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Editorial

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SYNERGIZING TECHNOLOGY AND HEALTH PROMOTION FOR THE PREVENTION OF TUBERCULOSIS

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Abstract

With the rapid global increase in the prevalence of tuberculosis, health promotion is crucial to raise communal health awareness. This service-learning health promotion activity aimed to increase awareness of TB amongst school learners in attendance at the 2016 National Science Festival. A computer-based pre- and post-intervention quiz, an educational poster, an interactive word search game, and a take-home information leaflet were utilized in a health promotion exhibit.

Junior and senior school learners who participated in the exhibit showed significant improvements in their post-educational intervention scores. The exhibit was effective as a preliminary measure in reinforcing health information and raising awareness.

Keywords: Tuberculosis, Health Promotion, Service-learning, Prevention, Technology

1. INTRODUCTION

The Republic of South Africa (RSA) faces a quadruple burden of disease, including a high prevalence of HIV/AIDS and the highest estimated incidence and prevalence of tuberculosis (TB) (Churchyard, Mametja, Mvusi, Ndjeka, Hesseling, Reid, Babatunde and Pillay, 2014; Pillay- Van Wyk, Msemburi, Laubscher, Dorrington, Groenewald, Glass, Nojilana, Joubert, Matzopoulos, Prinsloo, Nannan, Gwebushe, Vos, Somdyala, Sithole, Neethling, Nicol, Rossouw, Bradshaw, 2016; WHO, 2018). It has the second highest number of diagnosed multidrug resistant TB cases, a phenomenon that continues to drive the ongoing TB epidemic across the country (WHO, 2018).

In 2014, TB was the leading cause of South African deaths among both men (11.8%) and women (9.5%). There were 1,426 (3.1%) TB deaths among those aged between 0 and 14 years; 36,728 (18.1%) deaths among those 15 to 49 years old; 10,983 (10.6%) deaths among those 50 to 64 years old; and 4,771 among those over 65 (World Health Organization, 2015a). The TB related mortality rates continue to rise within these demographic groups (WHO, 2018). Despite significantly higher spending on health than other middle income and developing countries, RSA still faces poor health outcomes in both rural and urban areas (Nelson and Wells, 2004; World Health Organization, 2015a; Dieleman, Templin, Sadat, Reidy, Chapin, Foreman,

Haakenstad, Evans, Murray and Kurowski, 2016). There are large disparities across the country's nine provinces, with the two most urbanised – Gauteng and the Western Cape – faring far better in health outcomes than the more rural provinces. While many new clinics have been established, especially in rural areas there is a large discrepancy between the number of facilities per population, utilisation rates, and staffing levels across provinces, reflecting the under-provision of rural areas (World Health Organization, 2002, 2000; Health Systems Trust, 2017). New facilities often cannot be utilised adequately due to a lack of human resources. Figures of health care professionals per 1000 population show these shortages: 5.114 nurses and midwifery, 0.776 physicians, and there are 0.413 pharmaceutical personnel (World Health Organization, 2015b, 2015c, 2015d).

KwaZulu-Natal (KZN) is the province at the epicentre of South Africa's HIV and TB co-infection, followed by the Eastern Cape (EC) (Maharaj, Ross and Campbell, 2016). Since HIV infection and multidrug resistance are factors that drive the TB epidemic, treatment alone may be insufficient to curb the effects of the disease. The RSA Department of Health (DoH), in agreement with recommendations by the World Health Organisation, advocate that health education and health promotion interventions be used to reduce preventable health related concerns. Health promotion is a viable tool for comprehensive, equitable, and affordable health development, specifically in addressing TB (SA DoH, 2015).

One of the main obstacles to the integration of HIV and TB services is a lack of cooperation between health care workers from different disciplines (Health Systems Trust, 2013; Churchyard, Mametja, Mvusi, Ndjeka, Hesseling, Reid, Babatunde and Pillay, 2014). This could be addressed at an undergraduate level, by training students in disease control programmes, such as the national tuberculosis control programme. Collaborative networking between health professionals and stakeholders from other sectors could play a vital role in health promotion if these are encouraged early during health care professionals' training. Such service-learning projects would assist undergraduate health care students to understand and value the principles and targets of these programmes by accentuating the importance of interdisciplinary collaboration, community outreach, and the critical role fulfilled by each individual as a future healthcare professional. Service-based learning promotes critical thinking and social responsiveness by using the crucial activities of reflection, reciprocal learning and experimental learning with community partners (Bringle, 2011; Mc Menamin, Mc Grath, Cantillon and Mac Farlane, 2014).

