INTERNATIONAL JOURNAL

OF

INSTRUCTIONAL TECHNOLOGY

AND

DISTANCE LEARNING

PUBLISHER'S DECLARATION

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Editorial

Results Oriented Learning

Donald G. Perrin

The Carnegie Unit is a way to measure instruction for administrative purposes. It is related to the number of hours of face-to-face instruction, instructor pay, class schedules, and academic credit for courses completed. Academic credits may be transferable to other institutions of higher learning. Accreditation agencies determine if academic programs meet acceptable quality standards to be accredited.

The credit-hour, devised in the late 19th century, is a cornerstone for administration of higher education programs. It defines schedules, budgets and faculty workload; it qualifies students for college entrance, completion of coursework and degrees. The Carnegie unit is not a measure of educational attainment although it is often used that way on student transcripts where courses are listed with course grades. It is expected that more detailed performance or competency-based evaluations will be adopted in the future as a measure of academic success.

Radical changes to pedagogy brought about by technology and distance learning have changed the playing field for students, administrators and employers. Attempts to adapt the new pedagogies to produce the same metrics are confusing at best. It is true that learning management systems can collect and tally numbers, but this does correct deficiencies of the Carnegie Unit which measures *input* and *process* when we need to know *output* and *results*. A new management tool is needed to validate *academic* achievement that is consistent across disciplines and teaching strategies and learner attributes and methods of evaluation. This might complement rather than replace the Carnegie Unit.

It is time to rethink the management and evaluation of teaching and learning based on the changing pedagogies, research, and praxis. Learners are not all alike and pedagogy for distance learning is very different to face-to-face learning in a classroom. We can set much higher standards if we replace traditional grading systems with criterion-based learning. And we can use the data garnered by our technologies and learning management systems for continuous quality improvement.

For meaningful learning to take place, the student must be motivated. Objectives must be clearly stated, relevant and interesting. The learner must know why this goal is important and believe it can be achieved successfully (Keller – ARCS instructional design model). Content must be clearly organized and presented, and reinforced by feedback (Kemp - instructional design model; Bloom - Taxonomy of Behavioral Objectives; Gagne - Conditions of Learning; Vygotsky – scaffolding; Siemens – Connectivism; Skinner - operant conditioning, etc.).

When instruction is embedded in media such as books, audio, slides, video, interactive multimedia and mobile devices, students can learn independently at any time and place. Different levels of feedback can overcome the limitations of one-way communication. Feedback includes participation with other students, dialog with instructor and practitioners in the field, and interactive media that guide learners through complex experiences with feedback at every step. Computers can process learner responses to shape a path through subject matter to a predetermined goal. In programmed instruction, the student fills-in the answer and is then told the correct answer (immediate knowledge of results); a multiple-choice question can be a diagnostic to reinforce correct answers or present helpful instruction based on learner needs. Interactive multimedia can transport the learner through time and space and many other dimensions. Simulators can emulate real-world situations without cost or danger. Computers can determine the effectiveness of instruction at every step and this data can be used to improve the instruction for future learners, resulting in continuous quality improvement.

From an instructor point of view, grading A thru F is to accept failure. If the course has knowledge and skills that are essential to performance in real-world situations, there is a baseline that must be achieved by all students. For my courses it is A-minus (900 of 1000 points). Learners must complete all coursework and correct errors in assignments, projects, and tests to receive a full grade – a principle Edward Deming used to make production lines more efficient. To take pressure off the student, there is no penalty for late submission of homework, errors can be corrected, and learners can ask questions or request individual help and tutorial assistance as needed.

Learners are encouraged to collaborate in groups since that is the way most tasks are accomplished in today's world. Homework is submitted by computer. Turnaround time is about 24 hours. Solutions must show step-by-step how the answer was achieved, and Excel or other files used to obtain solutions must be attached. If the solution files don't work or if there is obvious copying of text, the homework is returned and a new problem is sent.

Do how does the administrator measure my performance? I have been criticized for limited presence in discussion boards; students do perfectly well in working things out together. I solve many problems proactively by producing templates and MP4 videos. I correct a tremendous volume of homework which, when done correctly by the student, takes seconds for me to grade; but when student make errors, I troubleshoot and prepare a specific, often step-by-step, response. This requires a considerable amount of time. If several students have the same problem, I prepare additional learning materials and modify the course for future students.

I claim that a results oriented approach with criterion based learning will achieve much more for the student, faculty and course than can be achieved by traditional methods. It does take a more time for the student and instructor because of the additional correction (feedback) and the amount of course development involved. Any attempt to convert this into Carnegie units makes no sense, even for the administrator. But it does focus the energy where it is needed to support the learner.

Analyzing usage of crowdsourcing platform Ushaurikilimo' by pastoral and agro-pastoral communities in Tanzania

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Tanzania

Abstract

Earlier studies report that agricultural extension service for livestock keepers in Tanzania is not effectively offered. 'Ushaurikilimo' which is a crowdsourcing platform consisting of a Web and Mobile based agro-advisory system. It is a system which complements the traditional agricultural extension provided to pastoralists and agro-pastoralists. Mobile crowdsourcing for agricultural extension service is an emerging approach to address some of the problems experiencing in traditional agricultural extension service.

This study explored the information seeking pattern of livestock keepers who are using 'Ushaurikilimo'. In total 1739 questions are in 'Ushaurikilimo'. Out of 1739 questions and answers, the study concentrated on 1312 questions since 427 questions related to forestry. Out of 1312 questions submitted to 'Ushaurikilimo' via livestock keepers' mobile phones, 605 (47%) questions relate to livestock and 53% relate to crops. Most livestock keepers asked questions with keywords related to chicken, pigs and milk from 'Ushaurikilimo' knowledge base. Further data mining analysis showed that the following keywords are the most queried information by livestock keepers: poultry management, poultry equipment and accessories, hatching equipment, feed equipment, feed storage, feed manufacturing machinery, product handling/transport equipment, quality testing equipment and energy saving equipment, milk processing, housing and environment, building materials and equipment, feeds and feeding, food preservation, feed additives and dairy products.

In this study, the pattern of information seeking behavior of livestock keepers matched the pattern which has been reported earlier by other researchers who explored the information seeking behavior of livestock keepers who are using other sources of information such as newspapers, television, radio, farmers' friends and extension agents. One peculiar result from this study is that the average response time after the question had been assigned to an expert to answer was 32.49 hours. Thus, the crowdsourcing platform, web and mobile based agro-advisory system proved to be effective compared to conventional agricultural extension methods. This calls for a need to scale up 'Ushaurikilimo' to complement the traditional agricultural extension service in Tanzania.

Keywords: information needs, information seeking behavior, pattern, livestock keepers, pastoral, agro-pastoral, agro-advisory systems, data mining.

Background information

Tanzania is endowed with abundant natural resources such as fertile land, water, a huge livestock resource base and conducive weather condition for agricultural activities (MLFD, 2015). Over 50% of households are engaged in livestock keeping: 21.3 million cattle's, 15.2 million goats, 6.4 million sheep. Other livestock include 1.9 million pigs, 35 million traditional chickens and 23 million layers and broilers (MLFD, 2015). Livestock keeping requires daily care with knowledge of livestock nutrition, treatment and control of diseases, breeding techniques and markets for their products; and other livestock information needs to increase productivity (Angello, 2015). In Tanzania, there is an extension officer in every ward to do basic extension service, namely:

supervision, training, logistics, and linkages with other knowledge and input systems (Rutatora & Mattee, 2001).

According to Mpande (2004), extension officers provide the farming community with information to enhance agricultural production, productivity and rural incomes) According to Rutatora and Mattee (2001), agricultural extension service contributes to improvement of welfare of farmers and other agricultural actors. The extension services aim at strengthening farmer's capacity to innovate and implement new technologies that can be applied in agriculture. Extension services provide access to agriculture knowledge and information. Apart from solving problems related to crops, marketing and forestry, extension officers also have to solve challenges that livestock keepers face today (Lin et al., 2012). This goes beyond technology transfer to facilitation; beyond training to learning, and includes assisting farmer groups to form, deal with marketing issues, and address public interest issues in rural areas such as resource conservation, health, monitoring of food security and agricultural production (USAID, 2002).

However, due to weak agricultural extension systems used in Tanzania where a single extension officer has to provide services to at least 4 or 5 villages. Problems include varied and heavy loads of extension staff, low or non-adoption of new agricultural technologies by farmers, poor farmer access to other resources (credit, land, market etc.) and lack of access to and relevant training by both service providers and farmers (MOFA, 2011; Ragasa et al., 2015). For example in Tanzania, only 20% of livestock producers are able to access extension services due to fact that there are few extension officers to serve many farmers (Due et al., 1997). This phenomenon is because the ratio between extension agent to 1000 farmers is 0.4 (Ragasa et al., 2015). The methods used by extension officers to assist farmers are farm visiting, home visiting and conducting seminars and training to livestock keepers (Rutatora and Mattee, 2001). These methods are not enough for all livestock keepers to have appropriate information at the right time. Thus in many developing countries low agricultural production has been attributed, among other factors, to poor linkages between Research-Advisory-Services and Farmers, and to ineffective technology delivery systems, including poor information packaging, inadequate communication and poor methodology (MOFA, 2011).

The use of Information and Communication Technology (ICT) can allow rapid and effective dissemination and communication of information and knowledge that can be utilized to improve delivery of extension services (Mussa et al., 2016). ICT can reduce home and farm visitation by extension officers to assist and teach livestock keepers. This is more efficient in dissemination of information that previously depended on inter-personal contact (MOFA, 2011; Sanga et al., 2013). Coordination of extension services is most efficient and effective when provided in a targeted manner where extension officers and livestock keepers congregate (Mussa et al., 2016). Thus by focusing on the use of ICT, Tanzania can revolutionize its research and extension system to determine the best methodology and methods that can be major drivers of a modernizing national livestock sector and targeted delivery of comprehensive extension services (MLFD, 2015).

The application of ICT such as mobile phones, web based systems, radios and televisions could assist livestock keepers to efficiently access current information and obtain the knowledge that will improve livestock productivity (Lin & Heffernan, 2009; Mussa et al., 2014; Wanga and Kalegele, 2015). Farmers will be able to learn how to manage farms, formulate feeds, or manage diseases by browsing through the Internet or linking with their veterinarian, fellow farmers and others (Opeyemi, 2015). This will reduce cost, tiresomeness and time that extension officers spend to visit livestock keepers in their home and villages to disseminate knowledge and information. And more importantly will simply increase the number of advice beneficiaries.

Mobile phone and other ICT can help the surveillance of animal and human diseases (Kipanyula et al., 2016). Livestock keepers living in different areas can access the information about diseases

outbreaks, vaccination programs, and treatment of diseases at low cost and without using a lot of their time to get those information from extension officers. According to Gandhi (2013), animal disease cause billions of losses every year around the world and in order to address this challenge he proposes a mobile phones application called iCow. The cause of the livestock losses is due mainly to lack of knowledge and information at the right moment (Gandhi, 2013). Mobile phones can play a key role in fighting livestock disease outbreaks, increase attendance and participation in animal health provider meetings, enable meetings to be convened or cancelled at short notice. Mobile phones can also reduce the transaction costs to the farmer since it is now possible to make a diagnosis over the phone without incurring transportation costs and drugs can be ordered by phone, thus avoiding the time and expense of unnecessary trips for drug procurement (Kithuka et al., 2007). Also it is possible in Tanzania for livestock keepers to buy needed drugs to treat their livestock through pay-by-phone to the veterinary shops using mobile money (e.g. Mpesa, Tigopesa Airtel Money etc.). This reduces the time they spend to buy and get drugs.

For example, if a livestock keeper observed an unusual symptom on an animal, s/he can quickly find a veterinary via mobile phone, explain the problem to a veterinarian, and receive advice on how to treat affected animals (Mwabukusi et al., 2014; Karimuribo et al., 2016). In Kenya, iCow is helping millions of farmers in prevention and cure of milk related diseases via mobile phone (Gandhi, 2013). Like all health situations, animal health challenges might develop at any time and farmers need to reach their health care providers to visit their farm or supply information about what to do to manage the situation. Farmers can visit the Internet, use email, social media, mobile phones or any other instant messaging device to seek for advice to treat any health challenge their livestock are facing (Nwagwu and Soremi, 2015).

Geographic Information System (GIS) integrated with surveillance information system can also be used by farmers to increase their knowledge on areas that are affected by certain diseases when they occur, how many putbreaksd, how many animals were affected and other questions can be answered easily from a web based GIS (Kipanyula et al., 2016). Furthermore, GIS can used as a tool to integrate various field data along with historical data to analyze historical and current livestock disease outbreaks in any region (Kipanyula et al., 2016). The geographic data are represented in the form of classified maps[1], showing distribution of livestock with respect to other baseline information such as administrative boundaries, transport network, human habitats, drainage, topographic contours and terrain as well as attribute data. This technology can also be used to gather data in affected areas during animal diseases such as bird flu and mad cow disease (Ranade and Mishra, 2015). Therefore such systems help the livestock keepers to be aware of the erupted diseases and the areas that are affected thus they can also prepare themselves on how to protect their livestock from the disease outbreak through the use of vaccination and contacting veterinarians and extension officers to get more information on how to prevent their animals from being infected.

Livestock keepers could easily use the mobile phones and other ICT to inform customers about the availability of products such as eggs, milk, fish, meat, skin etc. and negotiate prices. Also they can disseminate information to other livestock farmers to inform them on the livestock products that are marketable and where and at which price (Nwagwu and Soremi, 2015). Furthermore, mobile phones allow farmers to have access to basic financial services, new agricultural techniques, and new markets. Mobile phones do help farmers to secure better prices for crops and a better return on investments (Matuha et al., 2016).

Extension officers can provide education through PowerPoint presentations, YouTube and other ICT tools on how farmers can improve and add value to animal products (Wilson, 2013). The

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[1] http://41.73.194.138/ - climate data visualization and soil data visualization systems

mobile phone can be used to overcome literacy barriers between livestock keepers and livestock officer in either ward or district by providing information through an Interactive Voice Response System (IVRS) (Parikh and Lazowska, 2006). This suite of agriculture and livestock advisory services on mobile phones is providing information in a most cost effective and efficient manner. Information on breeding and nutrition are also reaching to farmers through SMS's and voice messages (Gandhi, 2013). Diifferent initiatives such as National Livestock Market Information System (NLMIS) address shortcomings in the traditional way of marketing livestock. NLMIS was developed to provide timely price and market information on livestock markets in Ethiopia, Kenya and Tanzania (Mussa et al., 2016). The objective was to improve and expand the analytical, reporting, and geographical relevance of livestock price and markets information to wider stakeholders in Ethiopia, Kenya and Tanzania. The NLMIS allows data entry into the system via short messaging service (SMS) of mobile phones. The system allows data collectors to send livestock price and markets information by SMS (Mussa et al., 2016). The data is stored in central server and stakeholders can request the price and markets information for specific markets using SMS (Wanga and Kalegele. 2015).

