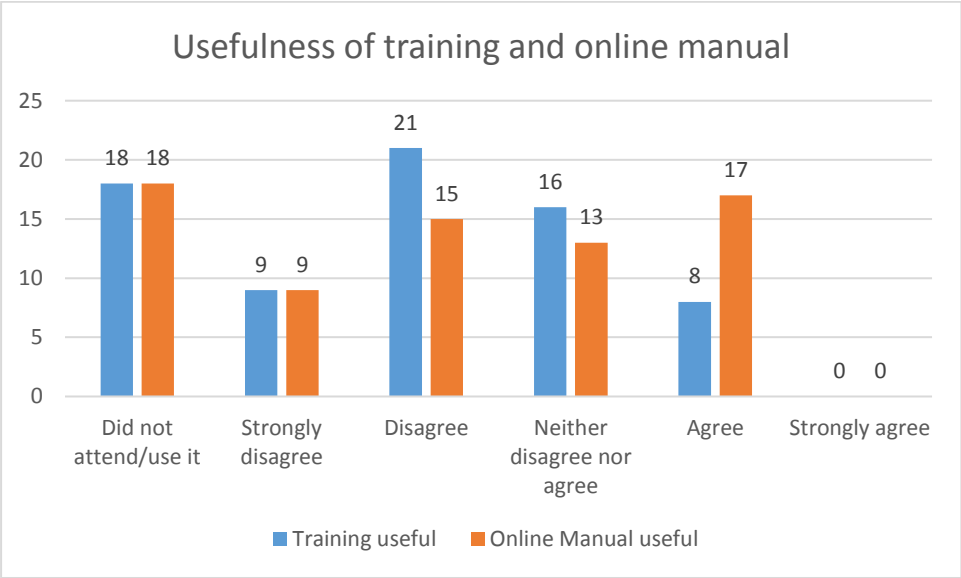


**Figure 6: Usefulness of the training session and the online manual**

All the students' comments and suggestions were sent to the hospital director and the software developers so that the necessary changes could be considered for the next version of Vetbox.

## DISCUSSION

Although students' initial experience of Vetbox was not favourable, they felt that if certain aspects were in place, they would consider using Vetbox. The following is a summary of the students' feedback in this regard:

- Even though a professional software company developed Vetbox, the user experience was not positive. Students felt that in order for them to consider using Vetbox, the login process needed to be streamlined, the number of actions that they have to complete should be reduced, and the whole experience needed to be made more user-friendly.
- Because of this lengthy process, students avoided logging their procedures. They suggested that the list of procedures be updated and that the lookup procedure be made easier. Students seemed to struggle to find the procedures that they wanted to log, and therefore became discouraged, and did not experience the program as helpful or as an aid that made their work easier.
- Students complained that they could not see their progress on the progress bar while they logged their procedures. This led to a feeling of failure that demotivated them to use Vetbox. However, they wanted to bargain with the researchers and said they would be prepared to use Vetbox if they were to receive incentives.
- The students suggested that when more than one software program is used, those programs should be seamlessly integrated and synergised.
- With regard to the devices used to access Vetbox, students suggested that Vetbox be redesigned as a mobile application, so that procedures could be logged during a dedicated timeslot each day, immediately after performing the procedure, or whenever they had time to do so at a later stage. In addition, the program also needed an offline functionality.
- The students stressed the need for proper training for both themselves and the clinical staff on the purpose, value and use of Vetbox so that they could make the best possible use of the program.

Whilst veterinary educators perceive Vetbox to be a program that fills an important gap in current teaching and learning practices; one that has been described as ‘impressive, ground breaking and novel’ (Odendaal et al., 2015), the first pilot of the software did not receive the positive response that had been envisaged. That was clearly because the voice of the students who were the intended users and beneficiaries of the program had not been sufficiently heard. This finding of this study confirmed the importance and value of exploring the user experience of the end product. Therefore, educators who wish to design and develop software for their own courses are encouraged to listen to the voice of their students during all the phases of the development process and to be willing to make significant changes based on the user experience of the intended beneficiaries.

## CONCLUSION

In this study, various valuable suggestions for the improvement of an education software program arose from the students’ feedback. Whilst these recommendations will be considered in the next version of the program, many of the issues raised could possibly have been addressed earlier on if there had been a way in which the students’ voice could have been heard sooner. Further research is needed to determine whether these proposed changes were indeed implemented and whether their implementation did indeed improve the use of the software.

From this experience it can be concluded that the student voice is not only important in the conceptual phase of designing a program, but that students also need to be consulted on an ongoing basis. Better still, it would make good sense to involve students throughout the design process on all possible levels as active members of the team who work together to develop a solution to a problem (Freeman, 1997). This study further corroborates what Phillips (Apr 23, 2015 posting by M Phillips to Edutopia, see ‘Notes’) claims, namely that academics contradict themselves when they say that most changes in education are made for the sake of students, if, in actual fact, the students are not included or have no voice in decision-making. The necessity of continuous inputs by students thus needs to be emphasised.

The participation of students in the development of software programs aimed at improving their learning experience is not only needed for the fine-tuning of the intended software, but it is also of the utmost importance for ensuring the buy-in of the students targeted to use the software. Academics often express frustration when they spend time and energy to develop software for teaching and learning purposes, only to find that the students do not want to use it. Therefore, the importance of taking into consideration the student voice when developing software for students cannot be emphasised enough. When students' inputs and suggestions are explicitly sought on an ongoing basis throughout the process, from concept development to the ultimate implementation, their specific needs can already be identified and addressed in the early versions of the program. Therefore the student voice is not only important for the design and development of the software, but also for ensuring that students make full use of the program when it is implemented.

**NOTE**

Phillips M is a teacher and educational journalist who wrote the blogpost 'Increasing Student Voice in Local Schools and Districts' on 23 April 2015.

**Section 4.2**

## Investigating perceived usefulness as a measure of acceptance for a veterinary mobile app


### ABSTRACT

Veterinary students need to be empowered with the necessary skills and knowledge as well as practical experience in an authentic clinical environment, during their years of study. However, due to the unpredictability of patients seen in the academic hospital, the same level of exposure cannot be guaranteed. In an attempt to get an overview of student's clinical exposure a computer-based logging system, called Vetbox, was developed. The implementation and use of Vetbox were not received as anticipated, and students' voice was sought to improve the software. Thereafter a mobile app was developed and deployed. In this qualitative case study, students and clinicians were sampled by means of a combination of opportunity and volunteer sampling. A group interview was held to record the participants' experiences in terms of the usefulness and ease of use of the mobile app. The themes that arose from the group interview, were indicative of the three distinct purposes that Vetbox were developed for, namely the booking of rotations, logging of procedures, and the verification and assessment of procedures done. In regards of both the bookings of rotations and the logging of procedures, clinicians and students found it useful and easy to use. However, some changes still need to be made so that the product can be improved. Although the assessment procedure was easy to use, both clinicians and students didn't find it useful at all and they identified specific educational flaws. This study confirmed the non-negotiable importance of stakeholder buy-in when educational software is implemented. Also, suggestions are made of what changes need to be made so that students can continue using the mobile Vetbox app.



**Keywords:** Mobile app; perceived ease of use; perceived usefulness; Technology acceptance model; veterinary education

## INTRODUCTION

One of the core competencies of practicing veterinarians is that they should protect the health and well being of animals by diagnosing diseases and treating the sick and injured (Sokanu, n.d.; South African Veterinary Council, 2016; World Organisation for Animal Health, 2012). Therefore, veterinary students need to be empowered with the necessary knowledge, skills and attitudes during the course of their professional training (World Organisation for Animal Health, 2012), that typically includes a combination of theory, hands-on practical experiences and authentic clinical exposure.

At the South African university where this research was conducted, undergraduate veterinary students are exposed to thirty-two clinical rotations during the final eighteen months of their studies. Whilst students work under the mentorship of qualified clinicians in each of these rotations, they cannot all be guaranteed the exact same level of exposure. The reasons for this are obvious, as some diseases are more prevalent in a particular season, and the natural ebb and flow in any veterinary practice will benefit those students who are attending a specific rotation when an interesting or a rare case present itself. Despite these inevitable differences in terms of practical exposure, the aim of veterinary education is always to ensure that students are adequately prepared to deal with any cases that they may encounter on their first day in practice (World Organisation for Animal Health, 2012).

In an attempt to get a comprehensive overview of a student's clinical exposure during training, the director of a South African veterinary academic hospital (VAH) designed and developed a computer-based logging system, called Vetbox (Odendaal, Ntshabele & Rose, 2015). The original purpose for designing the Vetbox system was that students would be able to firstly, book their clinical rotations, secondly log all the cases and procedures that they were exposed to during their time in these clinics, and finally, for clinicians to then verify, and in some cases, assess the procedures that the students logged.

When the Vetbox concept was originally presented to the students, they agreed that it would be helpful to have a collated record of the cases that they were exposed to, as well as the procedures that they mastered during the various clinical rotations.

Clinicians and faculty managers also responded positively to the concept, since they could appreciate the benefits of having access to a complete record of the students' exposure during their final eighteen months of experiential training (Odendaal et al., 2015). Further acknowledging the potential of the Vetbox system, an international accreditation board praised the hospital director for developing this innovative system (Odendaal et al., 2015).

## BACKGROUND AND CONTEXT

Given the initial positive nature of the feedback with regards to the concept and purpose of the Vetbox system, the negative response to the implementation of the first pilot version of the system came as a surprise. Once the students tested the first version of the Vetbox system, their main complaint was that it was not *easy to use*. For example, they struggled to log in to the online system and, once in, had difficulties locating the procedures that they were exposed to, for example 'Making a blood smear' or 'Diagnosing a pregnancy'. Furthermore, if they were exposed to the same procedure more than once, the students did not appreciate having to log the details of the entire procedure twice, instead of simply being able to change the quantity of procedures that they were exposed to. Students also complained that while they could see how many procedures they had logged so far, they could not measure their progress against what they were supposed to achieve to qualify as veterinarians, and that discouraged them from logging further procedures.

