Information and Communication Technology Practices in Biology Teaching in Lesotho High Schools

Bobojane Makuru and Thuthukile Jita

***Abstract*—Information and communication technology (ICT) has never been more important in schools than in the current context of the global COVID-19 pandemic. The COVID-19 pandemic has forced many more teachers to use ICT for teaching, even in less resourced countries such as Lesotho. In this quantitative study, teachers' ICT practices in Lesotho during the year 2020 were examined through the lens of technological pedagogical content knowledge (TPACK). The objectives were to investigate the ICT tools that teachers commonly use, describe the practices that characterize the patterns of use, and determine the correlation between teachers' practices and their use of ICTs for teaching. Altogether, 107 respondents, selected by a systematic probability sampling technique, completed a five-point Likert scale questionnaire comprising closed-ended items that explored their practices on ICT use for teaching the subject of biology. Data were analyzed for frequencies, means, and standard deviations using the Statistical Package for Social Sciences (SPSS) program. The results indicated that biology teachers in Lesotho use ICTs rather sporadically in their teaching and are consequently ill-prepared to adapt to and mitigate the negative impact of the COVID-19 pandemic on schooling in Lesotho. The study concluded that teachers' ICT practices are inclined towards supporting more traditional and teacher-centered approaches that rely on face-to-face teaching and learning, with most schools thus remaining closed during the pandemic. The study makes recommendations about the possible ways in which biology teachers in particular could be better prepared to specifically use ICT to teach biology either online or as part of a face-to-face classroom.**

***Index Terms*—COVID-19, high school biology, information and communication technology, Lesotho, TPACK.**

I. Introduction

The aspiration to renounce instructive practices that regard learners as submissive receivers of knowledge, and to switch to practices that consider learners as effective agents in the creation of knowledge, began over a century ago. This idea was inspired by renowned philosophers such as [1] and [2]. To date, campaigns for effective learner input in learning persist to gather interest, such that countries have started incorporating information and communication technologies (ICTs) in order to encourage a switch from conventional to contemporary teaching-learning practices. All over the world, the coronavirus-disease (COVID-19) pandemic has stimulated contemporary teaching-learning practices, such as flipped classrooms, in a number of school subjects.

Research on the use of ICTs in the teaching of subjects such as biology has been carried out around the globe [3]-[5] and reported a high likelihood that teachers were ignorant of the possible application of ICTs for teaching and learning. It has also been observed that teachers probably use ICTs mainly to keep updated with societal issues, which might have little or no use in the teaching and learning practices of specific subjects. [6] maintains that, the use of ICT enables flexibility in terms of learning spaces, as learners can continue learning anywhere they are, in spite of challenge such as COVID-19. Since biology as a subject is diverse, fast moving, and typified by a persistent outburst of fresh information, teaching it with ICTs will be quite useful. Thus, biology teachers are encouraged to know various technological tools to effectively teach biology content.

Literature has established that there are various ICT tools to be used in teaching biology for engaging learners in the learning process, such as virtual experiments, computer animations, simulation, and videos [7], [8]. These tools could be used for topics perceived difficult in a face-to-face class, a blended learning environment, and even in a totally remote teaching and learning environment. Other scholars argue that academic achievement of learners taught using ICTs is significantly higher than that of learners taught without them [9], [10]. Use of e-learning software or virtual laboratories to augment biology instruction was confirmed in a few schools in Zimbabwe [11]. Despite the teachers knowing that these tools would enhance learning ability amongst learners, they are seldom used, and reasons cited include shortage of data (Wi-Fi) and lack of connectivity in the school. [12] contends that the use of various ICTs for collaborative learning acknowledges and promotes learner independence and inventiveness. The ICT-integrated cooperative learning methods, facilitated by the teachers, assist learners to develop subject understanding, critical thinking, and analytical abilities.

According to [13], contemporary teaching aids, such as videos, slide projectors, computers, and multimedia, have supreme benefits over other teaching aids. Within a short space of time, they can clearly display undoubtedly difficult to observe organisms, life processes, and phenomena, thus enhancing swift understanding of abstract biological information. In addition, they can successfully arouse learners' quest for knowledge, and lure them to actively participate in the educational process. Practice confirms that learners' attention in the class can be attained by the use of updated teaching aids. [14] demonstrated in his study, that learners taught using multimedia achieved better than their classmates taught using the traditional teaching method. [15] reiterated that, learners taught using multimedia that are incorporated with computer animations, gained more knowledge, and better comprehension skills than learners

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taught in a conventional method of instruction. This is probably because availability of multimedia resources permits considerably diverse learning experiences to arise [16].

