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Evaluation of the feasibility of an electronic logbook in the BSc Clinical Sciences program in Zambia

Bachelor Thesis in the program Health Sciences

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Abstract

Background: Innovative strategies, like e-Learning, are being implemented to address the shortage of healthcare workers' and the inadequate quality of medical education. Particularly Sub-Saharan Africa is challenged by a lack of resources and a limited number of educational opportunities.
In 2020 an electronic logbook was introduced to strengthen BSc Clinical Sciences students' skills-based training within a first cohort of students at the Levy Mwanawasa Medical University (LMMU) in Lusaka, Zambia.
This mixed-method study aims to evaluate the feasibility of the e-logbook and to recognize the challenges and advantages of an e-logbook within this context. For this evaluation students' usage and their perception of the e-logbook during the pilot-phase have been assessed.

Method: Quantitative and qualitative data were collected and analyzed. The quantitative data was acquired through the system data of the e-logbooks and has been descriptively described. At the end of the pilot phase, the qualitative data was collected by conducting online semi-structured in-depth interviews with students. The interviews were digitally recorded, transcribed, and analyzed with a summative qualitative content analysis according to Mayring.

Results: From the ten students, who participated in the pilot-phase, seven students accessed and used the e-logbook once. One student got feedback from a mentor.
The interviews have been conducted with five students. The e-logbook was perceived as useful and user-friendly. Barriers to using the e-logbook were internet challenges and a lack of feedback from their supervisor.

Discussion: This study's findings indicate that the e-logbook based on "SurveySolutions" could be feasible in the BSc CS program. Nevertheless, existing challenges need to be tackled and further studies are needed to evaluate the on-going implementation process of the e-logbook.

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List of Abbreviations

BLiZ = Blended Learning in Zambia

BSc CS = Bachelor of Science in Clinical Sciences

DHI(s) = Digital Health Intervention(s)

eHealth = electronic Health

e-learning = electronic learning

e-logbook = electronic logbook

HIC = high-income countries

ICT = information and communication technology

LMIC = low- and middle-income countries

LMMU = Levy Mwanawasa Medical University

mHealth = mobile Health

m-Learning = mobile Learning

ML = Medical Licentiate

M&E-guideline = „monitoring and evaluating of digital health interventions - guideline“

NPCs = Non-physician clinicians

SDGs = Sustainable Development Goals

SSA = Sub-Saharan Africa

UN = United Nations

WHO = World Health Organization

1 Introduction

Healthcare workers are essential for health systems (Scheffler et al., 2016, p.8). Without an accepted, accessible, available, and qualified healthcare workforce, it is not possible to achieve the third goal of the United Nations (UN) Sustainable Development Goals (SDGs) ("Ensure healthy lives and promote wellbeing for all at all ages") (World Health Organization (WHO), 2016a, p.10).

To train new health workers, institutional and purely face-to-face modes of education are not feasible because there is a significant shortage of teachers and mentors in health professional education (Atun et al., 2015, xii). A transformation of education is needed to scale up health professionals' education and increase the quantity, quality, and relevance of health professional education (WHO, 2013, p. 11).

In 2018 did the World Health Assembly acknowledge the potential of digital technologies to advance the SDGs (World Health Assembly, 2018, p. 1). Especially in developing countries, considering limited health care budgets, limited access to infrastructure and equipment as well as inadequate training facilities and resources for healthcare workers (Barteit et al., 2020, p. 2), can the use of technology in education play a vital role (Atun et al., 2015, xii). For example, can e-learning play a significant role in teaching the right skills and addressing the skills gap to achieve universal health coverage (WHO, 2016a, p.6ff.).

However, the enthusiasm for digital health has led to the creation of short-lived implementations and a diverse ecosystem of digital tools (The Bellagio eHealth Evaluation Group, 2011, p. 1). It has to be confirmed that investments in health technologies are effective and appropriate and do not inappropriately take resources from alternative, non-digital approaches away (WHO, 2019, ix).

Therefore, this thesis will focus on the feasibility of a newly developed electronic logbook (e-logbook) in the BSc Clinical Sciences (CS) program in Zambia.

In the beginning, the theoretical background will be presented. The background includes a description of the existent healthcare workers shortage in Sub-Saharan Africa (SSA) and the use of ICT for health and education. Following this, the BSc CS program and the e-logbook will be presented. Chapter 5 will discuss different evaluation frameworks and outline the applied framework for evaluating the e-logbook.

The presentation of the framework is followed by a description of the data collection and analysis. After presenting the results, the findings will be critically discussed by including the current research situation. Furthermore, a critical review of the research method and

results will be done. This thesis will close with giving recommendations for further research and by summarizing the findings.

2 Background

2.1 Health care workers shortage in Sub-Saharan Africa

In 2013, Africa had the lowest density of skilled healthcare workers with 2.2 per 1000 population, equalling a shortage of more than four million healthcare workers. The deficit is expected to grow by 2030 to approximately six million missing health care workers (Scheffler et al., 2016, p. 13ff.). A 2016 report by the World Health Organization (WHO) stated that to achieve the health-related SDGs 4.45 skilled healthcare workers per 1000 population are needed. Skilled healthcare workers refer to physicians, nurses, and midwives (Scheffler et al., 2016, p. 13ff.). The missing of health care workers equals to millions of people not receiving essential health care and services (WHO, 2013a, p.11).

To improve health service coverage and health outcomes a well-educated and purpose-trained health workforce is vital. An increasingly older and larger population and changing epidemiology are intensifying the need for healthcare workers in the next years. New challenges are the treatment of non-communicable diseases and the building of resilient public health systems that can respond fast and flexibly to epidemics. Further, the aim to realize universal health coverage is a crucial challenge (Scheffler et al., 2016, p.8). Universal health coverage means making quality health care services affordable and accessible for everyone (UHC2030, n.d.).

Reasons for the shortage of healthcare workers can be the brain drain to High-Income countries (HICs). A 2009 published study estimates that between 25 % and 50 % of African medical school graduates had left the countries to practice in HICs (Saleh et al., 2019, p. 159). Another reason can be the limited amount of training programs in the region (Saleh et al., 2019, p. 159).

SSA consists of 49 nations and approximately one billion people (Barteit et al., 2019a, p. 2). In 2011 there were around 160 medical schools. These 160 medical schools should train the physicians to serve a population of approximately one billion (Saleh et al., 2019, p. 159; Barteit et al., 2019a, p. 2). Around 6000 medical doctors graduate per year in SSA. Even though the population is five times smaller, with approximately 200 million people, 42000 medical doctors graduate per year in Western Europe. This is seven times the number of graduates in SSA (Barteit et al., 2019a, p. 2).

In the last years different efforts have been made to improve the health care professionals' training, yet the health outcomes remain unacceptably poor. The lack of human workers and the lack of quality educational training opportunities contribute to poor health outcomes (Saleh et al., 2019, p. 160). The medical educational infrastructure in SSA is inadequate in quantity and quality. The medical training institutions do not have the capacities and resources to train the needed number of healthcare workers (Barteit et al., 2019a, p. 2; Barteit et al., 2019b, p. 2). Outdated and poorly functioning computers (Witt et al., 2015, p. 71), limited faculties, limited training sites, and the lack of learning resources affect medical schools' training (Saleh et al., 2019, S. 159). Consequently, does the inadequate access to medical information for health care providers lead to suboptimal delivery of health care (Witt et al., 2015, p. 71).

Practical and affordable education strategies (Barteit et al., 2020, p. 2), with high-quality, relevant, and up-to-date education, are vital for scaling up the health workforce (World Health Organization, 2016a, p. 76) and needed to achieve the SDG 3 (Barteit et al., 2020, p. 1f.).

2.2 Information and communication technology

The Information and Communication Technology (ICT) sector has been growing since the late 1990s (World Bank, 2016, V). ICT is the generic term for technological tools and resources used to transmit, store, share, or exchange information. Exemplary tools are computers, the internet, as well as telephony (UNESCO, 2020). In 2015 the United Nations acknowledged that ICT "has great potential to accelerate human progress, to bridge the digital divide and to develop knowledge societies, as does scientific and technological innovation across areas as diverse as medicine and energy" (International Telecommunication Union (ITU), 2018, p. 10). Mobile communication forms have evolved from simple voice and text services to innovative applications and mobile broadband internet (World Bank, 2016, V).

At the end of 2018, more than half of the worlds' population, 3,9 billion people, were using the internet. In developed countries are 80 percent online, and in developing countries 45 percent (ITU, 2018, p. 2ff.).

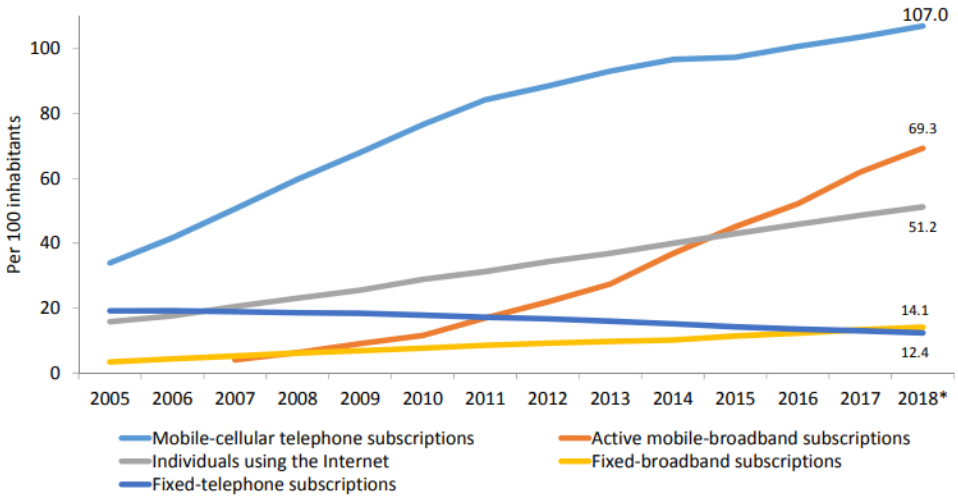

Figure 1: Global ICT Development 2005 – 2018 (ITU, 2018, p. 3)

As seen in figure 1, grows the number of access to and the use of ICT. Mobile access is becoming predominant with 69 active mobile broadband subscriptions to 14 fixed broadband subscriptions per 100 inhabitants worldwide. The greater use of mobile internet could result from mobile networks' flexibility and accessibility, as almost the whole world's population, 96 percent, lives in a range of mobile-cellular network signal (ITU, 2018, p. 2ff.). Especially in developing countries, the number of mobile internet users is high, with 33 active mobile broadband subscriptions per 100 inhabitants to 1 fixed-broadband subscription per 100 inhabitants (Bahia & Delaporte, 2020, p. 9).

There still exists a coverage gap between urban and rural areas in Africa, with 80 percent mobile coverage in rural areas to 100 percent mobile coverage in the urban areas. This gap makes it difficult for people living in rural areas to access the internet. However, this gap has been narrowing since 2017. Another positive development is that basic internet-enabled phones and mobile data are becoming increasingly affordable. Affordability is defined by the cost for an internet-device or 1 GB of data as a share of monthly GDP per capital (Bahia & Delaporte, 2020, p. 9). The growth in mobile coverage can improve connectivity by using mobile devices, also in rural areas, and can leverage ICT systems in developing countries (Witt et al., 2015, p. 71).

Considering the use of ICT there are different definitions. Relevant definitions will be explained in the following.

2.2.1 ICT and health

“The use of information and communication technologies for health” is defined by the WHO as eHealth (WHO, 2015, vi). In 2005 the WHO acknowledged that eHealth could have a unique opportunity for public health. Further that “the strengthening of health systems

through eHealth may contribute to the enjoyment of fundamental human rights by improving equity, solidarity, quality of life and quality of care" (WHO, 2005, p. 1). The term eHealth first appeared in 2000. Since then, different approaches to define eHealth were made. However, there is no universal consensus about an eHealth definition (Nievas Soriano et al., 2019). For this thesis, the definition of the WHO will be used.

A subdomain of eHealth is mobile health (mHealth). Mobile Health means the use of mobile and wireless technologies to assist the accomplishment of health objectives (WHO, 2015, vi.). Mobile technologies include mobile phones, personal digital assistants, smartphones, portable media players, and tablets. The mobility of these technologies offers the possibility to be accessed anytime and wherever it is needed (Free et al., 2013, p. 2).

The umbrella term for mHealth and eHealth is Digital Health (WHO, 2016b, p. VIII). Digital health encompasses eHealth and developing areas, like genomics, advanced computing sciences in "big data", and artificial intelligence (WHO, 2019, ix). Considering this, digital health interventions (DHIs) describe the action of intervening with ICT tools and services to improve prevention, diagnosis, treatment, monitoring, and management of health and lifestyle (Kowatsch et al., 2019, p. 253). DHIs offer the opportunity to improve existing health systems and increase access to and the quality of care (Mechael & Ke Edelman, 2019, p. 2).

There is a broad range of digital health interventions with dynamically evolving software and technologies (WHO, 2019, p. 5). The WHO intends to categorize the DHIs in the way they are being used to support the health system. They are organized into four groups based on the targeted primary user: Intervention for clients, interventions for healthcare providers, interventions for health system or resource manager, and interventions for data service. These groups should help establish a shared understanding to access and articulate functionality across different digital health implementations (WHO, 2018, p. 1f.).

2.2.2 ICT and medical education

With the rise of information technologies, new education opportunities have been created. In 2011, 50 different countries and more than 1000 institutions provided e-learning options. E-Learning can be described as the use of ICT to deliver education via electronic forms (Bhuasiri et al., 2012, p. 843f.) both inside and outside the classroom (Frehywot et al., 2013, p. 2).

A trend within e-Learning is mobile learning (m-learning). M-learning is an approach that uses mobile technologies, like smartphones or tablets, to enable students to access materials remotely (Frehywot et al., 2013, p. 4). Especially in geographically inaccessible

and resource-limited settings, different m-Learning interventions exist to expand access to information (Witt et al., 2015, p. 71).

Since the 1990s, e-learning has become important for healthcare workers' education (Ruggeri, Farrington & Brayne, 2013, p. 313). In 2016 the Global Survey on eHealth by the WHO asked their member states about their use of e-Learning (WHO, n.d.). More than 84 percent of the participating countries have used e-Learning for medical students' and doctors' education (WHO, 2016a, p. 6).

E-learning increases accessibility to information, on-demand availability, the possibility of personalized instruction and self-pacing (Kaliisa & Picard, 2017, p.7; Bhuasiri et al., 2012, p. 843f.). Moreover, does e-learning enable geographically isolated and previously disadvantaged people to access training facilities (WHO, 2016a, p. 76; Atun et al., 2015, p. 32ff.) and make health science education accessible for a broader audience (WHO, 2016a, p. 76). The technological advances help produce new teaching techniques like computer-based simulations or virtual patients (Krishnasamy et al., 2016, p. 1).

It may decrease teaching costs by exchanging course material between mentors and the omission of preparing classes or setting up laboratory equipment (Atun et al., 2015, p. 32ff.). Further costs may be reduced for classrooms and facilities, for travel, and printed material. However, it does require investments in hardware, software licenses, equipment maintenance, and training. After initial course development, e-learning can be more cost-effective than traditional teaching (Bhuasiri et al., 2012, p. 843f.).