This paper considers the effectiveness of one such service learning project hosted by the Rhodes University Department of Pharmacy at the 2016 National Science Festival. The health promotion exhibit, run by future pharmacists and targeted at school learners in attendance at the festival, was

formulated to incorporate an interdisciplinary approach, aided by modern technology, to address awareness of TB and health empowerment amongst children.

2. METHOD

This service learning health promotion activity was part of a fourth year pharmacy research project exhibited at the National Science Festival (2-8 March 2016). The health promotion exhibit was preceded by a pilot study conducted with Khanya Maths and Science Club school learners to evaluate the acceptability of the quiz (Srinivas, Wrench, Bradshaw and Dukhi, 2011). A combination of BKnow® and Microsoft PowerPoint software offered a reasonably basic computer-based multiple choice question and answer system. Only three of the keys on a standard keyboard had to be used. They were labelled with coloured stickers to further simplify the process of taking the quiz. Some participants were from rural and disadvantaged schools, where they had had little to no prior computer experience. A user-friendly method of entering responses was designed with this in mind. Participants' responses to the quiz and demographic data were captured and statistically analysed.

Posters about TB were displayed as part of the exhibit, and bilingual information leaflets and take home word-searches based on TB prevention were also made available to all who visited. For the seven day duration of the science festival, a bilingual facilitator was available to interact with non-English speaking visitors and to assist younger children unable to use the computer quiz. By communicating in isiXhosa and using interactive models and games, the facilitator was able to inform younger participants about TB prevention.

3. RESULTS

Assessment of whether the intervention made a difference in understanding tuberculosis, its causes, and treatment was dependent on students' t-test percentage scores for the junior and senior quizzes. McNemar $\chi 2$ tests were used to determine the percentage of correct answers obtained for each question before and after the intervention was conducted. Individual student's t-tests and ANOVA procedures were performed to determine the effects of age, gender, and type of school (independent or government-funded) on quiz percentage scores before and after the intervention. Means and standard errors were also calculated for pre- and post-intervention scores. All tests were performed using the statistical programming language R, with significance set at the 0.05 level. Separate analyses were performed on the junior and senior school quiz results.

3.1 Junior School Quiz

Demographics of participants were captured by the first five questions of the quiz, which had 131 respondents. Data obtained shows that 11 participants (8.4%) were 7 years or younger; 7 participants (5.3%) were between 8 and 10 years old; 61 (46.6%) participants were between 11 and 13 years old; and 52 participants (39.7%) were 14 years old or older. Of the total number, 64 (48.9%) were female and 67 (51.1%) male. Regional distribution shows that 118 (90.1%) were from the Eastern Cape and that the others were based in other South African provinces. Demographics further showed that 111 participants (84.7%) attended government schools, while the remaining 20 (15.3%) attended private or independent schools. Of 131 learners, 79 (60.3%) had used computers while at school, while the remaining 52 (39.7%) had not.

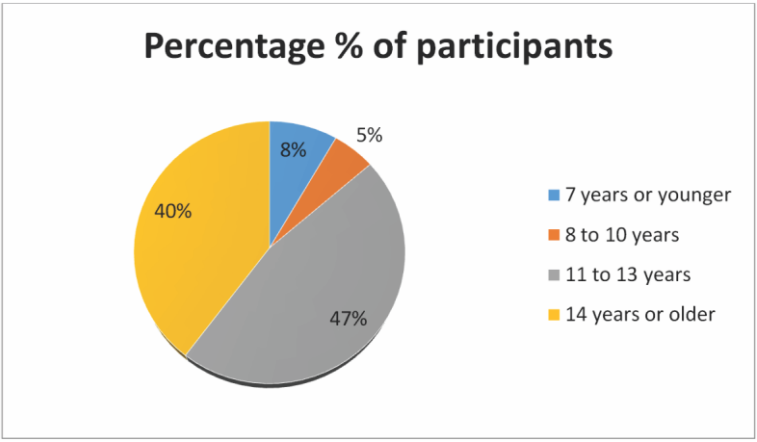

Figure 1: Age groups and percentage of participants.