The use of ICTs in teaching and learning practices makes the educational environment inventive and learner-centered. Thus, it arouses both problem-solving and high-level-thinking abilities, and promotes lively, cooperative, and discovery learnings [17], [18]. Learners are exposed to the most recent or latest release of smartphones or tablets, and connect with people by making use of social media platforms, such as Facebook, Instagram, WhatsApp, and Twitter, any time and at any place. Therefore, teachers should take the advantage, and use the recent and relevant ICTs for the benefit of teaching and learning practices. The use of ICTs for teaching biology in Lesotho, a developing country, affords the opportunity for continuous learning even in difficult times such as the pandemic. Moreover, ICT use assists teachers to save time, clarify difficult concepts, keep learners active, and simplify their job [19], [20]. Consistent with this, [21] stated that the "flexibility of place and time, availability of learning resources, and increased independence of teachers and students in using technology are the advantages of online biology learning during the COVID-19 outbreak"-page 48. Thus, countries with disparate economic positions encourage the use of contemporary technologies as instructional instruments in different subjects [22]

Scholars argue that learner performance picks up when ICT is applied and precedence is given to learner-centeredness [5], [22], [23]. This is probably because ICT affords quality instruction that complies with constructivism [24]. Few empirical studies [25]-[27] have confirmed that ICTs bolster efforts to better the quality of pedagogy implemented in classrooms; actually, they believe that, use of ICTs in classrooms would ensure academic excellence in instruction. Thus, countries with disparate economic positions encourage the use of contemporary technologies as instructional instruments in different subjects [28]. Therefore, this paper examines biology teachers' practical use of ICTs to teach in Lesotho schools during the COVID-19 pandemic.

The specific research questions were: 1) What are the biology teachers' ICT practices, and 2) to what extent do they engage in such practices? The purpose of these research questions is to determine the practices that characterise patterns of use of ICT by biology teachers. This would provide important information about the status of education in the era of the COVID-19 pandemic. Thus, the authorities in education could make informed decisions concerning necessary interventions.

II. Literature Review

Literature has revealed that teachers generally use ICTs for searching, sharing, organizing, filing, or recording of information; for fun, communication, presentations, or preparing learning and teaching material (handouts); and for writing or typing. ICT encompasses "technological tools and resources used to communicate and to create, disseminate, store and manage" [29] (p. 31). Consistent with this understanding, research has shown that internet users have access to plenty of tools [3]. These include Ask, Bing, Google, and Yahoo search engines for researching; Gmail, MSN Chat or Groups, Skype for synchronized and unsynchronized communication; YouTube, Flickr, Dropbox, and Google Drive for sharing files.

According to [30], computers and internet technologies permit contemporary teaching and learning methods instead of merely being advanced means for teachers and learners to continue their old-fashioned practices. However, in the context of this study, [31] point out that teachers have turned the internet into a source that features in their teaching approaches and which they use mainly to discover and pick out resources. Teachers develop these resources into activities that they may have to demonstrate in the classroom. Again, they use them to assess learners' performances. In addition, through the internet, teachers can handle issues relating to knowledge of content and knowledge of learners, while following learners' advancement and devising a logical sequence of ideas. This is corroborated by [32], who investigated the impact of the internet on planning and instruction in Aland Islands secondary schools. The study found that, the teachers viewed the internet as a significant supplementary teaching tool and one of the best information resources. [26] also confirm that Slovenian biology teachers used "computers for school work mainly as typewriters, as a source of information and a communication tool, for their preparation, tests and administration outside the classroom, most often at homes" (p. 43). In spite of this, [3] established that in Brazil, very little didactic application of internet instruments takes place, with teachers rather mostly inclined to looking for biology content for personal gain and downloading resources to distribute to their students. Also, [33] found that, amongst many different technologies, presentation software and internet browsers were the tools predominantly used in teaching-learning activities. The aim of their study was to "examine the ways teachers enact technological, pedagogical and content practices in mathematics and science lessons and to document the change with teachers involved in a year-long technology integration initiative" [33] (p. 395).

In India, it was found that, the teachers only sometimes used computers for teaching, pre-teaching, nonteaching, and self-instructional purposes [34]. Teaching purposes included lessons for the entire class, learner tasks controlled by teachers, and teachers' own learning. Pre-teaching purposes included lesson planning, and seeking and producing content for teaching. Nonteaching purposes included learners' grades measuring achievement, communication, and maintaining records. Lastly, self-instructional purposes included drill and practice exercises, simulations, and problem-solving practices. Teachers regularly used computers to bring their content knowledge and teaching expertise up to date, make lesson plans, and organize supplementary teaching material and set up item banks. Once a month, they would use the computers to illustrate lessons in class, produce exam papers, do simulations, and mark learners' homework. About 50% hardly ever or not at all used computers for delivery of the whole lesson, communicating with parents, issuing

assignments, administering tests, or keeping attendance register or recording grades.

