Chapter

Training Framework to Enhance Digital Skills and Pedagogy of Chemistry Teachers to Use IMFUNDO

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Abstract

The purpose of this study was to develop a training framework to enhance digital skills, practice and pedagogy of Chemistry teachers to effectively use a learning management system (LMS). The Department of Chemistry has been unsuccessful in adopting and integrating technology in teaching since 2011 due to the lack of a framework for training teachers in skills and competencies required to successfully implement digitalization pedagogy, engage students and improve student success. The challenge was that Chemistry teachers used LMS as a repository. This observation was not in line with the newly approved study University's Teaching, Learning and Technology Strategy and did not support student-centered learning. Action research was employed. It was found that the teacher-training framework and the remote training of Chemistry teachers were developed and implemented. After training, the design and development of online modules significantly improved. COVID-19 lockdown accelerated the transition to fully online teaching.

Keywords: training framework, learning management system, pedagogy, digital skills, higher education Chemistry teachers

1. Introduction

The Learning Framework of 2030 stated that the world is facing unprecedented social, economic and environmental challenges driven by accelerating globalization and a faster rate of technological developments [1]. A case in point is the recent COVID-19 pandemic, which forced universities worldwide to suspend all on-campus activities and move to online learning or distance learning either with or without any digital tools [2]. Linney et al. [3] reports that while adapting to this new normal, universities have quickly evolved their digital tools and platforms to ensure uninterrupted educational delivery to their isolated students. Teachers were expected to transform the way they teach, moving from the traditional contact model to an interactive online learning model [3]. Due to the changing nature of learning and teaching, there is a growing need for ongoing professional learning to equip teachers with skills

and competencies needed to adapt to the ever-changing student demographic and knowledge base, the speed of technological and societal changes [4].

In September 2015, the United Nations established the Sustainable Development Goals (SDGs), which serve as a road map for improving people's living situations, particularly in poorer nations [5]. The fourth of the Sustainable Development Goals pledges the international community to "provide inclusive and high-quality education for all and encourage lifelong learning" [5]. In realizing the National Development Plan's educational objectives (see Chapter 9), the study University's policy on Performance Management and Development [6] states that the employee and his or her line manager shall jointly develop an Individual Development Plan (IDP) to address any competency or other gaps that would impact on the employee's performance. This implies that upskilling teachers in the Department of Chemistry with competencies that would allow them to integrate technology in teaching for effective learning was part of the IDP that all teachers signed together with the line manager for 2020.

In 2011, the Nuffic-funded project intervention was introduced in the Department of Chemistry to train the teacher with the incorporation of technology in teaching. The Dutch teachers collaborated and assisted Chemistry teachers with developing a blended learning approach. In 2012, the department established the community of practice as Subject Groups. The purpose of the community of practice (CoP) was to facilitate collaboration, co-creating and sharing between Chemistry teachers. This CoP has been a success and still exists to date. Several teachers have also undertaken teacher training courses and workshops. Despite all these interventions, it was found that Chemistry teachers and students were still not using the learning management system known as IMFUNDO effectively for meaningful teaching and learning. For instance, more than half 56% of the teachers used the announcement tool to communicate relevant messages about the module to the students. Announcements were about changes to the teaching or assessment schedule, uploaded supplementary learning material such as videos, tutorials, etc.). However, the communication was one-way from the teacher to the students. More than half 53% of the modules used relevant learning resources such as PowerPoint presentations, notes or assessments. The PowerPoint presentations were, however, not interactive, not video presentations and did not have a voice recording of the teacher. Few of the modules used IMFUNDO for assessment purposes and used videos as a tool for anchored instruction. Based on these results, it could be argued that learning in the Department of Chemistry is largely teacher-centered based on the behaviorism learning theory [7]. The teacher-centered approach is perceived to have a negative impact on developing higher cognitive skills of students, encourages dependency on the teacher and memorizes content [8].

The challenge in this study was that Chemistry teachers used IMFUNDO as a repository, mainly for "dumping" PowerPoint slides of the learning unit, sending announcements to students and sharing the latest study guide. This observation is not in line with the newly approved study University's Teaching, Learning and Technology Strategy and does not support student-centered learning. If a teacher-centered approach and behaviorism continue in the teaching practice, it would be difficult for the institution to realize the University's 2020–2025 Institutional Strategic Plan Pillar 1: Future-ready graduates who make a positive societal impact and Pillar 4: Digitally-Advanced University.