3.1.1 Pre-intervention results

Results from the pre-intervention questions are shown in Table 1.

These show that learners had fair prior knowledge of tuberculosis, its effects, and how the disease can be prevented (overall percentage score 54.0%). The questions with the lowest correct percentage score were 5 and 7: “Who most is at risk of getting TB?” and “Why is it important to finish the anti-TB medication if one has TB?” 32.8% and 39.7% of participants answered the respective questions correctly. Questions 2 and 3 had the highest correct percentage scores: “Yes or No? All HIV positive people have TB” and “In what ways is TB transmitted from person to person?” 68.7% and 89.3% of participants gave the correct responses to the respective questions (Table 1).

3.1.2 Comparison of pre-versus post-intervention results

Of the 131 participants who took part in the pre-intervention questions, 81 (62%) continued to complete the post-intervention questions. To analyse the change in learners' knowledge after the intervention, one-sided McNemar dependent $\chi 2$ tests were used. These results are presented in Table 2.

The intervention resulted in a significant increase (at the 0.1% level) in correct responses to Question 1 ("When is World Tuberculosis Day?") ($p<0.001$). However, no significant improvement was observed in the number of correct answers to any other question. There was an improvement in participants' overall percentage scores at the 5% significance level ($p=0.024$).

Results show no significant gender differences for either pre- or post-intervention mean percentage scores (pre: Male: 58.5 ± 4.5%, Female: 48.5 ± 4.7%, $p=0.129$; post: Male: 65.1 ± 4.1%, Female: 59.8 ± 4.4%; $p=0.378$) nor between results from participants from government and independent schools, before (pre: Government: 54.7 ± 3.5%, Independent: 48.1 ± 8.9%; $p=0.490$) or after (post: Government: 63.1 ± 3.2%, Independent: 59.7 ± 8.2%; $p=0.707$) the intervention. There was no significant difference observed between results from across age groups for pre-intervention mean percentage scores. A significant difference at the 5% level was noted for post-intervention scores. The mean ± s.e.% scores of the participants in the age groups were: '7 years or under' (pre: 39.3 ± 15.1%; post: 28.6 ± 13.4%), '8 to 10 years' (pre: 42.9 ± 15.1%; post: 50.0 ± 13.4%), '11 to 13 years' (pre: 48.4 ± 4.5%; post: 60.6 ± 4.0%), and '14 years or over' (pre: 63.8 ± 6.8%; post: 71.0 ± 6.0%) (ANOVA: pre: $F=2.307$, $df=3, 77$, $p=0.083$; post: $F=3.899$, $df=3, 77$, $p=0.012$).

In addition, significant differences were noted between the pre- and post-intervention scores for the following groups: 0.1% significance level for participants in the '11 to 13' age category ($p<0.001$); 1% significance level for female participants ($p=0.004$); and learners from both government ($p=0.006$) and independent schools ($p=0.005$).

3.2 Senior School Quiz

As in the junior quiz, demographics of the 354 senior quiz participants were captured by the first five questions. The data obtained show that 61 participants (17.2%) were 12 years or younger; 121 (34.2%) were 13 to 15 years old; 137 (38.7%) were 16 to 19 years old; and 35 (9.9%) were 20 years or older. 189 participants (53.4%) were female and 165 (46.6%) were male. Regional distribution shows that 318 (89.8%) attended, or had attended, a school in the Eastern Cape, while the other 36 (10.2%) had been schooled in other South African provinces. Demographics further show that 314 participants (88.7%) attended or had attended government schools, while the remaining 40 (11.3%) attended or had attended independent schools. With regard to computer use, 175 learners (49.4%) responded that they had used

computers at school, while 179 (50.6%) had had no access to computers while at school.

3.2.1 Pre-intervention results

The results from the pre-intervention questions are shown in Table 3.

Based on the results of the pre-intervention study, learners had good prior knowledge of tuberculosis, its effects, and how it can be prevented (overall percentage score 64.2%). Questions with the lowest correct percentage scores were Questions 6 and 4: “When should one suspect the possibility of drug-resistant TB?” and “What can you do to lower the risk of getting TB?” 44.4% and 54.8% of the participants answered the respective questions correctly. Questions 1 and 2 - “How is Tuberculosis transmitted?” and “Yes or No: All HIV positive people have TB?” - had the highest correct percentage scores with 78.5% and 74.6% correct answers, respectively (see Table 3).