In Trinidad and Tobago, [35] studied the use of ICT-based technologies in classroom science teaching and discovered that the majority of teachers extensively used PowerPoint, whereas animations and hands-on practical activities were less commonly used. Virtual laboratories, computer-aided simulations, and smartboard were used by only a small number of teachers. Videos, demonstrations, simulations, and the internet can be used to bring practical problems to the classroom and thus generate productive environments to support and enhance learning [4], [36]. The modern-day technologies offer and back the resource-based, learner-centered environments and permit connection between learning and both context and practice, and thus fetch various educational opportunities [37], [38]. An example is the creation of learning communities, entailing communication and on-line learning for teachers with their peers who have similar educational interests and requirements [36]. These communities facilitate classroom-to-classroom interaction in the same school or globally, and also between parents, tertiary scholars, and subject specialists, to mention but a few. Connections with compatible international learners are enabled, creating essential communities and accessing a wide range of resources without difficulty [39]. These scholars emphasize on the benefits of using modern social and digital technologies, such as "their immediacy, reach and flexibility" [39] (p. 365). Thus, together with traditional instructional methods, they can assist teachers and promote learning.

[40] and [41] found that, the most frequently used technology was for preparation, management, and administrative purposes and rarely used for aiding learner-centered pedagogy. This was the case even with teachers who embraced learner-centered beliefs and had access to most of the ICTs in their schools. Most would rather use ICTs to back their teacher-centered teaching practices. Ndlovu and Meyer [42] also found that even teachers in some Gauteng schools that were well-resourced with ICT infrastructure used technologies mainly for mundane communication and administrative practices. In rare cases where ICT integration occurred, it was largely teacher-centered rather than affording learners meaningful learning experiences.

In Lesotho, [43] found that only the minority of the investigated science teachers used e-learning for preparation and demonstrations in class. However, learners had scanty active and collaborative experiences with the e-learning tools. The probed e-learning tools were tutorials, drills, simulations, educational games, and internet/e-mail. In contrast, it was found that the majority of the teachers used computing tools such as Word processing and spreadsheets, though only 38% used PowerPoint presentations. The sample, about 21 teachers, was quite small. Therefore, a larger sample, such as the one used in this study, was necessary to corroborate or extend the findings made by [43]. In another study, [44] found that Lesotho physical sciences teachers used flash drives and printers, though not so often, to store information and make hard copies of the material. Also, [45] established rare use of ICTs by teachers in physical sciences. Physical sciences teachers used ICTs slightly more for non-teaching activities than for teaching. They concluded that, the technologies were probably used for conventional practices such as improving their subject content rather than presenting it to the learners.

The technology used in most of the studies cited, thus indicate little or no inclination to constructivist teaching. This is rather disappointing because use of constructivist strategies in teaching and learning is associated with remarkable achievement [46]. ICT motivates learners, tools such as videos, television, and multimedia computer software present stimulating and realistic content that engrosses learners in the learning process because they blend textual matter, sound, and multi-colored moving images [30]. By means of tools such as simulations, hypermedia, and "problem-based" learning environments, technology becomes a collection of instruments for the creation of knowledge [47].

Pertinent to the context of the current study, [48] confirm the assertions of the academics in their study, *Biology teachers' methods of teaching and academic performance of secondary school students in biology*. They found that teaching methods affected Nigerian learners' performance in biology. Accordingly, they recommend that teachers should select learner-friendly teaching methods as it would promote the learners' assimilation and achievement in their examinations. These findings confirmed those of an earlier and similar study on the impact of teaching techniques on learner performance by [49], who also discovered that only efficient instructional techniques can result in successful learning. However, they reported that, the teaching tactics of many practical-based science subjects such as biology, physics, and chemistry were predominantly boring, leading to increasingly poor learner performance in the subjects, especially biology. Thus, teachers ought to be inventive, resourceful, and self-motivated with respect to the methodologies they select, in order to guarantee improved learner achievement in the subject. It is therefore imperative that Lesotho biology teachers' ICT-enhanced teaching practices be examined, especially because Lesotho high school learners have also exhibited low achievement in biology [50], mathematics, and science (biology included) in general [51].

Constructivist teaching methods can help a great deal in overcoming the challenges of teaching biology. They underscore the learner's responsibility in actively constructing knowledge and their sense of information [52] by experiencing and reflecting on their experiences [12]. Therefore, constructivist teaching is characterized by learner-centeredness in which learners are not passive recipients of knowledge. [12] contends that the use of various ICTs for collaborative learning acknowledges and promotes learners' independence and inventiveness. The ICT-integrated cooperative learning methods, facilitated by the teachers, assist learners to enhance subject understanding, critical thinking, and analytical abilities.

