Effectiveness of Web Based Training system on Knowledge and Skills for Pandemic Preparedness and Response among Frontline Nurses in Zanzibar

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Abstract

Background
Web based learning can provide nurses with the opportunity to develop new knowledge and skills for management and prevention of diseases [1] including the emergence outbreak. However, with regard to covid-19 outbreak in Zanzibar only traditional method of face-to-face was employed to train nurses which resulted into a very low number of nurses who received proper training on prevention and management of covid-19.

Aim
To design and tests the effect of web based training tool on knowledge and skills for pandemic preparedness and responses among frontline nurses from Zanzibar.

Methods
A pre-posttest single group quasi-experimental study was conducted in set of 139 nurses from Zanzibar to compare change in knowledge and skills followed by web based educational intervention. A web based training system was developed by researcher, learning content were adapted and modified from CDC, WHO and MoHCDGEC Tanzania. A computer-generated questionnaire with a total of 60 items was used and data were analyzed using SPSS software.

Results
Findings from the study indicates significant change in the knowledge scores followed by web based intervention with mean difference of 3.58 (P < 0.001) and cognitive skills scores, mean difference of 3.07 (P < 0.001). Only baseline scores were found to be significant predictors for changes among covariates (β = -0.66 and P < 0.001) for knowledge and (β= -0.62, and P <0.001) for cognitive skills. The range of system rating by users was varied across quality and usability variables from (M = 2.50, SD = 1.265) to (M = 4.04, SD = 1.188) indicating the level of satisfaction toward the developed web based system.

Conclusion
The developed web-based system was successful improved nurses' knowledge and skills for pandemic preparedness and response. Nurses positively evaluated the system in term of quality and usability.

Keywords: Nursing, Pandemic Preparedness and Response, Web Based Education, Zanzibar.

Abbreviations
MoHCDGEC: Ministry of Health, Community Development, Gender, Elderly and Children
CDC: Centers for Disease Control and Prevention

Background
Pandemic is a simultaneous global transmission of emerging and re-emerging of the infectious disease epidemics affecting large amounts of people, often resulting in substantial deaths and social and economic disruption , [2]. Studies historically, show that; there have been many significant pandemics outbreak recorded including Spanish Flu, Hong Kong Flu, SARS, MARS, Ebola, Zika etc [3]. while recently; the world has experienced another massive attack of covid-19 pandemic, which caused thousands of death worldwide.

The occurrence of this novel pandemic have revealed insufficiencies in the health systems to respond to a public health emergency, resulting in a health care workers infection and death [4]. Again, the covid-19 pandemic has demonstrated the importance of basic infection prevention and control measures and the importance of having minimum requirements in place including PPE and well trained (prepared) health workers, such as doctors and nurses ready to fight at a frontline [5].

Nurses indeed, play important roles in the secondary level management and the prevention of communicable disease during a pandemic. These roles include leading the pandemic response, efficiently managing limited resources, instituting infection control, and providing safe and effective care [6]. To accomplish these roles, nurses may need to be prepared with the specialized pandemic response education to overcome the challenges of managing and preventing the spread of a disease. However, the level and mode of this preparation do differ across the countries with the developing countries being more interestingly.

In USA for example, particularly in California followed by different pandemics outbreaks and other disasters; the California department of health services through its e-learning health system, created a live satellite program which intended to support the health management system in meeting the preparedness training needs of public health nurses, in building the ability to respond to a pandemic [7].

Likewise in United Kingdom (UK), with the reference to covid-19 pandemic, the health education team added special e-learning program to nurses and midwives, designed to help them as a health workforce's to receive an adequate and reliable update information to respond positively to covid-19 pandemic in their country [8].

In Africa, in particular, there are major shortages of human and nonhuman resources capacity such that the ICU beds and personnel trained in critical care are limited to tertiary hospitals, as assessed in the Republic of the Gambia which indicates a low level of preparation to respond with any pandemic outbreak [5].

For example, in 2018 report on the Level of preparedness by countries in Africa, the numbers of nurses or midwives to 10,000 populations was almost 6.0 in Côte d'Ivoire and Mozambique, around 11 in the Democratic Republic of the Congo and Kenya, while the corresponding figures for the United Kingdom were 81.7 and 132.4 in Germany [9].

Compared to industrial countries to which most of them seem to engage on the use of science and technology to disseminate information to their nurses; most developing countries including Africans', pandemic preparedness wasn't effectively implemented with a low utilization of technology in their plans, including the pre-pandemic education and training to nurses.

In Tanzania for example including Zanzibar, despite the early ini-

tiative of e-learning program in 1994 when the open university of Tanzania established the open learning to date for the best of my knowledge there is still no any integrations of this technology made into nursing education in both school of nursing and at work place level [10].