In clinical practice, m-Learning offers benefits of accessing educational content and information, sharing information and knowledge with other learners, or getting support from geographically distanced peers or instructors (Krishnasamy et al., 2016, p. 2). The communication between the students and the mentors may be improved. It can be improved by getting instant feedback and examination results, tracking students' understanding of taught lessons or helping students reviewing material (Kaliisa & Picard, 2017, p. 7; Krishnasamy et al., 2016, p. 2).

In conclusion, e-learning offers the chance to upscale training without the upscaling of resource-intensive infrastructure (Barteit et al., 2020, p. 2). Especially in resource-limited settings may m-learning enhance the learning experience for medical students (Kaliisa & Picard, 2017, p. 7; Witt et al., 2015, p. 71; WHO, 2016a, p. 79).

The use of e-learning for healthcare workers' education is one of the key themes of eHealth (WHO, 2016a, p. 150). Since the readiness and resilience of health systems are determined

by how and where students are taught and who educates and trains the new health workforce (Atun et al., 2015, v).

2.2.3 Blended Learning in Zambia – Project

An example of e-learning in medical education is the "Blended Learning in Zambia" (BLiZ)-project. The focus of the project is the BSc CS program at the Chainama College of Health Sciences (CCHS), which is a part of the larger Levy Mwanawasa Medical University (LMMU) (HUH, 2020).

The BLiZ-project addresses the problem of healthcare worker shortage "by implementing a sustainable and continuous blended-learning approach of teaching and training" (Heidelberg University Hospital (HUH), 2020). Blended learning is an approach to learning, which mixes traditional face-to-face classroom methods with computer-mediated activities (Frehywot et al., 2013, p. 3).

One past achievement was the development and implementation of an e-learning platform based on the open-source Moodle software in 2016. This e-learning platform provides medical e-learning material, such as medical books, medical pictures, and lecturers notes. It should address the lack of learning resources and medical lecturers during the practical training of the BSc CS students. Further, android-based tablets have been distributed to the students to access the e-learning platform (Barteit et al., 2019b, p. 2).

3 BSC Clinical Sciences program in Zambia

Zambia, a country in SSA, faces a severe lack of healthcare workers, with 1.2 healthcare workers per 1000 people. This shortage leaves essential population health needs unfilled (Barteit et al., 2019c, p. 2; Barteit et al., 2018, p. 2). Medical doctors are primarily in urban areas (16 per 10.000). In contrast, rural health clinics are lacking health care staff, with 7 clinicians per 10.000 people. Most rural health clinics are managed by healthcare workers who lack the needed medical qualifications to address their patient populations. A decrease of 140 % in human resources is necessary to reduce the current shortage (Barteit et al., 2018, p. 2, Barteit et al., 2019c, p. 2). In addition to the healthcare workers shortage, Zambia is facing a high disease burden through communicable diseases and non-communicable diseases (Republic of Zambia Ministry of Health, 2017, p. 5ff). The highest burden is HIV/AIDS, with 2.6 new cases per 1000 people per year, followed by neonatal disorders and stroke (Institute for Health Metrics and Evaluation (IHME), 2020).

In 2002 the Zambian Ministry of Health introduced a ML program at the CCHS to mitigate the health worker shortage. MLs are nonphysician clinicians (Barteit et al., 2019b, p. 2).

Non-physician clinicians (NPCs) are known as Clinical Officers, Health Officers, Physician Assistant, Nurse Practitioners, Nurse Clinicians, or Associate Clinicians. They have fewer clinical skills than physicians but more clinical skills than nurses. NPCs perform many diagnostic and therapeutic tasks at the primary and secondary health facility level, which were traditionally performed by physicians. In particular, the delivery of health services to some of the world's most vulnerable populations is being increasingly delivered by NCPs, e.g., HIV treatment, obstetrics care as well as NCDs (Eyal et al., 2016, p. 149). The training of the NCPs offers the advantages of being less time-consuming and less expensive while still achieving impressive patient outcomes (Mullan & Frehywot, 2007, p. 2158). Furthermore, and especially crucial for primary health care, the NCPs stay in rural and underserved settings longer than physicians. Their acceptance and importance keep on rising in the last years. This is displayed by the rising numbers of performed treatments and the different strategic plans dedicated to enhancing their training. In 2007 in nine SSA-countries, the number of NPCs has been as high or even higher than of physicians (Eyal et al., 2016, p. 149).

First, the ML-program in Zambia was a 2-year upgrade training/advanced Diploma. The program targeted NPCs who had finished their basic 3-year NPC training and had a minimum of 2 years' working experience. In 2013 it transformed into a 4-year Bachelor of Science degree in Clinical Sciences (Barteit et al., 2019b, p. 2; Gajewski et al., 2017, p. 2). Although students are now called BSc CS students, they still have the same clinical objectives and priority to work in rural areas (HUH, 2020).

The BSc CS students' training focuses on the four main specialties: pediatrics, surgery, internal medicine, and obstetrics, and gynecology. In the last two years, the students are undergoing clinical rotations in different hospitals to improve their practical skills. They rotate every eight weeks across different health facilities with a medical focus in 1 of the four main specialties (Barteit et al., 2019b, p. 2).

4 Student logbook for BSc Clinical Sciences

In 2017 a paper-based logbook was introduced to strengthen the training quality during the clinical rotation of the BSc CS. Followed in 2020 by an electronic logbook, which was developed in cooperation with the BLiZ-project. Before these two logbooks are described, general use and application of logbooks in medical education will be described, and examples of different logbooks will be given.

4.1 Logbooks for medical education

It is essential for learners to receive integrated experiences and to practice their competencies in a clinical setting (Schüttpelz-Brauns et al., 2016, p. 564). Students rotate across different clinical disciplines in the hospital to gain medical expertise. During these so-called clinical rotations, students' learning experience and process depend on the clinical teacher's educational expertise and the number and type of patients. To optimize the student's learning, the learning situation could be structured with clearly stated goals (Dolmans et al., 1999, p. 89). A tool to establish consistent quality and educational standards for clinical training is a logbook. Logbooks are being used worldwide for different levels of education and different specialties (Schüttpelz-Brauns et al., 2016, p. 564). It can guide the students and inform them about the objective of their practical education (Mazareie et al., 2016, p. 396).

Logbooks have the advantage of guaranteeing a standardized minimum of clinical training for one discipline over each practicum sites. Furthermore, trainees and clinical teachers can get a quick overview of the requirements of training and an idea of the student's learning process (Schüttpelz-Brauns et al., 2016, p. 564).

Traditionally the logbook is paper-based (Chan et al., 2005, p. 1). However, there are some reported challenges of a paper-based system. These include insufficient filling, lack of supervision, and issues with data storage. Further, the checking of paper systems is more time-consuming than of electronic systems (Neupane et al., 2014, p. 2; Rivett, Snodgrass & Onyango, 2014, p. 4), resulting in increased administrative time load for mentors (Rivett et al., 2014, p. 4). It is challenging to follow up on services and establish continuity of care within a facility or community (WHO, 2019, p. 67) because of the inconvenience of carrying paper forms around (Neupane et al. 2014, p. 2).

Electronic logbooks can offer the benefit of simplifying recording, storing, and analysis of data (Schüttpelz-Brauns et al., 2016, p. 566; Denton et al., 2007, p. 347f.), as the learner's activities are being automatically tracked and reported (Masic, 2008, p. 103). During clinical training, when the trainee moves around a lot, a portable database would be ideal (Watters, Green & van Rij, 2006, p. 181).

The first e-logbooks have been developed for different computer systems (Hammond & McIndoe, 1996, p. 93). Since then, there have been different approaches to digitalize the logbook. From handheld computers for surgeons (Al-Ubaydli, 2004) to an android-based application, called CommCare, for clinical associate students in South Africa (Adelman & Capati, 2015, p. 70). The application of e-logbooks is widespread from doctoral students

(Viseskul et al, 2019), through anesthesia (Barbieri et al., 2015), or surgical trainees (Merry et al., 2006), to clinical associate students (Adelman & Capati, 2015).

Existing studies report on the positive aspects of e-logbooks, like improved supervisor-supervisee relationships (Gondal, Khan & Ahmed. 2020, p. 142). Further, students are highly satisfied with the electronic system (Viseskul et al., 2019, p. 52), and mentors think that an e-logbook is a better monitoring tool than a paper-based (Gondal et al., 2020, p. 141). In some studies does an e-logbook help to evaluate the students as well as the clinical program (Adelman & Capati, 2015; Brouwer & Kiroff, 2002, p. 60f.).

Most of the existing e-logbooks were developed in HICs (Barbieri et, al., 2020; Brouwer & Kiroff, 2002; Gómez Díaz et al., 2015; Lonergan et al., 2011). Different factors, like limited technological and logistical resources or a low number of technical staff, are restricting the adaptation of HICs technologies in low- and middle-income countries (LMIC) (Steele, Tolani & Subramanian, 2019, p. 52f.; Howitt et al., 2012, p. 509). Therefore, before implementing an existing technology in a low-resource country, it is necessary to question whether it is appropriate to the country's capabilities (Steele et al., 2019, p. 54) or whether it is more effective to develop a more frugal technology. A frugal technology is explicitly designed to meet the needs of a low-resource setting (Howitt et al., 2012, p. 509).

Knowing these challenges, the BLiZ-project proposed to develop an e-logbook for the BSc Clinical Sciences, which will be presented in chapter 4.3.

4.2 Paper-based logbook

In 2017 the student practicum logbook (in the following called logbook) was introduced into the BSC CS program. In this logbook the students should record all the performed activities and procedures during clinical rotation. It should help keep track of the student's learning experiences and practices towards attaining the required competencies to meet 1st level hospital clinical care. Furthermore, it can be a tool for the continuous assessment of the student during practical rotations.

The logbook should be used as followed: The student observes, assists, or performs a clinical activity during the clinical rotation. After finishing, the student should fill in the details of the respective activity in the logbook and present the logbook to a mentor who signs it.

At the end of the clinical rotations, before taking the final examination, the logbook has to be completely filled in and signed by both student and mentor. The logbook is being graded and constitutes 25 % of the final grade from the students.

Following figure (figure 2) shows an exemplary page of the logbook.

1.2 Physical examination

S/N	Date	Provisional diagnosis	Grading and remarks	Student's signature	Mentor's signature
1					
2					
3					
4					
5					
6					

Figure 2: Exemplary page of the BSc CS paper-based logbook

However, the paper-based logbook is currently facing some challenges. It is not fully employed as a tool to strengthen the training but regarded as an administrative tool. Mentors are often burdened with high numbers of students while conducting their clinical work, which leaves little time to assess the logbooks in detail. Some logbooks are regularly lost during the training periods (changing locations) and are thus not available for continuous assessment. The logbooks are only handed in for final evaluation at the end of the study year, not allowing a continuous evaluation of the student's progress during the clinical rotations.

4.3 Electronic logbook

In 2020, the BLiZ-project developed an electronic logbook for the BSc Clinical Sciences program. This development is in line with the current eHealth strategy from the Zambian Ministry of Health. In this strategy, the Ministry of Health recognize the importance of eHealth to support the severely constrained health system. One of the objectives is "to reach more students through the use of technology" by implementing e-Learning (Republic of Zambia Ministry of Health, 2017, p. 5ff).

4.3.1 Project goal

The goal of the e-logbook is to strengthen the skills-based training and, with this, strengthen the education of the students.

The objectives for the e-logbook are:

- The e-logbook should be an aid/tool for continuous and transparent assessment of students' performance during their training.
- The e-logbook should help students to track and improve their learning progress.

- The e-logbook intends to reduce mentors' workload to assess and evaluate the logbook.
- The e-logbook should be an administrative tool and a resource for the training of BSc Clinical Science students.

The e-logbook can be classified as a digital health intervention in the group “interventions for healthcare providers” and there in the sub-group “healthcare provider training” (WHO, 2018, p. 4ff.) as the e-logbook is a tool to support learning (Scantamburlo et al., 2016, p. 210). A term, which is commonly used as a synonym for this sub-group is “e-learning” or “m-learning” (WHO, 2018, p. 14).

4.3.2 Content of the e-logbook

Although the content of the e-logbook is based on the existing paper logbook, the structure is different. The infrastructure for the e-logbook was set up by an IT consultant from the World Bank. A problem of setting up a new technology in a low-resource setting is often the cost (Howitt et al., 2012, p. 509, Steele et al., 2019, p. 53). The e-logbook is based on the open-source software “SurveySolutions” to avoid high costs. “SurveySolutions” was developed by the Data group of The World Bank. It is used for designing and conducting surveys (World Bank Group, 2020).

The advantage of this software is that it provides an android-based application that can be installed and used on tablets. This is beneficial because the students have been handed a tablet to access the e-learning platform by the BLiZ-project (see chapter 2.3.3). Furthermore, the application “SurveySolutions” offers offline functionality. That means that the students can use the e-logbook without an internet connection. Only for sending and receiving the e-logbook an internet connection is needed.

“SurveySolutions” is used for surveys, so the e-logbook design resembles an interview's structure and terminology. Each student logbook is a questionnaire, and when students enter their activities into the logbook, it is described as an "interview". The student is becoming the interviewer and the mentor the supervisor.

Before the students can do their first entry (“interview”), they have to synchronize the app on their tablet to download the respective logbook (“questionnaire”). Hereby internet connection is needed. If they open the questionnaire, there is the initial registration form. In this form, they should document the name of their mentor, their current institution, their department, and the start of their rotation. After that, they can start the questionnaire and give their name and their student ID.

The e-logbook is separated into 9 parts: “cover”, “logbook internal medicine”, “Cases”, “generic skills – communication”, “tutorials & theory classes”, “summary”, “e-logbook survey”, “overview”, “complete”.

The part “cases” is relevant for this study and will be displayed in more details. The process of entering a case in the e-logbook can be retraced in annex A.

In the part "cases" the students are supposed to describe the attended patient, the diagnose, and the procedures. The first step is to add the initials of all the patients the students attended that day. After that, the students can click on each patient and give information about the patient and their medical history. With each answered question, new questions appear so that the students only have to answer the questions which are relevant to their case. For example, when the students are supposed to name the provisional diagnosis for the affected organ system, possible answers are already shown from which the students can choose. If the students answer every question and sign their entry, the page turns green to show the completion.

When they filled in their activity for the day, they can recheck their answers in the "summary" part. Here it is also possible to see how many procedures they still have to observe/assist/perform. If the students finish their entry, they have to go to the "complete" part and press the "completed" button. As soon as the tablet is connected to the internet, the e-logbook will be sent to their mentor. After sending the e-logbook, they cannot access or change it until their mentor checked it.

The mentors utilize a computer to access the e-logbooks over the “SurveySolutions” web platform. On this web platform the mentors can check the e-logbook entries by the students and give their comments in an extra typing field. After assessing the e-logbook, the mentor has to press "reject" making the e-logbook ("interview") available for the student ("interviewer").

After downloading the e-logbook to their tablet, the students can read the feedback of their mentor, improve upon feedback given, and fill in more activities. After recording their activities, the students will send their e-logbook back to their mentor and a new feedback cycle begins.

When the students finish the clinical rotation, they have to send their e-logbook once again to their mentor, who has to press the "approved"-button. By “approving” the e-logbook it will be send to the headquarters of the LMMU for a final assessment.

The following table is giving an overview of the terminology for the e-logbook.