In a review study, [24] also concludes that ICTs aid instruction structures to give excellent education that is in harmony with constructivism, which is a modern concept of education. In their research to establish the impacts of a

constructivist learning approach on learners' academic achievement in Turkey, [53] found that the approach has positive effects in a number of subjects, including biology.

In view of the benefits of using ICTs to teach, as described in this literature review, the researchers hypothesised that Lesotho high school biology teachers' ICT practices are not inclined to support contemporary teaching. Hence, performance in the subject has been found to be poor [50]. Probably, they also use ICTs for conventional practices, as was concluded by [45] in a similar study involving physical sciences teachers in Lesotho. Therefore, this study was necessary to test the said hypothesis.

The practices that characterize patterns of Lesotho high school biology teachers' use of ICT were studied within the confines of the technological pedagogical content knowledge (TPACK) framework developed by [54]. TPACK is described by [55], [56] as a framework that underscores teachers' understanding of the productive application of technologies, especially ICTs, as pedagogical instruments. It extends Shulman's [57] pedagogical content knowledge to describe the knowledge necessary for teachers to successfully teach subject matter, such as biology, with ICTs in ways tailored to meet learners' needs [54], [56].

Researchers agree that TPACK is a productive framework for contemplating the incorporation of technology into teaching and learning as a form of extending domain knowledge [58]-[60]. Also, its application as a frame to assess teaching expertise could determine the nature of guidance and professional growth practices planned for preservice and in-service teachers. This study therefore uses the framework as a way to reflect on and measure the variables of the current study, namely use of ICT in pedagogical practices. It also offers theoretical lenses for the researchers to make sense of the practice of teaching using ICT [61] in Lesotho schools.

III. Research Methodology

A descriptive, non-experimental quantitative research design with a non-experimental survey following a deductive strategy was used as it is a common practice with positivist studies [62]-[64]. This design can be managed in various ways [65] and allows for representative samples to be used to examine the entire population [66].

The population for this study comprised more than 250 in-service biology teachers of Lesotho junior and senior secondary schools. The participants teach in inequitably resourced school environments and vary in gender (60 females and 47 males), age group (21 to 55), teaching experience (0-5 to above 25 years), and educational qualification (diploma in secondary education to master's in education).

A sample of 107 biology teachers was selected from different districts (Botha-Bothe, Leribe, Berea, Maseru, Mafeteng, Mohale's Hoek, Quthing, and Thaba-Tseka) using a systematic probability sampling technique. The highlands, foothills, and lowlands were all represented. This technique was selected because it is relatively simple, cheaper, and can be handily employed even with a large population size [67]. It was applied as described by [64], [65], [68]. Firstly, the sampling interval k was determined as the whole number to the ratio N/n; then, a random integer number (s) between 0 and k was picked. Finally, the sample consisted of the following units:

s, s + k, s + 2k, s + 3k ..., s + (n - 1), with k being the sample frame.

This randomization guarantees external validity, enabling generalization of the conclusions made on the population that generated the sample [62], [64].

A questionnaire, adapted from those used in similar studies, such as [69] (Ghana), [27] (Nigeria), and [26] (Slovenia), was used to collect data intended to answer the research question. It consisted of closed-ended items measured on a five-point Likert scale with the alternatives "1 = never used (not at all)", "2 = very irregularly used (at least once a term)", "3 = irregularly used (at least once a month)", "4 = regularly used (at least once a week)", and "5 = very regularly used (almost daily)".

As indicated by [70], the statistical methods considered for examining the research questions in a quantitative study should be clarified. After collection, the data from each respondent were captured into a Google form, which was a recreation of the questionnaire used. The Google form simultaneously generated a spreadsheet for the collected data. After capturing, the spreadsheet was downloaded as a Microsoft Excel document. The Microsoft Excel spreadsheet was uploaded into and handled using the Statistical Package for the Social Sciences (SPSS) software to generate frequencies, histograms, and the descriptive statistics meant to address the research question. As suggested by [64], the figures and percentages showing a description of the respondents and non-respondents were tabulated.

A Likert scale survey enabled the analysis of data as to provide the means, standard deviation, and descriptions on the use of ICTs in biology teaching. The summarized descriptive data for the mean and standard deviation are presented in Tables I, II, and III for interpretation.

Consent to conduct the research was granted by the university ethics committee and ethical clearance was approved. We pledged to maintain respondents' anonymity in the study by assigning pseudonyms or fictitious code numbers to them and their schools and also removing any distinguishing indicators from the associated papers [71]. The rights of involvement consent and confidentiality form was attached to the questionnaire for the respondents to complete. The respondents were assured that they would not be exposed to any harm and that the information they shared would remain private and not be used for purposes outside the study.