Familiarity with subject knowledge alone is not enough for teachers to engage in effective and pedagogically meaningful instructional practices. Modern curriculum

delivery requires teachers to do their best to find innovative ways that not only facilitate but also optimize students' learning to the greatest extent possible. The incorporation of technology in teaching is ubiquitous, therefore in considering the integration of technology in teaching, a potentially useful method is to consider what it is that needs to be addressed, and how technology can be used to assist [9]. In the current study, the Department of Chemistry has been unsuccessful in adopting and integrating technology in teaching since 201. This was due to the lack of a framework for training teachers in skills and competencies required to successfully implement digitalization pedagogy, engage students and improve student success.

The objective of this study was to develop a framework to improve the teaching of online modules using IMFUNDO, to ensure that students engage meaningfully with the online modules. Furthermore, it was critical that Chemistry teachers' digital skills, practice and pedagogy were effectively enhanced with the aid of IMFUNDO. To achieve the level at which Chemistry teachers adopted and integrated technology in teaching, a training framework based on Arena, Blended and Connected learning was developed and implemented via online webinars. The IMFUNDO reports were used to determine the number of modules developed and digital tools utilized.

2. Related literature

2.1 Technology-enhanced professional development of teachers

The importance of professional development in teacher education cannot be overstated [10]. Brown et al. [11], argued that there is no 'one size fits all' supply-driven or demand-led model of teacher professional learning. The Australian Government undertook an initiative called Teaching Teachers for the Future, to improve the preparation of future teachers by integrating technology into their practice [12]. The institution needed to support and upskill teachers if it desires to remain competitive in an increasingly uncertain global market, as most programs are only as successful as the people in charge of them [10]. In this study, the policy on Performance Management and Development [6], as well as the IDP, supports Li and Morris' opinion.

During the COVID-19 outbreak and national lockdown, the study university adopted the emergency multimodal teaching, learning and assessment strategy [2]. The strategy forced all the teachers to adopt and use IMFUNDO in their teaching practices to continue with learning and teaching in trying times [13]. Darling-Hammond et al. [10] argued that the nature of teacher development should be a continuous process of becoming and articulating an inner world of conscious choices made in response to the outward world of the teaching context. There are various approaches and strategies to teacher learning were established in higher education. At a study university in 2005, the Partners @Work empowerment strategy yielded positive results, but it was not sustained [14]. As indicated, the Nuffic-funded project as well as the eLearning Leaders intervention proved to be successful in introducing teachers to digital skills. However, the challenge remained of using the UMFUNDO to engage the students with the application of interactive tools. In an attempt to empower Chemistry teachers with the proposed professional development framework, the attention and emphasis were on including digital technology with various stages of curriculum delivery.

2.2 Transformative pedagogy

Transformative pedagogies include higher levels of pedagogical practice, are learner-centered, engage higher-order thinking skills and include a variety of interactions between learners, content and teachers [15]. To support pedagogy, teaching with a technology system should be capable of supporting a transformative learning pedagogy. This means it should allow for the integration of authentic learning activities as well as learning activities that support collaboration, discourse and reflective thinking by students [16]. This implies that the use of digital tools and resources in transformative pedagogies enhances deep learning [17]. DoBE [17] argued that the use of digital tools and resources in transformative pedagogies enhances deep learning. When implementing the DoE framework, thinking skills, information management and interactions between learners, teachers and content should be taken into consideration.

At the core of good teaching with technology, there are three core components: content, pedagogy, and technology. These three knowledge bases (content, pedagogy, and technology) form the core of the technology, pedagogy, and content knowledge (TPACK) framework [18]. The TPACK framework encourages teachers to design pedagogically sound learning activities that maximize the impact of both digital tools and content resources on teaching and learning in a given context [17]. Howard et al. [19] and Ngcapu et al. [13] support the use of the TPACK framework as it provided a focus on learning and pedagogy that is typically missing from conceptions of online learning. It would be safe to say that TPACK was the basis of effective teaching with technology [20] and was an essential component of transformative pedagogy [21]. Therefore, teaching successfully with technology requires continuous evaluation of the dynamic equilibrium among all TPACK components as well as continuous training of teachers and adequate ICT support by the university.

There is no perfect digital pedagogy model and there are always challenges and opportunities with the integration of technology in teaching. Some users of the TPACK model have criticized the model for lack of practical examples to explain knowledge required for the crossovers TCK and TPK and how technology fits into these crossovers [22]. A drawback of the TPACK model was that teachers who lacked training and information technology skills could not adopt the technology in their classroom and inadequate post-training support discouraged the use of technology. Challenges highlighted by teachers in a private higher institution in Malaysia with using ICT in teaching and learning environment were lack of TPACK teaching and learning skills and ICT support. These challenges were attributed to poor instructional design and 80% of the teachers not using ICT in their teaching and learning environment [23].