Failure to integrate has appeared to contribute significantly to ineffective preparation for nurses to respond to the COVID-19 pandemic as far as the lockdown was in place, resulting in no chance for the traditional method of face-to-face communication to be conducted and resulting in a low number of prepared nurses. According to only 300 health care workers including nurses (out of 38,492 registered nurses) in the country were officially trained to tackle covid-19 up to April 2020 [11].

As the requirement for learning both knowledge and skills has surpassed what's possible using conventional learning methods, e-Learning will let us to respond more efficiently to any pandemic the country might face in the future. With this phenomenon, the current research has been mostly focused on designing an online tool, which will assist in the preparation of nurses to respond to pandemic outbreak timely and confidently by imparting them with basic knowledge and skills [12].

Method and Setting
A pre-posttest, single group quasi-experimental study was employed to evaluate the effect of the web-based education on knowledge and skills for pandemic preparedness and responses among frontline nurses. The study was conducted In Zanzibar, a semi-autonomous country in the United Republic of Tanzania. This country is formed by two major islands namely Unguja on southern part and Pemba on North and are surrounded by Indian Ocean.

In this country health services is divided into three levels; Primary level which comprises of Primary Health Care Units (PHCUs); the secondary level covers the district and cottage hospital and the tertiary level covers the referral hospital. The nursing and midwifery council (ZNMC) controls all nursing activities in Zanzibar. Until the last published statistic of covid-19 from Tanzania, Zanzibar contributed about 11.4% (58 cases) and become the second leading part after Dar-es-Salaam [12].

Sample Size and Sample Technique
A multistage sampling technique was used to obtain sample frame and final respondent of the study. In stage one, Simple random sampling by lottery with replacement method was engaged to handpick two regions out of the five existing in Zanzibar. Stage two: Systematic random sampling was engaged to select the health facilities; the list of facilities was obtained from the DHMT office, then from the list every after defined interval one facility was selected. The interval was obtained by using Kth formula: (Kth = N/n).

Stage 3: the proportional sampling method was adopted in this study to handpick the number of study participants from each se-

lected facility by using the formula: ni = Ni/nt *n. Finally, in stage four; a simple random sampling employed to select participants from each facility within the obtained proportion.

The primary sample size estimation was 132 nurses (with attrition rate of 10% made it to be 145). The estimation was made by using the formula:

$$n = \frac{\left[Z_\alpha \sqrt{\pi_0(1-\pi_0)} + Z_\beta \sqrt{\pi_1(1-\pi_1)} \right]^2}{(\pi_1 - \pi_0)^2}$$

Data collection tool and outcome measurement

A self-administered computer generated questionnaires was adapted, modified and distributed to respondents through the developed web based tool. The questionnaire was divided into four parts, demographic characteristics, knowledge questions, cognitive skills questions and nurses' perception about system quality and usability. The knowledge and skills questions were in multiple-choice forms while perception about system quality and usability were in Likert scale form.

The demographic characteristics consisted of ten items including age, gender, residence, level of education, working experience, level of working facility, current section (department) of working, status of IPC training uptake, status of online training uptake, and status of any respiratory tract infection-training uptake.

The knowledge questionnaire was divided into three domains, which are general knowledge, knowledge on IPC, and knowledge on nursing management of the suspected and/or confirmed patient; each domain consisted of 10 items, where each item carries 1 point, resulting in a total score of 30 points in the knowledge questionnaire. The cognitive skills questionnaire, on the other hand, was divided into IPC implementation and nursing management skills for patients with COVID-19 infections; each of these two domains was worth 10 points, for a total score of 20.

To pledge the reliability of the tool for this study, a pre-test intervention was conducted to 20 BSc nurse students from the University of Dodoma and 16 Diploma Nurse Students from Huruma institute of Health and Allied Sciences. A Cronbach's alpha reliability test was done to determine the coefficient reliability between items within the group; the alpha coefficient for 30 items of knowledge was 0.748 and 0.659 for 20 items of cognitive skills as well as 0.691 for 10 items of satisfaction scales.

Development of training materials

The training manual for this study was adapted from CDC, Interim Guidance for Covid-19 USA, WHO-Case Management Manual and MoHCDGEC Tanzania Coronavirus Overview Manual, and was compiled as one document through peered reviews and experts appraisal methods. The peer reviews and appraisals was done by five students of Master of Science in Nursing Education from the University of Dodoma, a public health expert and senior lecturer from the University of Dodoma as well as senior nursing

practitioners from the Ministry of Health and social welfare Zanzibar. The critiques and comments from the experts and colleagues were put into consideration upon the development of this training manual.

Implementation of training

The training was virtually implemented through the developed e-learning platform named ZNCPDs – Zanzibar Nurses Continuing Education Professional Development system. The agreed participants for the study received the username and password through their e-mail address, WhatsApp accounts and SMS to use them for logging in to the platform and start the self-enrollment process to the course.