IV. Results

The respondents were requested to indicate whether they used the probed ICT tools for teaching or for non-teaching purposes. We found it necessary to include use for non-teaching purposes in this study because some non-educational ICT practices can easily be adapted to suit educational intents. It is thus important to know whether teachers do use certain technologies or not, and to what

extent if they do, even if it is not for teaching. This knowledge would help eliminate attributing nonuse for teaching to lack of access to tools, lack of awareness of the tools, or lack of expertise in the use of such tools. Therefore, the study would have narrowed the range of possibilities of what to look into regarding factors that undermine educational use of such ICT tools. Hence, necessary interventions would be sourced sufficiently early by the authorities in education. The findings are displayed in the bar chart in Fig. 1.

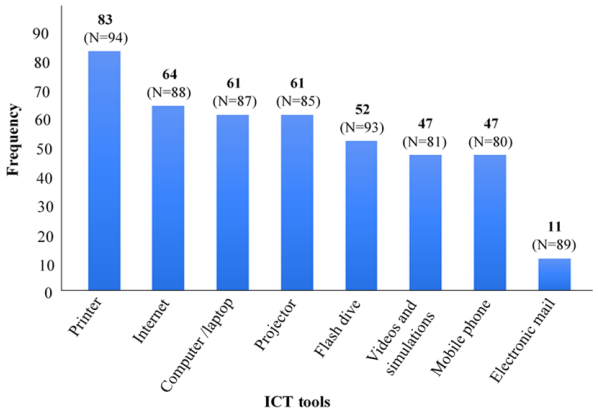

Fig. 1. Use of ICT tools for teaching purposes.

The findings revealed that the printer, internet, computer/laptop, and projector were the most frequent ICTs used by most of the respondents for teaching intents. The majority (over 60%) of those who responded to the item indicated that they used a printer (83), the internet (64), projector (61), and computer/laptop (61) for teaching purposes. The ICT that was most popular for use in teaching biology was the printer, followed by the internet and then almost equally popular were the computer/laptop and projector. The least commonly used ICTs were electronic mail (11), followed by mobile phones (47) and videos and simulations (47). As the data were collected before the COVID-19 pandemic had forced closure of the schools in the country, it would be interesting to see if the responses would be any different post-COVID-19. A similar study may be necessary to determine if the numbers would change.

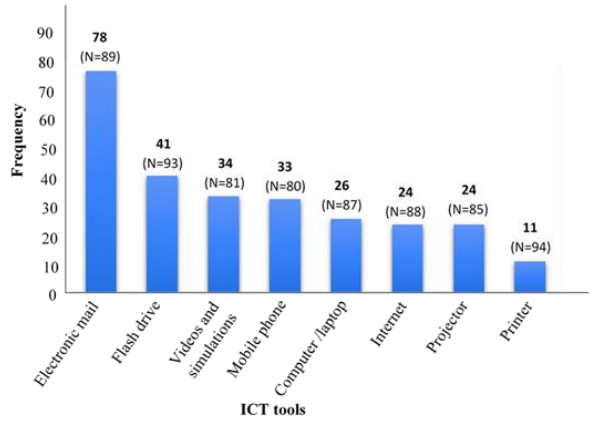

Fig. 2. Use of ICT tools for nonteaching purposes.

The findings confirm that the available tools were certainly used for teaching ends, as reported by the respondents. Nevertheless, some ICTs were used by far more respondents than others. Fig. 2 displays the frequency (count) of respondents who used the accessible ICTs for nonteaching purposes. With regard to nonteaching purposes, electronic mail was used by the majority (78) of those who responded. Electronic mail, flash drives (41), videos and simulations (34), and mobile phones (33) were amongst the tools used by most respondents for nonteaching ends.

The results displayed in Fig. 1 and Fig. 2 for the use of e-mail need further investigation to determine why it is applied so little in teaching, yet so much for nonteaching ends. The least used technologies were the internet (24), projector (24), and printer (11).

A. Practices that Characterize Patterns of Use of ICTs

The respondents' practices that typify their patterns of use of ICTs were measured on a five-point Likert scale with the options "1 = never used (not at all)", "2 = very irregularly used (at least once a term)", "3 = irregularly used (at least once a month)", "4 = regularly used (at least once a week)", and "5 = very regularly used (almost daily)". The scale comprised 20 items in all.