Constructivism is a learning theory central to transformative pedagogy. According to Bada et al. [24] central to the philosophy of constructivism is that learning is an active process. Hence, from a constructivist perspective, the primary responsibility of the teacher is to create and maintain a collaborative problem-solving environment, where students are allowed to construct their knowledge, and the teacher acts as a facilitator and guide. Furthermore, Hamlin et al. [16] adds another dimension that learning environments that are based on social constructivist learning principles can enhance transformative pedagogy. Donnelly et al. [25] implemented a constructivist learning approach in a blended problem-based learning module. Findings of the study indicate that some aspects of constructivist learning may be directly stimulated by using technology, the findings noted an increased level of collaboration and that involvement with content is often reinforced by technology use.

3. Research question

How can a training framework be developed and implemented to enhance the digital skills, practice and pedagogy of Chemistry teachers to teach effectively using IMFUNDO?.

4. Method

To respond to the question, action research was used to a better understanding of study problems. Action research is defined as an approach in which the action researcher and a client collaborate in the diagnosis of the problem and the development of a solution based on the diagnosis [26]. The process of action research involves, planning to initiate change, implementing g the change (acting) and observing the process of implementation and consequences reflecting on the process of change and replanning, acting and observing as well as reflecting [27].

On the 23rd of March 2020, a national lockdown in response to the COVID-19 pandemic was announced in South Africa [2]. To respond to the national lockdown regulation, the study university implemented a remote multimodal teaching, learning and assessment strategy from June 1, 2020. This required an unprecedented rapid transition from face-to-face teaching to online teaching and learning. To assist teachers with the design and development of online modules on IMFUNDO, the study university implemented Emergency remote teaching and empowerment [2]. For 3 months, the instructional designers conducted online teaching and empowerment. The emergency remote teaching and empowerments' purpose was to empower lecturers in transitioning from traditional teaching to online or remote teaching through the use of various tools on the IMFUNDO to benefit students [2]. Since technology alone does not guarantee a pleasant or effective learning experience, it was vital for instructional designers to ensure that pedagogy was given higher attention throughout [2].

To further ensure the training of teachers in the Department of Chemistry, the training that was scheduled for 4 months (March 1, 2020–July 31, 2020) was then reduced to 2 weeks (April 14–17, 2020 and May 11–15, 2020) to ensure that teachers have the necessary technical skills and competencies to teach remotely [15]. The Arena, Blended and Connected learning design approach was used for training teachers to develop online modules [2, 15]. The Arena, Blended and Connected (ABC) learning design, according to Young [28] is a quick way to (re)design programs and modules through a hands-on workshop where academic teams discuss and create storyboards of students' activities. A minimal version of the ABC learning design adapted from [28] was followed and consisted of the following elements:

- Pre-workshop: resources provided for teachers to engage with before each session
- Live session: daily using virtual conferencing tool IMFUMDO Collaborate for about 1 h 30 min
- Post-workshop: consisted of support provided through a community of practice WhatsApp chat group

To develop a successful framework that improves teaching and learning using digitalization pedagogy and TPACK principles, firstly, the chapter reflects on the findings of the preliminary study, which was conducted in 2019 to develop a plan

that improved the teaching and learning practices. From the findings, it was evident that a systematic approach was required for the training of teachers to ensure that they possess skills, values and attributes central to transformative pedagogies that were student-centered, engage higher-order thinking skills and include a variety of interactions between students, content and teachers. Secondly, the teacher development framework and a framework for designing online modules were developed and implemented.

4.1 Participants

In this study, purposive, convenient and was used to select the participants. Purposive sampling means that the researcher selects individuals and sites for study because they can purposefully inform an understanding of the research problem and central phenomenon in the study [29]. Convenience sampling refers to the selection of settings, groups, and or persons who are readily available and eager to engage in the study [30]. In this case, the participants were 25 full-time teachers who taught 756 students, of which 711 were undergraduate and 45 postgraduates in the Department of Chemistry. Their age ranged between 32 and 65 years. In terms of qualification, 17 (68%) of the teachers hold a PhD in Chemistry, 7 (28%) hold a Masters in Chemistry and one holds a Bachelor degree in Pharmaceutical Sciences.

4.2 Instrument and procedure

Document analysis (Remote Multimodal Teaching, Learning and Assessment Strategy and Plan as well as the Faculty Emergency Teaching and Empowerment Plan), and learning management system reports, were employed to collect data in this study.