3.2.2 Comparison of pre- versus post-intervention results

Of the 354 senior quiz participants who took part in the pre-intervention questions, 227 (64.1%) completed the post-intervention questions. McNemar's dependent one-sided $\chi 2$ test was used to analyse responses to the individual questions, and the results are shown in Table 4.

The intervention resulted in a significant increase in correct responses to all questions except Questions 1 and 6. Questions 2, 4, 5, and 8 showed improvement at the 1% significance level ($p=0.004$, 0.010, 0.006, and 0.009, respectively), while Questions 3 and 7 showed improvement at the 5% significance level ($p=0.013$ and 0.025, respectively). Improvement in the overall knowledge of participants after the intervention was significant at the 0.1% level ($p<0.001$).

Results showed no significant gender differences for the pre- or post-intervention mean percentage scores (pre: Male: 65.8 ± 2.4%, Female: 68.1 ± 2.3%, $p=0.497$; post: Male: 74.5 ± 2.3%, Female: 74.5 ± 2.1%; $p=0.991$). Furthermore, no significant differences in mean percentage scores were found between learners from government and independent schools, either before or after the intervention (pre: Government: 66.8 ± 1.7%, Independent: 69.6 ± 5.4%; $p=0.619$; post: Government: 74.2 ± 1.6%, Independent: 77.4 ± 5.1%; $p=0.555$). But there were significant age-related differences (at the 0.1% level) in both pre- and post-intervention mean percentage scores. The mean ± s.e.% scores of participants in the age groups were: '12 years or under' (pre: 50.8 ± 4.2%; post: 59.0 ± 4.0%), '13 to 15 years' (pre: 66.6 ± 5.0%; post: 75.8 ± 4.7%), '16 to 19 years' (pre: 70.8 ± 4.9%; post: 76.5 ± 4.6%), and '20 years or over (pre: 76.6 ± 6.5%; post: 83.3 ± 6.1%) (ANOVA: pre: $F=6.933$, $df=3, 223$, $p<0.001$; post: $F=6.603$, $df=3, 223$, $p<0.001$).

Significant differences were noted between pre- and post-intervention mean percentage scores for the following groups: 0.1% significance level for participants in the '13 to 15' age group, male participants, and learners from government schools ($p<0.001$ for each); female participants were measured at the 1% significance level ($p=0.001$); and the 5% significance level was reached by participants in the '16 to 19' age group ($p=0.012$) and learners from independent schools ($p=0.038$).

Table 1: Frequencies (count and %) of correct answers for the junior quiz for the pre- and post-intervention questions, and the means ± standard errors of pre- and post-intervention percentage scores.

Question with correct answer	Frequency	Frequency %	Pre-intervention (n=131)	Post-intervention (n=81)	p-value (1-sided)
1. When is World Tuberculosis Day?	80	61.1	48 (59.3%)	72 (88.9%)	<0.001***
2. Yes or No: All HIV positive people have TB.	90	68.7	54 (66.7%)	62 (76.5%)	0.098
3. In what ways is TB transmitted from person to person?	117	89.3	74 (91.4%)	71 (87.7%)	0.505
4. Which of the following are ways to avoid the spread of TB?	55	42.0	33 (40.7%)	37 (45.7%)	0.422
5. Who is most at risk of getting TB?	43	32.8	26 (32.1%)	28 (34.6%)	0.814
6. The chance of becoming infected with TB depends on what?	58	44.3	35 (43.2%)	41 (50.6%)	0.264
7. Why is it important to finish the anti-TB medication if one has TB?	52	39.7	35 (43.2%)	44 (54.3%)	0.067
Mean ± s.e.			53.8 ± 6.5%	62.6 ± 6.0%	0.024*

Frequency: No. of junior school learners who answered the question correctly.
* = significant at 5%; *** = significant at 0.1%

Figure 2 below illustrates percentage of questions answered correctly by the participants in both the junior pre- and post- intervention quizzes