TABLE I: DESCRIPTIVE STATISTICS FOR TEACHERS' USE OF HARDWARE AND SOFTWARE

Practices that characterize patterns of use of ICTs	N	Mean	SD
Searching for information on internet, hard disk, and compact discs (CD ROMs) to prepare for lessons	105	3.66	1.247
Using computer programs such as Microsoft Picture It!, Paint, and Movie Maker to create pictures, posters, diagrams, or animations for use in teaching	107	2.19	1.260
Using spreadsheets for recording test scores and other learner information	107	2.61	1.577
Using Microsoft PowerPoint to present lesson content, show pictures, diagrams, videos, and simulations to teach or facilitate discussions	106	2.08	1.336
Using Microsoft Office Word for writing notes for learners	107	2.09	1.363
Using educational software to learn how certain biology topics can be approached	107	2.48	1.216
Using printers and scanners to produce handouts showing different representations (textual, graphical, diagrammatic etc.) of biology content for learners	106	3.24	1.404
Using mobile applications such as WhatsApp Messenger, Facebook, SHAREit, Wi-Fi Direct, etc. for teaching purposes, information exchange, and discussion forums with and for learners	107	3.05	1.376
Receiving and sending emails to communicate with colleagues on issues related to teaching	99	2.55	1.473
Using computers for drill-and-practice and tutorial software packages	104	1.76	1.102
Valid N (Listwise)	93		

Cronbach alpha = 0.820, based on the standardized items

Out of the 107 cases, 23 (21.5%) were excluded and hence 84 (78.5%) were considered valid. The listwise N (93) only includes the respondents with no missing data on any variable requested in the output. The listwise deletion was

based on all variables in the procedure. The reliability statistics indicated that for the 20 items in this scale, the Cronbach alpha based on the standardized items was reported to be 0.885. For the purposes of analysis, the scale was divided into two subscales, one to show results for educational practices and the other to show results for noneducational practices. The former was further divided into two sub-subscales, one to display results for the extent of teachers' use of hardware and software and the other to show results for the extent of use of ICTs in teaching practices.

Table I shows the descriptive statistics for the use of hardware and software in educational practices.

Out of the 107 cases, 14 (13.1%) were excluded because the respondents had missing data on some variables requested in the output. Thus, 93 (86.9%) cases were considered valid. The listwise deletion was based on all variables in the procedure. The reliability statistics indicated that for the 10 items in this subscale, Cronbach's alpha based on the standardized items was 0.820.

The educational practice that scored the highest mean is "Searching for information on the internet and information storage devices to prepare for lessons" (M = 3.66, SD = 1.247). This was followed by "Using printers and scanners to produce handouts showing different representations (textual, graphical, and diagrammatic) of biology content for learners" (M = 3.24, SD = 1.404). The latter practice scored a mean almost equal to that of "Using mobile applications such as WhatsApp Messenger, Facebook, SHAREit, Wi-Fi Direct, etc. for teaching purposes, information exchange, and discussion forums with and for learners" (M = 3.05, SD = 1.376). The practices that scored the lowest means were "Using computers for drill-and-practice and tutorial software packages" (M = 1.76, SD = 1.102) and "Using Microsoft PowerPoint to present lesson content, show pictures, diagrams, videos, and simulations to teach or facilitate discussions" (M = 2.08, SD = 1.336). To have a more detailed representation of the distributions of options for these variables, histograms were produced in the SPSS program. For the latter practice, the histogram revealed that the commonest option was "never used". Correspondingly, a similar result was obtained for the use of computer programs such as Microsoft Picture It!, Paint, and Movie Maker to create pictures, posters, diagrams, or animations for teaching. The rest of the practices had mean values ranging from 2.09 to 2.61. This finding is consistent with those of many other researchers, who argue that animations, hands-on practical activities, virtual laboratories, and computer-aided simulations were less commonly used ICT-based technologies in classroom science teaching [72]-[74]. However, these findings are contrary to the ones made by European scholars such as [35] and [75], who maintain that the majority of teachers used PowerPoint extensively, along with electronic mail, the Internet and word processing in classroom science teaching. On the other hand, [76] argue that science teachers in underdeveloped countries with poor economic situations, such as Lesotho, need more support to integrate ICT in the classrooms.

The average of the mean values for all 10 items was computed and found to be 2.57. This outcome corroborates the findings displayed in Fig. 1. All these findings showed that the computer/laptop, internet, and printer were used more frequently for teaching purposes than other ICTs.

Table II shows the descriptive statistics for the listed teaching activities. Out of the 107 cases, 6 (5.6%) were excluded because the respondents had missing data on some variables requested in the output. Thus, 101 (94.4%) cases were considered valid. The listwise deletion was based on all variables in the procedure. The reliability statistics indicated that for the five items in this subscale, Cronbach's alpha was 0.891, based on the standardized items.

The practice that scored the highest mean was "Assessing learners' learning through tests/quizzes" (M = 3.12, SD = 1.465). This was followed by "Supporting collaboration amongst learners" (M = 2.93, SD 1.522). The rest of the practices had mean values ranging from 2.54 to 2.73. The average of the mean values for all five items in this subscale was 2.80, which is approximately 3.0. Therefore, the results suggest that generally, the respondents' use of ICTs in teaching activities is irregular. That is, most of them use ICTs at least once a month. This was unexpected. For individuals who hold optimistic perceptions of ICT use for teaching, such as the respondents of the current study, a higher frequency of use of these eight tools would have been logical.