Term in “SurveySolutions”	Meaning for the e-logbook
questionnaire	E-Logbook template for the different specialties
interview	An entry in the e-logbook by a student
interviewer	A student user
supervisor	mentor/ preceptor/consultant
“completed”	Submission of an "interview," i.e., logbook entry to "supervisor," i.e., mentor. The student has for the time being submitted his/her logbook. It is not available for him/her until sent back by a supervisor.
“reject”	A supervisor has reviewed/assessed a submitted entry and send it back to the student- this is a necessary action during the rotation – it does not equal a poor assessment. It is only the technical process
“approved”	E-logbook entries are being sent to the headquarters for final assessment (end of rotation)

Table 1: Terminology of the e-logbook

4.3.3 Pilot-phase of the e-logbook

Before the e-logbook is being fully implemented in the BSc Clinical Sciences program, it was tested as a pilot. The pilot-phase of the e-logbook took place in 2020 and was five weeks long (03.08.-04.09.2020). The site of the pilot-phase was the Kabwe General Hospital. The target group was the 4th year BSc CS students, who were doing their practical placement at Kabwe Central Hospital in Internal Medicine.

The pilot of the e-logbook was organized by the BLiZ-project together with the LMMU. On the third of August 2020, a workshop took place to inform the students and the mentors about the e-logbook. The site of the workshop was Kabwe General Hospital. First, the IT-staff of the LMMU explained the e-logbook and the application to the students and mentors. Then, the application was installed on the students’ tablets.

During the workshop, the participants had time to test the e-logbook and to see whether challenges occurred. After the workshop, students were asked to enter their activity into the e-logbook every day. Moreover, they should forward the e-logbook to their mentors twice a week during the pilot-phase. The mentors were asked to look at the e-logbooks twice a week, on Tuesday and Friday, and return the commented version to the student.

To demonstrate the objectives of a project, it is suggested to apply a logical framework. A logical framework is a management and measurement tool that summarizes the intentions

and key assumptions of a project (WHO, 2016b, p. 22). It can be split up into inputs (the applied resources), processes/activities of the project, outputs (direct products/deliverables of the project activities), outcomes (intermediate changes as a result of inputs and activities), and the impact (medium- and long-term effects) (WHO, 2016b, p. 27).

Following table (table 2) shows the underlying logic framework of the pilot-phase of the e-logbook. This framework is only relevant for the pilot-phase and not for the entire e-logbook project in the BSc CS. The pilot-phase's goal or long-term effect is that the e-logbook can be implemented in the BSc CS program.

Inputs	**Processes/ activities**	**Outputs**	**Outcomes**	**Impact**
Human resources: • IT-staff • BLiZ-Project staff • LMMU study personnel • 10 BSc CS students • 2 BSc CS mentors • World Bank consultant Technical resources: • tablets • e-logbook software • electricity • WiFi network	Before pilot-phase: • Meeting with project coordinators • design e-logbook software • preparation of introduction workshop Pilot-phase: • conduction of introduction workshop for students & mentors • installation of the application on the tablets • use of e-logbook for five weeks • Support by the IT-team	Usage/ utilization of e-logbooks by students/ mentors perception of e-logbook by students/ mentors	E-logbook is working as intended in the BSc CS program => Students and mentors can include the e-logbook in their study/training (Feasibility) Identification of challenges and advantages of an e-logbook	Implementation of the e-logbook in the BSc CS program

Table 2: Logical Framework for the BSc CS e-logbook Pilot-Phase

5 Evaluation framework

In this chapter, the definition of evaluation and approaches to evaluate e-logbooks and digital health interventions are described. Based on this, the planned evaluation framework is presented.

5.1 Definition evaluation

Numerous definitions of evaluation can be found in the literature (Döring & Bortz, 2016, p. 979). In general, evaluation is described as the systematic and objective assessment of an ongoing or finalized intervention to determine the achievements of objectives, efficiency, effectiveness, impact, and sustainability (WHO, 2016b, p. 4). Evaluations have the purpose of providing evidence of how and why programs are or are not working in practice (Iskarpatyoti, Sutherland & Reynolds, 2017, p. vii). Ideally, evaluations are an ongoing cyclical process, and the obtained data inform adjustments and improvement to further intervention planning and implementation (WHO, 2016b, p. 66).

In an evaluation, an evaluation object, which can be, e.g., a product or an intervention, is being assessed by different indicators with social sciences methods (Döring & Bortz, 2016, p. 979). In this study, the evaluation object was the e-logbook, more precisely, the e-logbook during its pilot-phase.

5.2 Approaches to evaluating e-logbooks

In the literature, some studies exist aiming to examine existing or newly developed e-logbooks. Many studies focus on the documented/tracked e-logbook data to describe data entry habits by students retrospectively (Barbieri et al., 2015) or analyze data entry accuracy (Achuthan, Grover & MacFie, 2006; Denton et al., 2007). Lonergan et al. used the collected e-logbook data to quantify the operative experience by surgical trainees and compare their experience to training targets (Lonergan et al., 2011). In 2012 Barbieri et al. compared students' recording compliance between a computerized or a computerized web-based logbook to test which version is more effective to document students' clinical activities. Used data was gained from the University's database (Barbieri et al., 2012).

Other studies are putting their focus on students' satisfaction (Viseskul et al., 2018), their perception and self-reported compliance (Harrington et al., 2020), or on supervisors' feedback regarding the e-logbook (Gondal et al., 2020). Self-developed questionnaires were used primarily to explore satisfaction, perception, or feedback (Viseskul et al., 2018; Gondal et al., 2020; Harrington et al., 2020). Viseskul et al. applied also focus group interviews evaluating strengths/benefits and problems/obstacles of the e-logbook in the doctoral students' training (Viseskul et al., 2018).

None of those studies mentioned above followed a framework nor a specific approach. Further, during this literature review, no evaluation framework specifically for the e-logbook could be found. As said before, the e-logbook can be classified as a DHI. Existing literature to evaluate DHIs was investigated and checked for their appropriateness to transfer them to the e-logbook.

5.3 Evaluation of digital health interventions

Guidelines for the systematic development and assessment of DHIs are still scarce (Kowatsch et al., 2019, p. 253). Existing frameworks are constantly changing, emerging, and being phased out (Henson et al., 2019, p. 52) because of a rapidly changing technology landscape. Results of DHIs evaluation have to be fast available. Otherwise, the results are outdated (Murray et al., 2016, p. 835).

Different researchers proposed approaches for evaluating DHIs. For example, did Murray et al. define 13 research questions and appropriate research methods (Murray et al., 2016, p. 836), and Kowatsch et al. proposed "The design and evaluation of DHIs (DEDHI)-framework". The DEDHI-framework should give guidance about which evaluation criteria and implementation barriers should be considered during the life cycle of a DHI (Kowatsch et al., 2019, p. 254). The Bellagio eHealth evaluation group also acknowledged the importance of adapting the evaluation study design and method to the project's stage in their report in 2011 (The Bellagio eHealth Evaluation Group, 2011, p. 3).

In 2016, after five years of research, the WHO published the "Monitoring and Evaluating of digital health interventions"-guideline (M&E-guideline). This guideline intends to provide a step-by-step guide for researchers and implementors (WHO, 2016b, p. v). Evaluation in this guide can be described as "the attempt to attribute a range of outcomes to the technology-based intervention" (WHO, 2016b, p. 2). Technical aspects of interventions are assessed first (i.e., feasibility, usability), followed by efficacy, effectiveness, economic evaluations, and lastly, implementation research (WHO, 2016b, p. 2).

In this study, the M&E-guideline by the WHO was regarded as most comprehensible and applicable to the e-logbook. As the others mostly focused on patient-related eHealth or mHealth interventions.

5.4 Evaluation framework for the BSc Clinical Sciences e-logbook

The guideline by the WHO as well as basic literature on evaluation was used to develop a framework for the evaluation of the BSc CS e-logbook.

Evaluations can be classified in different forms, such as formative and summative evaluation. The formative evaluations, often called process evaluation, aim to assess the

process of a project (Döring & Bortz, 2016, p. 990). They are conducted during the implementation to provide timely information to determine which improvements should be made. In contrast is the summative evaluation, which seeks to evaluate the effectiveness and the results. This one is conducted at or close to the end of an intervention (WHO, 2013b, p. 29).

The objective of this evaluation is to identify strengths and weaknesses in the implementation of the electronic logbook. It is a formative evaluation (WHO, 2016b, p. 68). The purpose is to optimize the evaluation object, help decide about further implementation (Döring & Bortz, 2016, p. 987), and ensure that end-user needs are incorporated (Bradway et al., 2017, p. 5).

Further, evaluations can be differentiated into external- and self-evaluation. In a self-evaluation the person who is performing the evaluation is also taking part in the project. On the contrary, external evaluation is done by a person who is not taking part in the project. This evaluation was an external evaluation because the person performing the evaluation is not a part of the studied evaluation object (Döring & Bortz, 2016, p. 989).

Before the evaluation, clear and measurable criteria have to be identified to obtain scientifically substantiated evidence about the evaluation object. Depending on the evaluation object's phase and the overall purpose of the evaluation, the criteria refer to either the assessment of the concept, the implementation, or the results. Specification of the relevant criteria depends on the evaluation object's goals, the wishes from the project leader, and the expectation from other stakeholders (Döring & Bortz, 2016, p. 983ff.). In the context of DHI the criteria depend on the maturity of the studied intervention (WHO, 2016b, p. 2).

The e-logbook was just tested out in a pilot-phase thus the stage of maturity is "pilot". In this stage of a DHI, the WHO recommends studying feasibility, usability, and process improvement (WHO, 2016b, p. 9). Considering the project goals of the pilot-phase, presented in chapter 4.3.3, the focus of this study is to assess the feasibility of the e-logbook. Feasibility in the e-logbook context refers to whether the e-logbook based on “SurveySolutions” works as intended in the BSc Clinical Science program.

To estimate the feasibility of the e-logbook, students' usage and their perception of the e-logbook will be evaluated. The indicators listed in table 3 will be examined to analyse students’ usage. Since this is a pilot study, there are no target scores to be achieved yet. The goal is to see if it is used at all and how it is used.

At the beginning of the pilot-phase the project coordinators requested the students to use the e-logbook continuously over the five weeks. Although there is no need for target scores, the request can be used to check whether the students followed the pilot-phase requirements. These requirements and forementioned indicators are displayed in following table (table 3).

Indicator	Pilot-phase requirements
number of students who accessed the e-logbook in comparison to the total number of students	All ten students
number of sent e-logbooks to mentors per student	Ten e-logbooks per student
number of received e-logbooks from mentors per student	Ten e-logbooks per student
number of entries/cases per e-logbook	at least 1 per e-logbook

Table 3: Indicators and pilot-phase requirements for students' usage

Students' perception of the e-logbook will be reviewed once at the end of the pilot-phase. Perception is a qualitative indicator thus no target score will be set.

6 Research objective

The objective of this thesis is to evaluate the e-logbook during its pilot-phase. The research questions are:

(i) whether an e-logbook (based on "SurveySolutions" software) can be feasible for the medical training of BSc CS students and

(ii) what are challenges and advantages of an e-logbook within this context.

For this purpose, the usage of the e-logbook and its perception by the students will be examined. The results of the evaluation should be used for further development and the overall implementation of the e-logbook in the BSc Clinical Sciences.

7 Methods

7.1 Study Design

The design of this evaluation was an observational, more specifically, a cross-sectional study. Cross-sectional studies are a one-time examination of a variable of interest (e-logbook) and other variables (students' usage and perception) in a defined population (WHO, 2016b, p. 68). This study does not intend to explain why effects were happening nor intend to quantify any relationship between the intervention (e-logbook) and an outcome. Therefore, it was an exploratory study (WHO, 2016b, p. 75f.).

7.2 Study population

The study population comprised all 10 BSc CS students who were part of the clinical rotation in the internal medicine specialty at Kabwe General Hospital and took part in the pilot-phase of the e-logbook. Data collection followed a purposive, non-random sampling procedure since all BSc CS students involved with the e-logbook were included.

Only the students who gave their consent during the introduction workshop were eligible as study participants. Each study participant got a code (S1, S2…) to identify the person if necessary.

7.3 Data collection methods

A convergent mixed-method approach was used to assess students' usage and perception. With the convergent design it is possible to get a complete understanding of a problem. The procedure of the convergent design is that first the quantitative and qualitative data will be collected and analyzed separately. After both results are available, the results are merged and compared. Lastly, it can be interpreted to what extent the results converge or diverge from each other (Creswell & Plano Clark, 2018, p. 65ff.).

This approach was selected because the aim was to get a comprehensive overview of challenges and strengths concerning the e-logbook. Following figure (figure 3) is presenting the data collection method of this study.

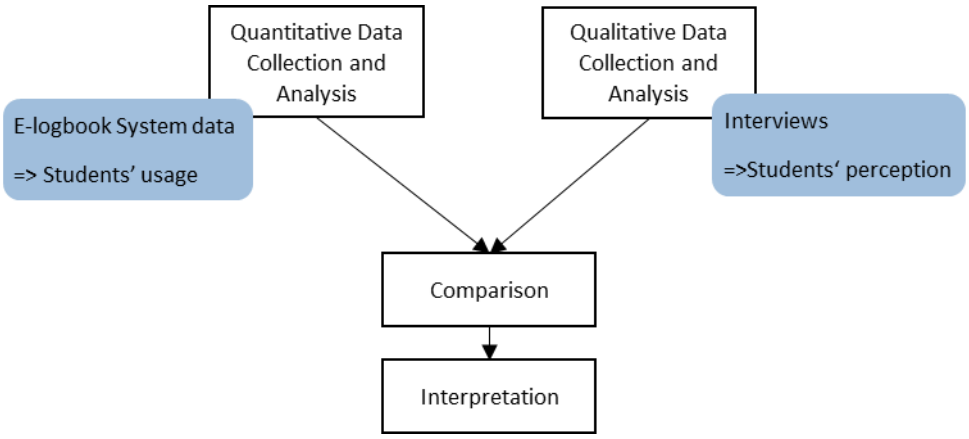

Figure 3: Mixed-method approach (based on Creswell & Plano Clark, 2018, p. 65ff.)

7.3.1 Quantitative data

The quantitative data, which should give information about the students' usage, will be assessed through the automatically created system data of the e-logbook. This automatically created system data can be called logfiles (Schmitz & Yanenko, 2014, p. 847). As described in chapter 4.3.2 is the e-logbook running over the application "SurveySolutions". Through the "SurveySolutions" web platform the researcher retrieved

the data of the e-logbooks. This platform documented each activity in the e-logbook, e.g., each time a student accessed an e-logbook, what the student entered, and when it was sent to the respective lecturer.

7.3.2 Qualitative data

To explore the students' perceptions of the electronic logbook semi-structured interviews were planned. The unstructured or semi-structured interview is the most used data collection method in the qualitative analysis. It has the advantage of gaining a deep individual insight as well as background information. The answers can also be way broader than when just answered in a questionnaire. Furthermore, it offers the chance to reach people who would usually not be able (e.g. people with a reading and writing disability) or are unwilling to answer a questionnaire (Döring & Bortz, 2016, p. 356). The interviews were taking place online over the platform "Zoom" or "WhatsApp"-messenger and have been conducted by the researcher Maike Jelena Schmidt, who was the student assistant of the BLiZ-project at that time.