4.3 Document analysis

The Remote Multimodal Teaching, Learning and Assessment Strategy and Plan (RMTLAS&P) was used because during the second announcement of COVID-19 national lockdown in April 2020 and to comply with the directive by the Ministry of Higher Education, Science and Innovation, the study university adopted the RMTLAS&P. The RMTLAS&P's goal was to finish the 2020 academic year successfully [31]. This was contingent on the possibilities during the lockdown and when the measures were eased to enable contact learning and teaching to resume. The RMTLAS&P was implemented in two approaches. The first approach used was the digital delivery through the IMFUNDO and the second was the distribution of printed study material to students who may not be able to use the digital mode due to various reasons. For this chapter, the digital delivery with the aid of IMFUNDO is presented. The university teachers were given mobile devices and Internet connectivity as well as training in remote teaching and learning methods. The training was conducted by Instructional Designers.

To assist university teachers with the planning, design, and development of online modules, an emergency remote teaching and empowerment plan was also developed. In the Faculties, the Instructional Designers adopted the institution empowerment plan and customized it to suit the Faculty of Science needs [32]. Simelane-Mnisi et al. [2] argued that it was vital not to compromise the quality of the online material when preparing for online or remote instruction. The concept of constructive alignment

was suggested to equip university lecturers to move their content online or remotely. Learning outcomes, learning material (content), learning activities, interactions (collaborations), feedback, and course technology can all benefit from constructive alignment. These ideas work together to guarantee that students attain the learning results they desire. Various instructional design models relating to Gagne's nine events of instructional design, backward design Revised Bloom taxonomy, and ADDIE model Analyze, Design, Develop, Implement and Evaluate were also used to ensure the design and development of online learning and teaching material on IMFUNDO.

4.4 Learning management system reports

The LMS report was used to determine the number of online modules developed and the tools used within the modules.

5. Results and discussion

5.1 Development of teacher-training framework

A teacher-training framework was developed to upskill university teachers in the Department of Chemistry with technological skills and TPACK pedagogical approaches to teaching online modules. The framework was designed and developed with the assistance of a Senior Instructional Designer in the Faculty of Science. The framework was adapted from the Faculty of Science training framework. This statement is supported by Sumer and Sim et al. [33, 34] who revealed that university teachers may or may not have prior experience with open, online, and remote learning during pandemics, so these authors emphasize that formal training on how the new system works and what teaching online looks like with adaptive frameworks supplied should be conducted.

It was critical that during this training session that the instructional designer ensured that pedagogy was taken into consideration. Instructional design principles relating to Gagne's nine events of instructional design, backward design Revised Bloom taxonomy, and ADDIE model Analyze, Design, Develop, Implement and Evaluate were considered during the facilitation of the online training sessions. Furthermore, the educational theories and models were also considered. The teacher-training framework was grounded by the ABC learning design, TPACK, Flipped learning approach, Revised Community of Inquiry and constructivism theory. These theoretical frameworks and models assisted the instructional designer and teachers to ensure that online modules provided quality in the online delivery of learning material, taking into cognizance the socio-economic backgrounds of the students. Summer and Sim et al. [33, 34] support these statements and further argue that to ensure that quality learning and teaching practices are established, appropriate pedagogical frameworks must be explicitly communicated to university teachers and just-in-time training be provided. The focus in this study was not only technology. However, incorporation of these strategies responded to the cry that often teachers fail to incorporate technology with pedagogy because training is mostly offered by facilitators who are technology experts, however, lack the pedagogy.

The study university serves the community from urban, rural, townships as well as informal settlements. It is not technology that matters, but teaching and learning to achieve the learning outcomes. In this regard, various teaching approaches were also

used during the remote training relating to active learning design, scaffolding as well as matters of quality. It is critical to recognize the time required to adapt teaching to an online platform that is engaging, interactive and gives a positive student experience while transitioning to online [33, 34]. In this case, the Arena, Blended and Connected Approach provide the opportunity for teachers' transition from traditional teaching to remote teaching using digital technologies. The ABC approach assisted the lecturers in this process. This approach guided converting the conventional teaching and learning activities lecturers use with their students to use remotely, online with digital technologies. The ABC approach further assists lecturers to select various six learning activities that support six teaching methods that encourage engagement and interaction in the online environment. The learning activities include acquisition, collaboration, discussion, investigation, practice and produce.