Capacitating livestock researchers and ward or district livestock officers in timely and relevant communication and advisory services to livestock keepers is the biggest problem facing traditional agricultural extension service in Tanzania (Lin et al., 2012; Mussa et al., 2014; Wanga and Kalegele. 2015). In this paper, the term agricultural extension officer will be used synonymous with either district livestock officer or ward livestock field officer or village livestock officer.

Previous literature in developing countries show that researchers have used different approaches: face-to-face meetings, TV, radio, pamphlets, video, newsletter, web based information systems, mobile based decision support systems and virtual learning systems (e.g. 3 D video games) (Lin & Heffernan, 2009; Mussa et al., 2014; Wanga and Kalegele. 2015). The main problems with each of these different approaches is: (i) Internet is not widely accessible and those systems which need it can't be used by majority of farmers, (ii) education level of livestock keepers is a hindrance, (iii) learning materials disseminated to livestock keepers from extension agents are not specific to the needs of each livestock farmer (Lin & Heffernan, 2009; Lin et al., 2012; Mussa et al., 2014; Wanga and Kalegele,. 2015). This identified gap in knowledge creates a need to operationalize a crowdsourcing platform called 'Ushaurikilimo'. 'Ushaurikilimo' is a mobile based agro-advisory system linking actors in various agricultural value chains (Sanga et al., 2016). Specifically, the goal of this paper is to explore the information seeking patterns among livestock keepers who are using Ushaurikilimo. Even though earlier researchers attempted to address this problem, there is no literature which indicates the actual implementation of the proposed framework for crowdsourcing platform 'Ushaurikilimo' (Mussa et al., 2014; Wanga and Kalegele. 2015; Antle et al., 2016; Barakabitze et al., 2016; Sanga et al., 2016). Antle et al. (2016) and Barakabitze et al. (2016) advocate the use of participatory action research approach (PARA) in developing of ICT for agriculture. This means the approach to be used in developing next generation information system for livestock keepers needs to adopt a "demand-driven" or "user-driven" rather than conventional "supply-driven" approach (Dulle, 2000). The emerging system called called for a crowdsourcing application for agriculture that is being developing from PARA (Frommberger and Schmid, 2013). Already, operationalization of a crowdsourcing application for agriculture in Tanzania has been reported from the Kilosa Open Data Initiative (KODI) (Sanga et al., 2016). It is the first mobile crowdsourcing application in Tanzania. Our research on a mobile crowdsourcing platform fills the gap in research that has been identified by Gupta et al. (2012) and and Arshad et al. (2014) who stated that crowdsourcing applications have not brought significant impact to poor communities of developing countries. Data mining tools will help to answer if the mobile crowdsourcing platform 'Ushaurikilimo' is impacting livestock information and knowledge to pastoral and agro-pastoral communities. Data mining tools are

important to understand the usage pattern of pastoral and agro-pastoral communities. The advancement of data mining and natural language understanding technologies provide a tool to understand the piling information (i.e. big data) regarding livestock keeping found in crowdsourcing platform 'Ushaurikilimo'. McKnight (2010) presented Wordle software for words analysis. Therefore, this study presents results after using up-to-date technique for post processing of the text files regarding livestock in Tanzania. The messages received from the mobile phones of pastoral and agro-pastrol users of crowdsourcing platform where unstructured hence allowed the authors to easily do data mining to obtain useful information directly from the farmers' national language (Swahili).

Thus, the purpose of this paper is to explore the information seeking patterns among livestock keepers who are using 'Ushaurikilimo'. Specifically, this paper will answer the following research questions:

1. How many of the questions from livestock keepers being posed through 'Ushaurikilimo', enquire about livestock related issues and what kind of livestock related questions are most frequently being asked?

2. How efficient is 'Ushaurikilimo' as regards providing efficient and timely answers to the livestock keepers questions and to what degree provide 'Ushaurikilimo' an option for two-way communication between livestock keepers and experts?

Methodology

Study area

This study was carried as qualitative research inquiry. The design of research was descriptive and interpretive case study that was analysed through qualitative method. Epistemological, philosophical and methodological for this study was grounded at interpretivism. It was adopted from Thomas (2010) to guide the analysis of data. Data found on a mobile crowdsourcing platform 'Ushaurikilimo' was interpreted using qualitative analysis software. These data are from a study which is conducted in Kilosa district, Tanzania for past two years (Sanga et al., 2016). Kilosa has a total population of 438,175 where by 219, 797 are females (URT, 2013). The district was chosen for this study because it is well known for its numerous and diversified agricultural activities. Also, it has good level of mobile phones usage.

Data collection

Data was collected using a simple search from the data submitted by the respondents on 'Ushaurikilimo' portal (http://ushaurikilimo.org/farmerview.php). The keywords in brackets which are in Swahili were used in searching: livestock (mifugo), cattle (ng'ombe), calves (ndama), milk (maziwa), goats (mbuzi), pigs (nguruwe), livestock business plan, cat (paka), dog (mbwa), rabies (kichaa cha mbwa), livestock structure (banda), rabit (sungura), piglet (vitoto vya nguruwe) and foot and mouth disease, chicken (kuku). Each keyword was entered on portal (http://ushaurikilimo.org/farmerview.php) and the results were further analysed using qualitative software for content analysis.

Data analysis

Content analysis method was adopted for data visualization. Data visualization was done to analyse different types of questions on 'Ushaurikilimo' along with their respectively answers.

Text data collected after searching the Ushaurikilimo knowledge database using the keywords livestock (mifugo), cattle (ng'ombe), calves (ndama), milk (maziwa), goats (mbuzi), pigs (nguruwe), livestock business plan, cat (paka), dog (mbwa), rabies (kichaa cha mbwa), livestock structure (banda), rabit (sungura), piglet (vitoto vya nguruwe) and foot and mouth disease, chicken (kuku). Outputs from searching were cleaned by removing all vague information. Then

the cleaned data were entered into the word visualization tool, Wordle (www.wordle.net) as plain text. According to Dietz (2016), Wordle is an open access free tool that generates word clouds of large amounts of written data, highlighting the words that more frequently appear in the text entered. In this study, data were entered according to the earlier given keywords in sequential order. According to McKnight (2010), users can build personal libraries on the Web represented as word clouds. A word cloud is a special visualization of text in which the more frequently used words are effectively highlighted by occupying more prominence in the representation.

Case study of crowdsourcing platform 'Ushaurikilimo'

Web and Mobile based Farmers Advisory Information System (M-FAIS & W-FAIS or 'Ushaurikilimo') is the web- and mobile-based system that provides advisory services to farmers. W-FAIS and M-FAIS have been in use for more than two years. We have more than 1000 advisories in form of questions and answers from more than 700 farmers, 20 agricultural extension officers and other agricultural actors from different parts of Tanzania (Sanga et al., 2016). Farmers can receive advice on agronomic practices, post-harvest technologies, poultry management, aquaculture, livestock keeping, farm management and marketing issues through web or mobile phone. The system is designed to provide timely and accurate information to farmers wherever they are and reduce cost and time for farmers to acquire such services from extension officers. This is one reason for 'Ushaurikilimo' to be classified as a crowdsourcing platform (Sanga et al., 2016). The project is jointly implemented in collaboration with the Local Government in Kilosa District, Ministry of Agriculture, Food and Cooperatives, Dar es Salaam, Kilosa Tele-centre (Kilosa Rural Services and Electronic Communication Centre – KIRSEC), Uyole Agricultural Research Institute and Kilosa Community Radio as local collaborators. The project also works with one collaborator from the Department of International Environment and Development Studies (Noragric), Norwegian University of Life Sciences.

'Ushaurikilimo' contain advisories related to crops, marketing and livestock (just to mention a few) but in this paper we shall present the type of advisories which were given to livestock keepers. 'Ushaurikilimo' was first piloted in Kilosa District by more than 337 farmers before allowing other farmers from other parts of Tanzania to use it (Table 1).

Table 1
Smallholder farmers involved in project implementation in Kilosa District

Village name	Male	Female	Total
Mkwatani	14	6	20
Mvumi	16	4	20
Tindiga	16	4	20
Lumuma	16	4	20
Masanze	13	7	20
Madoto	15	5	20
Magomeni	16	4	20
Kigunga	15	4	19
Mbuyuni	14	6	20
Msowero	17	3	20
Nyameni	16	4	20
Changarawe	19	1	20
Zombo	11	9	20
Mabwerembwere	18	2	20
Ilonga	16	4	20
Kivungu	18	1	19
Chanzuru	12	8	20
Ulaya Mbuyuni	17	3	20
Total	**358**	**79**	**279**

Findings

a. *How many of the questions from livestock keepers being posed through 'Ushaurikilimo', enquire about livestock related issues and what kind of livestock related questions are most frequently being asked?*

Currently, the 'Ushaurikilimo' knowledge base has 1739 questions and answers (see the below Figure 1).

Figure 1: Knowledge base from 'Ushaurikilimo'

The results after searching the knowledge base contain 1739 questions and answers but 427 questions and answers related to forestry. Thus, they were omitted in our analysis and we remained with 1312. Table 2 shows that 605 out of 1312 questions and answers were related to livestock keeping. This means that almost 47 per cent of the questions posted on 'Ushaurikilimo' were related to livestock and 53 per cent came from crops. This means 'Ushaurikilimo' is serving a community of both pastoralists and agro-pastoralists as defined by Ngowi *et al.* (2015). This is similar to a study by Ngowi *et al.* (2016) which indicate 82 per cent of agro-pastoralists in Kilosa District own mobile phones.

Table 2
Information seeking behaviour of livestock keepers who are using Ushaurikilimo

Type of information sought using 'Ushaurikilimo'	Frequency	Percentage
livestock (mifugo)	69	11.4
cattle (ng'ombe)	10	1.7
calves (ndama)	4	0.7
milk (maziwa)	11	1.8
goats (mbuzi)	15	2.5
pigs (nguruwe)	75	12.4
livestock business plan	1	0.2
cat (paka)	5	0.8
dog (mbwa)	21	3.5
rabies (kichaa cha mbwa)	6	1.0
livestock structure (banda)	47	7.8
rabit (sungura)	14	2.3
piglet (vitoto vya nguruwe)	1	0.2
foot and mouth disease	2	0.3
chicken (kuku)	324	53.6
Total	**605**	**100.0**

Figure 2 shows that majority of the livestock keepers asked questions related to chicken. This was followed by those asked about pigs and milk problems. Thus, the frequently asked questions in livestock category came from chicken, pigs and milk. These three keywords guided the researchers to create three word clouds.

Type of information sought using Ushaurikilimo	Frequency	Percentage
livestock (mifugo)	69	11.4
cattle (ng'ombe)	10	1.7
calves (ndama)	4	0.7
milk (maziwa)	11	1.8
goats (mbuzi)	15	2.5
pigs (nguruwe)	75	12.4
livestock business plan	1	0.2
cat (paka)	5	0.8
dog (mbwa)	21	3.5
rabies (kichaa cha mbwa)	6	1.0
livestock structure (banda)	47	7.8
rabit (sungura)	14	2.3
piglet (vitoto vya nguruwe)	1	0.2
foot and mouth disease	2	0.3
chicken (kuku)	324	53.6
Total	605	100.0

Figure 2: Pictorial representation of information needs related to livestock keepers

After obtaining Figure 2 then all questions and answers from the most ranked keyword 'chicken' was entered in the word visualization 'Wordle'. Texts were cleaned to remove all information that was not required (e.g. phone number of livestock keepers) before creating the first word cloud.
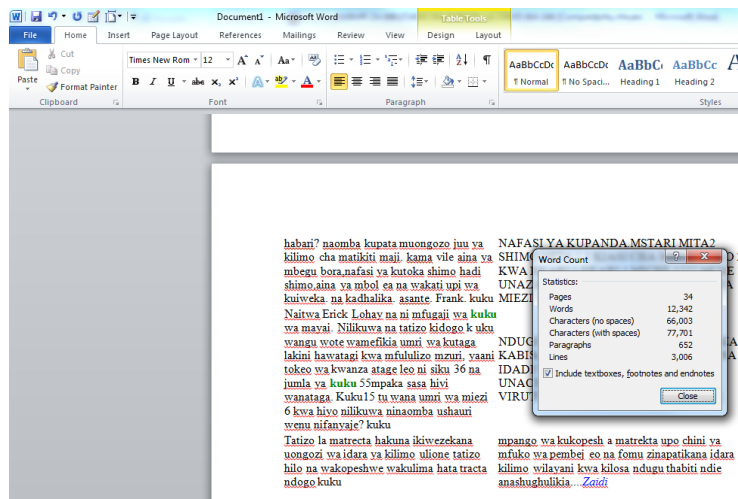
Figure 3: Data collected from 'Ushaurikilimo' related to 'chicken'

Data visualization from questions and answers with keyword 'kuku' or chicken

Deep analysis of 324 questions and answers containing the keyword chicken resulted into 34 pages of different statements. They were analysed and the below word visualization diagram shows the words which appear most.

Figure 4: Word cloud for chicken

From the diagram above the following keywords appear most: eggs, local chicken, diseases, medicine, chicks, feeds, food, poultry husbandry.

Also, from the above diagram the word 'local chicken' or 'kuku kienyeji' in Swahili is also highly ranked in appearance. Thus we did a detailed analysis of it by searching on 'Ushaurikilimo' using a keyword 'kuku kienyeji' or local chicken. We found that more than 50 questions and answers contain this keyword. 8 pages contain 2164 texts with the word local chicken which were entered in Wordle and the results is as shown below word cloud:

Figure 5: Word cloud for local chicken

From the above diagram, the words which appear most are: local, chicken, chicks, husbandry, eggs.

Data visualization of the keyword 'nguruwe' or pigs

The second most frequent used word is pig or 'nguruwe'. Data to be entered in Wordle were obtained after the keyword has been used to search all questions and answers with this keyword on 'Ushaurikilimo'. After searching we obtained 68 questions and answers. Thereafter the data was cleaned to remove all associated phone number of livestock keepers who asked questions and the extension agents who answered the questions via their mobile phones.