TABLE II: DESCRIPTIVE STATISTICS FOR TEACHING PRACTICES

Practices that characterize patterns of use of ICTs	N	Mean	SD
Issuing class instructions and/or communicating with learners	103	2.54	1.447
Organizing class discussion, demonstrations, and presentations	105	2.73	1.463
Assessing learners' learning through tests/quizzes	107	3.12	1.465
Conveying feedback to learners	107	2.71	1.498
Supporting collaboration amongst learners	107	2.93	1.522
Valid N (Listwise)	101		

Cronbach alpha = 0.891, based on the standardized items

Table III shows the descriptive statistics for noneducational practices that characterize patterns of use of ICTs. Out of the 107 cases, 4 (3.7%) were excluded, as the respondents had missing data on some variables requested in the output. Thus, 103 (96.3%) were considered valid. The listwise deletion was based on all variables in the procedure. The reliability statistics indicated that for the five items in this subscale, Cronbach's alpha was 0.665, and 0.660 was reported based on the standardized items. "Using mobile applications such as WhatsApp, Messenger, and Facebook for noneducational purposes such as chatting or socializing with other people" scored the highest mean (M = 4.23, SD = 1.040). Actually, as indicated by the histogram generated to display the distribution of options for this variable, the commonest option was "very regularly" followed by "regularly". It is the most frequently performed and common practice of all practices that were probed. This practice was followed by "Using internet for fun, downloading and/or watching or listening to music, and other personal purposes such as shopping" (M = 3.63, SD = 1.384). The least common practice was "Designing things like programs for functions and invitation cards" (M = 1.55, SD = 0.914). The average of the mean values for the five items on

noneducational practices was 2.86.

TABLE III: DESCRIPTIVE STATISTICS FOR NONEDUCATIONAL PRACTICES

Practices (activities)	N	Mean	SD
Designing things like programs for functions, invitation cards etc.	107	1.55	0.914
Organizing computer settings such as files, memory, system, etc.	105	2.15	1.299
Using internet for fun, downloading and/or watching or listening to music, and other personal purposes such as shopping	107	3.63	1.384
Playing games on computers	107	2.73	1.502
Using mobile applications such as WhatsApp Messenger, Facebook for noneducational purposes such as chatting or socializing with other people	105	4.23	1.040
Valid N (Listwise)	103		

Cronbach alpha = 0.891, based on the standardized items

The average of the mean values for all 20 items on the practices that characterize patterns of use of ICT was calculated at 2.70, also implying irregular use of ICTs in general. However, it is worthy to note that the overall frequency of use of ICT tools for noneducational ends was slightly higher than the overall extent of use for teaching intents. Therefore, the extent of use of ICT seemed to be a bit more inclined towards noneducational practices than teaching practices overall.

B. Reliability of the Instrument

The internal consistency involving items on the practices that characterize Lesotho biology teachers' patterns of use of ICTs was measured. The purpose was to evaluate the reliability of the instrument employed in the current study. According to [77], it is imperative to evaluate reliability of data, especially if the inferential statistics are to be run. The alpha values averaged at approximately 0.80, which is considered good [78] or "highly reliable" [79] (p. 774). Therefore, the instrument used in this study to measure the respondents' perceptions and practices that characterize patterns of ICT use was reliable.

In addition, the questionnaire used was tested in a pilot study to augment its reliability, validity, and its realistic use [79], and also to raise the quality of the items [80]. We wanted to rehearse the actual study using similar items and phrasing, to test the instrument and recognize its weaknesses as well as those of the survey procedure [67], [81] so that the necessary amendments could be made [82] and thus ensure validity and effectiveness in gathering the appropriate data. This practice is consistent with the assertion of [79] that "there is a need, therefore, to pilot questionnaires and refine their contents, wording, length, etc., as appropriate for the sample being targeted" (p. 278).

V. DISCUSSION OF KEY FINDINGS

The predominantly used ICT tools to teach biology in Lesotho high schools, as determined by this study, were the internet, computer/laptop, and printer. However, it was found that overall, these tools were used irregularly (at least once a month) for educational intents.