A flipped learning approach was used. Flipped learning is the approach to learning where content delivery is assigned as homework or pre-classwork in a form of a video, online learning material or lecture notes and assignments are completed as classroom activities in-class as well as after-class [35]. Due to the pandemic and in the case of RMTLAS&P, in-class activities and after-class activities were completed online. This implies that the instructional designer encouraged teachers who were students to engage using IMFUNDO and other technologies to ensure that students engaged with the learning content. When the instructional designer conducted live classes on IMFUNDO Collaborate Ultra, it was guaranteed that students would be better prepared to engage in interactive and higher-order activities, such as critical thinking, problem-solving, discussions, and debates in class [36]. In this study, Chemistry teachers had access to the learning content and activities on IMFUNDO before the online session and could also engage the learning content at their own time and pace. The aim development of the flipped classroom was to fulfill students' needs, develop twenty first-century skills, and integrate technology into regular education [37].

Flipped learning was driven by the Revised Community of Inquiry theoretical framework to benefit teaching and learning. The Revised Community of Inquiry (RCOI) is one of the frameworks that was employed in a flipped learning approach. It is argued that in RCOI [38] knowledge construction results from the collaborative interaction between active students and lectures, particularly in the technology-enhanced environment. The community of Inquiry theoretical framework by Garrison et al. [39] is a widely researched framework representing a process of creating a deep and meaningful learning experience [40]. The interdependent elements of the learning process central to the framework are cognitive, social, and teaching presence, each of which represents different aspects of the inquiry-based learning process [40]. These elements contribute to successful learning as well as a student-centered environment [41]. This framework was used based on the fact that RCOI provides a collaborative-constructive perspective to understanding the dynamics of online learning.

5.2 Chemistry teachers training framework

Figure 1 shows the training framework for Chemistry teachers to enhance digital skills, practice and pedagogy. Due to the COVID-19 pandemic and national lockdown, training was conducted online, using IMFUNDO Collaborate virtual conferencing platform. The IMFUNDO online module named "Emergency Remote Support" was created for all the Faculty of Science lecturers. This module was also used by the Chemistry teachers. All the teachers were given students access to the online module.

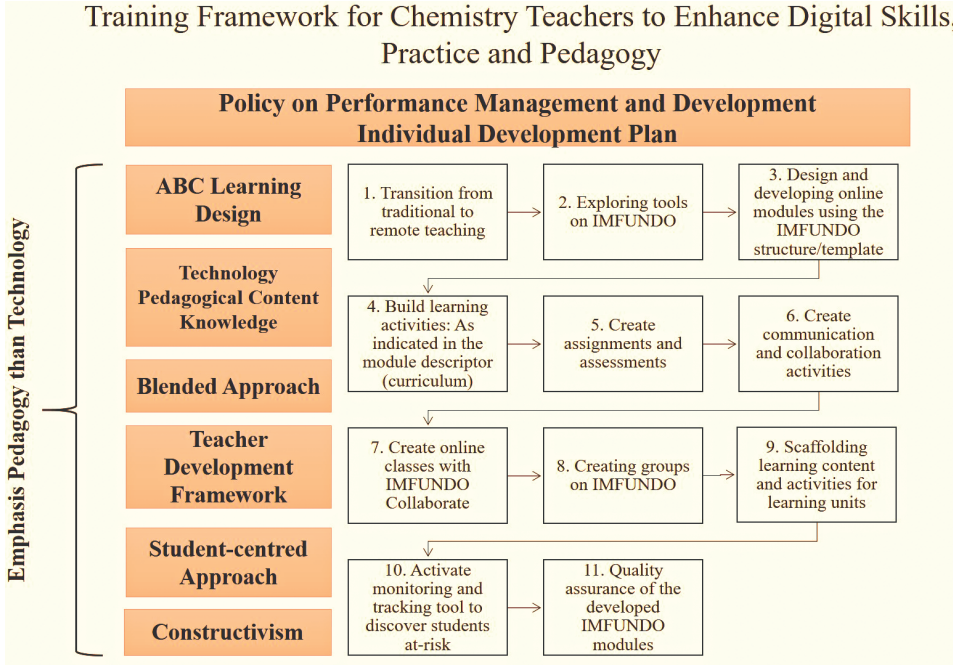

Figure 1.
The training framework for Chemistry teachers to enhance digital skills, practice and pedagogy.

Training took place twice daily (morning and afternoon) for 2 h over 2 weeks (April 14–17, 2020 and May 11–15, 2020), a link to the live session was sent daily to teachers using the announcement tool of the LMS and also using a WhatsApp chat group that was established for the teachers to stay connected during the lockdown. WhatsApp also serves as a safe environment as well as a community of practice where lecturers asked questions and share best practices about the development and implementation during the COVID-19 pandemic. The training framework consisted of 10 learning units with learning outcomes.