At the end of this process, 1935 words were entered in Wordle in order to create another word cloud.
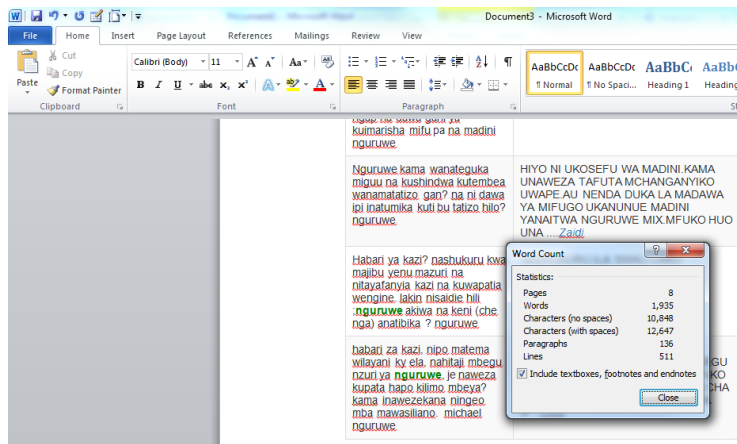
Figure 6: Data collected from 'Ushaurikilimo' related to pigs

Figure 7: Word cloud for pigs

From this word cloud, the words which appear most are: pigs, food, crop, livestock, husbandry.

Data visualization from questions and answers with keyword 'mifugo' or Livestock

The keyword 'mifugo' was searched on 'Ushaurikilimo'; the output contained 2657 words.
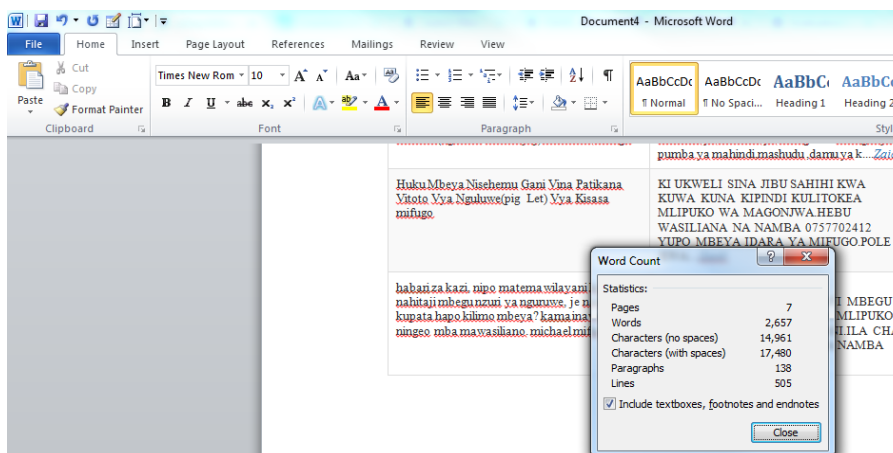
Figure 8: Data collected from 'Ushaurikilimo' related to livestock

2657 words were entered in Wordle cloud for word visualization. The results of looking for most words which appear most are presented in the diagram below.

Figure 9: Word cloud for livestock

From the above word cloud, one can deduce that the words which appear most are: livestock, medicine, pigs, crop, disease, local.

b. *How efficient is 'Ushaurikilimo' as regards providing efficient and timely answers to the livestock keepers questions and to what degree provide 'Ushaurikilimo' an option for two-way communication between livestock keepers and experts?*

In order to capture the trends of data in 'Ushaurikilimo', a decision support system was developed (Sanga *et al*., 2016). The system provides a real time monitoring of data in Ushaurikilimo. According to Sanga *et al.* (2016), the following are statistics proving that 'Ushaurikilimo' is efficient:

1. Average response time for a farmer to get answer from an extension agents is 35.07 hours.

2. The average number of questions answered per extension agent is 41.5 questions.

3. The average number of questions per farmer is 2.34 questions.

4. 33 questions were asked by a best ranked farmer while the least number was 1. The average number of questions per farmer was 2.35 questions

5. The top ten farmers asked questions as depicted in the Table below. The top ten extension agents provided answers as depicted in the Table below.

Table 3
Number of questions asked / answered
vs. Best ten ranked farmers / extension agents
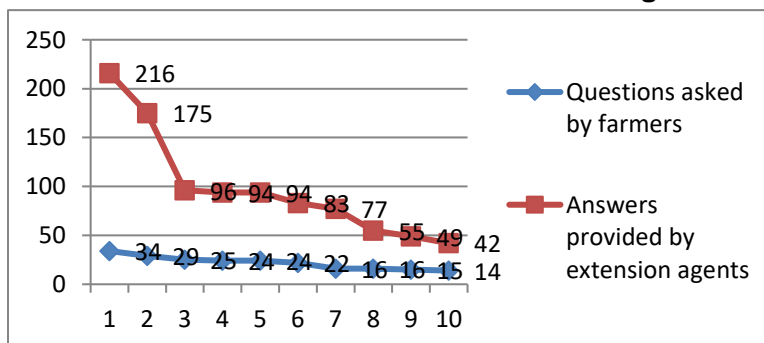
From the Table 3, one can deduce that top 10 ranked famers asked 219 while top 10 ranked extension agents provided a total of 981 answers. This two way communication has been enabled by the fact that a farmer or extension agents can use them to send question or receive answer on either mobile phone or Internet or e-mail. These services are provided by the mobile based farmers' advisory information system and web based farmers' advisory information systems which

are sub-systems in 'Ushaurikilimo'. A recent study by Ngowi et al. (2016) confirmed that 42 per cent of respondents indicated that their livelihood have been impacted positively with ICTs.

Discussions

According to McKnight (2010), grammatical words and non-frequent words are hidden so that the resultant representation cleanly shows the most frequently occurring words of importance. It should be noted that grammatical words in Swahili were not hidden. Thus, it should be noted that words like 'wa' , 'ya', 'kwa', 'kama' etc. are common predicate (grammatical) terms in Swahili language. They cannot be discussed as they are irrelevant for this analysis. Also, since we are trying to study meaning from text files/messages supplied by the local farmers as text then this research can have missed some important misspelled words that could reveal more important information. Misspelling may be caused by different factors. According to Barasa (2010), his findings reveal that factors like the need to use least effort, rapidity, technical limitations and informality play a key role in influencing the structure of messages. In his book, he further establishes that characteristics of the texts in Kenya involve variables such as pronunciation, spelling, abbreviation, acronyms, exclusive use of consonants, contractions, capitalization, punctuations marks, graphics, spelling errors, and code switching. All these characteristics may have affected the findings from this research.

In this study, questions related to chicken were the most asked queries. This matches with previous study by Temba et al. (2016) done in Morogoro. The study by Temba et al. found that 82.5% of farmers interviewed indicated their need for extension education on chicken husbandry. In this study, the percentage of queries related to chicken was 53.6% (Figure 2).

Figure 4 shows that livestock diseases are among the most words queried by livestock keepers. This confirms earlier findings by Angello et al. (2016) who found that 95.1% of the livestock keepers in Morogoro needed information on various types of animal diseases and how to treat or control diseases to avoid livestock deaths. Mlozi et al. (2003) had a similar observation in the Kilosa District in Morogoro. They found diseases such as Newcastle and Fowl typhoid are commonly found in free range local chicken and do affect marketing of byproduct of local chicken.

Other types of information needs on chicks and feeds found in this study (Figure 5) match what was found by Angello et al. (2016) where livestock keepers have chicken and goats similar to our study. Also, Angello et al. (2016) indicated that the livestock keepers need information on feeds for both livestock and chicken. Furthermore, they found 'poultry farmers needed information on poultry management, poultry equipment and accessories, hatching equipment, feed equipment, feed storage, feed manufacturing machinery, product handling/ transport equipment, quality testing equipment and energy saving equipment'. This is similar to our study (Figure 5).

Figure 10: Word cloud for milk

Figure 10 shows that livestock keepers need different information related to livestock production and this is similar to Angello et al. (2016) who found '…dairy farmers need information related to milk processing, housing and environment, building materials and equipment, feeds and feeding, food preservation, feed additives and dairy products'. The words that appear most in Figure 10 are: milk, diseases, side effect, medicine, seek, advisory, hybrid.

'Ushaurikilimo' as an agro-advisory information system is helping livestock keepers to address their information needs related to livestock information. From this study, we found that the personalized information given to individual livestock keepers is similar to what has been reported earlier by other researchers. Challenges facing livestock keepers mentioned by Angello and Wema (2010) in fulfilling their information needs (poor ICT infrastructure, lack of awareness on electronic information resources (e-resources), limited information literacy (IL) training opportunities and limited perception towards use of e-resources) have been addressed using the participatory action research approach (PARA) (Sanga *et al*., 2014) which was adopted in implementing 'Ushaurikilimo'.

'Ushaurikilimo' has multiple channels (mobile phones, Internet and community radio) to communicate livestock information knowledge to livestock keepers and other actors in various agricultural value chains (Sanga *et al*., 2016). The most used communication service for mobile phones was SMS. A recent study by Karimuribo *et al*. (2016) showed that livestock keepers in Kilosa prefer use of SMS for communicating with thelivestock extension service. Another factor that promoted wide acceptance of the 'Ushaurikilimo' by livestock keepers was use of the national language (Swahili) which was easy for livestock farmers to use on the crowdsourcing platform. Use of Swahili attracted many information seekers.

The unstructured format of the SMS makes it easy to ask questions. It confirms the Meyer's model and Wilson's model about information seeking behavior which state that most farmers are illiterate and depend on indigenous information systems and modern information systems (Wilson, 1997; Meyer & Boon, 2003).

Most farmers are unfamiliar with external sources of information. Thus, in this study, 'Ushaurikilimo' is considered as modern information system as per Meyer's model. The success of 'Ushaurikilimo' is therefore contributed by implementers adopting PARA and eliciting users' needs and requirements for participation in the crowdsourcing platform. Furthermore, from the initial stage of development to operationalization of crowdsourcing platform, information needs, information seeking behavior, usage behavior, enabling environmental and socio-economic factors, local policies, infrastructure and the contributions of different stakeholders involved in the crowdsourcing platform 'Ushaurikilimo', were considered.

New emerging applications (e.g. crowdsourcing platform for agricultural extension service) due to advancement of ICT in Tanzania are addressing the information needs of livestock keepers. In this study, the information seeking behavior of the livestock keepers who have been using pastoral and agro-pastoral advisory system (i.e. crowdsourcing platform 'Ushaurikilimo') have been presented. It was found that information seeking behavior of livestock keepers who are using the mobile and web based agro-advisory system resemble the patterns which have been reported for conventional agricultural extension services. In order to compliment what we found in this study, we need to analyse data related to livestock information in 'Ushaurikilimo' using specialized software for qualitative data analysis and data mining techniques. The aim will be to determine if results from this study are similar to those using computer assisted qualitative data analysis packages (e.g. CAQDAS, MAXQDA, Weft QDA or PC-ORD) and data mining techniques (Fenton, 2006; Saillard, 2011).

Arshad *et al.* (2014) mentioned the following challenges for crowdsourcing in developing countries, namely: lack of credibility, lack of skilled/ experienced talents, lack of auto matching

mechanisms and weak payment mechanisms. 'Ushaurikilimo' addressed some of these challenges. For example, the issue of credibility is being addressed through formation of a policy brief and national e-extension framework (Sanga *et al*., 2016). This has been shared with different policy makers so that ICT policy and policies related to extension service are incorporated into the crowdsourcing platform for extension service. Also, the formulated e-extension framework shows how experienced talents (i.e. experts) from agricultural research institutes, MATI, LITI, local government authority and universities can join hand in answering questions from crowds (Sanga *et al*., 2016). Many crowdsourcing programs lack an auto matching mechanism, but 'Ushaurikilimo' uses the Experts' Assignment Algorithm with the Weighted Sum Model (Fue *et al*., 2015). Furthermore, the issue of weak payment in most crowdsourcing platforms has been addressed in 'Ushaurikilimo' by involving extension experts and experts who are paid salary by Government; thus no need in paying additional incentives.

Finally, 'Ushaurikilimo' needs to be promoted so that many agro-pastoralists and pastoralists can use it. A recent study indicates that many agro-pastoralists and pastoralists communities in Kilosa District are not aware that there is 'Ushaurikilimo' (Ngowi *et al*., 2016). The reason for this is that our project was meant first to strengthen coverage of agricultural extension service in maize value chains.

Conclusion

This study answered the two research questions of interest. We found there are 1739 questions and answers in 'Ushaurikilimo'. The number of farmers who are using 'Ushaurikilimo' is 700. Out of 1739 questions and answers in 'Ushaurikilimo', 427 questions and answers related to forestry,e 605 questions and answers related to livestock keeping, and those remaining related to crops. Thus, out of 1312 questions and answers, 47 per cent of related to livestock while 53 per cent related to crops. The number of questions keeps on increasing daily. Twenty (20) extension agents provide advisory services. The questions posed to 'Ushaurikilimo' come from different actors including pastoral and agro-pastoral farmers. Livestock keepers seeking advice through 'Ushaurikilimo', enquire about livestock related issues. The livestock related questions most frequently asked are those related to keywords: chicken, pigs and milk. On issues related to chicken the following keywords appear most: eggs, local chicken, diseases, medicine, chicks, feeds, food, and poultry husbandry. On issues related to pigs the words which appear most are: pigs, food, crop, livestock, and husbandry. Other words which appear most are: livestock, medicine, pigs, crop, diseases, local.

The findings relating to the second research question show that the average response time for a farmer to get an answer from an extension agent is 35.07 hours. The average number of questions answered per extension agent is 41.5 questions. The average number of questions per farmer is 2.34 questions. 33 questions were asked by the best ranked farmer while the least number was 1. The average number of questions per farmer is 2.35 questions.

A future study is needed to answer the research question 'What are the lessons learned from assessing 'Ushaurikilimo' enquiries and how can the 'Ushaurikilimo' model be scaled up and become a sustainable solution for improving the efficiency of agricultural extension in Tanzania?' The reason for this future study is because crowdsourcing is tackling poverty in developing countries and we must sustain 'Ushaurikilimo'.

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Editor's Note: When the literature shows conflicting results for a particular instructional strategy, it is desirable to initiate a study of the chosen strategy with local student populations. This multivariate study confirms which elements are significant for the defined population and subject matter.

Investigating the effectiveness of web-based instruction on junior secondary school students' retention in basic technology in Nigeria

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Abstract

The study examined the Effects of Web-Based Instruction on Junior Secondary School Students' Retention in Basic Technology in Nigeria. Quasi-experimental design (pretest-posttest, non-equivalent, non-randomized control group design) was adopted in this study. 119 Junior Secondary School class two (JSS II) students were drawn from four co-educational registered private secondary schools in Minna Metropolis, Nigeria.

Three research questions with corresponding hypotheses were formulated and tested at 0.05 level of significance. Basic Technology Achievement Test (BTAT) consists of 50 items, multiple choice objectives question was used for data collection. Web-based instruction (WBI) and BTAT were validated by education technology experts, computer experts, industrial and technology education lecturers, secondary school basic technology teachers and basic technology students. BTAT was subjected to pilot test and 0.90 reliability coefficient was obtained using Pearson Product Moment Correlation Coefficient. BTAT was administered on students in experimental and control groups and data obtained were analyzed using Analysis of Covariance (ANCOVA) to test the hypotheses.