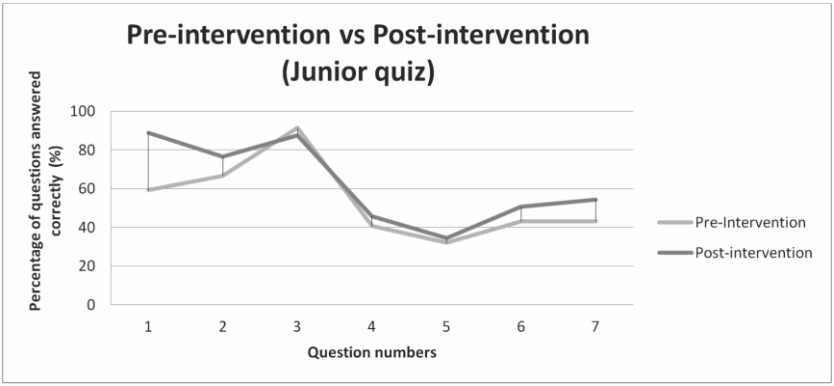

Figure 2: Junior quiz comparison of pre-intervention vs post-intervention.

Figure 3 below illustrates the percentage of questions answered correctly by the participants in both the senior pre- and post- intervention quizzes.

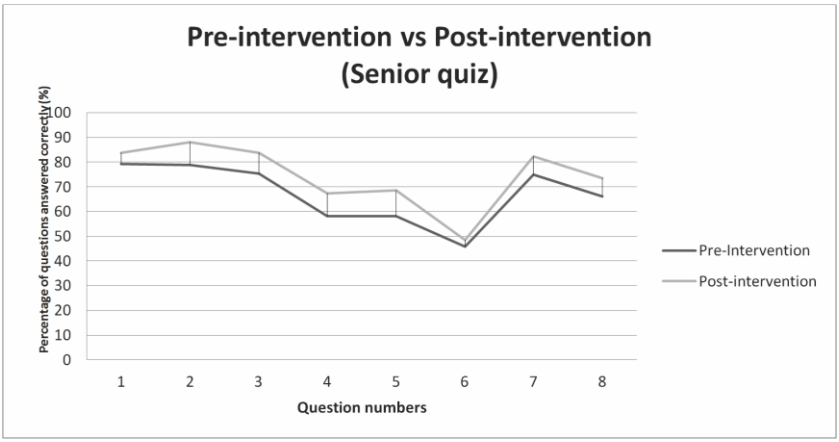

Figure 3: Senior's quiz comparison of pre-intervention vs post-intervention

Table 2: Frequencies (counts and %) of correct answers for senior quiz

Question with correct answer	Frequency	Frequency %	Pre-intervention (n =354)	Post-intervention (n=227)	P value (1-sided)
1. How is tuberculosis transmitted?	278	78.5	180 (79.3%)	190 (83.7%)	0.144
2. Yes or No: All HIV positive people have TB?	264	74.6	179 (78.9%)	200 (88.1%)	0.004**
3. Which one of the following is not a symptom of tuberculosis?	256	72.3	171 (75.3%)	190 (83.7%)	0.013*
4. What can you do to lower the risk of getting TB?	194	54.8	132 (58.2%)	153 (67.4%)	0.010**
5. TB and HIV are one of the leading causes of deaths in South Africa. Correct or incorrect?	203	57.3	132 (58.2%)	156 (68.7%)	0.006**
6. When should one suspect the possibility of drug-resistant TB? Answer: All of the above	157	44.4	104 (45.8%)	110 (48.5%)	0.525
7. If someone is not taking their anti-TB medication regularly, it can result in?	252	71.2	170 (74.9%)	187 (82.4%)	0.025*
8. Which of the following are ways to avoid the spread of TB?	213	60.2	150 (66.1%)	167 (73.6%)	0.009**
Mean ± s.e.			**67.1 ± 3.3%**	**74.5 ± 3.1%**	**<0.001*** **

Frequency: No. of senior school participants who answered the question correctly.
Pre-intervention: No. of participants who answered the questions correctly during the pre-intervention quiz.
Post-intervention: No. of participants who answered the questions correctly during the post-intervention quiz
* = significant at 5%; ** = significant at 1%; *** = significant at 0.1%

4. DISCUSSION

The Makana Municipality, located in the Eastern Cape and host to the National Science Festival, has been identified as one of the regions in RSA where TB infections have steadily increased (Onaga, 2014). Awareness of the country's burden of diseases, especially related to TB, is therefore of critical importance for individuals and communities within the province to adequately respond to health concerns.