The training was a two weeks program, which was divided into five lessons where each lesson required two hours per day to be completed; this gave the participants a chance to select their convenient time to enter the system and learn with their own pace. Participants were initially subjected to pre-test to obtain their baseline information concerning with knowledge and skills for Covid-19 pandemic preparedness and responses and then subjected to the educational intervention.

While implementing the intervention; the lesson were delivered in a chronological form with a short quiz at the end of each, to which participants were not able to skip the lessons or attending the next one before having completed the first (spending the required hours online). Different learning activities such as quiz available at the end of each lesson, discussion of the question posted in a forum as well as the use of video presentation such as on how to wear and remove the PPE so as to meet the psychomotor aspect of learning and increase motivation to the learners.

Data management and data analysis

Data from this study was statistically analyzed through the Statistical Product for Service Solutions (SPSS) software program version 20. A descriptive analysis was employed to determine the pattern of distribution of the respondents with regard to their socio demographic characteristics. Factor analysis was also employed to the study to reduce the number of individual questions into dimension (factor). Meanwhile, to verify the assumption for factor analysis the Keiser-Meyer –Olkin (KMO) and the Bartlett's test of sphericity was therefore done through SPSS software. One-way analysis of variance (ANOVA) was used to determine the mean distribution and standard deviation while paired sample t-test was then done to determine mean difference scores for knowledge and skills at baseline and post intervention. To identify predictors for knowledge and skills changes, a multiple linear regression analysis was then performed.

Results
Demographic characteristics of the respondents

This study included an aggregate of 139 frontline nurses from Zanzibar. Out of them, 69.8% were aged below 30years whereas majority of them (61.2%) being female. Nearly half of the re-

spondents (44.6%) were diploma holders' and majority of them (43.9%) had 2 to 5 years working experiences with the higher proportion (44.6%) being those working at the Primary Health Care Units (PHCU). With regards to CPD uptakes, majority (71.2%) had received IPC training and (66.9%) received RTI training; however, only 24.5% of them had a chance to participate to any of eLearning based training (see table 1).

Table 1: Distribution of Study Participants by their Demographic Characteristics (n= 139)

Variable	Frequency (n)	Percentage
Age		
Below 30	97	69.8
31-40	36	25.9
41+	6	4.3
Gender		
Male	54	38.8
Residence		
Urban Unguja	38	27.3
Northern Unguja	8	5.8
Southern Unguja	9	6.5
Wete Pemba	29	20.9
Micheweni Pemba	11	7.9
Level of Education		
Diploma	62	44.6
Advance diploma	21	15.1
Bachelor degree	51	36.7
Master degree/+	5	3.6
Working Experiences		
Less than 2 years	22	15.8
2-5	61	43.9
6-10	39	28.1
More than 10 years	17	12.2
Level of working facility		
Primary Healthcare	62	44.6
Cottage Hospital	25	18.0
District Hospital	31	22.3
Referral Hospital	21	15.1
Received IPC training		
Yes	99	71.2
No	40	28.8
Received RTI training		
Yes	93	66.9
No	46	33.1
Ever use eLearning		
Yes	34	24.5
No	105	75.5

Source: Field data 2021, Zanzibar.

Baseline nurses' knowledge on covid-19 pandemic

The results of the assessment of knowledge on covid-19 among frontline nurses from Zanzibar indicate that; the overall mean score knowledge of all respondents was (20.7±3.06) ranged from 13-26. Male and female respondents demonstrated nearly similar mean score knowledge (20.73±3.39 and 20.86±2.86 respectively) with no statistically significance difference.

With regards to the age groups of the respondents; elder nurses in the age group of (40+ years) shows a significantly higher mean knowledge score (23±2) compared to the young age groups P<0.001(Table-2). However this difference was significantly observed in the IPC and Nursing care knowledge (P< 0.001) only but not in the general knowledge of the covid-19 domain where both age group present almost similar mean scores, age group of 20-30 years (7.81±1.1), 31-40years (8.11±1.2) and 41+ years (8.67±0.52) with P= 0.107 (Table-3)

Nurses with master degree level were having a statistical significance higher mean knowledge scores (24.0±3.39) compared to those in the diploma, advance diploma and bachelor degree level

(P<0.001). Again, there was also a statistically significance difference in the mean score knowledge between nurses with working experience of more than 10 years (22.24±3.17) compared to those with <2years, 2-5 and 6-10 years (18.8±3, 20.17±2.66 and 21.88±2.96 respectively) P< 0.001 (Table-2). This significance different was specifically observed under the domain of IPC and Nursing care knowledge (P< 0.001) but not in the domain of general knowledge for covid-19 P=0.063 (Table-3)

Regarding to the status of IPC, RTI and eLearning training uptake; nurses with the history of participation in those training demonstrated a significant mean score differences while compared to those who were not (P< 0.001); yet, the difference in IPC training variable was observed being not statistical significance (P=0.132) in the domain of the general knowledge on covid-19 when it came to domain analysis. On the other hand, no difference in knowledge was observed according to the gender, residence and level of working facility P >0.05 (Table-3). Conversely, the domains based analyses indicate significant different of the mean knowledge score in the domain of the general knowledge on covid-19 (P< 0.001)