An interview guide was developed by the researcher (annex B). Although the guide has not been piloted, two different people have checked it for comprehension and relevance. This guide included questions covering six different topics. One topic was students' self-perceived technology acceptance. Hereby students were asked whether they usually use a smartphone or tablet and how they would describe their technological skills. This part was included as a control question to check whether the participants were skilled and open to use electronic devices. In the main part of the interview the participants were asked about their perception of the e-logbook in general and the application "SurveySolutions". Further, they had to describe their usage and which challenges or experiences they had with the e-logbook. In the end, they had the chance to propose ideas for improvement.

Prior to the interview, invitation letters were prepared and sent out to all ten students by e-mail or “WhatsApp”-messenger (Annex C), regardless of whether they were actively using the e-logbook or not. The project leader recommended “WhatsApp”-messenger because of the reduced access barriers.

From the ten contacted students, five replied and accepted the invitation for the interview. However, only two of the five students accepted the invitation right away. The other three students have been contacted more than once, before they replied and a date for the interview could be set.

The interviews took place between the 12.09.2020 and the 23.10.2020. They lasted between 16 and 30 minutes. Following table (table 4) shows the details of each interview.

Interview Number	Date	From - to (actual interview in min.)	Platform	Interview with
I1	12.09.2020	8:20 - 8:50 (23:24)	Zoom	S1
I2	16.09.2020	14:15 - 14:40 (18:39)	WhatsApp	S9
I3	01.10.2020	18:05 - 18:30 (23:49)	WhatsApp	S2
I4	02.10.2020	12:10 - 12:30 (15:10)	WhatsApp	S5
I5	23.10.2020	09:05 - 09:35 (25:12)	WhatsApp	S4

Table 4: Overview Interviews

Every interview started with the interviewer summarizing the goal of the interview and the details for the interview. After that, the participant could ask questions about the interview process. If all process-related questions were answered, the consent for taking part in the interview and its recording was orally given and audio-recorded by the researcher.

All interviews have been audio-recorded by the interviewer. No protocol was made but the interviewer took some notes. Notes were made when the connection broke or when the interviewee made valuable comments or relevant non-verbal remarks.

After conducting the interviews, they were promptly transcribed. There are different transcription systems (Mayring, 2014, p. 45). The applied transcription system is dependent on the planned analysis (Kuckartz, 2014, p. 135). In this study, the "Clean read" or "smooth verbatim transcript" was applied. With this system the transcription is done word by word, but decorating words or utterances are excluded. In the end, a coherent text that is simple to understand but still represents the original structure is the product (Mayring, 2014, p. 45). This system is useful for this research as the focus is not the way something was said but the content. Transcription of the interview was done with the help of MAXQDA 2020. The transcriptions rules, developed by the researcher and based on Dresing & Pehl (2015, p. 21ff.), are displayed in the following table (table 6).

Transcription rules
Transcription is done literally/verbatim.
The sentence form is kept, even if it contains syntactical errors. Decorating words or utterances are smoothed or omitted. They are included if the answer consists of only the decorating words or if the word doublings are used as a stylistic device for emphasis.
After each thought, statement, or lowering of voice, a dot is made to improve the readability.
Pauses are marked in the following way: (…)
Especially stressed words are marked by capitalization.
Incomprehensible or unclear words are marked with: (?).
For longer incomprehensible passages the reason is given: (?, reason).
Emotional non-verbal utterances are noted in brackets.
Every line has a number.
Each speaker change is marked with a time mark.
The interviewer is labeled with "I" while the interviewee is labeled with "B"

Table 5: Transcription Rules (based on: Dresing & Pehl, 2015)

7.4 Data analysis methods

7.4.1 Quantitative data

The system data of the e-logbook was automatically created, so before analyzing it, the data has to be purified. The data purification depends on what the data will be used for (Schmitz & Yanenko, 2014, p. 848). Before extracting the data from the “SurveySolutions” web platform an excel sheet was prepared with the in chapter 5.4 defined indicators. After that, relevant data was transferred to an excel sheet. The relevant data was produced from the ten study participants between the 03.08.2020 and the 04.09.2020.

Following the data extraction, the quantitative data was descriptively analyzed. The quantitative analysis does not intend to give statistical value because of the small sample size.

7.4.2 Qualitative data

For analyzing the qualitative data from the interviews, a qualitative content analysis was used. Utilized programs were MAXQDA 2020 and Excel 2019.

The content analysis is a systematic and intersubjective description of the meaning of different types of texts, e.g., interviews, journals (Renner & Jacob, 2020, p. 99). In Germany the qualitative content analysis by Phillip Mayring is the most established (Döring & Bortz, 2016, p. 542). Mayring developed a method for the content analysis, which allows a qualitative, systematic, and verifiable data interpretation (Mayring, 2015, p. 50). In the

process of the qualitative content analysis, the text is being gradually edited and summarized into categories (Ramsenthaler et al., 2013, p. 25).

The first step is the determination of the material. The basis of a content analysis should be a written text (Mayring, 2014, p. 57). In this research, the material consists of the five transcribed interviews with the BSc CS students from Zambia, who took part in the pilot-phase of the e-logbook.

Once the material has been determined, the next step is to determine the direction of the analysis, i.e., what one wants to interpret from the material (Mayring, 2015, p. 58). In the present study, interviews were used to gain insights into the BSc CS students' experiences and needs concerning the e-logbook. The approach is inductive. The aim is to gain as much information as possible to draw conclusions about the feasibility of the e-logbook.

This study's questions and the analysis are based on the non-existence of research regarding the use of an e-logbook based on the application “SurveySolutions” in the BSc CS program.

Next step is defining a specific analysis technique and developing the process model for the analysis. The specific model should be adopted to the material and the research question (Mayring, 2014, p. 53f.). Mayring presents three different interpretation forms: summary, explication, and structuring (Mayring, 2014, p. 63). The analysis technique used in this case was the summary. The goal of the technique summary is to create a comprehensive overview of the material by reducing it to only relevant and essential content (Mayring, 2014, p. 64).

The focus of the content analysis is the development of a category system (Ramsenthaler et al., 2013, p. 29). The category system is not only the central instrument of analysis but also supports the intersubjectivity of the procedure (Mayring, 2014, p. 40). The categories can be formed inductive or deductive. In the inductive procedure the categories are being built from within the material. The deductive procedure starts with the definition of categories and coding rules, which are being applied to the material. A similarity of both is the repetitive revision of the category system. If text segments are not fitting to an existing category, a new category is being built. In the end, the finished category system will be tested with a material review (Ramsenthaler et al., 2013, p. 29). The design of this study is explorative. Thus, the analysis technique summary with an inductive category building was appropriate (Mayring, 2014, p. 12).

Before the process model will be applied, the text should be divided into segments for interpretation. The dividing of the text into segments, also called analysis units, is a central

element of content analysis (Mayring, 2014, p. 51). These analysis units can be differentiated into following units:

- coding unit, smallest possible text part, which can be included in one category,
- context unit, largest possible text part, which can be included in one category, and
- recording unit, text parts, are being studied with one system of categories (Mayring, 2014, p. 51).

The definition of these units is critical for the intersubjectivity (Mayring, 2014, p. 51).

In this study coding unit is referring to a complete statement by a student. The context unit and the recording unit are coinciding in the summative form (Mayring, 2014, p. 69) Thus in this analysis this unit is referring first to an individual interview and later, when the category system is being transferred to all interviews, referring to all interviews.

Following the determination of analytical units, a procedural model is applied. The procedural model is not identical for every analysis. It should be adapted to fit the material and the research objective (Mayring, 2015, p. 51ff.). In this study, the “summarizing content analysis model” and the “inductive formulation of categories” (Mayring, 2014, p. 66) were combined. Following figure (figure 4) presents the developed step-by-step procedural model.

With the help of the research question selection criteria for the decision of relevant text passages can be set (Ramsenthaler et al., 2013, p. 30). The pre-defined objective was to evaluate students’ perception and usage of the e-logbook. Meaning that all passages are of interest referring to students' perception and usage and those passages referring to positive and negative factors concerning the e-logbook. These passages were marked in MAXQDA and paraphrased. Paraphrasing means a reformulation of the text passages in the own words of the researcher. This process is especially recommended for beginners to better understand the material (Rädiker & Kuckartz, 2019, p. 64ff.).

After relevant text passages were paraphrased, the data was transferred from MAXQDA to Excel. In Excel a sheet was generated for each interview with the text parts and the corresponding paraphrase.

The envisaged level of abstraction was general statements about the e-logbook, meaning all personal statements were generalized to establish a simple comparison and reduction between the interviews. Each interview was checked line by line, and identically or semantically similar text passages were crossed out. Following this step, all the remaining text passages were then put together in one Excel sheet.

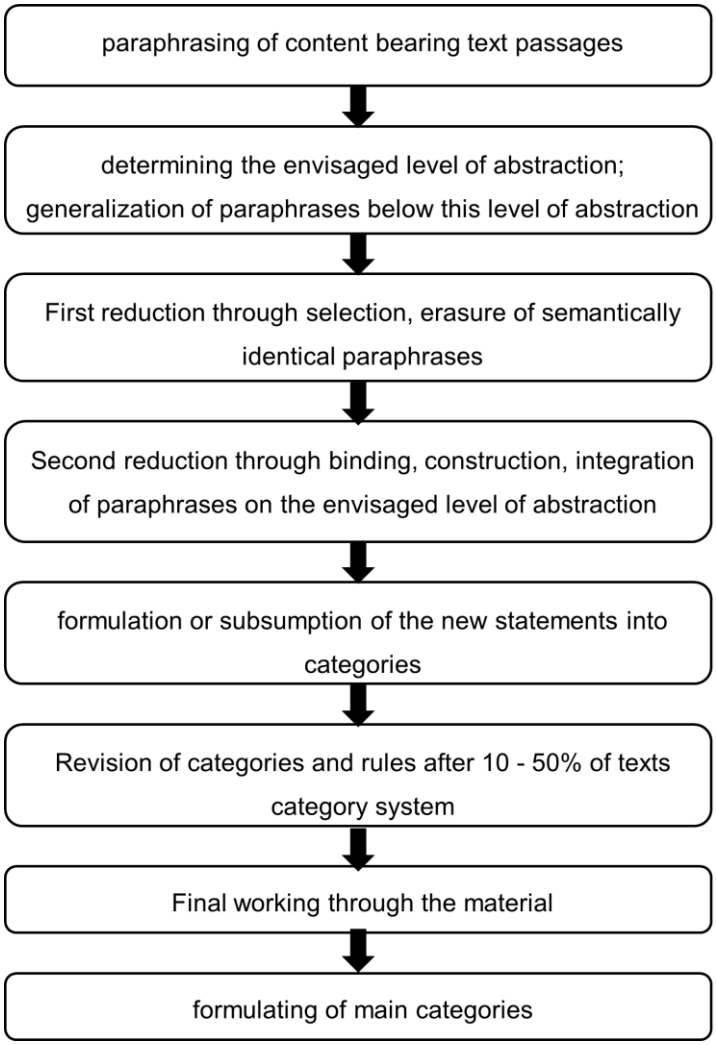

Figure 4: self-developed procedural model (based on Mayring, 2014)

As part of the second reduction, paraphrases referring to one another and occurring in several places throughout the five interviews were summarized and expressed as a single new statement. It would also have been possible to do the second reduction within the material from one interview. However, this was declined because of the small material size and the aim to retrace how many students had made similar statements.

After summarizing the paraphrases, the newly developed statements are being worked through, and categories are being formulated. The category labels are a term or short sentence formulated out of the material (Mayring, 2014, p. 81). Before this, the level or theme of categories has to be developed, which is a deductive element. The categories should hint at what the statements refer to (Mayring, 2014, p. 80f.). To keep the total numbers of categories low, the categories should not be too specific. If a category was too specific, it should be more generalized. For example, if there are challenges with the network and challenges with the tablet. Two categories could be built "network challenges"

and "tablet challenges". But to have fewer categories the category "technical barriers" was built, which refers to every technological aspect that is causing difficulties in using the e-logbook.

It is recommended to test the category system after 10 – 50 % of the material (Ramsenthaler et al., 2013, p. 30) to see whether the categories overlap and if the level of abstraction is adequate to the subject matter and aims of analysis. If the category definition has to be changed, the whole material has to be worked through again (Mayring, 2014, p. 81).

To gain a better overview of the categories and answer the research question main categories were formulated. This process was deductive as the researcher determined the main categories that would be most suitable for answering the research objectives (usage, factors enabling/limiting the use of the e-logbook, recommendations). One main category was built additionally as some categories were not fitting into the pre-defined main categories.

Quality criteria

The last step of the qualitative content analysis is the discussion of the quality of results by assessing the quality criteria. In quantitative research objectivity, reliability, and validity are being tested. However, it is not possible to solely apply the quality criteria for quantitative research on qualitative research. The criteria have to be redefined (Mayring, 2016, p. 140). Mayring recommends using the following six quality criteria to assess the quality of qualitative research:

1. Process documentation ("Verfahrensdokumentation"[1])
2. Argumentative Interpretation support („Argumentative Interpretationsabsicherung" [1])
3. Rules guidance ("Regelgeleitetheit" [1])
4. Proximity to the object ("Nähe zum Gegenstand" [1])
5. Communicative validation ("Kommunikative Validierung" [1])
6. Triangulation (Mayring, 2016, p. 144ff.)

1. For this work a detailed process documentation is available in which the individual analytical steps can be traced. Therefore, the individual steps within the research process are disclosed, comprehensible, and justified.
2. The data interpretation needs to be thoroughly documented to establish intersubjectively transparency (Lamnek & Krell, 2016, p. 145). The process of data

[1] Own Translation

interpretation is documented. Further, after finishing the analysis the categories have been checked and discussed with stakeholders from the BLiZ-project.

3. The quality criterion "Rules guidance" means systematic processing of the material according to specific procedural rules (Lamnek & Krell, 2016, p. 145). This criterion is met by following the content analysis according to Mayring and its underlying systematic approach.
4. The proximity to the object is a guiding principle of qualitative research and should ensure that the study participants' interests and problems are considered (Mayring, 2016, p. 146). In this study, the focus is on the BSc CS students' perception, on their experience, and on their needs in terms of the e-logbook. With this the proximity to the study object was gained.
5. A communicative validation, where the interviewees check and verify the interview transcripts, was not carried out due to the existing barriers in contacting the study participants.
6. With the descriptive quantitative analysis, the results have been triangulated to gain a deeper understanding of the context.

8 Results

Following the convergent design (Creswell & Plano Clark, 2018, p. 71), the quantitative and qualitative data will be presented separately. Then these results will be merged and interpreted.

8.1 Description of study population

Both data collections, quantitative and qualitative, were based on the same study population. However, the actual sample size differed. The reason for the different sample sizes could be because the interview partners were recruited separately. Further the interview could have been regarded as an additional workload for the students. As literature states, is the drop-out rate of online interviews higher (Deakin & Wakefield, 2014, p. 613). Following figure (figure 5) shows the different sample sizes.

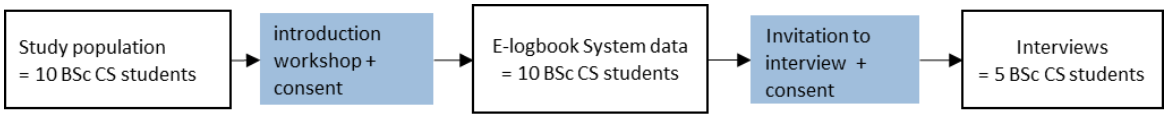

Figure 5: Sample size mixed-method study

The interviewed students were asked about their self-perceived technology acceptance. All five students said that it is easy for them to use technologies.