The aim of the transition from traditional to remote teaching was to create a safe environment for university teachers to learn more about the traditional learning activities that they provided in class on how they should use digital technologies. Gumede et al. [42], opined that it is essential for university teachers to acquire continuous support and skill development as they transition from face-to-face to online teaching and learning during the pandemic. To fulfill Gumede et al.'s [42]. opinion, the ABC learning activity was emphasized as it provided the fundamental of learning activities and methods. The literature revealed that the transition to online learning posed a big challenge to decide which online technology is best suited for university teachers [43]. In this study, teachers were introduced to interactive remote module development. Teachers prepared online teaching and learning material using a storyboard/course map using the approved university HEQSF curriculum. In this instance, the module descriptor and study guide supported this process to ensure the quality of online modules and to meet the standards as required by the professional and statutory and regulatory bodies. Namada et al. [44], argued that COVID-19 has compelled the education sector to adapt to the visible indicators of a new paradigm, our continuous experiences with online teaching and learning should frame our expectations of what will happen after the Covid-19 pandemic.

To understand the different functionalities of IMFUNDO, it was imperative to explore various IMFUNDO tools. The learning management system has the potential to facilitate both synchronous and asynchronous types of e-learning with the aid of a variety of digital tools [45]. In this study, the digital tools that were used to facilitate synchronous, asynchronous and binochronous learning were divided into seven categories namely, content, collaboration, communication, assessment, video conferencing, management and survey. Synchronous instruction occurs in real-time and requires the simultaneous participation of students and teachers [46]. Examples include test chats, audioconferencing, videoconferencing, whiteboards, and real-time break-out rooms. Asynchronous instruction on the other hand occurs in delayed time and does not require the simultaneous participation of students and teachers [47]. In an asynchronous setup, learning events are independently experienced by students and learning is not synchronized in time or space. Examples include discussion forums, emails, and surveys.

The content tools comprised of IMFUNDO server, folders, items, files. The collaboration tools included a discussion forum, the journal for reflection, groups, wiki and blogs. The communication tools included announcements, Chats (WhatsApp class group), email and calendar. The Assessment tool consisted of the IMFUNDO test, Microsoft Form, Respondus, assignment, rubric and plagiarism detective tool. The video conferencing tool is known and IMFUNDO Collaborate Ultra was used for live teaching or webinars. The management tools included reports, grade center, retention center for monitoring and tracking students-at-risk. The survey tool consisted of an Enterprise survey for student lecturer, evaluation. It can be seen that the LMS allows university teachers to use dynamic digital tools to make it what they want it to be to facilitate successful and efficient teaching and learning.

It was important to design and develop online modules using the IMFUNDO structured template. Research shows that to provide best practices for using technology for developmental education, the use of a common 'master' template in an LMS was observed at the College of the Mainland, Texas City, Texas [48]. In this study, the content structure was used which was aligned to the module descriptor and study guide. The structure assisted in providing the shell to build the online modules. The structure aimed to ensure to provide clear guidance to students as they were learning in isolation from their homes. Cho et al. [48] argued that the LMS common template/structure was seen to be effective with 100% teachers' usage and student participation. Also, in this study, the structure was created in a manner that was user-friendly and appealing to students. The teachers were trained to create a welcome page that consisted of inserting the Department banner in the module landing page, creating a text welcome statement, recording a short welcome video using their smartphone and uploading it on IMFUNDO, uploading a headshot picture, add teacher details and consultation time. The teachers had to create a page that included a module overview with a module purpose statement, module outline and assessment plan. In addition, the teachers had to populate learning content on the IMFUNDO server. In this case, lecturers had to create folders and upload files in relevant folders. The usage of a common pre-built template was shown to be efficient in alleviating instructor frustration [48].

The teachers were also empowered on how to build the learning activities as indicated in the module descriptor or study guide. In this regard, lecturers used ABC learning approach to create interactive and engaging activities in an online environment. The activities encourage assessment for learning, formative assessment as well as continuous assessment. Student's engagement, interaction and participation were

promoted by creating short quizzes and exercises using Microsoft forms, Respondus and IMFUNDO quiz tool. These engaging activities were created for each learning unit. Lapitan et al. [43] argued that teachers should transition from the old teaching paradigm to new teaching methods that are compatible with technology to teach online.