Table 2: Relationship between socio-demographic characteristics of the respondents with the overall mean knowledge scores on covid_19 pandemic by ANOVA (n=139)

variable	n	Mean	SD	P-Value
Overall Scores	139	20.69	3.06	
Gender				0.901
Male	54	20.73	3.39	
Female	85	20.66	2.86	
Age group				0.001*
20-30	97	20.08	2.79	
31-40	36	21.96	3.38	
41 +	6	23.00	2.00	
Residence (Region)				0.287
Urban West	82	20.54	2.85	
South Unguja	17	21.79	2.83	
North Pemba	40	20.54	3.53	
Level of Education				<0.001*
Diploma	62	19.41	2.92	
Advance Diploma	21	22.86	2.03	
Bachelor	51	21.03	2.78	
Masters+	5	24.00	3.39	
Working Experience				<0.001*
Less than 2years	22	18.82	3.00	
2-5years	61	20.17	2.66	
6-10years	39	21.88	2.96	
More than 10years	17	22.24	3.17	
Working Facility				0.062
PHCU	62	20.00	3.14	

Cottages	25	20.88	2.76
District	31	21.06	2.98
Referral	21	21.95	2.97
Status of IPC training			<0.001*
Yes	99	21.34	2.71
No	40	19.08	3.31
Status of RTI training			<0.001*
Yes	93	21.47	2.78
No	46	19.11	3.04
Ever use eLearning			<0.001*
Yes	34	22.43	2.34
No	105	20.13	3.07

Table 3: Relationship between socio-demographic characteristics of the respondents with the domain of knowledge for covid-19 pandemic by ANOVA (n=139)

variable	General Knowledge				IPC knowledge			Nursing care knowledge		
	n	M	SD	P	M	SD	P	M	SD	P
Gender				0.865			0.936			0.539
Male	54	7.91	1.32		7.05	1.326		5.78	1.21	
Female	85	7.94	1.00		7.06	1.313		5.66	1.04	
Age group				0.107			0.001*			<0.001*
20-30	97	7.81	1.10		6.80	1.256		5.46	0.98	
31-40	36	8.11	1.24		7.60	1.292		6.25	1.25	
41 +	6	8.67	0.52		8.00	1.095		6.33	0.82	
Residence (region)				0.263			0.222			0.417
Urban West	82	7.80	1.07		7.02	1.237		5.71	1.08	
South Unguja	17	8.24	0.83		7.56	1.223		6.00	1.17	
North Pemba	40	8.05	1.34		6.91	1.476		5.58	1.13	
Level of Education				<0.001*			<0.001*			<0.001*
Diploma	62	7.48	1.13		6.67	1.434		5.26	0.96	
Adv. Diploma	21	8.52	0.98		7.95	.669		6.38	0.87	
Bachelor	51	8.12	0.97		7.07	1.158		5.84	1.10	
Masters+	5	9.00	1.23		8.00	1.225		7.00	1.23	
Working Experience				0.063			<0.001*			<0.001*
< 2years	22	7.59	1.18		6.23	1.510		5.00	0.82	
2-5years	61	7.77	1.07		6.89	1.152		5.51	1.01	
6-10years	39	8.21	1.15		7.50	1.187		6.18	1.12	
> 10years	17	8.29	1.11		7.71	1.263		6.24	1.09	
Level of working facility				0.069			0.359			0.001
PHCU	62	7.68	1.25		6.94	1.380		5.39	1.01	
Cottages	25	8.04	0.94		7.00	1.225		5.84	1.03	
District	31	8.32	1.01		7.03	1.329		5.71	1.07	
Referral	21	7.95	1.02		7.52	1.167		6.48	1.17	
Status of IPC training				0.132			<0.001*			0.006*

	N	Mean	SD	Sig.	Mean	SD	Sig.	Mean	SD	Sig.
Yes	99	8.02	1.10		7.45	.995		5.87	1.09	
No	40	7.70	1.20		6.08	1.492		5.30	1.04	
Status of RTI training				0.007*			<0.001*			<0.001*
Yes	93	8.11	1.10		7.40	1.117		5.97	1.03	
No	46	7.57	1.13		6.37	1.420		5.17	1.08	
Ever use eLearning				0.007*			0.001*			<0.001*
Yes	34	8.38	0.95		7.69	.817		6.35	0.92	
No	105	7.78	1.15		6.85	1.380		5.50	1.08	

Effect of web based education on knowledge for covid-19

A paired sample t-test was conducted to compare the mean-score differences between pre and post educational intervention on the knowledge of covid-19 pandemic preparedness and response. The results show that there is a significant difference in the total knowledge score for pre intervention group (M=20.69, SD=3.06) and post intervention group (M=24.27, SD= 2.29) with P < 0.001 and total mean difference of 3.58 (Table- 4)

Thus, the result put forward that; web based training had significant effects on the knowledge of covid-19 pandemic preparedness and response among frontline nurses in Zanzibar; specifically the result implies that when nurses are trained through web based methods they can also increase their knowledge on pandemic response.