Students argued that they felt discouraged when they tried to log a procedure, only to find that it was not on the list. In contrast, they voiced their surprise when they found that certain procedures that they perceived to be extremely rare appeared on the list. Because veterinary students traditionally have very little spare time, they also felt that the use of Vetbox increased their already high workload, rather than make their lives easier.

The first edition of the Vetbox system was designed as a web-based application, and although it could be accessed on a mobile device via the Internet, it did not have a dedicated mobile application user interface, or offline capabilities. Because students had to compete to use the limited number of computers in the academic hospital to

record their cases, or needed to wait until they could access their own computers after a long day in a clinic, the need for a dedicated mobile Vetbox application with offline capabilities became clear. The fact that students, on a typical rotation, moved between examining rooms, laboratories, theaters, lecture halls, and sometimes remote learning spaces such as farms and rural veterinary practices, also complicated the matter. The original web-based Vetbox was therefore adapted and changed into a fully fletched mobile application.

During the process of designing the mobile application, many of the issues that students raised regarding the ease of use of the Vetbox system, were addressed. When the mobile app was eventually introduced, students were seemingly satisfied with the functionality of the mobile app, as, in contrast with the previous web version, they described it as user-friendly. Students also reported that the app did not take a long time to download and install, and that it opened a lot quicker than the web version. Unlike before, students could also retrieve a list of clinicians to assign their procedures to, for verification and assessment purposes, and they mentioned that it was much easier to book their assessments.

The clinicians also seemed more satisfied with the mobile app. Although the introduction of the original Vetbox system added to their workload, the use of the mobile app helped them to access, and sign off on procedures that were mastered, wherever they were, and whenever they had the time. This was reported as a huge improvement on the previous web-based version. The clinicians also confirmed that the assessment process was a lot easier on the mobile Vetbox than on the web version.

Despite the fact that both the clinicians and students agreed that the mobile app was easy to use, the buy-in was still lower than expected, and the *actual use* of the app only increased slightly. This should probably not have come as a surprise, though, as Davis (1989) in discussing his Technology Acceptance Model (TAM), claims that users would rather use a program because of the functions it performs and its *perceived usefulness*, than on how *easy or hard it is to use* those functions.

In this study, it seems as if most of the aspects relating to the *ease of use* of the Vetbox system were adequately addressed in the second iteration of the system. However, despite the progress, the resulting *actual use* of the system was still not positive. It is therefore necessary to take a closer look at the *perceived usefulness* of the system, in an attempt to influence user acceptance in a positive manner.

The focus of this article is to discuss the usefulness of the booking system, the logging procedures and the assessment features of the mobile Vetbox app in terms of the variables of the TAM as described by Davis (1989). This is done to identify modifications that need to be made to the mobile veterinary educational software, in order to influence user acceptance positively.

## LITERATURE REVIEW

We know from literature that students expect to be fully equipped with the practical skills required by their profession, so that they can adapt easily in the world of work once they graduate (Wharton, Goodwin & Cameron, 2014). As such, universities usually strive to provide their veterinary students with extensive hands-on training in a variety of clinical settings, including academic veterinary hospitals, laboratories, and private or state-owned veterinary practices (Murdoch University, 2016; University of California, Davis, 2016; University of Utrecht, 2016). Practical exposure of this nature provides students the opportunity to learn in a real-life context and has the potential to develop a wide variety of skills, including clinical reasoning, communication and fine motor skills.

One of the distinguishing traits between generation Y students and their predecessors is that they grew up with easy access to technology. While global statistics indicate that mobile device subscription rate reached 63% in 2015 (Abbassi, 2016), some researchers reported that between 86% and 94% of the students nowadays own a smartphone (Alfawareh & Jusoh, 2014; Deloitte, 2016; Farley, Murphy, Johnson, Carter, Lane, Midgley, Hafeez-Baig, Dekeyser & Koronios, 2015; Poll, 2015; Potgieter, 2015). To mirror this popularity, researchers showed that many students are already experimenting with mobile devices and applications in their particular teaching and learning environments (Alfawareh & Jusoh, 2014; Kim, Ilon & Altmann, 2013; Payne,

Wharrad & Watts, 2012). A definitive advantage of this trend is that the classrooms' boundaries seem to disappear when mobile devices are used, and that the learning environment now moves with the students wherever they go (Farley, et al., 2015; Martin & Ertzberger, 2013). This is particularly important to the veterinary students who move between various educational settings (Murdoch University, 2016; University of California, Davis, 2016; University of Utrecht 2016).

It is a well-documented fact that today's generation Y students regard themselves as active participants in the education process, with a strong desire to shape their own learning experiences (Bowen, Burton, Cooper, Cruz, McFadden, Reich & Wargo, 2011). Keiller and Inglis-Jassiem (2015) support this notion and state that when academics plan to implement new innovations and technology in teaching and learning, they should consider the students' voice, especially in relation to student preferences and their levels of competency regarding the new technology. According to Philips (2015) the value of including the students' voice in decision-making teaches students democracy, helps them develop student leadership, increases student achievement and engagement, and increases the quality of decision-making as the students add a different perspective than the academics.

When educational software is developed, the intent is usually that it should be useful and should improve student's learning. However, students often resist using educational software because it has been developed from an educator point of view, with limited input from students as the intended users. To understand the phenomenon of technology adoption, various diffusion and adoption theories and models were proposed over the years (Straub, 2009). This study conceptually framed the attributes of the Technology Acceptance Model (Davis, 1989), as its point of departure.

## THE TECHNOLOGY ACCEPTANCE MODEL (TAM)

Researchers frequently apply the TAM when they attempt to explain users' acceptance and usage of technology (Venkatesh & Davis, 2000). Davis (1989) adapted his theory from the Theory of Reasoned Action (Legris, Ingham & Collerette, 2003) and suggests that two elements namely *perceived usefulness* and *perceived*

*ease of use* are central to determine whether users will commit to using a specific technology, or not.

In Figure 1 below, the relationship between the different elements of the TAM is indicated, showing that users' *perceived usefulness*, and *perceived ease of use*, directly influence their *attitude towards* using a particular system. Their attitude then has an influence on whether or not the users will change their *behavior* sufficiently to *actually use* the system on a regular basis.

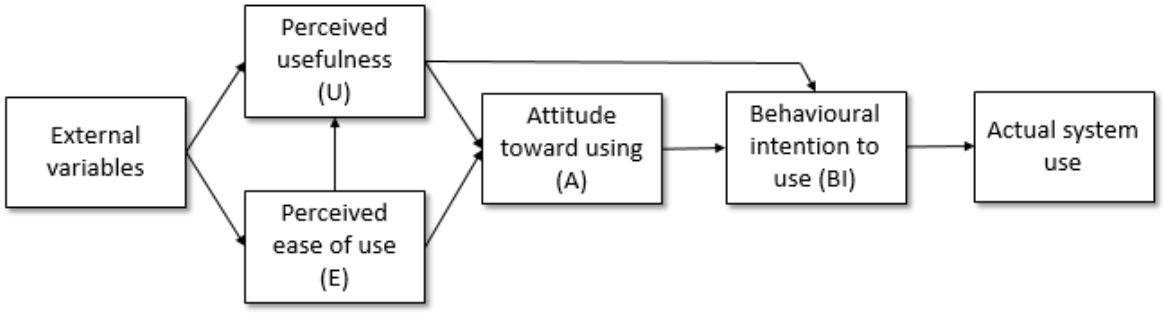


**Figure 1: Technology Acceptance Model (Davis, Bagozzi & Warshaw, 1989)**

According to Davis (1989), *perceived usefulness* and *ease of use* are seen as fundamental determinants of user acceptance. In the context of a particular software program, *perceived usefulness* is defined as whether, or not, the use of the software would be experienced by the user as beneficial and constructive, while *perceived ease of use* refer to the apparent amount of effort needed to operate and master the software (Davis, 1989; Saadé & Bahli, 2005).

Although both of the abovementioned determinants play a role in user acceptance, *usefulness* seems to have a greater correlation with user behavior, than *ease of use* (Davis, 1989). Davis (1989) claims that users will rather use a program based on the functions it performs for them, than on how easy or hard it is to use the program. This may explain why despite the fact that many of the students' complaints with regards to *ease of use* have been solved in the mobile application version, the uptake had not changed significantly. Understanding this phenomenon is important for the implementation of software, because developing a program that is easy to use but not simultaneously perceived to add value to the end user, seems to be a futile exercise. Karahanna and Straub (1999) also confirmed that *perceived ease of use* had no direct

influence on usage, but rather an indirect influence on *perceived usefulness*. So, while previously believed that both *ease of use* and *usefulness* predict system usage, it is rather the dependency between the two that seems important.

Furthermore, it should be mentioned that the *perceived usefulness* and *ease of use* of a system are subjective to the user (Davis, 1989). This is also true when users report on the interface factors that influence their willingness to use software (Kumar, Smith & Bannerjee, 2004). In addition, Brooke (1996) said that it is not possible to specify the usability of a system (where usability means ease of use as defined by the Cambridge dictionary), without first deciding whom the users will be and what they need to be able to do with the system. Therefore, the usability will depend on the context of the system (Brooke, 1996). Along the same lines, Cota, Thomaschewski, Schrepp and Goncalves (2014) argue that for products to be used in the long run, the user experience needs to be acceptable for all the relevant user groups.