8.2 Quantitative data

During the introduction workshop all ten students were given access to the e-logbook. From these ten students, seven accessed and used the e-logbook. After using the e-logbook all of the seven students sent their filled e-logbook one time to their mentor.

The number of documented cases in the forwarded e-logbooks varied between 1 to 14 cases (= patients) per student. Likewise, did the number of documented procedures diverge from 2 to 35 applied procedures per student.

Two mentors were responsible for overseeing the e-logbooks by the students. During the time each mentor checked one e-logbook. One e-logbook was checked and sent back (rejected). Another one was checked but sent directly to the headquarters at the LMMU for final assessment (approved), so the student could not access it anymore. The other five e-logbooks have not been checked by the mentors.

The usage data is presented in annex D.

8.3 Qualitative data

The interviews were conducted to investigate students' perceptions towards the e-logbook. From the inductive content analysis 20 categories and five main categories emerged. The categories are mostly representing the summarized statements of the students. Though, in some cases the category was built on a statement by one student (e.g. structural recommendation). As the objective is to gain a general overview the results will be presented as representative of this group. Only if they are conflicting options about one topic each side will be reflected. The category tree is presented in annex E.

Usage of the e-logbook

The students reported that the e-logbook comes two times a week. The process of filling the e-logbook was described like this: “the way it is done it is like that. I go on the ward or maybe in the outpatient department. I (clark, ?) my patient then I’ll get that information and feed into the system. when I am done with […] that interview, then I will send it to the consultant.” (I5: 213 – 216). To connect their tablets to the internet the students are using their smartphone for mobile hotspot. Thus, they are using their phone and tablet simultaneously.

Factors limiting the use of the e-logbook

In the beginning students were sceptical about the e-logbook. They worried about whether everything will work out with the technology and whether they will get a fair rating: “the most

thing that actually made it sceptical was like […] am I going to be able to get a fair rating. that was the concern." (I1: 78 – 82).

The factors that were affecting the use of the e-logbook the most were challenges in receiving feedback and technical barriers. For using the e-logbook an internet connection is needed. However, students reported that the Wi-Fi-network of the school is not always there and that it is difficult to connect to it.

The students used the tablets, which they have been using since the beginning of their training. The challenge was that "the tablets have got no sim card, so you really have to rely on a hotspot from the other phone. like to send you interviews for the patient and stuff. so that it is really proving some kind of a challenge" (I3: 3-7). As described, the students depend on their phone for providing a mobile hotspot for their tablet. That means that if the phone does not have battery or a sim card with sufficient mobile data, the e-logbook cannot be used either.

The e-logbook should improve the communication between the student and the supervisor. Further, it should improve the training of the students by offering a continuous assessment. For this, a regular feedback cycle is essential. However, all five students reported difficulties in receiving feedback after sending the e-logbook. As "the feedback is not given there and then" (I1: 56-57) the students have to wait to get feedback to keep on working on the e-logbook.

One student got feedback from the supervisor. However, "the days was not enough for me to continue using it" (I2: 48-49) because the clinical rotation was over.

An aspect which may influence the difficulties in receiving the feedback could be challenges concerning the supervisor. One student described the supervisors like this: "they are […] big, big busy people" (I5: 179 – 182). Another one observed: "it looked like she had some competing activities" (I1: 203 – 206).

The supervisors are not only supervising the students but also working in the hospital. This double burden was registered by a student: "so in terms of maybe giving feedback at the end of the day it is quite challenging for them also. as you can imagine maybe you have 10 students. then all of them feedback maybe 5 patients per day and then they off send this information to the consultant who is been working the whole day. you can imagine. […] he or she has to go through maybe 50" (I5: 182 – 188).

The students mentioned that the list of diagnoses is not compatible to the Zambian context and "some of the condition. some of the diseases. they are not indicated right. they are not there […] so the list is not exhaustive. (I1: 123 – 125). One difficulty are the co-morbidities:

“a patient can have. take tuberculosis. thinking of HIV. they can have crypto meningitis or whatever and anaemia inconclusive. so this is one patient. but it mean[s] that I have to enter this patient maybe four or five times if they have co-morbidities.” (I1: 142-145).

Factors enabling the use of the e-logbook

Even though different challenges and difficulties occurred students were in general open towards the e-logbook. Described positive factors were the accessibility of the e-logbook: "but with electronic one it is accessible everywhere. […] and it can be done anytime" (I2: 159 – 160). The accessibility is beneficial in the clinical work as they do not have to wait for their supervisor and simply send it to them.

The paper-based logbooks went missing during a previous clinical rotation and could not count anymore for the final evaluation. With the e-logbook the information is saved in a central database and available from anywhere. So “there are no other giving excuses of saying I misplaced the logbooks and will not send them school for your final evaluation […] that thing won’t be there because it will be in the database.” (I3: 84 – 87).

The evaluation preceptor can access the information in the database and design the exam according to what the student already knows or does not know yet. In this way the e-logbook can benefit the exam preparation. Another benefit for the training and study is the time-efficiency as “you have enough time [...] to do other things” (I2: 144 – 146).

The saved time is a result of being able to document the activities right away. Or as the student said: “you don't have to go back and sit on the table after signing start again. those things you know. so it is faster.” (I1: 85 – 90).

All students described the easy usability as a positive feature: "when you are using it you don't have to write something, you just have to click, it opens, you just fill in the […] information” (I2: 31 – 32) and “you just log out” (I2: 86).

Even though the listed diagnoses in the application are not fully compatible to the Zambian context (see above), the same student also remarked that “you get somewhere with it. […] you will not be lost like: ey I can not find this I can not find the patient saying this. at least you are finding something that is close to what you are looking for” (I3: 199 – 201).

Another student didn’t feel like something was missing and marked out that “as it is now everything is there that it is required” (I2: 91 - 92). Same student also preferred the e-logbook over the paper-based logbook since ”there are a lot of options […] which you can chose and anyway you can choose you specify. so I think according to me […] you benefit more if you use the electronic logbook than the paper based on” (I2: 184 – 187).

Framework

One student stated that the organization of the program was not clear. He said that their group was initially not supposed to conduct this evaluation and only heard about it while arriving at the clinical rotation site. This resulted in him not being appropriate equipped with a tablet: “I haven't been using much like the tablet. so like when I came from kabiwe going to kabwe i left it home“ (I5: 11-12). Another factor which caused confusion was the fact that the pilot-phase was conducted during the Covid-19 pandemic.

The e-logbook pilot-phase was initiated "almost towards the end of our rotation. probably there was not enough time to make follow-ups and so on" (I5: 51-53).

A student stated that the introduction workshop helped to get a better understanding of the e-logbook. The same student also mentioned that technical support was helpful and always available. This statement collides with a statement by another student, who said the IT-staff could not help provide the students with tablets with sim card slots. Furthermore, the IT-staff was not available for questions as they were at another site.

Recommendations

The students had many different ideas and tips when they were asked about recommendations.

First, they pointed out the importance of available and accessible internet, as the students' training depends on getting continuous and timely feedback for their work. They would like to have tablets with sim card slots. So, they can directly access the mobile network from their tablets and do not need to be depended on another internet source, like the Wi-Fi of their school.

During the interviews, it became visible that the students are sending their e-logbook not to their mentor, which is in the hospital with them every day. They are sending it to the consultant, who is coming once or twice a week. To improve the feedback process, the students should be “evaluated by the person […] that is working with us there and then. […] that person is able to give feedback promptly.it would be more encouraging.” (I1: 117 – 120). Both, students and mentors, need to improve their commitment in terms of follow-up on the e-logbook.

The application, as it is, is still not ideal. A consultation with the school should be done for developing a practical application for the Zambian setting. Also, an additional typing field to describe a longer or a more complex diagnosis would be helpful.

Introducing the e-logbook to the students at the LMMU before they leave for their clinical rotation would be more effective and time-efficient. The trainers do not need to travel to the training sites. They simply make one follow-up to see whether everything works out.

8.4 Summary of mixed-method results

First, it needs to be noted that all five interview partners were assessing at least once their e-logbook. This is positive because it is more appropriate to merge the qualitative and quantitative findings if they include the same study participants.

All students who assessed their e-logbook during the pilot-phase sent their e-logbook one time to their mentor. Matching this to the project coordinators' request, none of the students fulfilled the requirement to send ten logbooks over the five weeks. A reason for this could be that the mentors did not give feedback making it impossible for students to enter more activities in the e-logbook. Also, the number of rejected e-logbooks did not reflect the requirement of ten rejected e-logbooks by mentors per student. This could have been influenced by competing activities for the mentor.

Other challenges could have negatively influenced the e-logbook usage of the students. For example, challenges with internet connectivity or that the application was not compatible to the clinical setting in Zambia.

Positively stated is the number of cases each student attended, as each of the students at least documented one patient per e-logbook with a minimum of 2 applied procedures. If they sent their e-logbook at the beginning of the clinical rotation and never got feedback, it could explain the small number of cases.

Comparing the quantitative and the qualitative results, it becomes apparent that they are not contradicting each other. Instead, they support each other as the qualitative findings can explain the students' limited usage of the e-logbooks.

9 Discussion

The objective of this evaluation was to test the feasibility of the e-logbook in the BSc CS program in Zambia and identify existing challenges and advantages in this setting. This chapter first interprets the results with regards to the research question. Following this, the limitations of this study and recommendations for further research will be portrayed.

9.1 Interpretation of results

By assessing students' usage and perception of the e-logbook with a mixed-method approach it was possible to evaluate the feasibility of the e-logbook in the BSc CS program. Further, challenges and advantages could be identified.

The requirements of the pilot-phase have not been achieved by any student. However, the pre-defined usage target of this evaluation was to bring the students to use the e-logbook. This goal can be regarded as mostly achieved as seven of the ten students did start to use the e-logbook.

There was no determined target concerning the perception, but the goal to see how the students are approaching this new DHI. Through the qualitative data analysis, it was possible to identify existing challenges and different aspects, which the students defined as advantages of an e-logbook implementation.

The accessibility from anywhere and at any time was remarked as positive, which corresponds to a study by Witt et al. Participants find value in having consistent and constant access to information (Witt et al., 2016, p. 75).

The perceived usefulness and ease of use can be regarded as one of the main critical success factors for implementing an e-learning tool. Since these factors are positively associated with the intention to use it (Bhuasiri et al., 2012, p. 844). Findings are showing that students perceive the e-logbook as easy to use and potentially beneficial for their training. This result corresponds to a study by Viseskul et al. In which the students show a high level of satisfaction with the e-logbook. Further, the students describe the e-logbook as an effective tool to assess and monitor their academic progress (Viseskul et al., 2018, p. 52).

A factor that influences students' perception of the technology is their pre-existing digital literacy. Meaning that if they do not have any problems using these technologies, the perception of its usefulness will be positive (WHO, 2019, p. 35). Knowing the importance, one control question was integrated into the interview to test their digital-literacy or technology acceptance. However, the findings were not sufficient to fully grasp the technology acceptance of the students. Literature suggests applying the technology acceptance model (TAM) by Davis to investigate user acceptance (Bhuasiri et al., 2012, p. 845).

The possible influence of digital literacy on students' perception undermines the importance of training. Training can help establish acceptance and system use of a DHI and help in overcoming difficulties in understanding and usage (WHO, 2019, p. 36).

In this study, as well as in others, has the existence of a stable internet connection been reported as one of the main challenges (Viseskul, 2018, p. 52; Kaliisa & Picard, 2017, p. 8; Witt et al., 2016, p. 75) to use and access the e-logbook (Viseskul, 2018, p. 52). Harrington et al. recognize bad-functioning internet connection as the major obstacle to compliance (Harrington et al., 2020, p. 5). An advantage of the application "SurveySolutions" is that it is accessible over a mobile application and offers the possibility to be used offline. However, the findings show that the students were not aware of this functionality. This aspect underlines the importance of training and the availability of technical support again.

Another limiting factor was the missing feedback from supervisors. Getting feedback by a supervisor is regarded as vital as it can directly impact students' learning process and the number of patients they encounter (Mazaraie et al., p. 399) and can help to guide the students learning activities towards fields of deficiencies (Dolmans et al., 1999, p. 90).

In conclusion, the positive perception of the e-logbook indicates that the e-logbook based on “SurveySolutions” could be feasible within the BSc CS program. Nevertheless, this study showed that limiting factors have to be assessed before the e-logbook will be implemented in the BSc CS program.

9.2 Limitations

While conducting this study, some limitations occurred, which will be presented and discussed in the following.

Many of the used publications in this study are older than five years. Yet, they were included as they still showed relevance, and the current literature about e-logbooks in LMIC was not sufficient.

In preparation for developing the evaluation framework, a literature review was done to identify existing approaches or frameworks to evaluate e-logbooks. This literature review did not follow any systematic research strategy, and it does not aim to be a complete summary of the existing literature. The intention was to get an overview of existing studies. The lack of an evaluation framework for e-logbooks meant to adopt the DHI framework by the WHO to this evaluation object. The WHO framework is a guideline and not a validated framework, which means that its adoption is not validated.

The focus group of this study were the students who used the e-logbook. Literature suggests that studies that focus on the individual learner are restricted in their insight into intervention outcomes (Barteit, 2019a, p. 4). Especially cross-sectional studies are providing limited information (Davies & Mueller, 2020, p. 274) as there is not enough time

to explore issues in-depth to establish causal inferences, which could be achieved with a longitudinal research approach (Kaliisa & Picard, 2017, p. 10).

In this research, the instrument for collecting the quantitative data is the e-logbook database, where the data is being automatically created. Positive about the automatically created data is the non-reactivity (Schmitz & Yanenko, 2014, p. 848), which means that the researcher is not influencing the data collection process. Also, the reliability, how consistently the e-logbook database is measuring the data (Krebs & Menold, 2014, p. 427), can be regarded as relatively good because the data collection process is fully automated (Schmitz & Yanenko, 2014, p. 848). Validity refers to how accurately an instrument measures what it is intended to measure (Krebs & Menold, 2014, p. 430f.). The e-logbook database was utilized to measure the usage of the e-logbook. To validate the instrument, it would be helpful to compare the collected data to the data measured by another instrument.

The interviews were conducted online, as the study participants and the interviewer were not in the same location, and no face-to-face interview could take place. A challenge for online interviews is that subtle, non-verbal cues are lost, and it can be difficult for the interviewer to create a positive interview atmosphere. Also, participants need to obtain the requested software and make sure that they maintain an internet connection throughout the interview (Deakin & Wakefield, 2014, p. 605). These factors were especially in this study challenging. Since all students reported that they had challenges with having a constant internet connection and to load a new application, like zoom, requires a stable and adequate internet connection. To overcome this barrier interviews were conducted over WhatsApp. Nevertheless, the setting during the interviews was not ideal. The connection often broke down or was unstable, which made it difficult to understand the other person. Moreover, the challenging internet connection made it difficult to transcript the interviews afterwards. Further, the interviews were conducted in English. At the beginning of the interview two of the five students commented that they have difficulties understanding and speaking English.