Table 4: Mean knowledge score differences between pre and post intervention by Paired Samples Statistics (N=139)

		Mean	Std. Deviation	Mean difference	Effect size(d)	Sig. (2-tailed)
General Knowledge	Pre	7.93	1.13			
	Post	8.86	0.84	0.93		< 0.001
IPC Knowledge	Pre	7.06	1.31			
	Post	8.28	1.31	1.22		< 0.001
Nursing Care	Pre	5.71	1.10			
	Post	7.13	1.44	1.42		< 0.001
Total Knowledge Scores	Pre	20.69	3.06			
	Post	24.27	2.29	3.58	0.67	< 0.001

Predictors of knowledge change in the post intervention group by linear regression

To determine the effect of web based training on the knowledge for pandemic preparedness and response among respondents; a multiple linear regression analyses was run in the SPSS by using eight variables from demographics characteristics of the respondents against the knowledge score difference (Pre – Post = Score difference). The results indicates an overall statistical significant prediction of the demographic characteristics to the knowledge gain $F_{(138)} = 10.88$, $P < 0.001$, $R^2 = 0.531$. However, the capacity of each individual independent variable to predict the outcome was only statistically significant to the baseline knowledge variable with $\beta = (-0.66)$ and $P < 0.001$ (Table 5)

Table 5: Predictors of knowledge score change in the post intervention group by linear regression

Model	Unstandardized Coefficients		t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error			Lower Bound	Upper Bound
(Constant)	11.76	4.18	2.81	.006*	3.48	20.03
Baseline knowledge	-0.66	.065	-10.17	.000*	-0.79	-0.53
Age of the respondent	.26	.17	1.50	.137	-.08	.61
Gender (Female)	-.32	.36	-.91	.366	-1.03	.38
Level of Education						
Advance Diploma	.25	.66	.38	.702	-1.05	1.56
Bachelor Degree	.51	.42	1.22	.226	-.32	1.33
Master +	-.84	1.09	-.77	.440	-2.97	1.30

Working experience	-.22	.20	-1.10	.272	-.63	.18
Level of working facility						
PHCU	-.60	.44	-.11	-1.365	-1.46	.27
Cottage hospital	-.64	.55	-1.15	.252	-1.73	.46
Referral hospital	-.08	.59	-.13	.899	-1.24	1.09
Status of training uptakes						
IPC training	.35	.47	.74	.458	-.58	1.28
RTI training	.39	.45	.86	.393	-.51	1.29
Ever use eLearning	-.44	.43	-1.03	.306	-1.30	.41

$F(138) = 10.88$, $P < 0.001$, $R^2 = 0.531$

Baseline nurses' Cognitive skills on covid-19 pandemic

Nurses' cognitive skills scores was significantly differ among respondents based on their demographic characteristics. Of all respondents; the overall mean scores was (20.69±3.06) ranged from 8-18. There was no statistical mean difference between male (13.00±2.46) and females (12.53±2.70) cognitive skills scores (P=0.302).

Nurses within the age-group of (40+ years) were observed to have significantly higher Mean cognitive skills scores (14.50±1.87; P=0.017) when compared to the young age groups in overall cognitive skills scores (Table-6). Nevertheless; the domain based analysis (Table-7) demonstrate that, the different was only significant on the domain of IPC skills (P=0.031) but not in Nursing care skills, where all groups present nearly the same mean scores with no statistical significance difference (P=0.077).

With regard to the level of education, nurses with master degree were found to have higher mean cognitive skills scores (15.80±2.28) compared to those in the diploma, advance diploma and bachelor degree level (P<0.001). Nurses with working experience of more than 10 years yet were found to significantly differ in mean cognitive skills scores (13.18±2.38, P=0.008) from those with <2years (11.41±2.70), 2-5(12.51±2.41) and 6-10 years (13.18±2.38). Specifically, this significance different was more of IPC related skills (P=0.003) rather than nursing care skills (P=0.195) (Table-7).