Concerning the design of assignments and assessments, the teachers had to design formative and summative assessments in a form of formal online tests and assignments. These assessments were used as predicate for the final examination. It was reported that university teachers had to adjust their teaching plans, teaching styles, and assessment methods as a result of the abrupt move to full online teaching [43]. In this study, the continuous assessment strategy was adopted in most of the modules. The reason was the COVID-19 pandemic lockdown and the shutdown of the universities. Undergraduate students and teachers did not have access to campus nor attend classes. The assessments were built with the aid of Microsoft forms, Respondus, IMFUNDO quiz tool and assignment. Lapitan et al. [43] revealed that self-assessment questions were made available for each topic on the LMS. The assignments were used with an online rubric which was opened to students, to see what was expected of them and how they will be evaluated. For the assignment, the SafeAssign tool to detect similarity for plagiarism check was used. Mbhiza et al. [44] contends that the shift to online technology-based teaching and learning means that traditional assessment methods were no longer sustainable.

Teachers needed to learn the tools to promote student engagement on IMFUNDO relating to communication and collaboration. According to Cho et al. [49], if implemented with appropriate pedagogical approaches, online learning environments improve student engagement and learning outcomes. Teachers were trained on how to create announcements, send emails to students and different class groups, create a calendar for the module. In this regard, Summer and Sim et al. [33, 34] indicated that the university teachers were required to quickly adapt and establish innovative communication channels that could be accessed by both domestic and international students. With regards to collaboration with students, lecturers create a discussion forum, used the IMFUNDO journal for student reflection after each learning unit.

Since classes were to be presented remotely, teachers were also empowered on the use of a virtual classroom known as IMFUNDO Collaborate Ultra as stated by Study University of Technology [31]. Mbhiza et al. [44] identified other virtual classrooms that were used in most of the South African higher education institutions to ensure learning continuity, provide support to students throughout COVID-19, and so improve online learning. In this study, teachers were trained on the functions of IMFUNDO Collaborate Ultra relating to recording the session, muting participants, video, chat, raising hands, creating breakaway rooms for group discussion. They also leant to record their lesson and later upload it on the IMFUNDO for students to access. Teachers were trained to set times and dates and release the link using IMFUNDO announcements or student's institutional email. The aim was for teachers to emphasize students' engagement and participation during live classes.

Various interactive tools to promote student engagement were also used. In this instance, teachers were empowered to create groups on IMFUNDO, use social media network tools such as Facebook, WhatsApp, Twitter, and YouTube Videos as well as create social media groups. These social media tools were linked on IMFUNDO.

After teachers were empowered on each technology tool on IMFUNDO, the concepts of scaffolding and chunking content were applied. Chunking is the process of breaking down a component into smaller "chunks" of related information [50].

These authors further indicate that chunking is utilized in circumstances where content can be broken into smaller groups or categories to improve meaning clarity. Scaffolding is the process of breaking down learning content into chunks and giving each chunk a structure [51]. The aim of using these strategies in this study was to ensure a better and user-friendly learning material and activities delivery. This was to ensure a better student learning experience while learning in isolation and their homes. In the study conducted by Chen et al. [52] at Victoria University, it is reported that the Online Interactive Activities was used in a blended approach where the chunking content into bite-sized chunks to increase the sustainability of the activities (smaller topic-specific activities are more likely to be cloned, adapted, and incorporated into a variety of subjects), which allows students to focus on their learning without being distracted by outside factors. To achieve scaffolding and chunking content, the university teachers designed and developed online learning units using folders. In the folder they presented learning unit topic with a brief description, the file with learning outcomes and assessment criteria, they uploaded learning and reading material using PowerPoint presentation with audio narration, add links to web resources, audio and video (Notes, Videos, PPT/Video PPT, Audio files, PDF, etc.) using links tool. Teachers linked the learning activities which foster students to engage and participate in the online modules. In this way, students tested their understanding, knowledge and skills. They included a link to the virtual class and the reflective journal was provided at the end of each unit. In this study, the Instructional Designer then helped teachers to chunk the content into topics or chapters, linking it to complimentary activities to engage students through interactivity, knowledge testing, or reflection and interaction [53]. Chunking and scaffolding of learning material and activities promotes student-centered, as it for participation and engagement and avoid distraction or boredom.

Teachers needed to monitor, track and discover students at-risk while learning in isolation and provide necessary support during the earning process. The Retention Center tool was activated and the criteria were set accordingly. Teachers were also empowered on downloading various reports on the system to monitor students in an online environment.