The researcher of this study was at the time student assistant of the BLiZ-project and may have been regarded by the interviewee like a representative of the project, which can lead to a more positive response as it would be with a more neutral person. Another bias was that the study participants were asked about their experiences with the e-logbook respectively. This can increase the risk for recall biases.

It was constructive to choose a convergent mixed-method design to evaluate the feasibility of the e-logbook, as this design helped to gain a deeper insight. Still, it is important to note that theoretically the quantitative and qualitative methods are equally emphasized in the convergent design (Creswell & Plano Clark, 2010, p. 74). However, in this study, the

quantitative data collection yielded less content than the qualitative analysis, making it difficult to emphasize both equally.

A generalization of these findings is limited due to the small and homogeneous sample. Further, this study group has been part of the BLiZ-project and they have been introduced to the use of the electronic platform at the beginning of their training in 2017. Therefore, it is not possible to compare their experience with this e-logbook to the experience of new students, who have not been using any e-learning tool before.

9.3 Recommendations

Although the forementioned limitations exist, this study's findings can still be interpreted as useful and necessary for further development of the e-logbook in the BSc CS program in Zambia. In the following, a few recommendations will be portrayed.

Regarding the e-logbook, the students gave some useful tips for improvement. It should be checked whether it is possible to upgrade the existing Wi-Fi system at the hospital or change the existing tablets to tablets with sim-cards. Further, in the upcoming e-logbook project-phases, it should be reviewed whether the displayed content of the e-logbook is appropriate or whether the application needs more adjustments to the Zambian context.

Interventions need to be evaluated at different levels, from piloting to implementation, and diverse factors need to be considered, like multiple stakeholders and learner outcomes (Ruggeri, 2013, p. 316). To gain a deeper insight and comprehension of the feasibility of the e-logbook, it would be beneficial to assess the perception of the mentors' or the IT-staff. Moreover, it would be valuable to compare mentors' perspectives on the feedback with the ones from the student. Likewise, it would be interesting to check the network challenges with the IT-staff.

If the e-logbook gets implemented and scaled-up in the BSc CS program it is important to continue evaluating the e-logbook. After establishing a DHI's feasibility, the DHI should be tested for efficacy and effectiveness (WHO, 2016b, p. 2). To test the effectiveness and efficacy, it can be useful to follow the students prospectively and conduct interviews on multiple occasions. Additionally, their usage should be monitored over time.

Finally, it is critical to underline once again the importance of training and technical support. It has to be assured that the students are appropriately trained in the usage and that there will be technical support if needed. Especially the possibility to access the e-logbook offline has to be pointed out.

10 Conclusion

Technologies are being widely employed to overcome existing challenges and barriers in healthcare systems, like healthcare workers shortage or insufficient quality of care. However, it is crucial to evaluate new interventions before they are being scaled-up.

This thesis focused on the evaluation of the feasibility of a newly developed e-logbook based on "SurveySolutions" in the Zambian BSc CS program. It intended to address the gap of evidence of e-logbooks in Zambia and build on the existing body of literature on the use of e-logbooks in the setting of medical education in LMICs. By applying a convergent mixed-method approach it was possible to indicate that the presented e-logbook could be feasible in the BSc CS program. Nevertheless, stated adjustments need to be performed and the implementation needs to be closely monitored.

Evaluations are an ongoing process. Keeping this in mind, this evaluation is not in any way a final or a complete assessment of the e-logbook. Rather this evaluation should be regarded as the begin of a series of evaluations of the e-logbook.

References

Achuthan, R., Grover, K., & MacFie, J. (2006). A critical evaluation of the electronic surgical logbook. *BMC Medical Education*, *6*(1), 15. https://doi.org/10.1186/1472-6920-6-15

Adelman, S., & Capati, J. (2015). Using smartphones and tablets to improve access to evidence-based medical resources and document clinical practice by clinical associate students in South Africa. *Annals of Global Health*, *81*(1), 70. https://doi.org/10.1016/j.aogh.2015.02.666

Al-Ubaydli, M. (2004). Handheld Computers for Surgical Logbooks. *The Journal of Surgery*, *2*(1), 59–60. https://doi.org/10.1016/S1743-9191(06)60034-4

Attwell, G. (2006). *Evaluating E-learning A Guide to the Evaluation of E-learning*.

Atun, R., Kersnik, J., Švab, I., Majeed, A., Car, J., Al-Shorbaji, N., & Wheeler, E. (2015). *eLearning for undergraduate health professional education: A systematic review informing a radical transformation of health workforce development*. Imperial college.

Bahia, K., & Delaporte, A. (2020). *State of Mobile Internet Connectivity Report 2020*. GSMA. Retrieved January 19, 2021 from GSMA-State-of-Mobile-Internet-Connectivity-Report-2020.pdf

Barbieri, A., Giuliani, E., Lazzerotti, S., Villani, M., & Farinetti, A. (2015). Education in anesthesia: Three years of online logbook implementation in an Italian school. *BMC Medical Education*, *15*(1), 14. https://doi.org/10.1186/s12909-015-0298-1

Barbieri, A., Melegari, G., & Giuliani, E. (2020). Could an electronic log-book be effective for medical training in anaesthesiology? *European Journal of Anaesthesiology*, *37*(6), 515. https://doi.org/DOI:10.1097/EJA.0000000000001210

Barteit, S., Jahn, A., Bowa, A., Lüders, S., Malunga, G., Marimo, C., Wolter, S., & Neuhann, F. (2018). How Self-Directed e-Learning Contributes to Training for Medical Licentiate Practitioners in Zambia: Evaluation of the Pilot Phase of a Mixed-Methods Study. *JMIR Medical Education*, *4*(2), e10222. https://doi.org/10.2196/10222

Barteit, S., Neuhann, F., Bärnighausen, T., Bowa, A., Wolter, S., Siabwanta, H., & Jahn, A. (2019a). Technology Acceptance and Information System Success of a Mobile Electronic Platform for Nonphysician Clinical Students in Zambia: Prospective, Nonrandomized Intervention Study. *Journal of Medical Internet Research*, *21*(10), e14748. https://doi.org/10.2196/14748

Barteit, S., Neuhann, F., Bärnighausen, T., Lüders, S., Malunga, G., Chileshe, G., Marimo, C., & Jahn, A. (2019b). Perspectives of Nonphysician Clinical Students and Medical Mentors

on Tablet-Based Health Care Practice Support for Medical Education in Zambia, Africa: Qualitative Study. *JMIR MHealth and UHealth*, *7*(1), e12637. https://doi.org/10.2196/12637

Barteit, S., Jahn, A., Banda, S. S., Bärnighausen, T., Bowa, A., Chileshe, G., Guzek, D., Jorge, M. M., Lüders, S., Malunga, G., & Neuhann, F. (2019c). E-Learning for Medical Education in Sub-Saharan Africa and Low-Resource Settings: Viewpoint. *Journal of Medical Internet Research*, *21*(1), e12449. https://doi.org/10.2196/12449

Barteit, S., Guzek, D., Jahn, A., Bärnighausen, T., Jorge, M. M., & Neuhann, F. (2020). Evaluation of e-learning for medical education in low- and middle-income countries: A systematic review. *Computers & Education*, *145*, 103726. https://doi.org/10.1016/j.compedu.2019.103726

Bhuasiri, W., Xaymoungkhoun, O., Zo, H., Rho, J. J., & Ciganek, A. P. (2012). Critical success factors for e-learning in developing countries: A comparative analysis between ICT experts and faculty. *Computers & Education*, *58*(2), 843–855. https://doi.org/10.1016/j.compedu.2011.10.010

Bradway, M., Carrion, C., Vallespin, B., Saadatfard, O., Puigdomènech, E., Espallargues, M., & Kotzeva, A. (2017). mHealth Assessment: Conceptualization of a Global Framework. *JMIR MHealth and UHealth*, *5*(5), e60. https://doi.org/10.2196/mhealth.7291

Brouwer, R., & Kiroff, G. (2002). Computer-based logbook for surgical registrars: ELECTRONIC LOGBOOK. *ANZ Journal of Surgery*, *72*(1), 57–61. https://doi.org/10.1046/j.1445-2197.2002.02296.x

Chan, T., Corlett, D., Sharples, M., Ting, J., & Westmancott, O. (2005). Developing Interactive Logbook: A Personal Learning Environment. *IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'05)*, 73–75. https://doi.org/10.1109/WMTE.2005.16

Creswell, J., & Plano Clark, V. (2010). Choosing a mixed methods design [Chapter 3 from: Designing and conducting mixed methods research]. In J. W. Creswell & V. L. Plano Clark (Eds.), *Designing and conducting mixed methods research* (2nd ed, pp. 53–106). SAGE Publications. http://images.lib.monash.edu.au/swm5190/04129740.pdf

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3.). SAGE.

Davies, A., & Mueller, J. (2020). *Developing Medical Apps and mHealth Interventions: A Guide for Researchers, Physicians and Informaticians*. Springer International Publishing. https://doi.org/10.1007/978-3-030-47499-7

Deakin, H., & Wakefield, K. (2014). Skype interviewing: Reflections of two PhD researchers. *Qualitative Research*, *14*(5), 603–616. https://doi.org/10.1177/1468794113488126

Denton, G. D., Hoang, T., Prince, L., Moores, L., & Durning, S. (2007). Accuracy of Medical Student Electronic Logbook Problem List Entry. *Teaching and Learning in Medicine*, *19*(4), 347–351. https://doi.org/10.1080/10401330701542560

Dolmans, Schmidt, Van Der Beek, Beintema, & Gerver. (1999). Does a student log provide a means to better structure clinical education? *Medical Education*, *33*(2), 89–94. https://doi.org/10.1046/j.1365-2923.1999.00285.x

Döring, N., & Bortz, J. (2016). *Forschungsmethoden und Evaluation in den Sozial- und Humanwissenschaften*. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-41089-5

Dresing, T., & Pehl, T. (2015). *Praxisbuch Interview, Transkription & Analyse: Anleitungen und Regelsysteme für qualitativ Forschende* (6. Auflage). Eigenverlag.

Eyal, N., Cancedda, C., Kyamanywa, P., & Hurst, S. A. (2015). Non-physician Clinicians in Sub-Saharan Africa and the Evolving Role of Physicians. *International Journal of Health Policy and Management*, *5*(3), 149–153. https://doi.org/10.15171/ijhpm.2015.215

Free, C., Phillips, G., Watson, L., Galli, L., Felix, L., Edwards, P., Patel, V., & Haines, A. (2013). The Effectiveness of MobileHealth Technologies to Improve Health Care Service Delivery Processes: A Systematic Review and Meta-Analysis. *PLoS Medicine*, *10*(1), e1001363. https://doi.org/10.1371/journal.pmed.1001363

Frehywot, S., Vovides, Y., Talib, Z., Mikhail, N., Ross, H., Wohltjen, H., Bedada, S., Korhumel, K., Koumare, A. K., & Scott, J. (2013). E-learning in medical education in resource constrained low- and middle-income countries. *Human Resources for Health*, *11*(1), 4. https://doi.org/10.1186/1478-4491-11-4

Gajewski, J., Mweemba, C., Cheelo, M., McCauley, T., Kachimba, J., Borgstein, E., Bijlmakers, L., & Brugha, R. (2017). Non-physician clinicians in rural Africa: Lessons from the Medical Licentiate programme in Zambia. *Human Resources for Health*, *15*(1), 53. https://doi.org/10.1186/s12960-017-0233-0

Gondal, K., Khan, J., & Ahmed, A. (2020). Supervisor's Feedback on Progress of E-Logbook System of CPSP: A Cross-sectional Survey. *Journal of the College of Physicians and Surgeons Pakistan*, *30*(02), 139–143. https://doi.org/10.29271/jcpsp.2020.02.139

Hammond, E. J., & McIndoe, A. (1996). The electronic anesthetic logbook: The value of supervision. *Anaesthesia*, *51*(3), 284–284. https://doi.org/10.1111/j.1365-2044.1996.tb13652.x

Harrington, C. M., Jang, S. S., Mangaoang, D., O'Flynn, E., Minja, C., Chikoya, L., Bekele, A., & Borgstein, E. (2020). Integration and Sustainability of Electronic Surgical Logbooks in Sub-Saharan Africa. *World Journal of Surgery*, *44*(10), 3259–3267. https://doi.org/10.1007/s00268-020-05613-z

Heidelberg University Hospital (HUH). (2020). *Blended Learning in Zambia (BLiZ)*. Retrieved January 19, 2021 from https://www.klinikum.uni-heidelberg.de/heidelberger-institut-fuer-global-health/groups-projects/working-groups/global-health-policies-and-systems/projects/blended-learning-in-zambia-bliz

Henson, P., David, G., Albright, K., & Torous, J. (2019). Deriving a practical framework for the evaluation of health apps. *The Lancet Digital Health*, *1*(2), e52–e54. https://doi.org/10.1016/S2589-7500(19)30013-5

Holst, C., Sukums, F., Radovanovic, D., Ngowi, B., Noll, J., & Winkler, A. S. (2020). Sub-Saharan Africa—The new breeding ground for global digital health. *The Lancet Digital Health*, *2*(4), e160–e162. https://doi.org/10.1016/S2589-7500(20)30027-3

Howitt, P., Darzi, A., Yang, G.-Z., Ashrafian, H., Atun, R., Barlow, J., Blakemore, A., Bull, A. M., Car, J., Conteh, L., Cooke, G. S., Ford, N., Gregson, S. A., Kerr, K., King, D., Kulendran, M., Malkin, R. A., Majeed, A., Matlin, S., … Wilson, E. (2012). Technologies for global health. *The Lancet*, *380*(9840), 507–535. https://doi.org/10.1016/S0140-6736(12)61127-1

Institute for Health Metrics and Evaluation (IHME). (2020). *Zambia*. Institute for Health Metrics and Evaluation. http://www.healthdata.org/zambia

International Telecommunication Union (ITU). (2018). *Measuring the Information Society Report*.

Iskarpatyoti, B. S., Sutherland, B., & Reynolds, H. W. (2017). *Getting to an Evaluation Plan: A Six-Step Process from Engagement to Evidence*. MEASURE Evaluation.

Kaliisa, R., & Picard, M. (2017). A Systematic Review on Mobile Learning in Higher Education: The African Perspective. *The Turkish Online Journal of Educational Technology*, *16*(1), 18.

Kowatsch, T., Otto, L., Harperink, S., Cotti, A., & Schlieter, H. (2019). A design and evaluation framework for digital health interventions. *It - Information Technology*, *61*(5–6), 253–263. https://doi.org/10.1515/itit-2019-0019

Krebs, D., & Menold, N. (2014). Gütekriterien quantitativer Sozialforschung. In N. Baur & J. Blasius (Eds.), *Handbuch Methoden der empirischen Sozialforschung* (pp. 425–438). Springer Fachmedien. https://doi.org/10.1007/978-3-531-18939-0_30

Krishnasamy, C., Ong, S. Y., Yock, Y., Lim, I., Rees, R., & Car, J. (2016). Factors influencing the implementation, adoption, use, sustainability and scalability of mLearning for medical and nursing education: A systematic review protocol. *Systematic Reviews*, *5*(1), 178. https://doi.org/10.1186/s13643-016-0354-x

Kuckartz, U. (2014). *Qualitative Inhaltsanalyse: Methoden, Praxis, Computerunterstützung* (2., durchgesehene Auflage). Beltz Juventa.