A mean cognitive skills score for nurses working in referral hospital level (14.90±2.10) was significantly higher compared to those at PHCU level (11.90±2.39), cottage (12.56±2.58) and district level (12.97±2.58) at the level of 1% (P<0.001).Concerning the status of IPC, RTI and eLearning training uptake; nurses with the history of participation in those training demonstrated a significant higher mean score as compared to their counterpart (P< 0.01); however the domain based analysis indicate the difference to be significant under the IPC domain only P<0.001 (Table-7)

Table 6: Relationship between socio-demographic characteristics of the respondents with the overall mean Cognitive skills scores on covid_19 pandemic (n=139)

variable	n	Mean	SD	P-Value
Overall Scores	139	12.71	2.61	
Gender				0.302
Male	54	13.00	2.46	
Female	85	12.53	2.70	
Age group				0.017*
20-30	97	12.32	2.52	
31-40	36	13.47	2.71	
41 +	6	14.50	1.87	
Residence (Region)				0.177
Urban West	82	12.66	2.76	
South Unguja	17	13.76	2.49	
North Pemba	40	12.38	2.26	
Level of Education				<0.001*
Diploma	62	11.73	2.52	
Advance Diploma	21	12.62	2.29	
Bachelor	51	13.65	2.35	

Masters+	5	15.80	2.28		
Working Experience					0.008*
Less than 2years	22	11.41	2.70		
2-5years	61	12.51	2.41		
6-10years	39	13.18	2.38		
More than 10years	17	14.06	2.99		
Working Facility					<0.001*
PHCU	62	11.90	2.39		
Cottages	25	12.56	2.58		
District	31	12.97	2.58		
Referral	21	14.90	2.10		
Status of IPC training					0.003*
Yes	99	13.12	2.50		
No	40	11.70	2.63		
Status of RTI training					0.001*
Yes	93	13.23	2.52		
No	46	11.67	2.51		
Ever use eLearning					<0.001*
Yes	34	14.15	2.20		
No	105	12.25	2.57		

Table 7: Relationship between socio-demographic characteristics of the respondents and the mean scores within the domains of the cognitive skills on covid_19 Pandemic (n=139)

Variable	Cognitive skills on IPC				Cognitive skills on Nursing Care		
	N	M	SD	P-value	M	SD	P-value
Gender				0.277			0.501
Male	54	6.87	1.42		6.13	1.56	
Female	85	6.59	1.53		5.94	1.64	
Age group				0.031*			0.077
20-30	97	6.51	1.48		5.81	1.55	
31-40	36	7.03	1.42		6.44	1.72	
41 +	6	7.83	1.33		6.67	1.21	
Residence (region)				0.274			0.186
Urban West	82	6.60	1.54		6.06	1.62	
South Unguja	17	7.24	1.44		6.53	1.51	
North Pemba	40	6.68	1.39		5.70	1.57	
Level of Education				0.003*			<0.001*
Diploma	62	6.23	1.43		5.50	1.60	
Adv. Diploma	21	6.67	1.46		5.95	1.50	
Bachelor	51	7.20	1.39		6.45	1.40	
Masters+	5	7.60	1.67		8.20	1.10	
Working Experience				0.003*			.195
< 2years	22	5.86	1.39		5.55	1.82	
2-5years	61	6.59	1.50		5.92	1.38	
6-10years	39	7.00	1.24		6.18	1.73	

> 10years	17	7.47	1.63		6.59	1.66	
Level of working facility				<0.001*			0.003*
PHCU	62	6.21	1.36		5.69	1.50	
Cottages	25	6.80	1.53		5.76	1.64	
District	31	6.87	1.57		6.10	1.60	
Referral	21	7.76	1.09		7.14	1.42	
Status of IPC training				<0.001*			0.217
Yes	99	7.00	1.38		6.12	1.56	
No	40	5.95	1.50		5.75	1.69	
Status of RTI training				<0.001*			0.099
Yes	93	7.05	1.40		6.17	1.57	
No	46	5.98	1.41		5.70	1.63	
Ever use eLearning				0.001*			0.002*
Yes	34	7.41	1.26		6.74	1.52	
No	105	6.47	1.49		5.78	1.56	

Effect of the developed web based tool on cognitive skills for covid-19 pandemic

To compare the mean score difference between pre and post intervention group for the cognitive skills on covid-19 pandemic preparedness and response among frontline nurses in Zanzibar; a paired sample t-test was run on a sample of 139 nurses to determine whether there was a statistical significant difference between pre and post web based training intervention.

Results of the paired-samples t-test show that mean cognitive skills for pandemic preparedness and response differ before the web based training (M = 12.71, SD = 2.61) and after taking the training (M = 15.8, SD = 1.75). This indicate that there was a statistically significant increase of 3.07(95% CI, 2.72 to 3.42) mean score in the post intervention group for overall cognitive skills scores with the effect size (Cohen's d) d= 0.7 and P < 0.001 (Table 8)

Table 8: Mean Cognitive skills score differences between pre and post intervention by Paired Samples Statistics (N=139)

		Mean	Std. Deviation	Mean difference	Effect size(d)	Sig. (2-tailed)
IPC Skills	Pre	6.70	1.49			
	Post	8.04	1.04	1.34		< 0.001
Nursing Care	Pre	6.01	1.60			
	Post	7.75	1.08	1.74		< 0.001
Overall Skills Score	Pre	12.71	2.61			
	Post	15.78	1.75	3.07	0.7	< 0.001