Law, Roto, Hassenzahl, Vermeeren and Kort, (2009) state that user experience is context-dependent and subjective, and that it relates to the potential benefits to users when they use a system. Therefore, the user experience of products and systems has more of a personal than social nature, because it refers to how an individual user experiences a system or a product. User experience therefore seems to be subjective, and it does not only refer to the immediate use of products and services, but also to the possibility of prolonged use. In addition, user experience is dynamic, and as a result it is important to investigate user experience and to seek user input throughout all phases of the development of a product, so that users not only test products but also carry on using it in the long run (Law et al., 2009).

Although there are many variables to take into consideration in an attempt to determine whether users will find a system or product useful and easy to use, it is not always possible to determine it beforehand, because the user, the context and the system or products forms a tri-unit. Therefore system or product developers need to repeatedly take user feedback into consideration. They need to involve users throughout all developing phases when designing, implementing or improving systems or products (Keiller & Inglis-Jassiem, 2015).

In this article the researcher wanted to explore the veterinary clinicians and their students' perceptions with regards to the usefulness of the mobile Vetbox application. It is essential to establish a sense of Vetbox' practical worth in order to move students to a place where they change their attitude toward the application and show behavioral intent to actually start using it on a regular basis.

As mentioned by Law et al. (2009) the user experience is subjective and therefore the experience of clinicians and students might differ in how they perceive the mobile Vetbox app. As seen in the discussion earlier, TAM is a popular framework for determining whether users will use software, therefore the discussion is structured according to the TAM variables.

## METHODOLOGY

This qualitative case study is explorative by nature and was conducted in the natural learning environment (Creswell, 2007) of both the clinicians and students at a university in South Africa that offers an undergraduate Bachelor's degree in Veterinary Science (BVSc). Explorative case studies work best when little is known about the topic as is the case in this study, where the principles that influence user acceptance of mobile devices and applications in a variety of educational environments, still needed to be identified.

The target population for the study was the BVSc students in their final 18 months of study (clinical year), together with the clinicians who supervised their training. From this population three clinicians and three final year students were sampled by means of a combination of opportunity and volunteer sampling. Opportunity sampling refers to a technique where participants are selected based on their availability at a particular time and place (McLeod, 2014). Volunteer sampling, also known as self-selection sampling (Lavrakas, 2008) occurs when the participants volunteer to be included in the sample out of their own accord. Whilst this type of sampling, in isolation, may leave the study open for criticism with regards to the potential bias of the participants, it is important to note that the current focus on the usefulness of Vetbox, is part of a bigger research project. As such, many of the issues raised by the participants in this article, could be triangulated with feedback provided to other, related questionnaires and

group interviews. The researchers are therefore confident that the feedback provided by this sample of participants, is indeed representative of the bigger population.

In order to create interaction between participants, and to generate responses in an environment where participants are free to respond to questions as they see fit (Harrel and Bradley, 2009), a group interview method was used. After the participants gave consent that their responses could be used for research purposes, they were invited to describe their experiences of the use of the Vetbox mobile app in terms of the ease of use, usefulness and suggestions for future improvement.

The feedback was analysed according to the method described by Henning, Van Rensburg and Smit (2004), through which the process of coding, categorising and identifying themes resulted in the identification of recurring trends and patterns. These themes were indicative of the three distinct purposes that Vetbox were developed for, namely the booking of rotations, logging of procedures, and the verification and assessment of procedures done.

## RESULTS

In this section the *perceived usefulness* of the three distinct functionalities of Vetbox will be discussed, namely the booking, the logging and the assessment systems. Each of these systems is discussed in terms of components of TAM, namely the *perceived usefulness* and *ease of use*, the stakeholders' *attitude* towards the system, their *intent* to use Vetbox in the long run, as well as, finally, the *actual use* of the system. From this discussion, suggestions for modifications will be made, with the aim to increase the actual use of the mobile Vetbox.

### Booking system

In comparison to the logging and assessment components of the Vetbox system, the new booking system was seemingly well accepted. Both the clinicians and the students reported that they found the online booking system available through the mobile Vetbox application, *useful* and *easy to use*. The clinicians seemed particularly

impressed with the functionality of the system that allowed students to make their own bookings for the various rotations through the application.

Before the mobile Vetbox application was introduced, students were organised into fixed groups by an academic coordinator after which each group then followed a fixed rotation through the different clinics, for example moving homogenously from the Equine Medicine & Surgery clinic to Clinical Pathology, and then to Anesthesiology. The use of the online booking system, however, resulted in students grouped heterogeneously on a first come first serve basis and meant that they did not end up with the same group of students in each clinic.

The clinicians who participated in the study experienced this randomised declaration positive. The participants reported that they were motivated and keen to continue using the mobile Vetbox app to make online bookings.

However, room for improvement did still exist. The clinicians felt that the number of students that were allowed to book in any given clinic was not yet managed properly. For example, some clinics made provision for only six to eight students per rotation. However, in reality it happened that from time to time there were only four students who signed up for a particular rotation, leaving the clinic with practical difficulties.

In other cases, as many as seventeen students signed up for a particular clinic. Whilst the application was set up to allow a specific maximum number of students to sign up for each rotation, the ideal number of students for each clinic has not yet been researched empirically. As such, the gut feel allocations were not always accurate, and the problems were worsened if too few or too many student signed up for the specific clinic. It is obviously important to get these numbers right, as there are many negative consequences if a specific clinic is not staffed by the right number of students. If, for example, there were too many students booked in a particular clinic, the opportunities to learn from doing procedures by themselves were severely reduced. The resulting competition for learning opportunities is neither healthy nor enabling. On the other hand, undersubscribed clinics could result in poor health care with equally negative results.

In order to create an optimal learning environment the clinicians therefore suggested that the system make provision for a well-researched minimum and maximum number of students that can be booked for each clinic. This is to ensure that the students all get sufficient hands-on experience and that they have enough time to discuss the cases afterwards with the students. It would also enable quality assurance with regards to patient care.

It is, therefore, clear that even though the booking functionality of the Vetbox system was perceived as useful, there were still a number of problems that had to be ironed out before the value that it adds to the normal flow of the rotations, would be sufficient to encourage students to change their attitudes and ultimately their use of the application.

**Logging system**

One of the reasons why Vetbox was developed initially, was so that the hospital director, clinicians, veterinary educators and students could all get an indication of the clinical cases and procedures that individual students were exposed to during their final eighteen months of study. Each of these stakeholder groupings had different reasons for wanting to have more tangible data with regards to students' exposure to specific species, skills, procedures, diseases, illnesses and injuries.

The pivotal role that the pursuit of personally meaningful goals plays in the motivation and well-being of individuals, has long since been established in literature (Brunstein, Schultheiss, & Maier, 1999). Having a tangible measure of their personal progress seemed to be the driving force that made the logging of procedures in Vetbox an attractive option to many students. According to the participants in the study, Vetbox was perceived as a useful tool to capture students' progress towards becoming competent veterinarian.

It is therefore interesting that despite the fact that the participants stated that they found the logging system of Vetbox useful, the actual use of the system has not improved significantly. Digging deeper into their feedback, it became clear that even

though the usefulness of this Vetbox functionality was well established, the current application did not yet deliver on the expected outcomes.

The students seem to crave measurable goals that, from their perspective, had to be provided by the clinicians based on the curriculum requirements. For example, they wanted to have an indication of exactly how many bovine pregnancy examinations they were required to do, together with an indication of the level of success they had to achieve to be regarded as competent. As such, they expected the Vetbox system to give clear indications in this regard for their logs to become useful. It is apparent that whilst they found the idea of having a log of their exposure useful, the devil was in the details. Since the system has not, as yet, delivered on their expectations with regards to providing measurable goals, they did not perceive the current version of the logging functionality as personally useful. As such, there was no real change in the students' attitude towards Vetbox and their actual use of the application has not improved.

The process of developing measurable goals for each of the procedures that students needed to master, was going to require careful consideration and dedicated resources. Apart from identifying the number of times a student had to have been exposed to a particular procedure in order to achieve mastery, the nature of the exposure also had to be specified. For example, it is important to know whether a student simply observed a clinician performing a procedure such as a spay, or whether they actually assisted with the procedure. These types of exposure should be further differentiated from those where a student gets the opportunity to perform a procedure independently, albeit under the supervision of an attending clinician. It is furthermore acknowledged that a single, or even repeated, independent performance of a procedure does not guarantee competence, and as such, additional quality mechanisms have to be specified. For example, if a student managed to spay two male dogs successfully, within a specified timeframe and with no complications during or after the operation, they would be regarded as competent.

As it was not advisable to put the Vetbox project on hold whilst these goals and levels of achievement were developed, students were asked, in the mean time, to log at least 80% of the compulsory procedures that they were required to master before

graduation. To encourage participation, this requirement was set as a prerequisite for access to the final exam. The compulsory nature of the logs then became an external motivating factor for students; one that encouraged them to use the mobile Vetbox application to log their procedures. The usefulness of the system was now externally situated, in that the act of logging skills in Vetbox gave students access to the final exam.

Whilst more students now logged their skills using Vetbox, the change in their attitude towards the system, was not necessarily positive. The participants stated that their main purpose for logging their procedures was to get access to the final exam and this attitude resulted in various unintended problematic behaviours. In an attempt to reach the coveted 80% benchmark, some students logged the procedures that they observed, even though they did not do them personally. They also started to log specific procedures separately each time they were exposed to them. For example, they would log every x-ray image that they interpreted and each one of the multiple ultrasounds they were involved with, even though the skill associated with the procedure was identical to the previous one.

Apart from the flaw in the students' reasoning and their obvious misinterpretation of the intent of the 80% prerequisite, this behaviour created a multitude of logistical challenges. Each time a student would log something, the clinician assigned to them would receive an email indicating that there is a procedure that needed to be verified. The repetitive logging of the same procedures resulted in a magnitude of emails flooding the clinicians' inbox. This unintended consequence added unnecessary pressure to the already high workload of the clinicians. The overwhelming number of requests for verification resulted in the clinicians either ignoring all emails generated by Vetbox, or in them indiscriminately verifying all the procedures listed, without careful consideration of each student's work and skills level. It soon became clear that this practice had the potential to compromise the quality of the student learning.