Lamnek, S., & Krell, C. (2016). Qualitative Sozialforschung: Mit Online-Material (6., überarbeitete Auflage). Beltz.

Lonergan, P. E., Mulsow, J., Tanner, W. A., Traynor, O., & Tierney, S. (2011). Analysing the operative experience of basic surgical trainees in Ireland using a web-based logbook. *BMC Medical Education*, *11*(1), 70. https://doi.org/10.1186/1472-6920-11-70

Masic, I. (2008). E-learning as new method of medical education. *Acta Informatica Medica: AIM: Journal of the Society for Medical Informatics of Bosnia & Herzegovina: Casopis Drustva Za Medicinsku Informatiku BiH*, *16*(2), 102–117. https://doi.org/10.5455/aim.2008.16.102-117

Mayring, P. (2014). *Qualitative content analysis: Theoretical foundation, basic procedures and software solution*.

Mayring, P. (2015). *Qualitative Inhaltsanalyse: Grundlagen und Techniken* (Neuausgabe, 12., aktualisierte edition). Beltz.

Mayring, P. (2016). *Einführung in die qualitative Sozialforschung: Eine Anleitung zu qualitativem Denken* (6., überarbeitete Auflage). Beltz.

Mazareie, E., Danaei, S. M., Hosseininezhad, S., & Nili, M. (2016). Evaluating the effect of logbook as viewed by the juniors and seniors at Shiraz school of dentistry. *Journal of Medical Education and Development Center*, *13*(4), 395–402.

Mechael, P., & Ke Edelman, J. (2019). *State of Digital Health 2019*. Retrieved January 19, 2021 from

https://www.digitalhealthindex.org/stateofdigitalhealth19#:~:text=state%20of%20digital%20health%202019&text=The%20report%20presents%20data%20collected,consider%20when%20charting%20future%20growth.

Merry, C., Goodall-Wilson, D., Guest, G., Papas, C., Selvidge, J., & Watters, D. A. K. (2006). THE SURGICAL TRAINEE LOG WE NEED: MINIMUM OF WORK, MAXIMUM OF OUTPUT. *ANZ Journal of Surgery*, *76*(3), 185–189. https://doi.org/10.1111/j.1445-2197.2006.03676.x

Mullan, F., & Frehywot, S. (2007). Non-physician clinicians in 47 sub-Saharan African countries. *The Lancet*, *370*(9605), 2158–2163. https://doi.org/10.1016/S0140-6736(07)60785-5

Murray, E., Hekler, E. B., Andersson, G., Collins, L. M., Doherty, A., Hollis, C., Rivera, D. E., West, R., & Wyatt, J. C. (2016). Evaluating Digital Health Interventions: Key Questions and Approaches. *American Journal of Preventive Medicine*, *51*(5), 843–851. https://doi.org/10.1016/j.amepre.2016.06.008

Neupane, S., Odendaal, W., Friedman, I., Jassat, W., Schneider, H., & Doherty, T. (2014). Comparing a paper based monitoring and evaluation system to a mHealth system to support the national community health worker programme, South Africa: An evaluation. *BMC Medical Informatics and Decision Making*, *14*(1), 69. https://doi.org/10.1186/1472-6947-14-69

Nievas Soriano, B. J., García Duarte, S., Fernández Alonso, A. M., Perales, A. B., & Carreno, T. P. (2019). eHealth: Advantages, disadvantages and guiding principles for the future. A systematic review. *JMIR Preprints*. https://preprints.jmir.org/preprint/15366

Ramsenthaler, C. (2013). Was ist „Qualitative Inhaltsanalyse?“. In M. Schnell, C. Schulz, H. Kolbe, & C. Dunger (Eds.), *Der Patient am Lebensende* (pp. 23–42). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-531-19660-2_2

Rädiker, S., & Kuckartz, U. (2019). *Analyse qualitativer Daten mit MAXQDA: Text, Audio und Video*. Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-22095-2

Republic of Zambia Ministry of Health. (2017). *EHealth Strategy 2017-2021*. Retrieved January 19, 2021 from https://www.moh.gov.zm/?wpfb_dl=150#:~:text=The%20purpose%20of%20this%20strategy,a%20%E2%80%9CSMART%20Zambia%20Now%E2%80%9D.

Rivett, D., Snodgrass, S., & Onyango, L. (2014). Electronic practical skills assessments in the health professions: A review. *The Internet Journal of Allied Health Sciences and Practice*, *12*, 1–10.

Ruggeri, K., Farrington, C., & Brayne, C. (2013). A Global Model for Effective Use and Evaluation of e-Learning in Health. *Telemedicine and EHealth*, *19*(4), 312–321. https://doi.org/10.1089/tmj.2012.0175

Saleh, M., Naik, G., Mwirigi, A., Shaikh, A. J., Sayani, S., Ghesani, M., Asaria, S., Sohani, A. R., Sayed, S., Moloo, Z., Budhwani, K. I., & Talib, Z. (2019). Bridging the Gap in Training and Clinical Practice in Sub-Saharan Africa. *Current Breast Cancer Reports*, *11*(3), 158–169. https://doi.org/10.1007/s12609-019-00322-6

Scantamburlo, G., Vierset, V., Bonnet, P., Verpoorten, D., Delfosse, C., & Ansseau, M. (2016). LA VIGNETTE DIAGNOSTIQUE DE L'ÉTUDIANT. *Rev Med Liège*, 210–215.

Scheffler, R., Cometto, G., Tulenko, K., Bruckner, T., Liu, J., Keuffel, E. L., Preker, A., Stilwell, B., Brasileiro, J., & Campbell, J. (2016). *Health workforce requirements for universal health coverage and the Sustainable Development Goals – Background paper N.1 to the WHO Global Strategy on Human Resources for Health: Workforce 2030. Human Resources for Health Observer Series No 17.*

Schmitz, A., & Yanenko, O. (2014). Web Server Logs und Logfiles. In N. Baur & J. Blasius (Eds.), *Handbuch Methoden der empirischen Sozialforschung* (pp. 847–854). Springer Fachmedien. https://doi.org/10.1007/978-3-531-18939-0_65

Schüttpelz-Brauns, K., Narciss, E., Schneyinck, C., Böhme, K., Brüstle, P., Mau-Holzmann, U., Lammerding-Koeppel, M., & Obertacke, U. (2016). Twelve tips for successfully implementing logbooks in clinical training. *Medical Teacher*, *38*(6), 564–569. https://doi.org/10.3109/0142159X.2015.1132830

Steele, P., Tolani, F., & Subramanian, L. (2019). The Multi-Faceted Challenges of Health Technology in Low—And Middle—Income Countries. *Acta Scientific Pharmaceutical Sciences*, *3*(11), 52–56. https://doi.org/10.31080/ASPS.2019.03.0426

The Bellagio eHealth Evaluation Group. (2011). *Call to Action on Global eHealth Evaluation: Consensus Statement of the WHO Global eHealth Evaluation Meeting*. Retrieved January 19, 2021 from https://www.who.int/reproductivehealth/topics/mhealth/WHO-Bellagio-eHealth-Evaluation-Call-to-Action.pdf?ua=1

UHC2030. (n.d.). *Accelerating progress towards Universal Health Coverage*. UHC2030. Retrieved January 19, 2021, from https://www.uhc2030.org/

UNESCO. (2020). *Information and communication technologies (ICT)*. Retrieved January 19, 2021 from http://uis.unesco.org/en/glossary-term/information-and-communication-technologies-ict

Viseskul, N., Nantsupawat, A., Tachaudomdach, C., Fongkaew, W., & Sriteerajit, G. (2018). Developing an Electronic Logbook to Monitor Progress for International Doctoral Students in Thailand: A Pilot Study. *Walailak Journal of Science and Technology (WJST)*, *16*(1), 8. https://doi.org/10.48048/wjst.2019.3749

Watters, D. A. K., Green, A. J., & van Rij, A. (2006). REQUIREMENTS FOR TRAINEE LOGBOOKS. *ANZ Journal of Surgery*, *76*(3), 181–184. https://doi.org/10.1111/j.1445-2197.2006.03663.x

Witt, R. E., Kebaetse, M. B., Holmes, J. H., Ryan, L.-Q., Ketshogileng, D., Antwi, C., Kovarik, C., & Nkomazana, O. (2016). The role of tablets in accessing information throughout undergraduate medical education in Botswana. *International Journal of Medical Informatics*, *88*, 71–77. https://doi.org/10.1016/j.ijmedinf.2016.01.006

World Bank. (2016). *The Little Data Book on Information and Communication Technology 2015*. Washington, DC. https://doi.org/10.1596/978-1-4648-0558-5

World Bank Group. (2020). *Survey Solutions*. Retrieved January 19, 2021, from https://mysurvey.solutions/en/

World Health Assembly. (2018). *Digital Health*. Seventy-first World Health Assembly. Retrieved January 19, 2021, from Digital health (who.int)

World Health Organization. (n.d.). *WHO | Third Global Survey on eHealth—2015*. WHO; World Health Organization. Retrieved January 19, 2021, from http://www.who.int/goe/survey/2015survey/en/

World Health Organization. (2005). *A58_21-en.pdf*. Retrieved January 19, 2021 from https://apps.who.int/gb/ebwha/pdf_files/WHA58/A58_21-en.pdf

World Health Organization. (2013a). *Transforming and scaling up health professionals' education and training: World Health Organization guidelines 2013*. Retrieved January 19, 2021 from 9789241506502_eng.pdf (who.int)

World Health Organization. (2013b). *WHO evaluation practice handbook*. Retrieved January 19, 2021 from 9789241548687_eng.pdf (who.int)

World Health Organization. (2015). *The MAPS toolkit: MHealth assessment and planning for scale*. Retrieved January 19, 2021 from

9789241509510_eng.pdf;jsessionid=E6DB4850D32CF7DEC1644E23439AA0CB (who.int)

World Health Organization. (2016a). *Global diffusion of eHealth: Making universal health coverage achievable: report of the third global survey on eHealth*. Retrieved January 19, 2021 from 9789241511780-eng.pdf (who.int)

World Health Organization. (2016b). *Monitoring and evaluating digital health interventions: A practical guide to conducting research and assessment*. Retrieved January 19, 2021 from https://apps.who.int/iris/bitstream/handle/10665/252183/9789241511766-eng.pdf

World Health Organization. (2018). *Classification of Digital Health Interventions v1.0* (p. 20). Retrieved January 19, 2021 from https://www.who.int/reproductivehealth/publications/mhealth/classification-digital-health-interventions/en/

World Health Organization. (2019). *WHO guideline: Recommendations on digital interventions for health system strengthening*. http://www.ncbi.nlm.nih.gov/books/NBK541902/

Annexes

Annex A: Screenshots of the e-logbook based on “SurveySolutions”