Service learning programmes are becoming common practice in various higher education institutions globally (Bringle and Hatcher, 2000, 1996; Toncar, Reid, Burns, Anderson and Nguyen, 2006; Stewart, Wubbena, 2015) and have been successfully integrated into the curricula of several countries. This current study is evidence that service learning programmes can be as beneficial to school learners as they are to pharmacy students facilitating such programmes. In other studies, service learning programmes have been

proven to increase grade point averages, civic responsibility, and life skills (such as interpersonal and leadership abilities, social self-confidence, critical thinking skills, conflict resolution skills, and understanding national and community problems) (Astin, Vogelgesang, Ikeda and Yee, 2000.; Astin and Sax, 1998; Eyler, Giles, Stenson and Gray, 2001; Markus, Howard and King, 1993; George-Paschal, Saviers, 2016). Understanding the benefits that students receive from service learning offers educators the opportunity to improve on and develop service learning activities linked with computer technology. Such programmes can therefore maximize the academic value of interventions and improve subsequent health related choices within communities.

The service learning activity, during which final year Pharmacy students from Rhodes University engaged with scholars visiting an exhibit designed to promote awareness of TB and its prevention, synergistically incorporated a computer-based multiple choice quiz that was both fun and easy for participants to use. The interactive learning environment not only made it possible to assess participants' existing knowledge, but also to increase their awareness of TB. The interactive exhibition enabled children to understand prevention of TB by exposing them to fun games, exciting demonstrations, interesting information leaflets and an informative poster.

The quiz, designed for ease of use by both those with and without prior experience using computers, is appropriate to disseminate knowledge in developing countries. 89.9% of the senior quiz participants and 90.1% of junior participants hailed from the Eastern Cape. The majority attended government schools. It was encouraging to see that public schools, many of which lack health and science related resources, enabled their learners to engage with the health promotion activity at the National Science Festival. The ability to use computers is closely linked to levels of economic and social development challenges. Using an integrated technology-based service learning health promotion by involving the local community assists in achieving the Sustainable Development Goals (SDGs) 3 and 4 (United Nations, 2016; WHO, 2008), especially goals number three and four. Hence this service-learning project used a combination of technology and computer-based approaches, complemented with traditional ones such as take-home bilingual information leaflets.

A large number of learners were willing to participate in computer-based activities. Information and communication technology integration into school curricula depends on the availability of and access to computers at individual schools. Post-intervention quizzes showed an increase of correct answers chosen by the participants, which indicates that even those with little or no computer background understood which keys to use to navigate and respond to the computer quiz. This service-learning project incorporated technology to proactively respond to a public health challenge by working with school learners. Use of technology is extremely important in the progress of

developing countries (Davison, Vogel, Harris, and Jones, 2000; Steinmueller, 2001; Martin and Chamberlain, 2015) while addressing the digital divide. The health promotion service-learning project provided the platform for the pharmacy students to integrate their knowledge and skills that arise from the broader curriculum goals and outcomes; to respond to actual community needs; to choose, plan, design and implement a service project; and to integrate the life skills learned outside the classroom back into classroom learning and in their future careers.

5. CONCLUSION

The health promotion exhibit was designed to increase individual and communal health awareness through a service learning-based approach aimed primarily at school learners. The exhibition was effective as a preliminary measure in educating participants on TB. The intervention results indicated that school learners were made more aware of the signs, symptoms, prevention and transmission TB. The school learners were also more aware of the importance of adhering to TB medication and the relationship between TB and HIV. A comparison of the results from pre-intervention and post-intervention quizzes indicate that the synergistic use of information technology as an additional tool in increasing health awareness, especially among the new generation, which engages with electronics more frequently than their elders, is highly effective. Learners from both independent and government schools showed significant improvements in their post-intervention knowledge mean scores.

6. LIMITATION

The pilot-study was restricted to grade six and nine learners. The National Science Festival was open to all members of the community, and could therefore not be restricted to scholars. The computer-based quizzes were not completed by all participants, as these were subject to constraints of the school-based schedules. Another limitation was the availability of computers, as only three were available for use by high school learners and two by primary schools pupils.

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JOURNAL FOR NEW GENERATION SCIENCES

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