To prevent the problem in future, clinicians recommended that the number of submissions for verification be limited. This suggestion is in line with the discussion above, where it became clear that the requirements for each procedure had to be specified, both in terms of quantity and quality. The student respondents further

suggested that they would appreciate it if, when they reached the maximum number of procedures required, the option to submit the procedure for verification be hidden. Any further logging of that particular skill would then only influence the student's own progress and records, but would no longer require action from the supervisory clinician.

The clinicians, as an important stakeholder in the process, were excited about the prospect of seeing a comprehensive list of each students' practical exposure during their clinical year. One of the core competencies of practicing veterinarians is that they should protect the health and well being of animals by diagnosing diseases and treating the sick and injured (Sokanu, n.d.; South African Veterinary Council, 2016; World Organisation for Animal Health, 2012). The participants argued that it was important for them to know what procedures students were exposed to, in order to ensure that students are prepared for the world of work once they graduate from the university.

One clinician also considered Vetbox as useful in the sense that it creates opportunities for discussion between clinicians and the students in a particular rotation. She stated:

> "I think it is positive for the students to log their skills as it motivates them to go through the procedures, and to ask you to go through certain ones [if] they didn't see it during the rotation – so I think that is a good thing." [P3]

The clinicians who participated in the study, did however, make a couple of valuable suggestions for improvement of the Vetbox system. For example, they suggested that if procedures were grouped per clinic/rotation, it might motivate students to actively seek out the specific procedures that were relevant to that rotation. Originally the intent was to list all the procedures alphabetically and not to link them to a specific environment, because of the large number of generic skills that can be mastered in any one of the clinics. For example, 'Taking a medical history' could apply in any of the clinics where the students work as the first point of interaction with the owner of a patient. Similarly, a fecal flotation can be taken in a large number of clinics.

Structuring the generic procedures separately from those that were clinic-specific made sense to the clinicians, as it would improve efficiency in terms of teaching the skills during the rotation and assessing the students' mastery thereof at the end. The clinicians who participated in the study indicated that they would appreciate such a classification as it would make it easier for them to discuss a manageable number of clinic-specific procedures with the students, as opposed to having to deal with a multitude of generic ones that could potentially be verified and assessed by the qualified nursing staff, or even the dedicated clinicians in the skills laboratory.

The participating students also reacted positively and said it would help them too because they too identified the overburdened workload of the clinicians as a hindering factor. At that stage not all the clinicians were comfortable with using Vetbox and as such, the sheer number of procedures that they were required to verify became a problem. The participating students were of the opinion that if the procedures that were available in Vetbox, were limited to only the most essential ones, and they were aligned to a particular clinic, they would get a better response from their attending clinicians. It seems as if these logistical issues obscured the usefulness of the logging functionality.

Both the participating clinicians and the students agreed that the list of procedures that needed to be mastered, verified and assessed had to be narrowed to include only the essentials. The students did, however, indicate that they still wanted to be able to log procedures of so-called lesser value, or those that were relating to rare cases, or those of a highly specialised nature, for personal reflection purposes. They repeatedly referred to the motivational value of seeing their own progress. These logs would also be valuable to the hospital managers who could potentially find the statistics valuable for budgeting and planning purposes.

The students also indicated that they would appreciate it if Vetbox allowed them to log the additional procedures that they were exposed to when they do voluntary work in veterinary practices during their spare time over weekends and during holiday seasons. This is interpreted as an indication of the students' behavioural intent, in that they would be keen to use Vetbox if only some of the issues that they currently experienced were addressed satisfactorily.

From a management perspective, the logging functionality of Vetbox was perceived as a welcome addition in that it provided invaluable management information. Once the system is running smoothly, the academic hospital administrators will have concrete numbers and verified statistics for budgetary and planning purposes. For example, if it was statistically proven that most students did not have sufficient exposure to a specific procedure, arrangements could be made to provide alternative mechanisms. One way would be to simulate the procedure in a skills laboratory with models, such as a bovine rectal examination station or a radiographic simulator. Another would be to partner with private practices in order to arrange that students benefit from the cases that are treated there.

Although there were problems raised with regards to some of the details concerning the logging functionality of Vetbox, the attitude towards the use of the system was positive overall. Both clinicians and students made suggestions to improve the system and this was read as an indication that if these problems were sorted out, the stakeholders would be prepared to continue using the system in the future. Behavioural intent (as a component of TAM) was therefore established.

**Assessment**

Although the clinicians who participated in the study found the assessment functionality of Vetbox *easy to use*, they did not find it all that *useful*. In fact, this functionality was rated the least convenient and handy of all three the Vetbox features. There were some aspects of the assessment functionality that the clinicians regarded as educationally flawed. For example, they did not agree with the “Approve all” option that was available in Vetbox. They commented that it may happen that a clinician was busy, and that as a result they would select the “Approve all” button, without carefully considering the actions of the student under their supervision. Such carelessness would compromise the quality of the students’ learning. One clinician commented that

> “…there is an option … to select all and approve all and that is what is going to happen because we just don’t have time to go through everybody’s assessments.” [P2]

As mentioned earlier, it seems as if the number of procedures that had to be verified was too high, and that, in order for the system to work well, the quantity and quality of the procedures that have to be verified and assessed, will have to be explored.

Some clinicians also raised concern with the fact that some procedures required of them to simply verify their assessment with a simple Yes or No response. This concern is mirrored in the following comment:

> "…the ones that I am having to assess is yes or no; have they done it or haven't they?" [P1]

The participating clinicians indicated that they did not think a simple "yes" or "no" response to a logged procedure added any educational value. They felt that a simple "yes" without the addition of constructive feedback, did not contribute to a student's learning. Being conscious of the busy schedules of clinicians, the participants indicated that even just the addition of a mark would provide students with feedback with regards to the level of their current performance. Clinicians also admitted that the requirement of giving students a specific mark for the procedures done in their clinics, would force them to watch, and guide more closely, how the individual students under their guidance, were performing.

Clinicians further noted that they would appreciate a shorter list of clinic-specific procedures to assist, as they could then organise verification and assessment opportunities somewhere during the course of the rotation, or even formally at the end of the rotation.

The clinicians also felt strongly that Vetbox could be used to verify and assess those critical and mandatory procedures that students needed to master before they could qualify as veterinarians. As one participant stated:

> "The assessment should probably only be on the critical [procedures] because if you can't do those you shouldn't be a vet." [P1]

The clinicians also indicated that because there would be fewer procedures to assess, more attention could be given to the quality of the assessment itself.

It seemed as if the usefulness of Vetbox could be improved if constructive criticism were to be given to students once they have logged their skills. It was reported by the participating clinicians that the feedback from a qualified mentor could help struggling students to gain insight into their own levels of competence and progress. One student confirmed this by stating:

> "I will appreciate more comments like 'you do a good job' or 'you are struggling a bit', rather than somebody just accepting my skills." [S6]

## CONCLUSION

These results of this study confirmed what has been said about the TAM, where the lack of ease of use and lack of perceived usefulness had a negative influence on students' attitudes, their intention to use the application, and their actual use of the system.

The findings however also supported the Davis' (1989) notion that people may be willing to actually use an application if they found it useful overall, even if it is not particularly easy to use. Because subjectivity and context (Law, et al., 2009) seemed to play a role in students' perceived usefulness and ease of use the Vetbox application, it was necessary for the developers to listen to the voice of the students and their clinicians, in order to ensure buy-in and to secure a willingness to invest their time and effort in mastering and actually using new applications. Without the buy-in of those who will be most involved and affected, whether directly, or indirectly, the application would in all probability never be used to its full potential. Involving the students right from the start, and throughout the implementation of the application, therefore seems to be non-negotiable. In the current version of Vetbox, subtle changes were suggested to ensure that students and clinicians find the application useful for booking, logging and assessment purposes.

This study also confirmed the importance of the perceived usefulness of a specific technology, when it is required that users be motivated to change their behaviour, and to start using it for the purpose it was designed for. The study noted that even though intrinsic motivation is always preferred, extrinsic factors could sometimes create a sense of usefulness.

# CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

## INTRODUCTION

Over the past decade or so, mobile devices have become an integral part of students' lives. Therefore, many studies had focussed on the use of technology in education and many researchers claimed that blended learning tools can be used with great success in students' educational contexts (Schepman, Rodway, Beattie & Lambert 2012; Sooryamoorthy, 2014; Walace, Clark & White, 2012).

In this section, a summary will be provided of the research done with regards to blended learning, the use of mobile devices for note-taking purposes and the importance of student input when educational software is designed and developed. This section also includes a discussion on the researcher's personal learning experience throughout the study, coupled with a reflection on the study as a whole. Finally, the researcher will make recommendations for future research.

## SUMMARY

Many students at higher education institutions already own a mobile device (Potgieter, 2015), and the challenge was to determine how these technologies could be integrated into the students' learning environment. Therefore, the following question was asked:

> *How can mobile devices be used in a blended learning environment in higher education?*

To answer this question, this research study was undertaken and the outcomes documented as a series of journal ready articles. Three distinct themes emerged namely, blended learning, the role of mobile devices in note-taking and the way in which an application (Vetbox) used for booking, logging and assessment purposes could be refined after student input. Each of these themes was addressed in a related section. An overview of the themes, research questions, research methodologies and data sources used, is displayed in the Table 1 below.