Predictors of Cognitive skills change

A multiple linear regression analysis was conducted to determine the influence of the socio demographic characteristics of the respondents on the increased level of the cognitive skills score in the post intervention group. The results indicate that there was an overall statistically significant association between social demographic characteristics of the respondents with the increased level of cognitive skills scores in the post intervention group F (138) = 13.012, P <0.001, R^2 = 0.595 (Table 9). Specifically, this association was statistically significant attributed by baseline skills test β= (-0.624), P <0.001

Table 9: Association between the demographic characteristics of the respondents and cognitive skills for covid-19 pandemic preparedness and response

Model	Unstandardized Coefficients			95.0% Confidence Interval for B	
	B	t	Sig.	Lower Bound	Upper Bound
(Constant)	11.620	4.046	<0.001*	5.936	17.304
Baseline skills	-0.624	-11.155	<0.001*	-0.735	-0.514
Age of the respondent	-0.003	-0.027	0.979	-0.254	0.248

Gender (Female)	0.079	0.294	0.769	-0.455	0.613
Level of Education					
Advance Diploma	-0.055	-0.118	0.907	-0.974	0.865
Bachelor Degree	-0.366	-1.194	0.235	-0.973	0.241
Master +	1.257	1.627	0.106	-0.272	2.786
Working experience	0.028	0.192	0.848	-0.263	0.320
Level of working facility					
Cottage	0.202	0.552	0.582	-0.522	0.926
District	0.289	0.849	0.397	-0.384	0.961
Referral	0.099	0.230	0.819	-0.757	0.956
Status of training uptakes					
IPC training	0.300	0.875	.383	-0.378	0.977
RTI training	-0.142	-0.430	0.668	-0.796	0.512
Ever use eLearning	-0.513	-1.631	0.105	-1.136	0.110

$F_{(138)} = 13.012, \ P < 0.001 \ R^2 = 0.595$

Perception of nurses on system quality and usability

Satisfaction of nurses on the developed web based training system was measured by ten items questionnaire in five likert scale ranging from 1 to 5. The tool contained six positive questions to which strongly agree indicates the most correct answer and four negative questions where strongly disagree indicate the most correct answer. With this scale the mean rating was set at fifty (50) percentile which is 3; thus those variables with mean rating of greater than or equal to 3 were perceived satisfied by users. A descriptive analysis was then done to determine the mean rating given to the developed system.

The results show that the respondents perception about the quality and usability of the developed web based training system for pandemic education have a mean rating for all variable of > 3.6 and SD ≥ 1.15 The highest mean rating variable was system recommendation to the government (M = 4.04, SD = 1.188) and the lowest being Motivation to learn (M = 2.50, SD = 1.265). (Table 10)

Table 10: Mean rating for quality and usability of the developed web based training tool

	Variables / Quality and usability	Mean	Standard deviation
1	Contents	3.98	1.21
2	Learner support	3.61	1.23
3	Computer use	3.71	1.19
4	Motivation to learn	2.50	1.27
5	Accessibility	3.91	1.12
6	Interactivity	3.83	1.19
7	System integration	3.54	0.97
8	General course evaluation	3.76	1.18
9	Expectation of system usability to other nurses	3.77	0.99
10	Recommendation to the government	4.04	1.19

Discussion

This study evaluated the effect of the web based training on knowledge and skills for pandemic preparedness and responses among frontline nurses. Findings from this study indicate a significant increased mean scores knowledge on covid-19 pandemic after the educational intervention done through the developed web based tool. This finding corroborate with the findings of other published work regarding the increasing of nurses knowledge followed by web based education intervention.

The study of for example has also found that there were increasing in mean score knowledge of nurses followed by web based education intervention [14]. Although the mean different knowledge score in the current study was lower (3.58) compared to Moattaris' (6.21) this difference could be due to the difference in sample size, learning content and duration for retention of knowledge. For example Moattari evaluated only 31 nurses (who completed the study) while according to the lower sample size might exaggeratedly inflate or deflate the mean scores [15].

In a similar manner the study of which was done in USA, Canada and Zanzibar respectively, all of them had demonstrated the significance increase in knowledge of the respondents followed by web based education [16-18]. Although the study of wasn't par-

ticularly for nurses but for secondary students instead, the findings can still provide meaningful association with the current study as it reflect how the web based learning can impart knowledge to the learners from Zanzibar [18].

With regards to skills, findings revealed that web based training has significantly increased cognitive nursing skills on managing and controlling the covid-19, followed by the web based education intervention. This finding corroborated the findings from other studies done elsewhere [19]. for example; in their study concerning with the effectiveness of a computer based educational program on nurses' knowledge, attitude and skills they found that the level of skills being increased in post web based intervention compare to pre intervention, indicating the positive effect of the web-based learning.