The results of the study indicated that students exposed to Web-Based Instruction retained basic technology concepts better than their counterparts exposed to Conventional Teaching Method. There was no significant difference between the mean retention scores of male and female student exposed to Web-based instructions; high, medium, and low achievers' students exposed to web-based instruction retained the concept of Basic Technology equally. Based on the above findings it was recommended that Web-Based Instruction should be used to improve students' retention in Basic Technology.

Keywords: web-based instruction, basic technology, retention, achievement level, gender.

Introduction

Junior Secondary School education is both pre-vocational and academic, universal and compulsory for all Nigerian children. The goal of Junior Secondary School is to enable students to acquire knowledge and skills which will prepare them for useful living within Nigerian society. In specific term, Junior Secondary School Education should give learners opportunity to discover and develop their potentials. The three main objectives of Basic Technology as stated in the national policy of Education are: to provide pre-vocational orientation for further training in Technology; to provide Basic Technology literacy for everyday living, and to stimulate creativity (Ajani, 2009; FRN, 2013).

Basic Technology is a subject borne out of the desire of educators of Nigerian origin to have an education that will fit into the culture and development trend of the nation. This is the kind of education that will prepare students towards acquiring manipulative skills for effective participation in nation building. This subject, in addition to the above, introduces a child into the

world of technology, the knowledge of which can help the Nigerian child to acquire technical skills in relevant fields. But in Nigerian society today the reverse is the case. Most of these aspirations are not met and these can be traced to a number of problems which include:

> Curriculum inadequacy; Problem of Funding; Problem of Equipment installation; Shortage of Trained Technical Teachers; Wrong Method of Education and Educational Policy; Inadequate Facilities and Instructional Media; and Poor Methods of Instructional Delivery (Uwaifo, & Edigin, 2011).

Presently, the common method of instruction applied by teachers in secondary schools in Nigeria is the lecture method which involves verbal presentation of subject matter/content. Lecture method, as the conventional method of instruction, is didactic, stereotype and not result oriented. It is often described as a "talk and chalk" method because its presents information to the students who merely listen. Teacher do all the talk while students listen and copy notes from the chalkboard after the lesson (Akpoghol, Ezeudu, Adzape, Otor, 2016). This teacher-centered approach dominates the educational system in Nigeria except few private schools that are well equipped with modern Information and Communication Technology (ICT) facilities such as computer laboratories with internet facilities, interactive whiteboards, learning software, and other ICTs. These schools have internet connectivity and Wi-fi with adequate bandwidth to enable their students to learn via World Wide Web.

The World Wide Web can be used to provide instruction and instructional support. Web-based instruction offers learners unparalleled access to instructional resources, far surpassing the reach of the traditional classroom. It also makes possible learning experiences that are open, flexible, and distributed, providing opportunities for engaging, interactive, and efficient instruction (Olson & Wisher 2002). Web-based instruction offers multiple dimensions of use in education and training environments. It is capable of providing direct instruction to meet individual learning needs and objectives. Due to its networking capability, the Web can play additional roles: promoting and facilitating enrolment into courses, accessing the syllabus or program of instruction, posting and submitting assignments, interacting with instructors and fellow students, collaboration on assignments, and building learning communities.

In spite of the many potentials of web-based instruction (WBI), empirical studies on the effectiveness of web-based instruction are conflicting. For instance, Guzeller (2012) reported that students exposed to WBI achieved better than their counterparts exposed to the conventional instructional strategy. Also, Evelyn, Phillip and Kirk (2008) reported that students in the web-based instruction sections of a course outperformed their counterparts in a traditional classroom. Similarly, Yamauchi (2008) observed that students in the experimental group had a significantly higher gain score than students in the control group. In another study, Erdogan et al (2008) reported that web-based education has positive effects on the improvement of academic achievement and on motivation for learning. However, Okeke and Osuagwu (2012) reported that the students who learned in the traditional way performed marginally better than the Technology Enhanced Learning (TEL) students. Similar to Okeke and Osuagwu's report, Wagner, Garippo and Lovaas (2011) and Stack (2015) reported no significant difference in student performance between the two modes of course delivery (online and traditional instruction.

Retention, the ability to remember or recognize the content that has been learned or experienced, is an important issue in teaching and learning. Learning is complete when knowledge can be transferred into a new situation. There is a need to have varied practice tools is to facilitate transfer and enhance retention. Studies on types of learning tools that promote students' retention are yet to be concluded. For instance, Shieh and Yu (2016) revealed that guided discovery instruction influenced learning retention. Similarly, Wang (2016) results showed that the vocabulary mean scores from both immediate and delayed testing demonstrated significantly

better results in word gain and word retention with the customised reading group and that the adaptive reading system was appealing for the students. In a study conducted by Dasdemir. (2013) results revealed that students' use of animation in basic education had positive effects on the academic achievements and retention of the students. Similarly, Chang (2015) investigated the effects of test trial and processing level on immediate and delayed retention. The results showed that single test trial enhanced immediate retention and enhanced deep processing and immediate and delayed retention.

However, Ong and Tasir (2015) conducted a study on the information retention among trainee teachers using a self-instructional printed module based on Cognitive Load Theory for learning spreadsheet software. Results showed no effect on information retention. In another study, Bond and Ellis (2013) investigated the effects of metacognitive reflective assessment instruction on student achievement in mathematics, no significant difference was found between the posttest and retention test results for the experimental groups or the control group.

Gender disparity between male and female students' learning outcomes has been identified as one of the factors worthy of investigation. Studies on effects of gender on students' performance is yet to be concluded. For instance, Tsai (2015) reported that females displayed more favorable attitudes than males did regarding the impacts of socioeconomic status on students' performance of Web-based learning. In another study, Andrew, Janice and Stephen (2007) found that females performed better than males with Web-based learning when compared to the traditional method. Similarly, Johnson (2014) found that female instructors have a significant positive effect on female student performance and do not have a statistically significant effect on male student performance. In support of this study, Kost, Pollock and Finkelstein (2009) reported that females outperform males on homework and participation, and males outperform females on exams, resulting in course grades of males and females that are not significantly different. Contrarily, Richards-Babb and Jackson (2011) reported that male students' average success rate improvement was double that of female students. Similarly, Murray (2016) found that male students outperform female in the STEM disciplines.

However, Dhindsa and Shahrizal-Emran (2011) found that the mean achievement scores of male and female students taught using constructivist approach were not statistically significant.

In a normal classroom setting, students can be categorized based on gender, social economic background, achievement level (high, medium and low achievers) among others. This classification could be identified as individual differences among the students which may influence their academic performance. Studies on students' achievement level (high, medium and low achievers) are inconclusive. For instance, Gambari, Balogun and Alfa (2014) reported that high achievers performed better than medium and low achievers respectfully when exposed to Interactive Whiteboard. Similarly, Rajappa, Bobby, Nandeesha, Suryapriya, Ragul, Yuvaraj, Revathy and Priyadarssini (2016) found that low achievers performed better in tutorial than high and medium achiever students. In addition, high and medium achievers obtained more gain from open book assignment than group tutorials. In another study conducted by Lin and Lin (2016), the results indicated that the science comic book and science text booklet benefited the low, medium and high achievers equally. In addition, Lin, Chen and Chang (2015) reported that students with average and low academic achievements exhibit small and medium levels of effectiveness but are insignificant for high academic achievement students.

Contrarily, Gambari, Kutigi and Fagbemi (2014) found students of high verbal ability performed better than medium and low verbal ability students respectively.

Secondary education in Nigeria is increasingly focused on improving students' academic achievement and retention through a variety of instructional strategies. Higher retention rates of students at this level of education is directly correlated with system of instructional delivery.

Therefore, a number of instructional delivery tools have been developed to enhance students' performance and retention. How well can Web-based instruction influence students' ability in retaining basic technology concept being taught in junior secondary schools in Nigeria? It is against this background that this study investigates the effectiveness of three modes of presentation on achievement and retention of Junior Secondary School Students' Basic Technology in Nigeria.

Research questions

The following research questions were raised to guide the study:

1. What is the difference in mean achievement scores between students taught using web-based instructional package and those taught with traditional method?

2. What is the difference in mean retention scores of students taught using web-based instructional package and those taught with traditional method?

3. What is the difference between the mean retention scores of male and female students' taught basic technology using web-based instructional package?

4. What is the difference in the mean retention scores of high, medium and low achievers' students' exposed to web-based instructional package?

Research hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

Ho1: There is no significant difference in the mean achievement scores of students taught basic technology using web-based instructional package and those taught with traditional method.

Ho2: There are significant differences in the mean retention scores of students taught Basic Technology using Web-based Instruction and those taught with lecture method.

Ho3: There is no significant difference in the mean retention scores of male and female students taught using Web-based Instruction.

Ho4: There is significant difference in the mean retention scores of high, medium and low students taught using Web-based Instruction.

Methodology

The research design adopted for the study is a quasi-experimental design involving pretest, posttest, non-equivalent, non-randomized control group using a single treatment factorial design. A 2 x 2 x 3 factorial design was employed to test the three hypotheses in the study. Two levels of independent variable (experimental & control groups), two levels of gender (male & female), and three levels of achievement (high, medium & low) were investigated on students' performance in Basic Technology. The factorial design is shown in Table 1.

All the groups (experimental and control) were given pretest before the treatment. Experimental group 1 was exposed to the use of Web-based Learning instructional strategy (WBL) while the control group was exposed to Conventional Teaching Method (CTM). The posttest was administered on the groups after four weeks' treatment. The research design layout is as shown below in table 2.

Table 1
2 x 2 x3 Factorial design

Groups	Gender	Ability levels		
		High (1)	Medium (2)	Low (3)
Experimental Group (WBL)	Male 1	111	112	113
	Female 2	121	122	123
Control Group (CTM)	Male 1	211	212	213
	Female 2	221	222	223

Table 2
Research design layout

Groups	Pre-test	Treatment	Posttest	Retention
Experimental Group	O_1	X_1	O_2	O_3
Control Group	O_4	X_o	O_5	O_6

Where: $O_1, O_2\ O_3$: represents the pre-test, posttest and retention test of the experimental group,

O_4, O_5, O_6: represents the pretest, post-test and retention test of the control group,

X_1 represents the treatment (Web-based instruction) for the experimental group,

X_o represents the traditional teaching method for the control group.

The population for the study is made up of the entire population of JSS II students in all the 296 private schools having JSS II classes (source: Annual School Census 2014/2015 Ministry of Education Niger State). The purposive sampling technique was used to select the four schools in Minna Niger State for this study. These schools were selected for the study based on the following criterion: Equivalence (laboratories, facilities and manpower), school type (private schools), gender composition (mixed schools), ICT equipment (computer laboratories under the SchoolNet programme), and candidates' enrollment (enrolling students for JSSCE basic technology examination for a minimum of ten years). The schools were assigned into experimental group and control group. 119 students were selected using stratified random sampling technique. One arm of intact class was randomly selected from each school.

The treatment (WBI) was developed by the researcher and the programmers where the researcher took care of the content of the package and the programmer designed the Website. The contents of Basic Technology were prepared by the senior teachers and researchers after outlined the difficult concepts in Basic Technology. The computer programmers helped in designing the user interface which was a combination of static and dynamic web pages using Macromedia Dreamweaver (8) and Macromedia Fireworks (8), PHP programming language and MYSQL software for creating database and finally host the site. The web presents information and displays animation to the learner on each of the unit/lesson after which the students attempted some multiple choice objective questions. Each of the units/lessons were presented by the web through interactive mode, that is, exposure to information, facts and practice on the topics and immediate feedback/response to the questions. The students were made to have at least 90% mastery of one topic before moving on to the next.

The Basic Technology Achievement Test (BTAT) has two sections namely A and B. The section A contains the students' biodata and section B consists of 50 multiple choice objective questions with five options (A-E) as possible answers to the questions. The questions were structured from JSS II Basic Technology curriculum on (I) Materials and their uses and, (ii) Wood lathe machine covered in the WBI. The test item covered different levels of understanding based on Bloom's

taxonomy of educational objectives (i.e. knowledge of facts, application of knowledge, interpretation of concepts). Students were requested to indicate the correct answers by ticking or circling the correct answers matching the questions and only one option was correct from the options A-E. On the scoring of the multiple-choice items, '1' was awarded for each correct answer and '0' for each wrong answer. The instrument was scored over 50 (1x50 items).

Both WBI and BTAT were validated by experts in basic technology teachers, industrial and technical education lecturers, educational technology specialists, computer programmers respectively. Comments, opinions and suggestions of the experts were used to make necessary amendments on the instrument. Field trial validation was carried out on WBI using 83 students from a selected school which is part of the population but not participate in the real study. Similarly, a pilot test was conducted on 42, JSS II students from a school that was not part of the selected schools for the real study. The test was administered twice and the reliability coefficient of 0.90 was obtained using Pearson Product Moment Correlation (PPMC).

The objectives and the modalities of the study were specified and clarified before the teachers and students. The researcher administered the BTAT on sample students as pretest to ascertain the equivalence of the students before the treatment. Treatment was followed immediately and lasted for four weeks, thereafter BTAT was administered as posttest to measure the achievement of the sample students in each school. The scores obtained were subjected to data analysis. The data were analyzed based on the stated hypotheses, using mean, standard deviation and Analysis of Covariance. The significance of the various statistical analyses was ascertained at 0.05 alpha level.

Results

The data obtained from BTAT after pretest and posttest were analyzed using mean and standard deviation to answer research questions while Analysis of Covariance (ANCOVA) was used for testing the research hypotheses at 0.05 level of significance.

Research Question One: What is the difference in mean achievement scores between students taught using web-based instructional package and those taught with traditional method?

In answering research question one, mean scores of the students in experimental and control groups were analyzed using mean and standard deviation as shown in Table 3.

Table 3
Mean and standard deviation of pretest and posttest scores
of experimental and control groups

Group	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
Experimental Group	60	19.80	5.38	80.53	8.84	60.73
Control Group	59	18.34	6.30	41.05	9.43	22.71

Table 3 shows the mean and standard deviation of the pretest and posttest scores of the experimental and control groups. The result reveals that the mean and standard deviation of the pretest and posttest scores of experimental group are 19.80 ±5.383 and 80.53 ±8.844 respectively. This gives a mean gain of 60.73 in favour of the posttest. Similarly, the mean and standard deviation of the pretest and posttest scores of the control group are 18.34 ±6.304 and 41.05 ±9.427 respectively. This gives a mean gain of 22.71 in favour of the posttest. Also from the result, it can be seen that there is difference between the mean posttest scores of the experimental group (80.53) and the control group (41.05). The difference being 38.48 which is in favour of the experimental group.