**Table 1: Research design overview**

| Chapter | Theme | Research question (sub-questions) | Research methodology | Data sources |
|---|---|---|---|---|
| 1 | Introduction | | | |
| 2 | Blended learning | How can *blended learning* tools be used to promote success among South African undergraduate students? | Literature review | Scholarly books<br>Journal articles<br>Issue reviews |
| 3 | Note-taking | How can mobile devices be used to support the learning experience of veterinary students in the *pre-clinical* component of the study? | Case study | Questionnaire<br>Group interviews<br>Observation |
| 4 | Vetbox | How can mobile devices be used to support the learning experience of veterinary students in the *clinical* component of the study? | Case study | One-on-one interview<br>Group interviews<br>Questionnaire |
| 5 | Conclusion | | | |

In the next section, first a response will be given to each one of the sub questions. The rest of the section will be structured according to the broad themes of blended learning (Chapter 2), note-taking (Chapter 3) and the development of veterinary educational software (Chapter 4).

## Research questions

The overarching question guiding this study is: *How can mobile devices be used in a blended learning environment in higher education?* To answer this question, the following two sub-questions were considered:

1. How can blended learning tools be used to enhance student success?
2. How can mobile devices be used to support the learning experience of veterinary students in (a) the pre-clinical component of the study and (b) the clinical component of the study?

**Reseach question (1):** How can blended learning tools be used to enhance student success?

**Answer**: To answer the first sub question a list of proposed blended learning tools, with suggestions on its use, to address the factors that influence students' success by enhancing the learning process, was given.

In response to the first part (a) of the second sub question, "H*ow can mobile devices be used to support the learning experience of veterinary students in the pre-clinical component of the study?",* four further questions were asked and answered. These questions and answers are summarized below:

**Research question (2a.1)**: How do higher education students experience the use of mobile technologies in a variety of different learning environments?

**Answer**: Students experimented with a variety of mobile devices and applications and indicated the minimum requirements that a mobile device / mobile app need to have to be used for note-taking. The mobile devices and mobile app need to be easy accessible and easy to use. Although students do not give any preference to any specific mobile device, they do mentioned that the device will differ from educational setting to educational setting (lecturer hall or practical class). However, they do emphasize that when the information is captured it need to be stored at the same location to make access easier especially when they want to share their information for with current or future students

**Research question (2a.2)**: How can students' own videos be used for note-taking purposes?

**Answer**: Students emphasized the importance of short (3-5 minutes) videos of their practical classes. They demonstrated how they incorporated these videos in their class notes and shared the videos in their study group. In addition, they prefered to use a mobile phone to record the videos rather than a tablet of hand held video camera because most students have a mobile phone and the video can easily be shared on WhatsApp or through email.

**Research question (2a.3)**: How can a mobile action camera (such as a *GoPro*) be used in veterinary education?

**Answer**: Students mounted the action camera on their own body and record procedures that were demonstrated during official classes or when doing extra work at private veterinary practices. They also indicated that these short video clips are valuable when they need to revise for their tests and examinations.

**Reseach question (2a.4)**: What are the affordances of mobile devices and note-taking applications that support cognitive demanding note-taking?

**Answer**: A list of note-taking affordances are presented that if taken in consideration when developing a note-taking application, it might make it possible for higher education students to take cognitively demanding notes that contribute to their learning.

In response to the second part (b) of the second sub question, "H*ow can mobile devices be used to support the learning experience of veterinary students in the clinical component of the study?",* two further questions were asked and answered. These questions and answers are summarized below:

**Research question (2b.1)**: How can the student voice be used to improve educational software?

**Answer**: The student voice is not only important in the conceptual phase of designing educational software, but students need to be consulted repeatedly throughout the

design and development process on all possible levels as active members of the team who work together to develop a solution to a problem.

**Research question (2b.2)**: To what extent can perceived usefulness serve as a measure of acceptance for a veterinary mobile app?
**Answer**: This study confirmed the non-negotiable importance of student buy-in when educational software is implemented. Also, suggestions are made of what changes need to be made so that students can continue using the mobile Vetbox app.
This study also confirmed the importance of the perceived usefulness of a specific technology, when it is required that users be motivated to change their behaviour, and to start using it for the purpose it was designed for, even if it is not easy to use.

**Blended learning (Chapter 2)**

In Chapter 2, the focus was on how blended learning tools can be used to promote success among South African undergraduate students. According to research done in South Africa, one of the challenges of higher education is the low success rate of university students (HESA, 2009). The challenge put forward by the government to the higher education sector was, therefore, to find better ways of teaching and learning in order to improve outputs of students (HESA, 2011), as it was clear that the traditional way of teaching was no longer effective.

Section 1.1, *The effective use of blended learning tools that promote success among South African undergraduate students,* was based on a review of existing literature. Current research in education, emphasizes that practices such as blended learning has the potential to increase the success rate of students (Bawaneh, 2011; Delaney, McManus & Ng, 2010; Hiralaal, 2012). Therefore, to answer the question on how blended learning tools can be used to promote success among South African undergraduate students, and to relate ideas and theories with the application thereof, a number of literature and empirically-based research studies that focused on blended learning, were identified. This was done by searching academic databases and the Internet for keywords, such as, blended learning, blended learning tools, blended learning in higher education, motivation, critical thinking, under-preparedness, assessment, and higher education. The resulting articles were then grouped according

to identified success factors and analysed. To relate the research outcomes with practical applications, blended learning tools were examined to determine whether they could assist in addressing the identified success rate factors, either inside, or outside the classroom. The result of this relationship between blended learning tools and success rate factors was tabled at the end of the discussion of each one of the success rate factors. These tables indicated how mobile devices can be used as blended learning tools to promote student success.

**Note-taking (Chapter 3)**

In Chapter 3, the focus of the research was on how mobile devices could be used in the various pre-clinical educational environments of the students. Based on informal observations, as well as an analysis of the responses to a questionnaire that was completed by pre-clinical veterinary students, the theme of note-taking became a prominent focus of this chapter.

In the first section (3.1), *Taking notes with mobile devices: a university case study,* participants' experiences when taking notes with mobile devices, were explored. Firstly, respondents reported that 96.6% of them owned a mobile device. This is in agreement with existing literature that indicated that more than 84% of students have access to mobile devices (Farley, Murphy, Johnson, Carter, Lane, Midgley, Hafeez-Baig, Dekeyser & Koronios, 2015; Potgieter, 2015). Furthermore, participants indicated that they still take extensive notes, regardless of whether they are told to do so, or not. This tendency to take notes without being prompted was also confirmed by Morrison, McLaughlin and Rucker (2002). The participants indicated that they take notes, either by writing the traditional pen-and-paper way, or by typing using their mobile devices. They reported that they would personally take comprehensive notes, whether they received partial lecture notes before the class, or not.

However, participants emphasized the importance of saving notes, or pictures of veterinary patients for future reference purposes, albeit for themselves for future use, or for younger students who would follow in their footsteps in later years. Therefore, for them it was important to be able to share their notes with relative ease. In addition, the participants emphasized the advantages of having all of their notes and study

material available on one device, or through one centralized application. The fact that WiFi access is more readily available nowadays, will no doubt play a big role in how students access the notes that they save in the cloud.

In their feedback, participants made observations with regards to how traditional note-taking can be simplified using mobile devices. For example, they suggested that students use their digital devices to create new notes, type, write or insert objects, write on lecture notes, and save and share notes. Understanding how students use these functionalities in an authentic learning environment could be of value to software developers when they plan to develop note-taking software for institutions of higher education.

In section 3.2 and 3.3, *Exploring videos as note-taking tools* and *Exploring the use of an action camera in veterinary science education* the focus shifted from text-based note taking, to note taking by means of video recordings. It is not surprising that the use of videos for note-taking purposes is one of the themes that emerged. The 21st century students that are attending classes nowadays are also known for their affection for downloading and watching videos (Heltai, 2016). Humphrey (2016) and Morrison (2016), for example, found that millennials watch between two and thirty hours of videos per week.

In this study participants explored the usefulness of recording noteworthy information in theory or practical classes, by means of video clips, rather than through the activity of writing or typing. Without prescribing to the participants which devices they had to use, they spontaneously explored mobile phones, tablets, action cameras and hand-held video cameras. However, participants soon realized that it was not worthwhile to record a theory-based traditional lecture, because the videos were lengthy, the quality was not good, and in some cases it was difficult to see what was projected on the screen in the larger lecture halls.

Therefore, the participants indicated that the true value of making video recordings for note-taking purposes lay in the recordings of practical sessions. However, since students needed to assist in surgeries from time to time, they needed to use both their hands which made the holding of a camera impossible. In those cases, the action

camera was used with great success. Participants claimed that video notes were valuable to use, especially before an exam. Because these videos are short and to the point, participants reported that they watched them repeatedly to remind themselves of the steps they needed to follow. This tendency was confirmed by Roshier, Foster and Jones (2011) where students study habits gradually changed because they accessed videos more frequently, especially before a test or exam.

In the last section (3.4) of the note-taking theme, namely, *Affordances of mobile devices and note-taking apps to support cognitively demanding note-taking,* the focus was not only on the student experiences of note-taking but also on the affordances of mobile devices when taking notes. The idea was that when students take notes, they not only transcribed verbatim what they hear, but also that they are cognitively involved in the note-taking process. Researchers confirmed that the true value of note-taking lay in the cognitive processes that took place during note-taking and not just the transcribing of text (Bui, Myerson & Hale, 2013; Piolat, Olive & Kellogg, 2005). Therefore, the mobile devices used for note-taking needed to have the necessary hardware and software capabilities that support effective note-taking practices. However, not only do the device and application have to be user-friendly, it also need to give students options so that they can capture, organize and record information in such a way that the note-taking is cognitively challenging and contribute to their learning. Therefore, this section of the research was concluded with a list of considerations that need to be in place in developing a note-taking application that can be accessed by means of a mobile device.

In **Chapter 3**, the focus of the study was to determine how mobile devices can be used to support the learning of veterinary student in their pre-clinical years. Participants were urged to use their mobile devices in the different learning environments that they found themselves in on a daily basis, without the interference or guidance of their lecturers. Although the researcher used the themes identified through observation and an analysis of the questionnaire data to guide the weekly contact sessions during which the group interviews took place, the participants were given autonomy in terms of the exploratory activities that they eventually completed. They also had autonomy with regards to how, where and when they used their mobile devices.