The training was hands-on, teachers were provided with step-by-step instructions on how to design and develop modules, how to choose the relevant technology and tools for their subject matter and how to integrate technology in teaching online modules. All training sessions were recorded, to monitor attendance and so that the teachers can revisit any session that they need to, at their own time. At the end of the training, an "online teaching toolbox" was developed and shared via email with all teachers to ensure that they engage with the training material at their own pace. The toolbox contained links to all the recorded training webinars, standard operating procedures of how to develop an online module using the standardized template, how to record audio over PowerPoint presentations, how to create online to check the quality of the design, developed of the online modules for remote teaching, teachers' self-evaluation on quality assurance were used. The quality assurance instruments were developed by the researchers.

5.3 IMFUNDO reports

A standardized template for IMFUNDO modules was developed using a blended approach of synchronous (live lectures online) or asynchronous (work at own pace). The blended approach often leads to deeper processing and retention of knowledge [54].

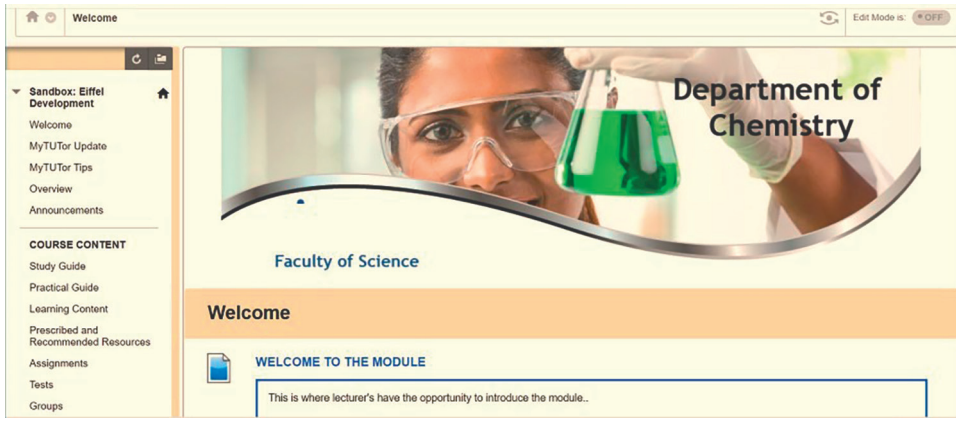

Figure 2.
An example of IMFUNDO online module.

People do not learn from interacting with content only, however, they learn from processing that content and through social interactions [54]. Learning content in IMFUNDO modules was structured to maximize retention and promote student success using the scaffolding and chunking design approach. All modules complied with this basic requirement. An example of an IMFUNDO online module with the standardized Department of Chemistry banner is illustrated in **Figure 2**.

A sample of data of 39 modules offered by the Department of Chemistry from June 1, 2020 to November 31, 2020 was retrieved from IMFUNDO on December 3, 2020. A quality rating using a descriptor Yes or No was applied to evaluate the module design. The IMFUNDO module design quality results from the 2019 development project were compared to those obtained in 2020 after the implementation of the digitalization pedagogy framework in the Department of Chemistry. The IMFUNDO results show the comparison of the statistics of the module design in 2019–2020. A significant improvement in the design and usage of the functionalities of IMFUNDO was observed after teachers in the Department of Chemistry were upskilled and gained relevant competencies to integrate technology in teaching. In 2020, 100% of the online modules had the latest study guide and timetable uploaded on the VLE, compared to 54% in 2019. The learning content was arranged in smaller easy to follow learning units in 79% of the modules in 2020 compared to 53% in 2019. The use of online assessments increased tenfold from 5% in 2019 to 55% in 2020. Similarly, asynchronous activities such as assignments and tutorials increased from 16% in 2019 to 50% in 2020.

6. Conclusions

In this chapter, the training framework to enhance digital skills and pedagogy of chemistry teachers to use IMFUNDO was developed and implemented. It was reported that the COVID-19 lockdown reportedly hastened the move to entirely online learning. For the university teachers to be able to transit from traditional to online or teaching remotely, professional development needed to be conducted to equip chemistry teachers with the necessary skills to teach online. It may be observed that the various pedagogical approaches ad well as the instructional design principles

were taken into consideration to bridge the gap between the two. A standardized structure for IMFUNDO modules was created utilizing a hybrid approach of synchronous and asynchronous. The scaffolding and chunking of learning content were applied to ensure student engagement. All the online modules were created using a similar structure/template. There was a significant improvement in 2020 on the module created of LMS in the Department of Chemistry as compared to 2019. We observed an increase in the digital tools created that promoted synchronous and asynchronous learning in 2020. It was imperative to create such activities as students were learning from home.

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Conflict of interest

The authors declare no conflict of interest.

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