Research Question Two: What is the difference in mean retention scores between students taught using web-based instructional package and those taught with traditional method?

In answering research question one, mean scores of the students in experimental and control groups were analyzed using mean and standard deviation as shown in Table 4.

Table 4
Mean and standard deviation of posttest and retention scores
of experimental and control groups

Group	N	Posttest		Retention		Mean Gain
		Mean	SD	Mean	SD	
Experimental Group	60	80.53	8.84	81.20	7.89	0.67
Control Group	59	41.05	9.42	39.08	9.52	-1.97

Table 4 shows the mean and standard deviation of the posttest and retention scores of the experimental and control groups. The result reveals that the mean and standard deviation of the posttest and retention scores of experimental group are 80.53 ±8.84 and 81.20 ±7.89 respectively. This gives a mean gain of 0.67 in favour of the retention test. Similarly, the mean and standard deviation of the posttest and retention scores of the control group are 41.05 ±9.42 and 39.08 ±9.52 respectively. This gives a mean loss of -1.97 in favour of the posttest. Also from the result, it can be seen that there is difference between the mean retention scores of the experimental group (81.20) and the control group (39.08). The difference being 42.12 which is in favour of the experimental group.

Research Question Three: What is the influence of gender on students' mean achievement scores when taught basic technology using web-based instructional package?

In answering research question two, mean scores of the male and female students in experimental group were analyzed using mean and standard deviation as shown in Table 5.

Table 5
The mean and standard deviation of pretest and achievement scores
of male and female experimental group

Group	N	Posttest		Retention		Mean Gain
		Mean	SD	Mean	SD	
Male	30	60.53	21.51	59.77	22.41	0.76
Female	30	61.59	22.88	61.14	23.61	-0.45

Table 5 shows the mean and standard deviation of the retention scores of male and female in experimental group. From the result. It can be seen that the mean score of the posttest and the retention scores of the male are 60.53 ±21.51 and 59.77 ±22.41. The mean gain is 0.76 in favour of the male retention score. Similarly, the mean and standard deviation of posttest and retention scores of female are 61.59 ±22.88 and 61.14 ±23.61. The mean loss is 0.45 in favour of the female posttest score. Also the result reveals the difference of 1.37 between the posttest score of male and female in favour of the female.

Research Question Four: What is the difference in mean achievement levels (high, medium & low) of students taught using web-based instructional package?

In answering research question three, mean scores of high, medium and low level students in experimental group were analyzed using mean and standard deviation as shown in Table 6.

Table 6
The Mean and Standard Deviation of the Pretest and Achievement Scores of
Low, Medium and High Level Experimental Group

Group	N	Posttest		Retention		Mean Gain
		Mean	SD	Mean	SD	
Low Level	21	74.86	7.07	75.62	7.38	0.76
Medium Level	19	81.05	7.98	81.68	6.50	0.63
High Level	20	86.00	7.86	86.60	5.58	60.90

Table 6 shows the mean and standard deviation of the posttest and retention scores of low, medium and high level experimental group. The result revealed that the posttest and retention scores for low level students in experimental group are 74.86 ±7.07 and 75.62 ±7.38 respectively while the mean gain is 0.76 in favour of the low level retention score. Similarly, the mean score for the posttest and retention scores for the medium level students in experimental group are 81.05 ±7.98 and 81.68 ±6.50 respectively while the mean gain is 0.63 in favour of medium level students in retention score. Also the mean of the posttest and retention scores for high level students in experimental group are 86.00 ±7.86 and 86.60 ±5.58 respectively while the mean gain is 0.6 in favour of the high level retention scores. It can also be seen from the result that there is difference between posttest scores of the three levels. The high level students have the highest mean retention score of 86.60 followed by the medium level with 81.68 while the low level students have the least mean posttest score of 75.62.

Testing of hypotheses

Hypotheses one: There is no significant difference in the mean achievement scores of students taught basic technology using web-based instructional package and those taught with traditional method. In testing hypotheses one, the mean scores of students exposed to web-based instructional package and those taught with traditional method were analyzed using ANCOVA as shown in Table 7.

Table 7
ANCOVA Result of achievement scores of experimental and control groups

Source	Type III Sum of Squares	df	Mean Square	F-value	P-value
Corrected Model	51692.595	2	25846.297	673.717	.000
Intercept	15242.180	1	15242.180	397.307	.000
Pretest	5319.586	1	15319.586	138.662	.000
Groups (Treatment)	41844.822	1	41844.822	1.091*	.000
Error	4450.195	116	38.364		
Total	498332.000	119			
Corrected Total	56142.790	118			

*: Significant at p < 0.05

Table 7 shows the ANCOVA results of the achievement scores of groups taught using the web-based instructional package (experimental group) and those taught with traditional method (control group). From the table, the F-value = 1.091 and p < 0.05. This indicates that there is significant difference between the mean scores of the experimental group and the control group. Hence, hypotheses one is rejected. Therefore, there is significant difference in the mean achievement scores of students taught Basic Technology using Web-based Instructional Package and those taught with traditional method. This reveal that the treatment has effect on the students' performance.

Hypotheses Two: There is no significant difference in the mean retention scores of students taught basic technology using web-based instructional package and those taught with traditional method. In testing hypotheses one, the mean retention scores of students exposed to web-based instructional package and those taught with traditional method were analyzed using ANCOVA as shown in Table 8.

Table 8
ANCOVA result of retention scores of experimental and control groups

Source	Type III Sum of Squares	df	Mean Square	F-value	P-value
Corrected Model	60401.631	2	30200.816	2.6903	.000
Intercept	105.616	1	105.616	9.408	.003
Posttest (Covariate)	7637.942	1	7637.942	680.370	.000
Groups (Treatment)	268.746	1	268.746	23.939*	.000
Error	1302.234	116	11.226		
Total	494676.000	119			
Corrected Total	61703.866	118			

*: Significant at p < 0.05

Table 8 shows the ANCOVA results of the retention scores of groups taught using the web-based instructional package (experimental group) and those taught with traditional method (control group). From the table, the F-value = 23.939 and p < 0.05. This indicates that there is significant difference between the mean retention scores of the experimental group and the control group. Hence, hypotheses one is rejected. Therefore, there is significant difference in the mean retention scores of students taught Basic Technology using Web-based Instruction and those taught with traditional method. This reveal that the treatment has effect on the students' performance.

Hypotheses three: There is no significant difference in the mean retention scores of male and female students taught Basic Technology using web-based instruction.

In testing hypotheses two, the mean retention scores of male and female students in experimental group were analyzed using ANCOVA as shown in Table 9.

Table 9
ANCOVA results of the achievement scores of male and female experimental group

Source	Type III Sum of Squares	df	Mean Square	F-value	P-value
Corrected Model	3100.471	2	1550.236	154.177	.000
Intercept	170.170	1	170.170	16.924	.000
Posttest (Covariate)	3023.404	1	3023.404	300.690	.000
Gender	8.279	1	8.279	0.823^{ns}	.368
Error	573.129	57	10.055		
Total	399280.000	60			
Corrected Total	3673.600	59			

ns: not significant at $p > 0.05$

Table 9 shows the ANCOVA results of the retention scores of male and female students in experimental group. From the result, there is no significant difference between the mean retention scores of the male and female experimental group at 0.05 level of significance. (F = 0.823; p > 0.05). Therefore, hypotheses two is not rejected. Hence, there is no significant difference in the mean retention scores of male and female students taught Basic Technology using Web-based Instructional Package.

Hypotheses Four: There is no significance difference in the mean retention levels (high, medium, low) of students taught Basic Technology using web-based instruction.

In testing hypotheses three, the mean retention scores of high, medium and low level experimental group were analyzed using ANCOVA as shown in Table 10.

Table 10
Ancova results of the achievement scores
of high, medium and low level experimental group

Source	Type III Sum of Squares	df	Mean Square	F-value	p-value
Corrected Model	3141.345	3	1047.115	110.170	.000
Intercept	212.668	1	212.668	22.375	.000
Posttest (Covariate)	1899.602	1	1899.602	199.862	.000
Levels	49.152	2	24.576	2.586^{ns}	.084
Error	532.255	56	9.505		
Total	399280.000	60			
Corrected Total	3673.600	59			

ns: not significant at $p > 0.05$

Table 10 shows the ANCOVA results of the retention scores of high, medium and low level experimental group. From the table, there is no significant difference in the mean retention scores

of the three levels at 0.05 level of significance. (F = 2.586; p > 0.05). Therefore, hypotheses three is not rejected. Hence there is no significant difference in the mean retention scores of students' achievement levels (high, medium and low) when taught Basic Technology using Web-based Instruction. This also revealed that the WBI enhanced the learning outcomes of the students in the three levels especially the medium and the low level learners.

Discussion

The students taught with web-based instructional package performed better than those taught with traditional method. This finding is in agreement with the finding of Guzeller (2012) and Yamauchi (2008) which showed that students exposed to WBI achieved better than their counterparts exposed to the conventional instructional strategy. It also agrees with the finding of Erdogan *et al.* (2008) who reported that web-based education has positive effects on the improvement of academic achievement and on motivation for learning. In contrary, this finding is not in agreement with the finding Okeke and Osuagwu (2012) who reported that the students who learnt in the traditional way performed marginally better than those taught with Technology Enhanced Learning (TEL) students. It also disagrees with Wagner, Garippo and Lovaas (2011) and Stack (2015) who reported no significant difference in student performance between the two modes of course delivery (online and traditional instruction.

The study revealed that students taught basic technology using web-based instruction had a better retention than those taught with traditional method. This finding is in agreement with the finding of Shieh and Yu (2016) which revealed that guided discovery instruction influenced learning retention. It also agrees with the finding of Wang (2016) which showed that students taught vocabulary demonstrated significantly better retention. The result also agrees with the result of Dasdemir. (2013) which revealed that students had positive effects on academic achievement and retention when exposed to animation in basic education. This study concurred with the finding of Chang (2015) which showed that single test trial enhanced immediate retention and deep processing enhanced immediate and delayed retention. In contrary, this finding is not in agreement with the finding the result of Ong and Tasir (2015) which no retention effect on trainee teachers when taught with spreadsheet software. It also disagrees with the finding of Bond and Ellis (2013) which showed no significant difference between the posttest and retention test results for the experimental groups or the control group.

This study also revealed that male and female students retained the concept of basic technology equally. This finding is not in agreement with the result of Chen, and Tsai (2007) which showed that females displayed more favorable attitudes than male students' performance of Web-based learning. It also contradicts the results of Andrew, Janice and Stephen (2007) and Johnson (2014) which revealed that females performing better than males with Web-based learning and traditional method. Contrarily, this study also disagrees with the result of Richards-Babb and Jackson (2011) which showed that male students' average success rate improvement was double that of female students. It also disagrees with the results of Murray (2016) which revealed that male students outperform female in the STEM disciplines. However, this study agrees with the findings of Dhindsa and Shahrizal-Emran (2011) and Kost-Smith, Pollock and Finkelstein (2010) which showed males and females that are not significantly different when taught using a constructivist approach.

The study also showed that high, medium and low achiever students performed equally better when taught basic technology using web-based instruction. This finding is in agreement with result of Gambari, Balogun and Alfa (2014) and Gambari, Kutigi and Fagbemi (2014) which showed that high achiever students performed better than medium and low achiever students when exposed to Interactive Whiteboard and Oral English respectively. However, the finding contradicts the results of Rajappa, Bobby, Nandeesha, Suryapriya, Ragul, Yuvaraj, Revathy,

Priyadarssini (2016) which showed that low achievers performed better in tutorial than high and medium achiever students. It also in disagreement with the result of Lin and Lin (2016) which revealed that science comic book and science text booklet benefited the low, medium and high achievers equally. It also disagrees with the finding of Lin, Chen and Chang (2015) which revealed that students with average and low academic achievements exhibit small improvement not seen with high academic achievement students.

Conclusion

This study has critically examined the concepts of basic technology at junior secondary school level in a rapidly changing world. It is the view of the authors that there is still a wide gap to be bridged in the area of teaching and learning. The innovative technology using web-based instruction seems to be the answer. The study showed that, Web-Based Instruction (WBI) improved students' achievement in Basic Technology better the conventional teaching. The male and female students exposed to WBI achieved equally better in Basic Technology. Web-Based Instruction (WBI) improved students' ability levels irrespective of high, medium and low levels of intelligence.

Recommendations

Based on the findings of this study the following recommendations are proffered:

1. Since the treatment (WBI) was found to be effective, teachers should be encouraged to teach their students with WBI to enhance the teaching and learning of Basic Technology.

2. Gender imbalance in teaching and learning Basic Technology could be bridged by teaching with WBI which promote active learning and is gender friendly.

3. Web-based Instruction could be used to bridge the gap between students of different abilities level. Basic Technology teachers should be encouraged to use WBI to bridge the gap within High, Medium and Low achievers' performance.

4. The students should be encouraged on the use of web-based package to learn since it is interactive, student-centred approach and user friendly.

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Self-directed peer-based vs. structured learning in a virtual community of practice teacher professional development program

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USA

Abstract

Data collected within this qualitative, multiple-case study included teachers' knowledge building preferences for structured and facilitated, versus self-directed, peer-based formatting in the PLATEAU virtual community of practice (VCoP) professional development program. These data were analyzed through the theoretical lenses of computer-supported collaborative learning (CSCL) and Vygotsky's zone of proximal development (ZPD). Through heterogeneous sampling, six sites were selected from 11 urban, town, and rural PLATEAU participating schools in four states, AZ, CO, NM, and UT, with 11 PLATEAU teachers purposively selected from these sites. Following semi-structured participant interviews, data were transcribed, coded, and analyzed, where the findings indicated that participants' preferred the self-directed, peer-based learning format to the structured VCoP component. School administrators may use the research findings to guide cost-effective virtual alternatives to face-to-face professional development models. Recommendations for future research include longitudinal studies that address the long-term impact of self-directed, peer-based VCoP professional development on teacher knowledge building and classroom practice.