Because the research was done in an authentic higher education learning environment, this chapter contributes by showing that mobile devices are highly effective tools with which notes can be taken in undergraduate lectures, practicals and demonstrations. As such, the deduction can be made that note-taking is one of the key affordances of mobile devices.

This chapter also revealed students' expectations with regards to taking notes, and video notes specifically, with their mobile devices. The student perspective as presented in this chapter, distinguished the study from other research projects where researchers merely wanted students to test specific hardware or software, or focus on the use of video materials that was developed or recommended by a lecturer.

**Veterinary educational software (Chapter 4)**

When veterinary students are busy with the clinical component of their studies, they need to book clinics, record and show evidence of their exposure to specific clinical procedures, and be assessed as competent in their newly acquired skills afterwards. Whilst this study focussed specifically on veterinary students, the abovementioned need is similar to that of many other health science training programmes as well. Therefore, once the need was identified, the veterinary faculty that participated in the study decided to move away from the paper-based logging system that were in place for many years, to an online system. The initial expectation was that there would be a ready-made off-the-shelf application available in the market that could be used to address the needs identified above. However, after a review of the existing portfolio-based applications available in the market, the faculty decided to rather develop a customised veterinary education application (Vetbox) that could be used as an all-inclusive booking, logging and assessment system.

The idea was, amongst others, to provide administrators, clinicians, and students themselves, with a comprehensive overview of students' exposure to specific cases, clinical skills and procedures throughout the final work-integrated part of their training programme. The customised veterinary education application (Vetbox) was also needed to simplify the bookings of students' clinical rotations before they got into an authentic learning environment, and to verify and assess the clinical skills that they

acquired afterwards. The first version of the Vetbox application was developed and deployed based on an intuitive understanding of the needs as expressed above, but it turned out that this version was not well received by the veterinary students or their clinicians. Therefore, in **Chapter 4**, the importance of taking into consideration the opinion of stakeholders throughout the conceptualisation, design, development and implementation phases of educational software, was emphasised.

In the first section (4.1), *Listening to the student voice to improve educational software,* the researcher was curious as to why students were hesitant and in some cases, unwilling, to use Vetbox. Through an initial one-on-one interview with the hospital director, a group interview with a sample of clinical students and clinicians, and the subsequent questionnaires that were distributed to the entire cohort of clinical student, the researchers discovered that the intended end-users did not find Vetbox *easy to use*. For example, the participants indicated that they struggled to log into Vetbox and, once in, had difficulties locating the procedures that they wanted to log. Furthermore, if they were exposed to the same procedure more than once, they did not appreciate having to log the details of the entire procedure twice, instead of simply being able to change the quantity of the number of times they were exposed to that specific procedure. Students also complained that while they could see how many procedures they had logged so far, they could not measure their progress against what they were supposed to achieve and that discouraged them from logging further procedures. Because veterinary students traditionally have very little spare time, they also felt that the use of Vetbox increased their already high workload, rather than making their lives easier, and as such did not experience the application as *useful*.

Although the students' initial experience of Vetbox was not favorable, they indicated that if certain aspects were in place to improve their *ease of use*, they would consider using Vetbox. The participants felt that the logging process needed to be streamlined and they wanted to be able to monitor their own progress. The participants also indicated that they needed Vetbox to integrate with other hospital software that was already compulsory to use, and that they required more comprehensive hands-on training.

One of the suggestions made by the students was that a mobile application could be developed to give them the freedom to log their procedures, wherever they are and at any given time. Therefore, taking in consideration some of the suggestions made from the first Vetbox study, a mobile application was developed and piloted. The veterinary students were not the only users of this system. Clinicians also had to use it to check, verify and sign off on students' exposure to cases, and on their mastery of certain procedures. Therefore, the importance of taking into consideration the opinions of all stakeholders throughout the conceptualisation, design, development and implementation phases of educational software was highlighted as essential.

In the second section (4.2), *Investigating perceived usefulness as a measure of acceptance for a veterinary mobile application,* the researcher further explored the mobile Vetbox app in terms of its booking, logging and assessment functionalities. The focus was specifically on the variables of the Technology Acceptance Model (Davis 1089) and how the perceived *usefulness* and *ease of use* had an influence on students' *attitude*, *behavioural intent* and the *actual use* of Vetbox.

Through a group interview, the researchers discovered that, although some small changes still needed to be made to the revised mobile version of the application, clinicians and students now found both the bookings of rotations, and the logging of procedures, *useful* and *easy to use*. To further improve the mobile application, and to ensure that clinical students can optimally benefit from using Vetbox, suggestions were made with regards to additional changes that still needed to be made to ensure it is *easy to use*. It was surprising, though, that the end-users were willing to *actually use* Vetbox, despite some remaining negative perceptions with regards to its *ease of use*. However, with regards to the assessment procedure, Vetbox was found to have specific educational flaws, and therefore that part of the application was not yet regarded as *useful*. As a result, the assessment functionalities of Vetbox have not yet been actively used, thus highlighting the importance of *perceived usefulness* as a prerequisite for *actual use*. This study finally also confirmed the importance of the involvement and buy-in of all the stakeholders when developing educational software.

## METHODOLOGICAL REFLECTION

The outcomes of this research study were documented as a series of scientific articles. A PhD thesis that documents a series of journal ready articles seems to be gaining momentum as an acceptable manner to achieve a PhD (Guerin, 2016). According to Guerin (2016), the competitive post-PhD job market, and the need for researchers to publish, are the main drivers for PhD by publication. Students and researchers who are busy with their PhDs, find this method appealing because apart from gaining a formal qualification, they also get a higher number of articles ready for publication, in a shorter amount of time. This is possible because their research is focused and organised into publishable units (Cowden, 2013). In addition, research that is presented in an article format are peer-reviewed and published to a wider audience (Dlamini, 2013). Although, PhD by publication is not an entirely new concept (Badley, 2009), documenting a thesis in the format of articles is a relatively new way of presenting research findings at the faculty where this study was undertaken. However, the researcher recognised the value of doing so, after exploring international trends (Alexander, 2014; Cowden, 2013). What is important to take into consideration, is that the articles presented need to focus on a related theme (Guerin, 2016).

In this study, the use of mobile devices and mobile applications in a blended learning environment in higher education, was central to the research. Therefore, theories that explained what would influence or determine the *intent of use*, *actual use* and *continued use* of mobile devices and applications, underpin this study. Many technology acceptance models, each with a variety of different sets of acceptance determinants, exists. In a study, Venkatesh, Morris, Davis and Davis (2003) compared eight acceptance models and empirically tested each one of them to formulate a unified theory of acceptance and use of technology (UTAUT). They described four direct determinants that play a role in behaviour intention and usage, namely performance expectancy, effort expectancy, social influence and facilitation conditions. The relationship between these determinants and intent or usage, will be moderated by gender, age, experience and voluntariness of use (Venkatesh et al, 2003). Initially, the researcher thought that this might be an acceptable model to underpin this research study. However, after careful consideration she realised that because the target population in this study are mostly from the same age group (either

pre-clinical or clinical students), have more or less the same experience in the use of devices and Vetbox (it is new software), and the use of Vetbox was mandatory, only gender might have a moderating effect. From Venkatesh et al's (2003) empirical analysis, only performance expectancy and effort expectancy have a significant influence on intent, while social influence and facilitating conditions are dependent on the moderators. The two remaining determinants performance expectancy, or "perceived usefulness", and effort expectancy, or "perceived ease of use", still surfaced in this case as the two main constructs that influenced intent and actual use (Venkatesh et al, 2003). This is in line with what Davis (1989) advocate in the early version of the Technology Acceptance Model (TAM). Although later researchers improved on the TAM and added determinants such as experience, output quality, computer anxiety and perceived enjoyment (Venkatesh & Bala, 2008), the original TAM was deemed sufficient to be used in this study.

In this study, students' experiences with regards to the use of mobile technology in their blended educational settings were central to the research. As this research was conducted at a campus where veterinary students attend their classes, the focus was on the educational environment of both the pre-clinical and clinical students.

To prevent the participants from being influenced by the presence of the researcher, the researcher was not present when participants were experimenting with their mobile devices and apps, and the participants were not even attending the same classes when they used their devices. However, I was present when the participants were giving feedback. It is a possibility that need to be taken in consideration that participants could be influenced and pressured by their peers to provide certain answers and feedback. But, because the participants were experimenting with their own chosen devices and apps, I believed that the participants were honest in their feedback. In addition, during the course of the group interviews, participants also did not contradict themselves, and that made me to believe that they were honest when reporting on their experience.

The observations made during this research was not planned, and was randomly observed, therefore, the presence of the researcher did not have an influence on

participant's use of mobile devices. The researcher is not a lecturer at this institution and therefore the student – lecturer power role could not influence the experience or feedback of the participants. With regards to the two electronic questionnaires, the first one was done with the help of clickers, and their responses could not be linked to a specific participant. The second questionnaire was done through an online application where participants could not be identified. Therefore, the researcher believe that the data provided by the participants is a true reflection of their in-depth experience with the use of mobile devices in their organic learning environments either in a lecturing hall, laboratory or academic hospital.

During the journey I took in reviewing existing literature relating to studies done in other parts of the world, or even other universities in South Africa, I tried to think of ways how similar studies could be done in the learning environment at the university where I was working, or at the university where the research was conducted. However, the social contexts of the students did not only differ from country to country and university to university, but also between faculties in the same university. I constantly needed to remind myself to remain aware of these contextual differences. In this study, taking away the limitations of not having access to devices or poor internet access, participants had an opportunity to experience with their own devices (smartphones, tablets, laptops), in an environment where Wi-Fi and free internet access were available. Therefore, in this study, the results might not be a true reflection of what is possible at all universities, in all countries, but an ideal of how mobile devices can be used in a blended learning environment .