The positive effect of web-based learning on improving nurses' skills in the present study could be the result of integrating pedagogical approach that assist the learner to learn effectively within the system. For example video such as "How to put on and off the PPE", "How to use the ventilator machine" and how to wash hands" were used within the system so as to meet the need for psychomotor function of learning. The same approach was also found to be applied in the study of while trying to enhance nurses' competencies on managing diabetic patients and result into the positive outcome [14]. Again used a live videos in his study where students could have to see the teachers' do from where they ware, however this need a little bit more advance ICT specialized skills and platform compared to one used in the current study [18].

With respect to quality and usability of the developed web-based training system; findings from the current study indicate that; the developed web-based system was feasible to the users and may enhance the improvement of nurses' knowledge and skills for pandemic preparedness and responses in Zanzibar. Participants was positively evaluated the system with regard to its quality and usability.

The study indicated that almost 76% percent of all respondents had never been exposed to any of the eLearning program before, however, with regards to the system usability users were seem to be satisfied with the system use as the mean rated computer use was (3.71±1.19) out of 5, overall course evaluation (3.76±1.18) and the expectation usability to others (3.77±0.99) out of 5. This could be due to how simple the system was made that even a low experienced computer user can follow the procedures. This findings support the findings of whose results precisely demonstrated the users system satisfaction in relation to computer use with access to software and hardware [17,20,21].

With regard to the system quality, users were satisfied with contents quality, learner supports, interactivity and accessibility qualities with a moderate to higher mean rating scores. This could be due the use of advanced version of the learning platform (Moodle LMS version 3.10) which allows smoothly functioning of the sys-

tem as well as the use of nursing education experts in planning and arranging the course contents. This finding support the finding from previous studies done elsewhere related to the quality of the web-based system for learning. The study of (20) for example concluded that contents and learning qualities were the most rated and acceptable criterion.

Apart from that; the findings was further indicating low satisfaction in motivation to learn (2.50±1.27) out of 5. This indicates that the system lacks some of the inspirational features to the users [14]. This finding is however contradict the findings of which found that users were extremely satisfied with the quality of the system motivation to learners. This discrepancy could be due to the nature of the respondents and methodology used, for example Moattari yielded 31 respondents whom they have prior knowledge on the use of eLearning platforms and trained for 8 weeks which is 4 times higher compared to the present study.

Conclusion

The developed web-based system was successful improved nurses' knowledge and skills for pandemic preparedness and response. Nurses who attending this study were positively appraised the developed system in terms of quality and usability. As for these findings; this study conclude that; application of the low budget web based training system for nurses' training is feasible to nurses in Zanzibar and leads to increased knowledge and skill for pandemic preparedness and response. It is also hoped that, time has come for Ministry of Health to embrace technology for nurses training, thus adopting this system will have helpful clinical outcome on empowering nurses' competence through knowledge and skills.

Recommendation for Action

This study has proved that; a very low budget web-based training system has potential to raise the standard and quality of nursing care in responding to pandemic outbreak by improving their knowledge and skills. Thus, the Ministry of Health should consider the adoption and utilization of web-based training system when it comes for pandemic outbreak instead of face to face training with the views to ensure all nurses across the country are updated in the care of the emerged outbreak.

Second, since findings from the study revealed that the system has potential in nurses Continued Education Professional Development (CPDs) and other managerial functions, there is a need for Zanzibar Nurses and Midwifery Council (ZNMC) to consider adopting this tool in order to foster nursing activities in the isles.

Third, as the study demonstrated nurses being satisfied with web based training, it is also my believe that they will find use of this mode of training beneficiary even in the regular classroom basis, therefore this study recommend to the Ministry of Health to prioritize nurses who pursue higher learning in the field of nursing informatics so as to break the barrier of inadequate ICT technicians to oversees and assisting in running minor programs and lessons that need technical expertise.

Fourth, to nursing curriculum planner in master degree programs; the study recommends that they should reconsider the integration of nursing informatics course into Nursing Education program to equip candidates not only with pedagogical knowledge but also with ICT skills that will help them in the near future to produce young nurses who are aware in some of important technological parts in nursing.

Recommendation for Further Studies
This study yielded a single group quasi experimental design to test the efficacy of the developed web based tool to which for some reasons couldn't provide the relative benefits of the web based training approach over the traditional method of face to face. Therefore it is recommended that a comparative study between web based and face to face training to be conducted in Zanzibar to address this gap.

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Authors' contributions
Both SK and HM contributed equally in the conceptualization and designing of this study. All authors have read and approved the manuscript.

Ethical Considerations
An ethical clearance and research approval letter for this study was obtained from the Health Research Ethics Committee of the University of Dodoma. The letter was then submitted to the ethical board of Ministry of Health Zanzibar; and finally to the office of Second Vice President of Zanzibar, for permission to undertake the study in Zanzibar. Written consent was also obtained from the participants. Participants were full informed about the aim, advantage, disadvantage and their roles in this study and left them to make an informed decision.

Competing Interests
The authors declare that they have no competing interests in this study.

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