Keywords: Computer-supported collaborative learning, knowledge building, peer-based learning, self-directed learning, social constructivism, teacher professional development, virtual communities of practice, Vygotsky, Web 2.0, zone of proximal development

Introduction

In today's world, Web 2.0 is neither fad nor the domain of digital natives, but reflects a fundamental shift in the way humans communicate (Aparicio, Bacao, & Oliveira, 2016; Bhagat, Leon, & Chun-Yen, 2016). Providing both formal and informal learning opportunities, interactive websites enable learners to control and create Web 2.0-based Internet content and engage in interactive exchange through communication resources such as social media, blogs, forums, wikis, and video sharing (Brooks & Gibson, 2012; McConnell, Parker, Eberhardt, Koehler, & Lundeberg, 2013). It is within this context that Web 2.0 holds the potential to transform teacher professional development through virtual communities of practice (VCoPs), where like-minded professionals in a topical domain engage in collective, Internet-based learning (Brooks & Gibson, 2012; Prestridge & Tondeur, 2015). As a knowledge-building tool, VCoPs expand the reach of adult education, providing access to learning removed from the isolative practices of most in-house, teacher professional development programs (Carruth & Carruth, 2013; Cooper, Grover, & Simon, 2014; El-Hani & Greca, 2012; Prestridge & Tondeur, 2015). Within a virtual community of practice (VCoP), teacher professional development can evolve to include an expansive base of teacher cohorts and mentored support across multiple schools, district wide, and beyond (Cooper et al., 2014). Teacher-training participants and facilitators can share a specialized interest and collectively assist one another in knowledge building through shared communication, with anywhere, anytime access (Carruth & Carruth, 2013; Liu & Lan, 2016).

Given the cost-effective nature of VCoPs and their ability to extend knowledge-building opportunities to a large cohort of professional peers, VCoP professional development can offer

more than one-size-fits-all, lecture-based seminars and workshops, which teachers have consistently reported as ineffective for advancing classroom practice (Carruth & Carruth, 2013; Prestridge & Tondeur, 2015; Zhu, 2012). Instead, teachers have asserted that intensive, extended classroom-based mentoring that is both reflective and experiential enhances knowledge building and teacher practice (Brooks & Gibson, 2012; Glover et al., 2016; Kemp & Baker, 2013; Petras, Jamil, & Mohamed, 2012; Prestridge & Tondeur, 2015). As an example and focus of this study, the PLATEAU program is a teacher professional development model that provides experiential and mentored place-based training in science, technology, engineering, and mathematics (STEM). This 2-year, voluntary teacher training model offers individualized, semi-monthly classroom mentoring by state specific PLATEAU facilitators (Regional Coordinators), intensive 5-day summer and fall institutes, and assistance in curriculum development, lesson planning, and program delivery in schools across the Four Corners region of the U.S. (southwest CO, south-eastern UT, northeastern AZ, and northwestern NM). Although the PLATEAU program was founded in 1989, this face-to-face only professional development program did not include a virtual community of practice and become a blended learning program until the 2015/16 school year.

While research findings have shown that teacher professional development models that do not include communities of practice often produce limited benefits for teacher praxis, few onsite professional development programs provide VCoP options, due in part to there being too few teachers of the same grade level or content areas to form diverse colleagueship with multiple peers in a topical domain (Brooks & Gibson, 2012; El-Hani & Greca, 2012; McConnell et al., 2013; Tang & Lam, 2014). Virtual communities of practice provide an alternative to this problem, where knowledge building with more learned peers and facilitators expands learning opportunities beyond the isolative context of school-based teacher professional development models (El-Hani & Greca, 2012; King, 2011). Within VCoP professional development programs such as PLATEAU, teachers from small rural schools to those whose specializations isolate them within larger districts, can access a broad and diverse range of teachers within the same specialty area, thus creating a wide network for support and knowledge building.

Yet, despite the benefits of VCoPs and their networking potential, there is wide variation within VCoP program formatting. While VCoPs can offer highly structured program delivery models, they can likewise be autonomous and self-directed. Given this structural variation, the purpose of this study was to investigate the most effective formatting for meaningful knowledge building in the PLATEAU VCoP teacher professional development program. While the results of this study are not generalizable, the findings may inform educators who are seeking to transition their professional development programming to a more engaging and relevant venue for their teachers.

Conceptual framework

To assess the impact of VCoP formats on knowledge building, their examination was grounded in a theoretical framework that served as a lens through which to guide analysis and interpretation of the findings. Framed within the context of social-constructivism, knowledge building in computer-supported collaborative learning (CSCL) occurs through social exchange using computer and Internet technology, where knowledge building is collaborative, facilitated, and socially cohesive (Brierton, Wilson, Kistler, Flowers, & Jones, 2016; Fischer, Kollar, Stegmann, & Wecker, 2013; Liu & Lan, 2016; Stahl, Koschmann, & Suthers, 2014). Grounded in socially cohesive discourse, CSCL promotes individual change through collective engagement, where dynamic meaning making creates a knowledge building tension integral to VCoP learning (Brierton et al., 2016; Fischer et al., 2013; Stahl et al., 2014). This cognitive tension is a product of the synergy of personal experience and the diverse experiences of others that occurs through online colleagueship and networking activities (Brierton et al., 2016; Tang & Lam, 2014).

Through this knowledge building tension, learners reconcile new information with past experience, either reconstructing knowledge or discarding new information as irrelevant (Vygotsky, 1962, 1978). Learners are thus active creators of knowledge, gaining self-awareness and understanding through sharing and knowledge building from challenging and reflecting upon personal learning experiences (Brierton et al., 2016).

Significantly influenced by the learning theories of Lev Vygotsky, CSCL is a product in part of Vygotsky's theory of the zone of proximal development (ZPD), where an individual, supported by a community of learners, can exceed independent performance capacity (Lu & Chang, 2016; Poehner, Zhang, & Lu, 2015; Vygotsky, 1978). Through this process, an individual's ZPD reflects the distance between autonomous problem solving abilities and the cognitive level attained through problem solving with collaboration or guidance from more knowledgeable others (Poehner et al., 2015; Vygotsky, 1978). This reflects the upper and lower limits of a person's ZPD, where the most powerful forms of learning occur when more competent individuals in mediated environments advance learners to the highest ranges of their ZPDs (Vygotsky, 1978). Yet, according to Vygotskian theory self-perceived cognitive ceilings occur as individuals rarely strive to maximize their potential, instead self-arresting cognitive development at the point of learning discomfort (Vygotsky, 1962, 1978). Through collective practice and knowledge building with more experienced others, learners can be urged beyond comfort zones to overcome self-perceived cognitive limitations (Haywood, 2012; Poehner et al., 2015; Vygotsky, 1978). As individuals bring varying degrees of expertise to online communities of practice, VCoPs provide opportunities for knowledge building that can transcend these perceived limitations and challenge the upper limits of a learner's ZPD (Churcher, Downs, & Tewksbury, 2014; Razak, Yusop, Hahili, & Chukumaran, 2015; Tang & Lam, 2014).

Literature review

Although an emerging trend in education is a decisive inclusion of technology-based activities within the classroom, teacher professional development has arrived late to the fray (Brooks & Gibson, 2012; Dorner & Kumar, 2016; Prestridge & Tondeur, 2015; Vu, Cao, Vu, & Cepero, 2014). While there has been considerable research that has demonstrated that online learning is effective, the body of theoretically based literature regarding VCoP teacher professional development is less well defined (Bayar, 2014; Kazempour, & Amirshokoohi, 2014; Tang & Lam, 2014). Given that the literature has indicated that most traditional teacher professional development is not meeting the increasingly complex demands within today's educational arena, theoretically grounded research in the domain of VCoP professional development can advance the relevancy of Web 2.0-based education programming, as an effective alternative for teacher training (Glover et al., 2016; Gulamussein, 2013; Prestridge & Tondeur, 2015).

Computer-supported collaborative learning (CSCL) is one such theoretical model that is responsive to the learning needs of those engaged in computer-based learning. Emerging in the 1990s in response to the isolative engagement associated with early e-Learning software and static curricula, CSCL has become a topic of broadening research as it provides a social constructivist framework that is also applicable to Web 2.0 knowledge building through social media exchange (Borstnar, 2012; Dorner & Kumar, 2016; Mostmans, Vleugels, & Bannier, 2012; Okello-Obura & Ssekitto, 2015; Stahl, et al., 2014; Zhu, 2012). As CSCL theorists place community knowledge building in a collaborative context, the theoretical lens of Vygotsky's ZPD provides context for understanding the nature of social constructivist learning in an online community of practice (Kao, 2015; Okello-Obura & Ssekitto, 2015; So & Kim, 2013; Stahl et al., 2014; Vygotsky, 1978). As the literature has shown that Vygotsky's theory of the ZPD can be successfully applied to all learning fields for those of all ages, the ZPD serves as theoretical means to assess learning in CSCL formats to determine that which is best suited to VCoP

knowledge building (Fischer et al., 2013; Hamrin et al., 2016; Kao, 2015; Lantolf & Poehner, 2011; Poehner et al., 2015; Vygotsky, 1978).

However, to maximize the VCoP knowledge-building potential through a learner's ZPD, CSCL theorists have posited that online communities of practice require structured and scripted formatting and facilitated programming to be effective conduits for learning (Fischer et al., 2013; Karakostas & Demetriadis, 2014; Weinberger, Marttunen, Laurinen, & Stegmann, 2013). Recommending that VCoP facilitators administer resources, mitigate technical problems, and deter cognitive overload, CSCL theorists contend that online communities of practice will not function successfully without guided and structured intervention (Karakostas & Demetriadis, 2014; Kirschner & Erkens, 2013; Tsompanoudi, Satratzemi, & Xinogalos, 2015). By way of scripting, or learning contracts, facilitators and learners jointly clarify learning objectives, define sequences, and outline activities within CSCL environments (Capdeferro & Romero, 2012; Kirschner & Erkens, 2013; Weinberger et al., 2013). Moreover, proponents of structured VCoPs have suggested that ZPD-based learning occurs best when facilitators provide guidance, assign group or individual processes, define learners' roles, and monitor their discussions and activities (Fischer et al., 2013; Karakostas & Demetriadis, 2014; Tsompanoudi, et al., 2015; Warring, 2013). Through structured delivery and organized facilitation, participants are better able to engage within their learning environments and are thus more likely to maximize their learning potential within the upper ranges of their ZPDs (Dorner & Kumar, 2016; Karakostas & Demetriadis, 2014; Kao, 2015; Rummel, Mullins, & Spada, 2012).

Although a substantive body of literature has indicated that structured CSCL VCoP models supported learning and improved teacher practice, proponents of self-directed, peer-based learning formats have argued that highly structured and over-scripted VCoPs can reduce flexibility, inhibit higher-order thinking, and restrict learner autonomy (Dillenbourg, 2002; Fischer et al., 2013; Karakostas & Demetriadis, 2014; Prestridge & Tondeur, 2015; Rummel et al., 2012; Tsompanoudi et al., 2015). Research related to this rival perspective has shown that learners were more responsive to peer exchange, to content materials and tasks that were self-selected, and to personal goals that were self-determined (Chametzky, 2014; Knowles, Holton, & Swanson, 2015; Raes & Schellens, 2015; Siqin, van Aalst, Chu, & Wah, 2015; Stahl et al., 2014). Moreover, CSCL researchers who have examined self-directed online learning formats have reported that online communities that were autonomous, peer driven, and supported collaborative practice promoted egalitarian participation, improved learners' critical thinking and problems-solving skills, and elicited more complex collaborative dialogue (Liu & Lan, 2016; Mello, 2016; Noroozi, Teasley, Biemans, Weinberger et al., 2013; Tsai, 2015).

Yet, research has also demonstrated communication challenges inherent to self-directed VCoP environments, which precipitated learner disengagement due to disorganized content, an absence of technological support, and lack of facilitator reinforcement (Karakostas & Demetriadis, 2014; Noroozi et al, 2012; Weinberger et al., 2013). Although CSCL can strategically augment online professional development and impart consistency for applied purposes, the debate continues regarding the appropriate structural level through which to maximize knowledge building in online communities of practice (Dorner & Kumar, 2016; El-hani & Greca, 2012; Fischer et al., 2013; Kao, 2015; Karakostas & Demetriadis, 2014; Kirschner & Ervens, 2013; Pozzi, Ceregini, Ferlino, & Persico, 2016; Tsai, 2015; Tsompanoudi et al., 2015).

Methodology

This study employed a qualitative, multiple-case study design to examine teachers' perspectives regarding their knowledge-building preferences for the structured, versus self-directed, peer-based PLATEAU VCoP professional development program. Eleven public schools in Colorado, Utah, Arizona and New Mexico participated in the 2015/2016 PLATEAU program, where 21

teachers volunteered to participate in this professional development model. Nine of 11 PLATEAU participating school superintendents and principals agreed for their schools and PLATEAU participating teachers to take part in the study, with 16 teachers from the selected schools available for recruitment.

Non-random purposive sampling for schools selection from the nine potential sites was based upon heterogeneous representation of urban, town, and rural schools that comprised the 2015/2016 PLATEAU sample universe. Six sites were selected, where purposive sampling ensured that specific criteria and categories within the sampling universe were adequately represented in the research findings. A heterogeneous sample likewise enabled the opportunity to compare similarities and differences between PLATEAU teacher populations at selected schools and potentially increased the likelihood for transferability through diverse site selection.

Participants. From the six heterogeneously selected sites, 11 PLATEAU participating teachers volunteered to take part in the study. Teacher participants were required to be enrolled in the 2015/2016 PLATEAU program at selected participating schools and to be licensed to teach in their home states. All participants had a minimum of a bachelor's degree, were of similar socioeconomic status, and were proficient in English. Teacher representation was determined by site selection, a willingness to participate in the study for 6 consecutive months during the 2015/2016 school year, and agreement to meet the terms and conditions of the PLATEAU VCoP program. These terms and conditions of the study required the following teacher participation:

- One-on-one, face-to-face monthly classroom-based mentoring sessions with the state specific Regional Coordinator.
- One-on-one, structured, monthly VCoP mentoring sessions with the state specific Regional Coordinator.
- Two or more weekly self-directed teacher blog and discussion forum posts.

Table 1 identifies gender-neutral pseudonyms and participant demographics relevant to this study:

Table 1
Participant educational attainment, teaching experience, and grades taught

Participant pseudonym	Site	Educational attainment	Years teaching experience	Current grades taught	Locale classification
Terry	1	MA	20	7-12	Remote town
Pat	1	MA	16	K-5	Remote town
Jaime	2	BA	12	1-2	Mid-size city
Jesse	2	MA	17	5	Mid-size city
Morgan	2	BA	19	2	Mid-size city
Taylor	3	BA	2	6	Mid-size city
Hunter	4	MA	12	6	Mid-size city
Daryl	4	MA	33	6	Mid-size city
Alex	5	MA	2	6	Distant town
Kim	5	BA	6	6	Distant town
Jordan	6	BA	3	4	Remote town

Note: Site 1 remote town: Population 721 and >103 miles from an urban area.
Sites 2-4 midsize city: Population 139,097.
Site 5 distant town: Population 6,578 and >15 miles from an urban area.
Site 6 remote town: Population 864 > 109 miles from urban area (U.S. Census Bureau, 2014).