When doing a qualitative study, the purpose is not to generalize the results, but to gain an in-depth understanding of why certain practices happens. Therefore, when a qualitative study is repeated one is not likely to get the same answers (Koonin, 2014). However, the study could have been improved, if the questions included in the research instruments were tested beforehand, and such an addition could have led to additional themes emerging.

During this journey of doing a PhD through writing a series of journal ready articles, personal lessons were learned. The first lesson was to be able to write coherently and stay focused on one's research goals. Secondly, to write for publication, one also

needs to take in consideration the journal and journal audience to which one want to submit one's article. The guidelines of the journals are not all the same and one need to diligently follow their instructions, to avoid delays in the publication process. Thirdly, although one has to deal with rejection, valuable feedback is given after the review process. Finally, one experiences the joy of acceptance once an affirmative answer is received back from an editor.

## SUBSTANTIVE REFLECTION

After an initial review of existing literature relating to blended learning, the researcher was interested to see how students were already intuitively using their mobile devices in the various learning spaces that they were exposed to as part of their undergraduate studies. The resulting feedback from the participants was not anticipated. The expectation was that if students get the opportunity to explore the use of mobile devices in class, without specific guidance from the researcher, but with the blessing of their lecturers, they would come up with innovative ways to use the technology in the various educational settings they found themselves in on a daily basis. However, when the data was analysed, the note-taking theme surfaced rather prominently in relation to the way that pre-clinical students use their mobile devices in class. Therefore, although not originally intended, the notion of taking notes by means of a mobile device became the central theme of one of the chapters in this thesis.

Furthermore, the study highlighted that students did not only take notes through writing or typing, but that they also made extensive use of videos. Once again, though, they surprised by not finding it helpful to video record their theoretical lectures. The participants were, however, keen to explore the use of videos in their practical and clinical learning settings.

Although students used a variety of mobile devices to take their video notes, the use of the action camera was prominent, probably due to the visual, and often kinaesthetic, nature of veterinary science as a discipline. What was interesting, is that while current research indicated that it would be to the advantage of students to take handwritten notes, rather than to use electronic devices (Mueller & Oppenheimer, 2014), participants in this study tried out, and ultimately favoured, the use of mobile devices

for note-taking purposes. Vincent (2016) agrees with this notion and said that taking notes in an online environment was simply more practical than when they are done in the traditional way. This study, therefore, showed how the learning practices of students can benefit from the use of mobile devices for note-taking purposes.

Students did not only use mobile devices in their pre-clinical years, but also in the work-integrated clinical component of their studies. During the pre-clinical years of study mobile devices were mostly used for note-taking purposes, while in their clinical year students mostly used their devices for the booking of rotations, and the logging and assessment of clinical skills and procedures. The software that was developed was not favourably accepted initially, and therefore, the students' voice was sought. The student input painted a picture of uselessness and a struggle to get things done in Vetbox. This unhappiness and resistance were mirrored in Davis' (1989) TAM, namely that *usefulness* and *ease of use* would have an influence on adoption. Based on the students' inputs, revisions were made and a mobile app was developed. This mobile app was specifically needed to ensure that students could use it on their personal mobile devices instead of the hospital computers, during a time that was convenient for them. The new version of the app gave the students the freedom to log their procedures whenever they had the time available. This study showed how important it was to take student input into consideration throughout all the stages of development. It also showed that end-users may be willing to actually use a new application despite it not being *easy to use*, if they perceive it as personally *useful*.

## SCIENTIFIC REFLECTION

In spite of living in the digital age where 21$^{st}$ century skills are advocated, lecturers still make use of the traditional way of lecturing. Therefore, students are highly depended on taking extensive notes, and in many cases, still make use of the traditional pen and paper. Although some students intuitively recognise the affordances of mobile devices and use these devices for note-taking, researchers are currently debating the usefulness of mobile note-taking for cognitive demanding processes and deeper learning. Therefore, this study contributed to this debate in terms of the following:

- The affordances of mobile devices such as connectivity, portability, omnipresence, individualism and communication, create opportunities for students to take notes in a way that forms part of their learning process and not merely recording or transcribing information.

- Short videos of practical demonstrations are more of value than recording lengthy lecturers. These short videos will most likely be valuable in a practical or clinical environment if it is recorded by a lecturer using an action camera. The use of the action camera is not only valuable in the veterinary science, but can also be of value in the medical field, or perhaps any kind of practical field, where it is important to observe in detail a certain procedure.

- The outcome of this study also challenge the literature in terms of the statement “the pen is mightier than the keyboard”. It might rather be more appropriate to look at the affordances of mobile devices and how the students can take notes with these devices, the subject field or educational environment in which they take notes, and what they do with the notes afterwards.

- Despite the fact that literature about the use of computers and educational technology in education emphasise the importance of taking in consideration the student voice when developing applications, it is still in many cases not the case. For example, in this study, the researcher realised that the user experience is highly subjective and context specific and that the user input need to be sought after with each iteration and use of the software. Therefore, this study contributed to the existing body of knowledge by emphasizing the continuous seeking of user approval and input when developing educational software for students.

- In addition, the research also confirmed the importance of personal usefulness and the student’s preparedness to use software because of the value added to their own lives, despite not finding it easy to use. This confirmation is in agreement with what Davis (1989) also advocate in the original version of the Technology acceptance model.

- This research also confirmed that depending on the context, the technology acceptance model in its original version is sufficient to underpin a research study, depending on the similarity of context and social roles of the participants.

## PERSONAL REFLECTION AND POSSIBILITIES FOR FUTURE RESEARCH

When the researcher studied the literature about blended learning and blended learning tools, and came to understand the benefits of using those tools to address or promote student success, she reflected on the behaviour of her own peers and was surprised at how limited the use of blended learning tools was in her teaching environment. It was not that the researcher's fellow lecturers did not necessarily know about the affordances of educational technologies, they simply were not yet using it in their own teaching and learning processes. Often the researcher's peers justified their unwillingness to introduce blended learning tools into their teaching by saying that they experienced it as distracting rather than enabling. This phenomenon raised the researcher's curiousity as to why some lecturers embrace blended learning tools whilst others so clearly chose not to. It might be worthwhile, in a future study, to investigate why so many higher education lecturers have such a strong resistance to the use of blended learning tools even though they are omnipresent and well supported by management structures and technical staff.

When doing the chapter about mobile note-taking, the researcher was surprised by the fact that note-taking was still such a high priority for the 21st century higher education students. The prominence of note-taking might be the result of lecturers still using 'lectures' as their most prominent teaching style, or it could be that students fear that they may miss out on some information if they don't capture it in as much detail as possible.

It was surprising to see to what extent students go to ensure that their notes are extensive. For example, participants reported that they often worked together in groups, where each partner had a different role. After class, they then shared their notes and packaged it in what appeared to be their own unique open educational

resource. These OERs were then used to study from. When students reflected on their note-taking practices, they however emphasized the importance of not only having notes available for themselves, but also being able to hand it down to future generations of students in what seemed to be an interesting community of practice. This illustrated that students intuitively utilised the affordances of mobile technologies to store and share information, to work together and to construct their own notes from the contributions of all their group members. It may, therefore, be interesting to further explore the dynamics of informal student communities of practice and the possible role that mobile technology can play in supporting such formations.

Because the researcher has extensive prior experience in making videos in support of student learning, she was aware that short video clips were almost always more effective than lengthy ones (for example, of an hour-long lecture). However, the researcher was surprised that some students experimented by making video recordings of full lectures, just to realize that they never watched it again. Although the benefits of shorter videos (i.e. 6 minutes or less) was confirmed in this research (Guo, 2013), it was interesting to see that some lecturers still believe that there was merit in producing lengthy and comprehensive educational videos. Whilst there seems to be a body of knowledge that praise the value of making video recordings of lectures available to students after class, this aspect of the debate seems to need further investigation.

The biggest surprise of the use of mobile technology for note-taking purposes was the popularity of the action camera. Whether the action camera was in the hand of one of the students, or mounted on the forehead of a lecturer, the footage ensured that all students, even the short ones or those standing at the back, could get a clear view of what was demonstrated. These recordings that were made during an authentic learning experience, as the demonstration took place, were good enough for students to learn from afterwards as they could see the essence of what was being demonstrated. It seemed that the students were content with the quality and felt that they would not necessarily have had a better learning experience if they had a professional video to study from. Although, many training videos are available on online platforms such as YouTube or iTunesU, participants of this study preferred to make their own videos. They reasoned that in many of the online videos, the content

was not on the required level and that the techniques demonstrated varied from what they were taught. However, it would be interesting to explore this aspect further in a controlled experiment. Also, they felt very strongly that interesting cases that were presented, be recorded, saved and kept for future students to watch.

However, the value of the action camera does not only lie in its potential to record footage for note-taking or referencing purposes, but also in the possibilities of using it for assessment purposes, for example in practical examinations. Using an action camera to capture students performing critical procedures wherever they are exposed to them, for example at one of their off campus veterinary clinics, or when they are doing community outreach programmes, could come in handy. It could be of value to explore the potential of assessing students' ability to perform skills using the footage of an action camera. If proven to be an effective use of action cameras, the asynchronicity of such an assessment practice may be useful to overcome current logistical constraints concerning large class sizes, physical presence of clinical staff and geographical positioning.

Although the tablet was a popular device to use for note-taking and accessing the Vetbox app, the use of a smart phone seemed more appropriate in most of the veterinary students' learning spaces. In some cases, though, a video camera was reportedly more effective. Therefore, it was interesting to note that students did not necessarily favour one specific device above another, but they used a multitude of mobile devices depending on what they regarded as fit for purpose in the specific situation.