The chief practices were "Searching for information on internet, hard disk, and compact discs (CD ROMs) to prepare for lessons" and "Using printers and scanners to produce handouts showing different representations (textual, graphical, diagrammatic etc.) of biology content for learners". It appears that the respondents printed the information obtained from the internet, hard disks, and CD ROMs to hand out to the learners and to back their teaching in the classroom. This is consistent with what [44] also found about Lesotho high school physical sciences teachers, that they irregularly used flash drives and printers to store information and make hard copies of the information for their learners. Therefore, results of this study confirmed that teachers use internet tools and computers mainly as sources of information used to update their subject knowledge and to better prepare for lessons, as established by [26], [32], [34], and [3]. Like [41], [40], [26], and [34], [42] found that technologies are used for communication and administrative practices, Respondents reported the same practices, though they performed them to a lesser extent. What still remains to be established is why teachers do not carry out these ICT practices very frequently despite having access to them and being competent in their use.

In contrast, presentation of lesson content; showing pictures, diagrams, videos, and simulations to teach or facilitate discussions; and creating pictures, posters, diagrams, or animations for teaching were some of the most rarely used practices. These practices make use of computer applications such as Microsoft Picture It!, Paint, Movie Maker, and Microsoft PowerPoint, which the results indicated were even never used by some respondents. From these findings, once again, one may posit that computers are used mainly for printing materials, searching for information and sharing it on the internet, or using it for lesson preparations. [3] discovered similar results with biology teachers in Brazil, that internet tools for educational purposes were very rarely used, which largely inclined to looking for biology content for personal gain and downloading resources to hand out to learners. The results of the current study are in agreement with [26], who also found that Slovenian biology teachers used "computers for school work mainly as typewriters, as a source of information and a communication tool, for their preparation, tests and administration outside the classroom, most often at homes" (p. 43). For the practices that typify patterns of use, refer to Tables I and III, which should better shed light in this regard. However, contrary to [26], the results of the current study showed very irregular and no use of Microsoft Office Word for typing notes for learners. The result was similar for communication with learners or colleagues.

The inference made from the respondents' patterns of ICT practices is that they rarely use ICTs, as has been indicated, thereby continuing their teacher-centered practices, rather than providing opportunities for active learning experiences for their learners. This revelation confirms the finding by [43] that Lesotho science learners have scant active and collaborative experiences with e-learning tools. The conclusion by [45] that Lesotho high school physical sciences teachers use technologies probably for conventional practices such as improving their subject content rather than presenting it to learners has also been confirmed by this study.

The results of this study pose serious concerns and possible implications with regard to the status of biology instruction and learning. Biology education is likely to be dominated by the passive transmission of knowledge to learners. The results suggest lack of ICT-enhanced constructivist practices, yet literature has shown that tactics that apply modern ICTs offer several opportunities for constructivist learning. Therefore, learners are denied such opportunities and benefits they could otherwise have, as expressed in the literature review section [37], [36], [39], and [12]. This probably explains the poor performance in biology [50] as well as in mathematics and science in general [51]. [5] argues that learner performance picks up when ICT is applied. Actually, [53] found that the constructivist learning approach has positive effects in a number of subjects, including biology. This is probably because ICT affords quality instruction that complies with constructivism [24].

VI. Conclusion

The ICTs that were used by the majority of the respondents for teaching intents were the printer, internet, and computer/laptop. "Searching for information on internet, hard disk, and compact discs (CD ROMs) to prepare for lessons" and "Using printers and scanners to produce handouts showing different representations (textual, graphical, diagrammatic etc.) of biology content for learners" were found to be the most regular practices that characterize patterns of use of these ICTs to teach biology in Lesotho high schools. However, it was notable that respondents used the said ICTs irregularly for the described purposes. It was concluded that when they used them, it was to support teacher-centered approaches. Technologies that combine textual matter, sound, and multi-colored moving images to actively engage learners in knowledge construction were found to be used to a lesser extent.

Very little is known about ICT practices in the teaching of biology. Therefore, this study has extended knowledge in this regard, particularly on teaching of biology in the context of Lesotho. It has also afforded an opportunity to us and other biology teachers to rethink and reflect on our instructional approaches. It would be interesting to see how the results would differ post the COVID-19-pandemic era.

Care should be taken not to make generalizations to all teachers as the study focused solely on ICT use in teaching biology. Future studies may have to establish the situation with different subjects and use other and/or a combination of data collection techniques, as this one used a purely quantitative approach. Triangulation of results may give a better insight of the practices that characterize patterns of ICT use in teaching. In addition, it would be interesting to know why teachers choose certain ICTs to teach.

Conflict of Interest

The authors declare no conflicts of interest.

Author Contributions

Mr Bobojane Makuru contributed to this paper as part of his Master's thesis under the supervision of the co-author, Dr Jita. He was responsible for introduction, data collection, and collaborated with the co-author in writing the methodology, results and conclusion. Dr. Thuthukile Jita updated literature review and closely supervised the questionnaire formation. In addition, she worked extensively on data analysis and interpretation of the results. The paper was continuously edited under her guidance.

All the authors have approved the final version of the paper.

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