Data collection and analysis

Through semi-structured, 60-minute interviews at each participant's home school, selected PLATEAU teachers' were questioned regarding their perceptions of VCoP knowledge building and preferences for the structured, versus self-directed PLATEAU VCoP. Interviews were conducted following 6 consecutive months of VCoP program participation in the 2015/2016 school year. Interviews were audio-recorded, transcribed and coded, and cross-case analyzed for pattern and thematic matching and literal and theoretical replication. Both site codes and participant pseudonyms were used throughout the duration of the study and were the only identifiers entered into the qualitative software program.

Results

Although there are rival theoretical perspectives regarding the effectiveness of structured, versus self-directed, peer-based CSCL learning formats, the results of this study supported the body of evidence that has shown that adults are more responsive to online knowledge building that is peer driven, autonomous, and self-determined (Dorner & Kumar, 2016; Kazempour, & Amirshokoohi, 2014; Knowles et al., 2015; Pozzi et al., 2016; Siqin et al., 2015; Stahl et al., 2014). This theoretical perspective was reflected by the findings of this study where 8 of 11 participants preferred the self-directed, peer-based component of the PLATEAU VCoP to the structured and scripted format. Taylor's interview response summarized the views of those who preferred self-directed, peer-based learning:

> I would pick peers, because when I think of other professions you typically don't have a facilitator and even when you do, you might have a manager who has suggestions, but the people who really have the tips and the ways to perfect something are the ones doing it every day; the ones practicing the same craft as you. I think that there is so much to learn there.

While the findings of this study corroborated educational theorists who have posited that ZPD-based learning is applicable to adults in CSCL environments, ZPD-based learning only occurred among those who preferred the self-directed, peer-driven component of the PLATEAU VCoP. Of the eight participants who preferred the self-directed, peer-based VCoP format, six reported greater knowledge gains through the support of experienced peers than they would have achieved alone. (Churcher et al., 2014; Elola & Oskoz, 2016; Kao, 2015; Poehner et al., 2015; Vygotsky, 1962, 1978). Pat's comment reflects this perspective:

> You're already meeting people at a level of experience and knowledge that is helpful to you, so they are able to offer you advice or just posts or whatever the case may be that can help you rise from the level that you are. Seeing people's comments on some of the things that I have shared on there [PLATEAU VCoP], they have come up with ideas of how I could do lesson plans and activities the next time so that they would be better developed. It's nice to have that level of support.

Jordan also highlighted how ZPD-based knowledge building occurred through peer support in the self-directed component of the PLATEAU VCoP:

> I think a lot of the teachers have been great. We've been able to talk things out and figure things out together. A lot of them have different backgrounds with different experiences and see things in different ways, so I used that to my advantage. It was nice to see what the other teachers had done and some of their thoughts on different ways to teach a lesson. Like after they taught it they learned, oh, this doesn't work very well – here is a different way you can teach it. This was extremely beneficial to see what others

were doing and how they fixed problems when they arose. I can add my own ideas and go from there.

In contrast, three of the 11 participants preferred the structured component of the PLATEAU VCoP, which included the PLATEAU Personal Professional Development Plan. This script or contract defined learning goals and associated tasks, timelines, and Regional Coordinator school visits and online mentoring schedules. Of the three participants who preferred the structured format, each reported marginal online knowledge gains through the support of their Regional Coordinator, while all three denied peer-based learning. Alex summarized these perspectives:

> I don't know how often I really interacted with other teachers on the PLATEAU VCoP. I would look at their messages and feel like oh, that's cool, but that was it, so there wasn't that direct chat experience with anyone, except my Regional Coordinator. As a learning tool? I liked the structured component because its very direct and organized and it was more time effective. But, I don't know, I feel I learned more from my Regional Coordinator face-to-face.

Of the three teachers who preferred the structured component of the PLATEAU VCoP, each reported that face-to-face knowledge building was their preferred learning modality. Morgan summarized this perspective:

> I would say, I probably got more from the Regional Coordinator just because they [sic] kind of knew what I was teaching, but for real learning, I would do face-to-face . . . it opens up more and it opens more opportunities to hear what other people are thinking and what their ideas are. When it's online, it's a little less, um, I don't know, give and take. You don't hear as much maybe.

In conclusion, the findings of this study indicated that there were no regional differences in teachers' perspectives regarding knowledge building in the PLATEAU VCoP. Likewise, teachers' preferences for structured, versus self-directed learning varied across participating sites irrespective of locales. Instead, differences regarding knowledge building perspectives and structural preferences appeared more closely associated with participants' preferences for face-to-face learning. Across locales, those who preferred face-to-face learning expressed preferences for the structured VCoP format, but consistently reported minimal PLATEAU VCoP knowledge gains.

Discussion and implications

While there has been considerable debate among CSCL researchers and theorists as to the most effective online learning format, broader knowledge gains in this study were made by participants who preferred self-directed, peer-based learning (Dorner & Kumar, 2016; El-hani & Greca, 2012; Fischer et al., 2013; Kao, 2015; Karakostas & Demetriadis, 2014; Kirschner & Ervens, 2013; Pozzi et al., 2016; Tsai, 2015; Tsompanoudi et al., 2015). This was corroborated by the findings, where participants who preferred the self-directed, peer-based PLATEAU VCoP also reported that learning was enhanced through the support of more knowledgeable peers (Vygotsky, 1978). While these findings supported CSCL research that has indicated that ZPD-based learning is effective within virtual settings, ZPD-based learning only occurred among those who preferred the self-directed, peer-based PLATEAU VCoP format (Churcher et al., 2014; Elola & Oskoz, 2016; Poehner et al., 2015; Vygotsky, 1962, 1978). In contrast, participants who preferred the structured component of the PLATEAU VCoP reported marginal knowledge gains, stating instead that the most significant learning occurred during face-to-face experiences with their Regional Coordinators.

There were, however, inherent limitations in this study, which included the voluntary participation of teachers in the PLATEAU VCoP professional development program. As a

consequence, these participants may have had higher motivational levels and career initiative than occurred in the general teacher population. Moreover, the first-year status of the PLATEAU VCoP with its evolving growth and development and limited number of participants may have negatively impacted teacher responses. Of the eight teachers who preferred the self-directed, peer-based format, four stated that they would have preferred a larger teacher cohort and a broader body of resources. As participants were not representative of the national teacher professional development population, they more clearly represented educators who participate in voluntary and long-term teacher-training programs.

While teachers generally reported that the structured and scripted component of the PLATEAU VCoP did not meet their learning needs, it represented the most costly and time consuming feature of the PLATEAU VCoP regarding program development and delivery. This is significant from a practical standpoint for those within the field of education who may be considering VCoP professional development within their school districts, as the self-directed, peer-based format, which teachers perceived as most effective for learning, was the most cost effective and easily maintained component of the PLATEAU VCoP. Thus, the results of this study may inform school administrators, website and content developers, and curricula specialists who seek to provide online teacher professional development through a cost-effective vehicle that is both dynamic and expands knowledge building resources beyond the boundaries of a teacher's home school. As the field of education trends toward the inclusion of Web 2.0-based technology to enhance teacher training, program formatting and content options should be grounded in a theoretical framework that provides school administrators the confidence they need to be assured that VCoP professional development experiences best serve teachers' learning needs and subsequent classroom practice.

Conclusion

The analyses of teachers' perspectives regarding VCoP structure and its impact on knowledge building through social exchange, may inform theoretical understanding regarding the influence of ZPD-based knowledge building in Web 2.0 learning environments. Most important perhaps, theoretically based research regarding teachers' perspectives on VCoP knowledge building places teachers' views foremost in defining that which is most relevant to their learning needs, where meeting those needs is essential for effective professional development training (Bayar, 2014; Chinnasamy, 2013; Darden, 2014; Knowles et al., 2015; Samaroo, Cooper, & Green, 2013). Although debate continues in the field of CSCL regarding the most effective structural format for knowledge building, this study's participants indicated a decided preference for the self-directed, peer-based component of the PLATEAU VCoP, as it enabled them to exchange expertise with like-minded professionals, who shared similar learning needs and practice challenges (Dorner & Kumar, 2016; El-hani & Greca, 2012; Fischer et al., 2013; Kao, 2015; Karakostas & Demetriadis, 2014; Kirschner & Ervens, 2013; Pozzi et al., 2016; Tsai, 2015; Tsompanoudi et al., 2015).

Future replication studies could include established VCoP professional development models as the primary units of analysis. This would increase the trustworthiness of the findings, as it would circumvent the limitations associated with this study. Likewise, correlational studies could be conducted to investigate a possible association between VCoP program structure and knowledge building. Should an association exist, correlational studies could measure the strength of that association, which was not addressed within the findings of this study. In addition, recommendations for future research include larger sample studies that address the long-term impact of self-directed, peer-based VCoP professional development on teacher knowledge building and classroom practice.

To this end, there is an expanding need for understanding and implementing effective professional development, as education becomes an increasingly complex field. Thus, the

practical application of this study's findings and those of future research may engender VCoP professional development as a theoretically grounded alternative to the static teacher training that persists in many schools today. Through VCoP professional development, teachers can unite their voices and expertise to create broad resources for knowledge building that transcend twenty-first century teacher training models that remain fettered to the practices of yesterday.

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About the author

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Editor's Note: YouTube has a plethora of videos with excellent value for instruction. Others can be adapted and/or personalized by the instructor to make them or relevant and effective for distance learning on mobile devices. This paper has valuable insights to create or adapt YouTube videos and animations for learning.

Investigating best practices for effective YouTube programming in online higher education

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Abstract

Online learning has drastically changed how students can earn a degree, learn content, and master concepts. With technological tools being continually developed and marketed to educators and students, options are overwhelming and need to be chosen with attention to the specific needs of the online learner. Additionally, given the steady increase in online students, online higher education institutions are seeking pedagogically sound ways to make learning more accessible to all students given their varying needs and backgrounds. Online institutions report a need for clarity on the types of technology that work best to meet students' learning needs while instructors desire guidance on creating and implementing innovative technology based programming to enhance learning. This report will explore YouTube as a beneficial learning tool. Guidance is provided for the pedagogical inclusion of such programming in order to meet the unique and specific needs of today's online learner.

Keywords: education, distance learning, online education, adult learner, continuing education, college instruction, e-learning, virtual classrooms, educational strategies, Mayer's Cognitive Theory of Multimedia Learning; animation design; screencast recording

Introduction

Almost 30% of students in the United States are enrolled in online or distance learning courses at higher education institutions; over 5.5 million students are presently attending online learning courses (U. S. Department of Education, 2015). While attendance of online learners continues to grow, the retention rates for such students remains 10-20% lower than retention rates for students attending traditional postsecondary institutions (Carr, 2000, Diaz, 2002; Frankola, 2001; Willging & Johnson, 2009; Xenos, 2004). Because of the continued growth of online learning and the lack of precise research on how to best increase the retention of students, it is critical to better understand online students' learning preferences and styles.

According to one study, one of the most important and commonly preferred programs used by all students to learn is YouTube (Thirunarayanan et al., 2016). Research furthermore indicates that students find YouTube to be instructive and highly engaging (Buzzetto-More, 2014; Jaffar, 2012; Roodt, 2013). Another resource echoes these benefits while importantly reporting that use of online videos improves retention rates (Brecht, 2012). Given the various educational benefits of YouTube, it can be seen as a format that is pedagogically sound. Not only is it an academically rich resource, it also can be seen as a necessary one for today's twenty-first century digital learner. For instance, regarding the use of media resources such as YouTube, Facebook, and Twitter, Heather Mansfield, a business consultant who helps colleges and universities improve their online communication and development, notes, "The thing with higher ed and social media is that colleges really don't understand that they have no choice whether they want to use social media" (Gilroy, 2010, p. 21). Therefore, ignoring the academic opportunities inherent in the use of platforms such as YouTube may be inhibiting to students, and research supports this resistance as a reality. In fact, in one study, up to 93% of university faculty were reluctant to develop

materials using technological programming; this same study suggests that such instructors are "inhibitors" of learning rather than "innovators" (Watty, McKay, & Ngo, 2016, p. 2).

Furthermore, research supports the notion that both higher education research and practice have been reluctant to acknowledge the cultural effect new technologies have had on literacy and learning (Goodfellow, 2011). In response to such inaction, today's students can be found to believe it is imperative for educators to reform education and take into consideration the digital literacy inherent in our media-rich world (Anderson & Rainie, 2012). Such reform can begin with the mainstream media outlet known as YouTube.

YouTube as a motivational factor

To guide technological reform, John Keller's ARCS Motivational Process can be utilized to best ensure the motivation of an adult learner. Keller (1999) posits that emphasis should be placed on specific design considerations and their relevance to online lesson design, "These dimensions were derived from a synthesis of research on human motivation and are known as attention (A), relevance (R), confidence (C), and satisfaction (S), or ARCS" (p. 39). If designed appropriately, YouTube instructor-created instructional videos and animations can meet these criteria.

With regard to the first principle of the ARCS Motivational Process, *attention*, an article positing the use of the ARCS motivational process in the online classroom notes, "Three potential strategies that are easily applied to online learning include using videos, graphics, and comic strips for gaining attention" (Milman & Wessmiller, 2016, p. 69). To aid in securing the attention of learners, animations can be easily created through low-cost programming such as GoAnimate for Schools while simulations/tutorials can be created without difficulty through free programming such as Screencast-O-Matic. Once created, such animations or screencasts are easily uploaded to YouTube. To emphasize the importance students place on such resources, research in one study indicates that what students found most interesting and motivating in their e-learning courses were the animations, simulations, and interactive quizzes that were embedded in activities (Kim, 2009). To add the quiz element to any creation, the YouTube can be uploaded to a program like TED-Ed, which is a free educational program associated with TED Talks to enhance instruction by making it more interactive. With this program, the instructor uploads the YouTube to his or her TED-Ed account and then develops quizzes and discussions around the content of the video. Once the attention of the learner is attained through the animation or screencast, deeper learning can be ensured through the quiz feature built into the TED-Ed programming.

After ensuring student attention is attained, YouTube programming also should be created with *relevance* in mind. Keller (2008) emphasizes that relevance "includes concepts and strategies that establish connections between the instructional environment (content, teaching strategies, and social organization) and the learner's goals, learning styles, and past experiences" (p. 177). Because the instructor controls the content of the tutorials and animations when designing such videos, emphasis should be placed on why the video is relevant. For instance, in one tutorial I created on using the TurnItIn plagiarism checker, in addition to showing students how to read and operate the plagiarism checker, I emphasize to students that avoiding plagiarism in the workplace is just as important as avoiding it in the academic environment. Establishing the relevance of a lesson helps to ensure the student is more personally and academically invested in the topic.