While conducting the research about the Vetbox app, the researcher was convinced of the vital importance of the intended user's *perception of usefulness* with regards to a new software or new technology. As explained earlier in this thesis, usefulness relates to the advantages of a particular application or technology to a user, which translates to the question "*What is in it for me?"* Therefore, it is of vital importance for a student to know what they could gain, or how they could benefit from a new system that is introduced. However, the students studying veterinary science, forms part of a close knitted community of practice, and they strive to contribute to the learning experience of future students. This was clearly seen in their dedication to make notes

and take videos and make it available for future students. I believe that these students will not only be concerned about their own learning experience but also of those that will follow in their footsteps. Therefore, they will use an app like Vetbox if they know that their input will help to improve the software for the students of the future.

What was sad to realize, is that despite their best intentions to the contrary, educators and software developers often make assumptions about students' expectations and readiness to embrace new applications and technologies that turn out to be completely misplaced. Again, the importance of taking the input of all the stakeholders or users in consideration before deciding on the development or use of software or technology, is emphasized. In fact, this study confirmed that stakeholder inputs should not only be seeked at the end of each of the different stages of the development and implementation process, but that educators should aim to include students as active and equal participants in the entire process.

Based on the findings of this research study, it is clear that health science students, such as the veterinary ones who participated in this study, need a note-taking application that allows them to take notes at any given time and in any of the learning spaces where they need to capture information. A note-taking application that allows them to store important information quickly and efficiently, whilst also making it possible to access their notes on any of their other digital devices, is deemed necessary. Although, a variety of note-taking applications are available from the different operating system's app stores, specific functionalities that have the potential to contribute to student's learning, are elusive. As mentioned before, cloud-based computing could contribute greatly to some of the issues in regards with note-taking applications, but one could possibly explore the usefulness of the cloud for collaboration and shared learning.

The recording of student exposure to specified critical procedures and skills provided extremely valuable management information to the director of the academic hospital. This peripheral benefit of the logging feature of the app helped the management team of the veterinary academic hospital to plan for an inevitable increase in student numbers the following year. The app made it possible to quantify an individual students' exposure to specific cases, procedures and skills, and in doing so, also

contributed to the quality assurance of students' learning in the clinical phase of their training.

The participants in this research study were selected from a group of veterinary students who needed to comply with strict selection criteria. Therefore, the majority of them were hardworking, highly motivated and high achieving students. While the finding of this study cannot be generalized to all other fields of study, it could possibly be transferred to similar health science programmes such as nursing, dental studies and medical education. However, further research need to be done to determine if similar results will be found if the study is replicated in other academic environments.

To conclude, as the topic of this study indicates, the focus was on the use of mobile devices, such as smartphones, tablets, laptops and action cameras, in a blended learning environment in higher education. Research about **blended learning** in higher education was addressed in Chapter 2 and a number of blended learning tools were identified to assist with ensuring student success.

This study was, furthermore, conducted at a university that offers a Bachelor's degree in Veterinary Science (BVSc). Prominent themes that evolved from the first part of the research (Chapter 3) were the value of mobile devices in **taking notes**, and the value of using custom-made videos produced by the students themselves, especially when produced with action cameras. Because of the popularity of videos in the minds of 21st century higher education students, it was noteworthy to find that students found value in producing and sharing their own instructional videos by means of mobile devices.

From the next part of the research (Chapter 4), the importance of taking the students' voice in consideration throughout all the processes involved in **developing educational software** was highlighted. It was also found that students seem to be willing to actually use a new application if they regard it as personally useful, even if they find it difficult to use.

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## APPENDIX A: MobiTech questionnaire

### The MobiTech Project

*Faculty of Veterinary Science*

### What is the MobiTech project all about?

- We would like to investigate the ways you can use mobile technologies for learning purposes here at OP.
- What mobile devices are you using already?
- How are you currently using it (with emphasis on *academic* use)?
- How can we introduce it in the Onderstepoort teaching and learning processes in future?

I am Mari van Wyk a PhD student working on the use of Mobile Technologies in an educational setting. I am working on the project in collaboration with the OPVSC and the Director: Teaching and Learning Prof Linda van Ryneveld

### Ethical approval:

Before you take the questionnaire, you should be aware of the following:

- The data will be used for research purposes
- All the data will be treated anonymously and confidential
- Your participation is voluntary
- When you take this questionnaire you give us permission to:
    - Use the data for research purposes
    - You agree that you take the questionnaire voluntary

### Questions:

1. What mobile device(s) are you currently using?

a) Laptop
b) Tablet
c) Smartphone
d) None

2. How do you use your mobile device **socially**?

a) Social media
b) Email
c) SMS
d) Instant messaging
e) Videos and music
f) News & weather
g) Browsing
h) Games
i) Calendar
j) Other: _____

3. How do you use your mobile device for **academic** purposes?

a) Not using it for academic purposes
b) Searching information
c) Accessing clickUP
d) Taking notes
e) Taking photographs
f) Recording lectures
g) Doing assignments & tests
h) Discussion groups
i) Other: _____

4. Which device(s) do you normally use to access the Internet?

a) Laptop
b) Tablet
c) Smartphone
d) None

**The MobiTech project is …. looking for passionate participants…**

**What is the MobiTech project all about?**

- Use your mobile device in a learning environment in a particular way
- Keep a reflective diary of your experience (short)
- Share your feedback in a focus group

**How long?**

- 6 weeks

**Time commitment?**

- Approx. 2 hours per week

**When do we meet?**

- Friday afternoons (1 hour max)

**What's in it for me?**

- Free lunch ☺
- Knowing that you will be making a difference…

**Who should participate?**

- Approx. 10 students

*Need to be the same in terms of*

- Passion
- Commitment
- Enthusiasm about mobile technologies

*Need to be diverse in terms of*

- Academic programmes (BVSc & DVN)
- Year groups
- Social backgrounds
- Gender

**Are you interested in participating?**

- Surname and Initials
- Student number
- Programme and Year *(e.g. BVSc III New)*
- Cell phone number
- E-mail address
- Mobile devices that you currently own *(e.g. Iphone 5S or Samsung Galaxy S4 mini)*

- Why you would like to participate in one sentence.

**Thank you for your participation!**

**APPENDIX B: Vetbox Experience survey**

1. **Please indicate your gender (this is only for statistical purposes).**
   Female
   Male
   Other

2. **Please indicate your race (this is only for statistical purposes).**
   Black
   Coloured
   Indian
   White
   Do not want to disclose
   Other (please specify)

3. **Please indicate your age in years at your last birthday.**

4. **I found the face-to-face VetBox training during our clinic orientation week useful.**
   Did not attend it
   Strongly disagree
   Disagree
   Neither disagree nor agree
   Agree
   Strongly agree

5. **I found the online manual useful.**
   Did not use it
   Strongly disagree
   Disagree
   Neither disagree nor agree
   Agree
   Strongly agree

6. **To access VetBox, I used:**
   Computer in clinics
   Computer/laptop elsewhere
   Smartphone
   Tablet

7. **I access Vetbox using:**
   my own data bundle
   my own WiFi
   WiFi on campus
   the computer lab connected to UP network

8. **I found it easy to log into Vetbox**
   Strongly disagree
   Disagree
   Neither disagree nor agree
   Agree
   Strongly agree

9. **Please help us understand why you selected the above answer.**

10. **I attempted to log all the procedures that I completed.**
    Never
    Rarely
    Sometimes
    Most of the time
    Always

11. **Please help us understand why you selected the above answer.**

12. **It was easy to find the keyword for the procedure I wanted to log.**
    Strongly disagree
    Disagree
    Neither disagree nor agree

Agree

Strongly agree

**13. All the procedures that I wanted to log were available.**

Strongly disagree

Disagree

Neither disagree nor agree

Agree

Strongly agree

**14. Please help us understand why you selected the above answer.**

**15. I logged most of the procedures:**

in the clinic, immediately after completing the procedure.

at the end of the day.

at the end of the rotation.

only when reminded to do so.

I did not log procedures.

Please explain you answer above and mention challenges you have experienced.

**16. I would prefer to log my cases and procedures as follows:**

UVIS only

Vetbox only

UVIS and Vetbox

UVIS and Vetbox where UVIS and Vetbox are seamlessly linked to one another

Neither UVIS nor Vetbox

**17. Clinicians verified all my procedures.**

Never

Rarely

Sometimes

Most of the time

Always

**18. I would prefer it if the following people could verify my procedures**

Final year students

Nurses

Clinicians

Private vets

Other (please specify)

**19. I would prefer it if the following people could assess my procedures**

Nurses

Clinicians

Other (please specify)

**20. The progress bar motivated me to add all my procedures.**

Strongly disagree

Disagree

Neither disagree nor agree

Agree

Strongly agree

**21. Please help us understand why you selected the above answer.**

**22. I used the feedback option to voice my opinion.**

Never

Rarely

Sometimes

Most of the time

Always

**23. I received regular feedback about my progress from the clinicians through Vetbox.**

Never

Rarely

Sometimes

Most of the time

Always

**24. It is important to reflect on each case/procedure that I recorded.**

Strongly disagree

Disagree

Neither disagree nor agree

Agree

Strongly agree

**25. I could use Vetbox to reflect on my learning.**

Strongly disagree

Disagree

Neither disagree nor agree

Agree

Strongly agree

Please explain you answer above.

**26. I could use UVIS to reflect on my learning.**

Strongly disagree

Disagree

Neither disagree nor agree

Agree

Strongly agree

Please explain your answer above.

**27. In your opinion, why do you think the Faculty introduced the Vetbox system?**

**28. What will encourage you to log your procedures/skills on a regular basis?**

**29. Do you have any suggestions for improving Vetbox as a program?**

**30. Do you have any suggestions for improving Vetbox for logging procedures/skills?**