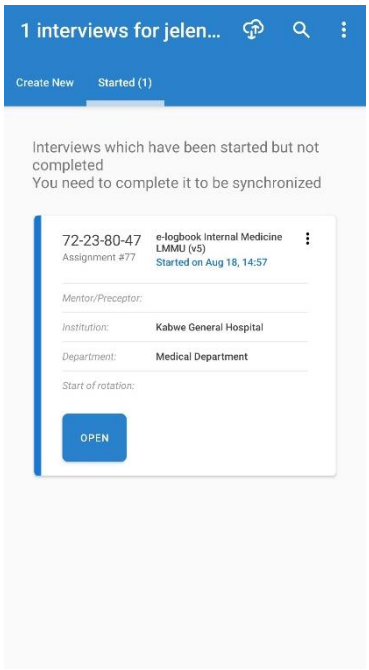

Figure 1: Downloading e-logbook

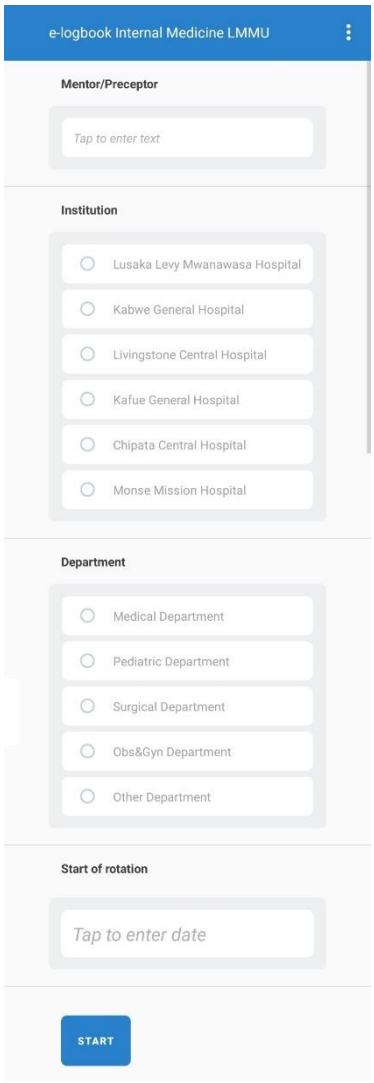

Figure 2: Registration form e-logbook

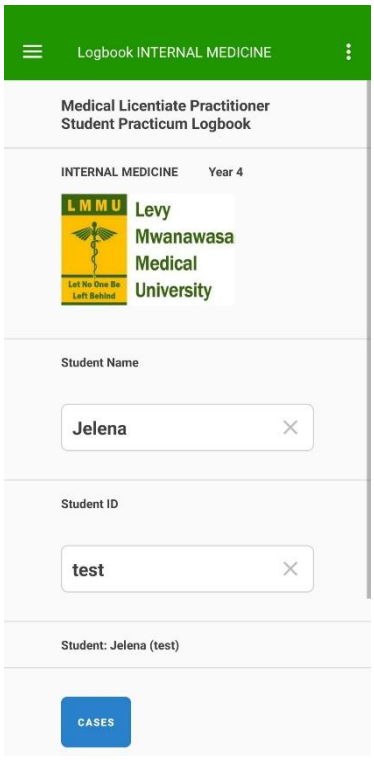

Figure 3: Frontpage e-logbook

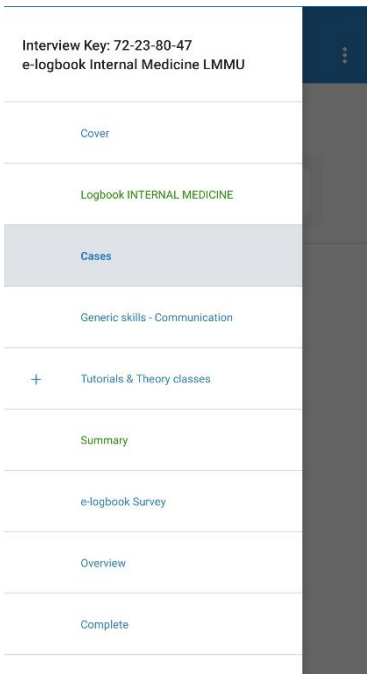

Figure 4: e-logbook structure

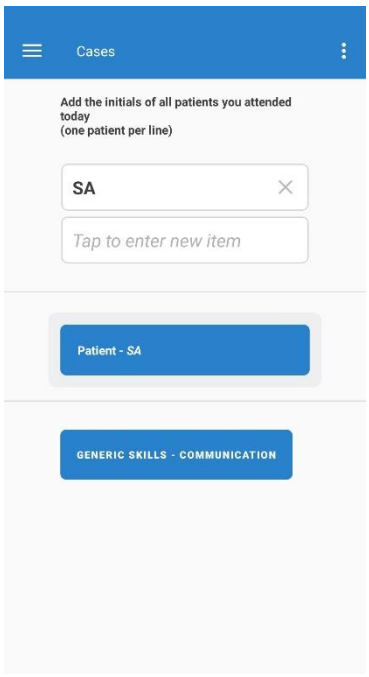

Figure 5: Adding a new patient

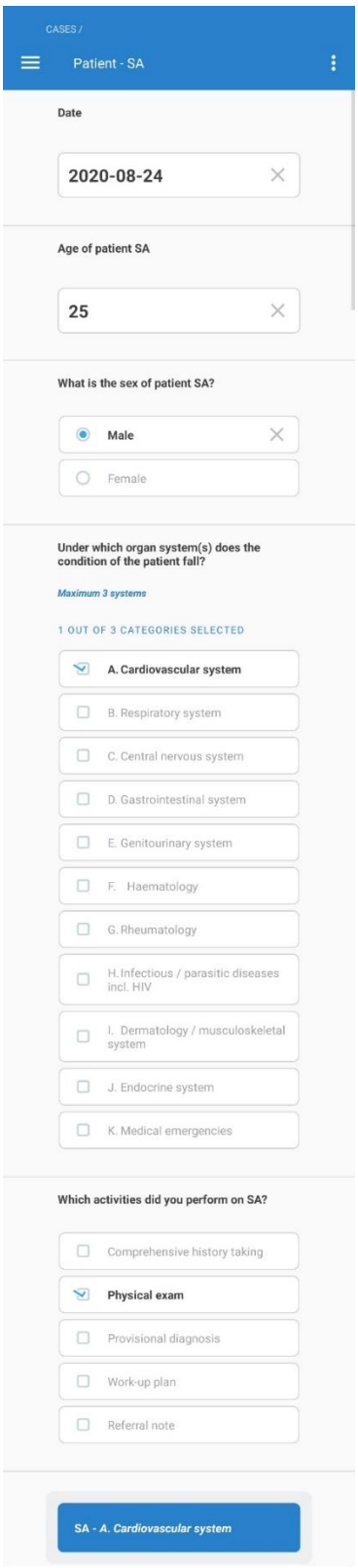

Figure 6: Adding the diagnosis of a patient

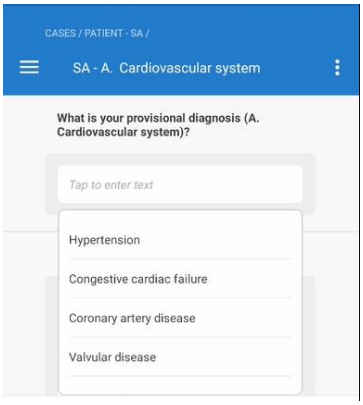

Figure 7: Drop-down menu to choose a diagnosis

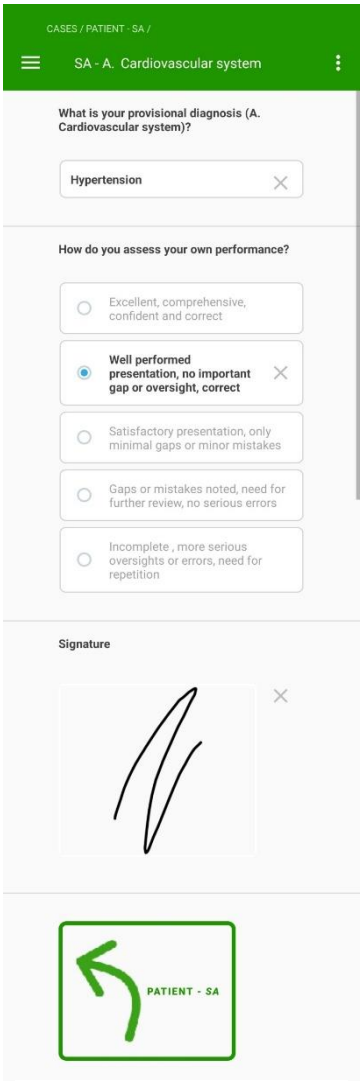

Figure 8: Review and signing of the diagnosis

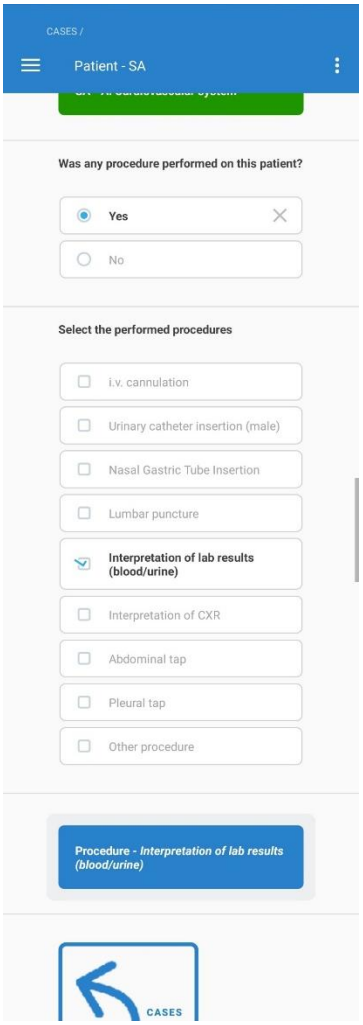

Figure 9: Adding a procedure

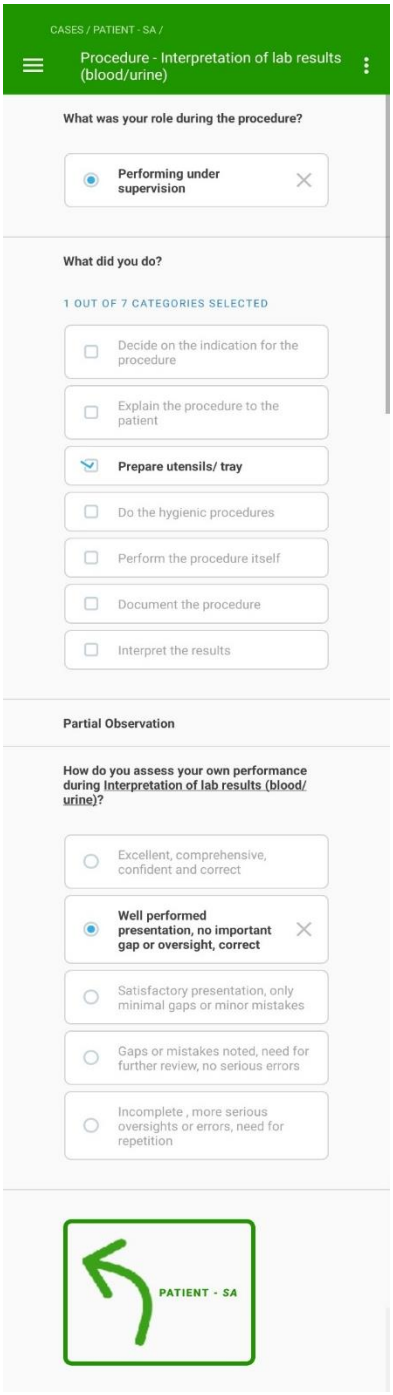

Figure 10: Review procedure

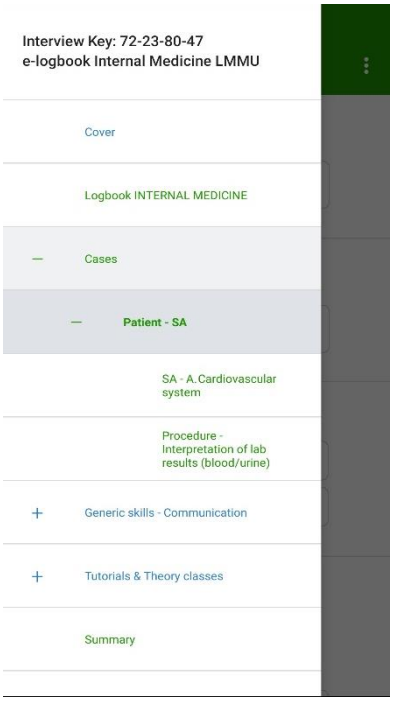

Figure 11: Entry completed

Annex B: Interview guide

Opening:

- Introduction of person
- Topic of the interview
- Ground rules
- Check consent
- Question from interviewee

Main part:

Topic: Technology Acceptance

- Do you normally use a smartphone or a tablet?
  - Since when do you use it?
- How would you describe your technological skills?
  - Is it easy for you to use laptops, tablets etc.?
  - Do you have difficulties understanding new IT-systems?

Topic: Description of the electronic logbook and typical workday

- What is the electronic logbook?/Can you describe the electronic logbook?
- Can you describe a typical day when you used the logbook?
  - When did you use it?
  - Why did you use it?
  - Where did you have the tablet during the time you worked?
- How frequently did you use the electronic logbook? (quantitative answer possible)
  - Times in a day/week
  - How many entries did you do in the whole time during the clinical rotation?
- How was the contact between you and your supervisor?
  - How long did you have to wait for feedback?
  - Was the feedback helpful?

Topic: Perception of the electronic logbook

- What was your first thought, when they told you that you are going to use an electronic version of the logbook during your clinical rotation?
  - What worried you?
  - What made you excited?
- Did your opinion change?
  - What do you think now about the use of an electronic logbook during your clinical rotation?

- In which way does the electronic logbook benefit your study/training?
    - Time, feedback, learning guideline/objective
    - Is the benefit different than the benefit of the paper-based logbook?

Topic: Perception of the application SurveySolutions

- Can you explain me how the process of a new entry into the application SurveySolutions works?
- What do you think about the application SurveySolutions?
    - How would you describe the structure of the application?
    - Was something missing from the content?
    - How would you rate the user friendliness?

[Summarizing of the described positive and negative points the person made]

These were the positive/negative aspects you described. I would like to ask you now whether there are more positive or negative aspects which have to be included.

Topic: Experiences and Challenges

- What kind of other positive experiences did you have with the e-logbook?
- Which other challenges occurred will you used the electronic logbook?
    - internet, tablet, support, misunderstandings, staff hospital, time
- If you encountered a challenge/problem, what did you do?
    - Did you contact someone?
    - What would you have wished to have in that moment?

Topic: Further use and recommendations

- Would you like to keep on using the electronic logbook?
    - If yes:
        - What kind of changes do you think would benefit the e-logbook or the application?
    - If no:
        - Why not?
        - What kind of changes does the e-logbook or the application need?

End:

- Summary of important aspects
- "Do you want to add something?" "Do you have a question?"
- Saying what will happen with the information
- Goodbye and "thank you"

Annex C: Letter of invitation

V1.0

Letter of invitation to potential participants for Interview

Title of study

Evaluation of an electronic logbook to strengthen medical education within the BSc Clinical Sciences at Lewy Mwanawasa Medical University in Lusaka, Zambia

Introduction

I am Maike Jelena Schmidt, and I am a student assistant in the BLiZ-project. Currently, I am evaluating the pilot-phase of the electronic logbook. In the following, I will give you some information and invite you to keep on being part of this research.
Please ask me or someone of the other researchers if you have questions or if there is something you do not understand.

At the beginning of August 2020, you kindly agreed to participate in the second pilot phase of the electronic logbook in the Kabwe General Hospital.
The objective of the pilot phase was to test the electronic logbook in a small study population.

Purpose

Our next step is to evaluate the pilot phase of the electronic logbook. The evaluation seeks to analyze if and under which conditions the electronic logbook can be fully implemented into the Bachelor of Clinical Sciences.

Study Procedures

As part of the evaluation, we would like to arrange an interview with you to listen to your experiences with the electronic logbook. We chose you as a study participant because everything you have to say can help the evaluation and further development of the electronic logbook.
Hereby it is important to say that there will be no wrong or right experiences or answers. Furthermore, if you do not wish to answer any of the questions, we will move on to the next question.

The interview will take place online over the platform "Zoom"/ "WhatsApp." It would last about **30 minutes**. To take part, you would need a stable internet connection for the time of the interview. Also, you can decide whether you would like to have the interview with or without the camera.
To document the interview and to analyze it later, the interview will be audio recorded.

Risks and Benefits

There are no risks associated with your participation in this study. However, a benefit of taking part is, that you have a chance to test an e-logbook and to share your experience which may lead to direct improvements/changes in the e-logbook for the BSc CS study program.

Confidentiality

The information recorded is confidential, and no one else except for me, Maike Jelena Schmidt, Sandra Barteit, and Florian Neuhann, will have access to the recordings.
We will pseudonymize your personal details. That means each participant gets a code instead of their name. Only the researchers will know the name behind the codes.
After the analysis of the interviews, the results will be summarized and published as part of the evaluation.

Voluntary Participation/Withdrawal

The interview participation would be completely voluntary and has no implications for your BSc Clinical Science studies. Furthermore, you can cancel your consent at any time without giving reasons and without any consequences. You can object the analysis of your data and demand their elimination.

If you have any questions, you can contact me:
Maike Jelena Schmidt: +4917626590229; maikejelena.schmidt@haw-hamburg.de

I would be happy to hear back from you and to have you as an interview partner.

Kind regards
Maike Jelena Schmidt

Details from other researchers:

- Sandra Barteit (Project lead BLiZ-project): +49 6221 56-34030, barteit@uni-heidelberg.de
- Florian Neuhann (Project lead BLiZ-project): +49 6221 56-5335, florian-neuhann@uni-heidelberg.de

Annex D: students' usage data

ID	Student assessed e-logbook	cases	procedures	e-logbook sent to mentor	e-logbook rejected by mentor	e-logbook approved by mentor
S1	x	9	21	x		
S2	x	1	5	x	x	
S3						
S4	x	1	2	x		
S5	x	14	35	x		
S6	x	6	3	x		
S7	x	7	20	x		
S8						
S9	x	3	4	x		x
S10						

Annex E: category tree

Main Category	Category	Interview
usage of the e-logbook	usage of the e-logbook	I1, I2, I4, I5
factors limiting the use of e-logbook	challenges concerning the supervisor	I1, I2, I5
	challenges in receiving feedback	I1, I2, I3, I4, I5
	negative features of the application	I1, I2
	negative attitude towards the e-logbook	I1, I2
	technical barriers	I1, I2, I3, I4, I5
factors enabling the use of the e-logbook	accessibility of e-logbook	I2
	central saving of data	I3
	benefit for study and training	I1, I3
	easier evaluation of students' entries	I3, I4
	easy usability	I1, I2, I3, I4, I5
	positive attitude towards the e-logbook	I1, I2, I3, I4, I5
	time-efficiency of e-logbook	I1, I2
	useful features of the application	I2, I3
framework	organisational factors	I5
	technical support	I1, I2, I4, I5
recommendation	recommendation concerning the student-mentor communication	I1, I2, I5
	Structural recommendation	I5
	recommendation for the application	I1, I3
	technical recommendation	I1, I2, I3, I4

Statement of originality

I hereby declare that I have written the present thesis independently, without assistance from external parties and without use of other resources than those indicated. The ideas taken directly or indirectly from external sources (including electronic sources) are duly acknowledged in the text. The material, either in full or in part, has not been previously submitted for grading at this or any other academic institution.

Hamburg, 28.01.2021

Maike Jelena Schmidt