In keeping with Keller's ARCS Motivational Process, *confidence* is the next guiding principle to consider when designing video-based lessons for uploading to YouTube. Keller (2008) asserts that students are motivated to learn when they gain confidence from assigned tasks. Moreover, research indicates that videos in general increase learner confidence in understanding material (McAlister, 2014). By embedding a quiz within the YouTube by uploading the YouTube to Ted-

Ed, students can interactively engage with material and gain confidence in mastery of the material through the completion of such quizzes. Being able to add this formative assessment quiz to the YouTube is invaluable to instructors and students alike because it focuses student learning and aids in helping students to master concepts more readily while allowing them self-regulate their learning (Collett, Gyles, & Hrasky, 2007; Greene, Moos, & Azevedo, 2011). Empowering the learner in such a way is motivating. Research shows that when a student's attention is drawn to key concepts embodied in quizzes, the student is empowered with a better ability to self-teach going forward (Afitska, 2014; Van Duijn, Swanick, & Donald, 2014). Building student confidence in the online classroom is critical to student success. Furthermore, such online formative assessments reduce overall student anxiety as students find success in mastering concepts in a low-risk environment (Zakrzewski & Bull, 1998). By reducing anxiety and by improving mastery of content, students feel empowered and more confident in their educational journey.

Finally, the last principle of Keller's ARCS Motivational Process is *satisfaction*. In noting the primary disadvantages that result in unsatisfying experiences with e-learning, some of the major concerns were that distance learning:

- does not embody a traditional learning atmosphere
- minimizes contact between instructor and student
- requires more dedicated time due to inefficient set-up (Bouhnik & Marcus, 2006).

Videos can be used to offset these concerns. For example, in recording lectures on content and in creating tutorials to walk students through the completion of assignments, virtual teaching helps to improve the conceptualization of learning objectives while also mimicking a traditional learning atmosphere where instructor physical presence is the norm. Furthermore, by using videos where the instructor can be seen and/or heard on the screen dialoguing with students, the degrees of separation between an instructor and student are decreased because the instructor virtually enters the student's workspace (DeVaney, 2009). Students also believe that instructors who create videos are more dedicated to student success (McAlister, 2014). Equally important, the use of the well-known media source of YouTube results in greater efficiency and satisfaction on behalf of the user due to the self-pacing inherent in such videos as they can be started and stopped at will and reviewed when necessary (Kovach & Revere, 2011; McAlister, 2014). Overall, the use of videos via YouTube in the classroom results in motivating users to more readily meet the demands and challenges of online learning and leaves them feeling more satisfied with their experiences (Brecht, 2012; Choi & Johnson 2007; Kim, 2009).

YouTube as an academic factor

Not only is video instruction within the online classroom motivational, it also promotes academic achievement. Research indicates that video instruction is more effective than text-based resources in improving comprehension (Brecht, 2012; Choi & Johnson, 2007; Gunawardhana & Palaniappan, 2016; Hegeman, 2015). Additionally, video instruction increases student retention of information (Issa et al., 2011; Shin, Kim, Park, Jang, & Chung, 2013). Improved overall retention of students and reduced drop-out rates moreover correlate with Instructor-generated videos (Brecht, 2012; Hegeman, 2015). Therefore, by recording video screencasts or by creating instructional videos, learning can be enhanced in various ways.

YouTube videos are not only associated with improved learning; such a mode of learning appeals to a variety of types of learners. For instance, one study notes, "The research data clearly indicate that the majority of the participants found that the digital videos were a valuable addition…as they made the learning environment more authentic, memorable, realistic, varied, and accommodating to different learning styles" (Kellam, MacDonald, Archibald, & Puddester, 2012,

p. 57). Also, students desiring a more supportive online environment benefitted from the personalization of instructor-created videos as this improved the students' satisfaction with the course and contributed to a more positive learning experience (Greenberg & Zanetis, 2012; Mandernach, 2009). Importantly, the visual and audio formats also appeal to the dual-coding needs of learners aiding all students in improving understanding (Clark & Mayer, 2011). The presentation of information using multimedia, especially video multimedia, subsequently appeals to millennial and digital learners of today (Buzzetto-More, 2014; Roodt, 2013). The needs of learners with special needs and who are at-risk are also well met by the visual and audio instructions (Lancioni et al., 2015). Finally, while being appreciated for the rich audio-visual elements YouTube videos and multimedia works bring to the learning environment, when coupled with interactive components such as online quizzes, questions, or otherwise interactive elements, such learning activities are more fully realized and lead to greater interest and engagement (Hegeman, 2015; Kim, 2009; Li, 2016). Collectively, all of these benefits work to aid in the twenty-first century student's learning needs as the digital world continues to evolve.

YouTube aids in accessibility

YouTube additionally is widely accessible in a plethora of ways while meeting the learning needs of diverse learners. First, according to one study, YouTube is considered to be the frontrunner of all video-sharing services and the "accessibility of YouTube content by students via mobile devices is significant in that it has implications to instructors whose students may have inconsistent computer access or lack the software to properly access or view other forms of content" (Buzzetto-More, 2014, p. 30). Students also appreciate the flexibility of having access to YouTube videos at any time and from anywhere (Van Duijin et al., 2014). As mobile device usage grows and as online students often juggle work, school, family, and various other obligations, reliance on mobile devices will continue to grow and programs compatible with mobile devices will continue to be needed. It behooves the online instructor to develop materials that are easily accessed from a variety of devices as well as in a format familiar to students. YouTube is an excellent platform for meeting such needs.

Another reason YouTube is beneficial is that online institutions find it to be a versatile program to utilize. Such institutions appreciate the low cost associated with the creation and posting of screencasts or animations (McAlister, 2014; Wright & Abell, 2011). Additionally, YouTube is generally compatible with the majority of learning management systems. "The availability of cheap computing, broadband, and mobile networks and a range of Web-based services is clearly changing the way both students study and the way the universities they attend conduct their work" (Jones, 2012, p. 37). The evolution of online learning needs to embrace more readily the resources already embedded in students' digital lives.

Accessibility for users with special needs is another reason YouTube is a sound pedagogical choice to use as a platform for online learning. Researcher Marianne Raley (2016) notes, "When deciding to implement digital learning…in an online classroom, consideration should be given to accessibility for any assignment" (p. 58). Descriptive closed captioning can readily be added with YouTube's automated transcript functionality, and any compliance concerns can be addressed with ease.

Guidelines and programming options

Given the benefits of YouTube programming, it is no surprise that the creation of online screencasts and animations should be guided by distinct and intentional processes and developed with human learning cognitive processes and retention in mind. Mayer's research on designing effective multimedia materials provides a pedagogically sound framework to use to ensure maximum impact of screencast or animation design. Mayer (2003) is careful to note that

instructors need to understand that computers do not ensure student learning; well-designed and research-based e-learning programming will ensure better learning occurs.

Effects from Mayer's Cognitive Theory of Multimedia Learning to use to guide instructional design

Effect	Definition	Practical Design Applications
Multimedia Effect	Students viewing animation and narration simultaneously perform better on tests than students who received only audio narration (Mayer, 2003).	Animation and screencasts more readily appeal to learners than podcasts or sound clips. Students acquire more thorough information from words and pictures combined rather than just words. Animations and screencasts improve instruction and are valued and useful to students; learner preference for length ranges from 3-7 minutes for online students, and preferences for face-to-face learners range from 90 seconds to 3 minutes (Buzzetto-More, 2014).
Modality Effect	Students viewing animation and narration perform better on tests than students viewing on-screen text only (Mayer, 2003).	Students attain deeper learning from animation and narration rather than on-screen text. On-screen text poses complications for adult readers; special attention needs to be given to text that is too long, too small, and does not utilize gaps in reading content, leading to eye and mental strain (Mohamad, Hussin, & Shaharuddin, 2015).
Personalization Effect	Students learn more from conversational narration than formal narration (Mayer, 2003).	The use of informal conversation or tone when creating screencasts or animations contributes to greater student learning. Conversational tone makes learning more accessible. Situating the screencast or animation in a storyline also personalizes learning and encourages the student to personally identify with and connect to the storyline (Greenberg & Zanetis, 2012; Shin et al, 2013).
Coherence Effect	Students perform better when viewing animation and narration rather than viewing animation and narration in addition to elements such as background music, special effects, or other sound clips (Mayer, 2003).	When designing animations or screencasts, avoid inserting distracting extraneous elements such as effects, music, or sounds. Aim to streamline learning content to avoid unnecessary distractions. Understanding of an animation or screencast can be improved and enhanced by including a context-relevant graphic (Gemino, Parker, & Kutzschan, 2005).
Redundancy Effect	Students perform better when presented with an animation and narration rather than an animation, narration, and on-screen text (Mayer, 2003).	The effect posited here, when examined in a virtual classroom and a language learning classroom, suggest the reverse is true in that animation, narration, and on-screen text result in greater transfer of knowledge (Liu, Lin, Gao, Yeh, & Kalyuga, 2015; Morrison, Watson, & Morrison, 2015; Samur, 2012). Further research is needed in this area.
Pre-training Effect	Students perform better when they receive explanatory info prior to presentations as opposed to after the presentation (Mayer, 2003).	When designing animations or screencasts, pre-training is necessary to reduce cognitive load and promote schema acquisition. Pre-training in the form of concise narration and verbal labeling was found to be the most effective pre-training mode (Jung, Kim, & Na, 2016).
Signaling Effect	Students perform better when they receive a signal that important information is going to be narrated rather than non-signaled narration (Mayer, 2003).	When designing screencasts or animations, use a change in tone or an indicator to notify students that critical information is about to be imparted. The use of an animated pedagogical agent (APA), specifically, arm movements of that animated agent are particularly effective in signaling information in comparison to the simple use of an arrow (Johnson, Ozogul, & Reisslein, 2015). Additionally, an onscreen agent that exhibits human-like gestures (facial expressions, eye gaze, and bodily movements) encourages greater learning; a human (vs. machine) voice is also preferred (Mayer & DePra, 2012).

Effect	Definition	Practical Design Applications
Pacing Effect	Students perform better when the video they are viewing is segmented, and the viewers are able to control the pace of the presentation (Mayer, 2003).	When designing screencasts or animations, ensure that the viewer has control over the presentation. A "Continue" button or "Stop" and "Play" buttons support this learning need. Uploading screencasts or animations to a program like PlayPosit allows for quiz questions to be inserted throughout the playing of the video, leading to segmented learning. More segmentation leads to more learning; too much information too quickly can overload learners (Doolittle, Bryant, & Chittum, 2015).

To ensure effective multimedia design, the effects of Mayer's Cognitive Theory of Multimedia Learning should be used as guiding principles for instructors.

Designing multimedia programming that uses these effects to guide development clearly increases student learning and better meets the needs of diverse digital learners. Clark and Mayer (2011) note, "Instructional methods that support rather than defeat human learning processes are an essential ingredient of all effective e-learning courseware" (p. 8). Furthermore, when determining which programs to use to develop screencasts or animations that can be uploaded to YouTube, consider the following programs.

Free or Low-cost Applications to Use to Develop YouTube Programming			
Program	**Description**	**Uses**	**Application site & example**
YouTube	This is a free video-sharing website. It allows for Closed Captioning and transcript creation. This program is readily accessible on mobile devices, tablets, and computers with internet connection or Wi-Fi.	Houses various instructor-created screencasts and animations	**Application site:** https://www.youtube.com/ **Example:** https://www.youtube.com/watch?v=ttagND5niWo&t
Screencast-O-Matic	This is a free screen and webcam recording software program that allows the user to record up to 15 minutes of the user's screen content. The program will simultaneously record the presenter and what he/she is saying. It allows the recording to be downloaded as a video file or uploaded as a screencast to resources such as Screencast-O-Matic's private site, YouTube, OneDrive, Google Drive and Vimeo. This program is readily accessible on mobile devices, tablets, and computers with Wi-Fi.	Records screencast lessons, tutorials, demonstrations, overviews, wrap-ups, and messages	**Application site:** https://screencast-o-matic.com/ **Example:** https://www.youtube.com/watch?v=XT9AP7rBG_M&t
GoAnimate for Schools	This is a low-cost program for creating professional animations. The animations can be downloaded as MP4 files or uploaded digitally to YouTube.	Creates animated lessons, tutorials, overviews, wrap-ups, and messages	**Application site:** https://goanimate4schools.com/ **Example:** https://www.youtube.com/watch?v=Wv1QyLTSt7w&t
TED-Ed	This is a free program associated with TED Talks where quizzes, questions, discussions, and differentiated materials can be added to YouTube presentations to enrich learning. This program is readily accessible on mobile devices, tablets, and computers with Wi-Fi.	Adds quizzes and discussions to created animations or screencasts, allowing for better student pacing	**Application site:** https://ed.ted.com/ **Example:** https://ed.ted.com/on/oFfRvhGI
PlayPosit	This is a free program where created YouTube animations or screencasts are uploaded and seven types of interactive questions can be added to the video to more readily engage learners and encourage greater understanding. This program is readily accessible on mobile devices, tablets, and computers with Wi-Fi.	Adds quizzes to created animations or screencasts, allowing for better student pacing and segmented learning	**Application site:** https://www.playposit.com/ **Example:** https://www.playposit.com/share/249164/500291%20
Piktochart	This is a free infographic design app for creating graphics or infographics.	Develops context-relevant graphics, reducing cognitive load contributing to the Coherence Effect	**Application site:** https://piktochart.com/ **Example:** https://magic.piktochart.com/output/7352017-week-5-wrap-up

Using programs such as these while keeping Mayer's effects on cognitive load in mind can guide instructors in creating programming that is supported through research-based methodology aimed at maximizing learning potential and meeting the needs of learners. Clark and Mayer (2011) emphasize this point by concluding that "the benefits gained from these new technologies will depend on the extent to which they are used in ways compatible with human cognitive learning processes" (p. 8). Importantly, however, research reminds online instructors that while multimedia material development improves learning, persistence, and engagement, specific techniques for design may vary by discipline (Hegeman, 2015; Jones, 2012). As instructors, it is critical to remain current with innovative technology research as it is published to ensure that dynamic and appropriate YouTube programming is created.

Conclusion

Because social media outlets such as YouTube are central parts to so many twenty-first century students' lives, higher education instructors should seek to exploit the potential promise that media outlets hold in motivating students and increasing learning (Hrastinski & Aghaee, 2012). Low-cost computing, broadband, mobile learning, and the wide range and availability of e-learning programming is altering the way students learn best and the way instructors best help their students to learn (Jones, 2012). YouTube programming holds much promise in its ability to increase the motivation, learning, and accessibility of digital learners. Becoming familiar with the guiding principles associated with effective multimedia design will ensure the most pedagogically sound multimedia lessons are created. As the higher ed community speeds forward into the twenty-first century, it will be critical to teach in ways that keep pace with the twenty-first century student's needs.

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