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Predicament and Development Direction of Network Effectiveness Learning: Analysis and Research of Ergonomic Effectiveness

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Abstract: ***Human Factors and Ergonomics play a key role in the design and development of computer applications and tools. This is a multidisciplinary approach used to ensure that systems and learning environments are designed to aid in user's performance. This study aimed at analyzing the human factors and ergonomics, their effectson the effectiveness of e-learning platform at Rongo University.A descriptive research methodology was usedto collect and analyze the data from a sample size of 150consisting of faculty and the students.Using stratified sampling technique from five schools, a questionnaire was the main data collection tool and data was analyzed using SPSS. It was observed that the level of e-learning platform at Rongo University is very low at less than 2%. The study found that, psychological effects such as,motivation, individual perception, self-regulation, course content, computer literacy and lack of discipline from the e-learning students, were the major contributing factors.Student and faculty correlated significantly with each other across schools with course content being the main factor at a mean score of 8.60 for faculty and 21.40 for students. TheActivity Theory has been used as a theoretical background that guided the study.***

Keywords: Human factors and ergonomics, e-learning, online learning

1. Introduction

Human factors and ergonomics are closely related with engineering psychology, which is the study of human performance in the operation of systems (Proctor and Vu 2010). The invent of digital technology in the recent past, has had a great influence on learning and teaching practices within our colleges and universities around the world. Teaching institutions are making efforts to embrace e-learning developments in the curriculums and are investing effortlessly in information technology infrastructure, with some greater expectations on return on investment. But with this huge investment and expectations, e-learning platforms are still underutilized by the faculty and students.

Loosely defined, e-learning are a set of instructions delivered through an electronic media such as internet, intranets, satellite broadcasts, audio and video tapes, interactive TV's and CD- ROMs. E-learning may also be defined as teaching and learning through the web. E-learning is increasing gaining prominence in tertiary institutions as universities scramble to launch contents for students sign up. With e-learning, geographical barriers can be eliminated and e-learning is therefore seen as an enabler for lifelong and life wide learning, that will give resources and facilitate educated population. E-learning offers the advantages such as inexpensive mode of delivery, self-paced, consistent content, use of multimedia and access to anywhere any time. This far much outweighs disadvantages such as cost of developmentthat requires new skills for the developers of content. The sheer use of technology might also affect user's psychology, intimidating, confusing, and frustrating. Thus e-learning requires a student to be very responsible and must have self-discipline to keep up with an unconstrained and robust learning process.

2. Problem Statement

There has been exponential growth of public universities in Kenya over the few years with many campuses getting established. These campuses mostly get upgraded into full fledge universities through a charter. It is on this backdrop that Rongo university was born. The crave for students both online and part-time has become big business and many universities are starting e-learning models, just to have additional numbers for sustainability. There is a general shift on the current student population to access learning over distance (distance education learners). The advancements in technology has enabled e-learning possible with a means of providing students an avenue for engagement with course information at their leisure anywhere everywhere.

The rush and dash for numbers with no golden standard rule for e-learning platforms, has exposed the learners and lecturers to the physical and cognitive ergonomic factors that has had an impact on the performance of e-learning students. The study's main objective was to examine the ergonomic factors that impact e-learning performance and provide recommendations on how to improve these limitations for a better e-learning experience.

3. Literature Review

With many challenges affecting African countries such as poor ICT infrastructure, unreliable power supplies, poor funding for education and research, with lack of experts, education institutions are steadily embracing new forms of learning networks to respond to the rapidly advancing technology in the other parts of the world. The flexibility of e-learning offers students a chance to focus and be motivated to maintain the balance between school, work, and home life. Gibson (as cited in Banas& Emory, 1998) explains that distance learners should be more focused,

manage time effectively, be able to work both independently and in groups, have strong self-motivation and self-discipline, and be assertive. Blocher, Sujo de Montes, Willis, and Tucker (2002), says that a student's ability to self-monitor and self-regulate their learning, gather resources, and seek support from peers for understanding is important and could hinder or improve their success.

The psychological effects involved in self-regulation such as***student motivation*** is a psychological construct that activates the self-regulation process (Zimmerman, 2008). Ryan and Deci (2000, p. 56), says that,*intrinsic motivation* is the psychological feature that makes a student to carry out an activity for its inherent satisfaction, fun, challenge entailed, rather than for some sort of consequences. Contrary to that opinion, *extrinsic motivation* on the other hand will make a student to take an action towards a certain goal for obtaining a different outcome such as reward or recognition.

A learner's ability to ***self-regulate*** is one of the major assumption of the constructivist learning model. It states that, learners learn better when they discover things on their own time and pace. This assumption means that, when students are self-regulated and independent learners, they will be more successful in an online learning environment. According to Zimmerman (1989, p. 329), a self-regulated learner is motivationally and behaviorally active in his or her own learning process. They therefore, take personal initiate and direct their own efforts to acquire knowledge and skills, that makes them strongly associated with superior academic achievements.

Learners perception and faculty culture has a role in lecturer's acceptance or rejection of e-learning platform (Nanayakkara, 2007). The faculty perceive that online dialogue will replace the face to face interaction is a concern and also that online teaching would be mandated rather than a supplementary option for faculty and students. Negative perceptions and misinterpretation of e-learning content by both lecturers and students could affect an effective e-learning platform. A report by Grunwald (2002), that potential adopters' beliefs and attitudes whether perceived goals, positive attitudes on technology, perceived usefulness and the perceived ease of use, can influence technology adoption. The e-learning ***platform usability*** refers to the ease with which the portal can be used by its intended users to achieve learning objectives. The usability covers many elements relating to e-learning such as instructional design, infrastructure functionality, e-learning environment structure, and information architecture. With the ever evolving internet access devices, information is readily available and attainable despite location. This may introduce ergonomic concerns. As cited by Kamau2016, ***lack of discipline*** amongst the learners may also affect the learning process.

4. Theoretical Underpinning

The theoretical underpinning is a guideline used for this study to give an overall direction in variables identification to be measured. TheActivity Theory has therefore been used in this study. Previous studies have used empirical data evaluate learning environments. It was the researcher's goal to leverage Activity Theory to examine the ergonomic issues students experienced while using e-learning platforms at Rongo University.

As per figure 1, below showing a basic Activity Theory diagram, which gives focus on learning using three features of ***subject*** (students), an ***object*** (course content) and ***tool*** (infrastructure). An activity is taken on by a subject using tools to achieve an objective of the object to produce learning outcomes.

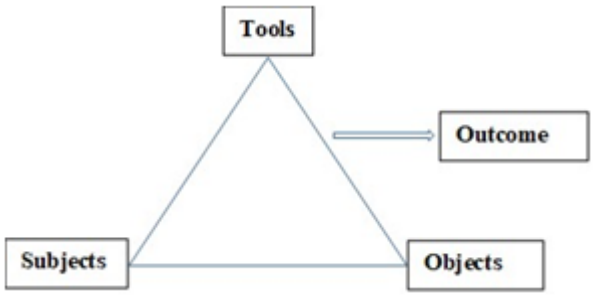

Figure 1: Basic Activity Theory (Source: Vygotsky, 1978)

Activity theory was used to analyze humancomputer interaction, interface design, technology in education and provided a framework for understanding the learning experience of students using technology. The Engeström Expanded Activity Theory Model (Engeström, 2001) shown in figure 2, is used to address the activity's ecosystem by expanding on the basic model figure 1 to include three more features, namely, rules, community, and division of labor.

These elements of the expanded activity theory system are therefore applied to e-learning environment as:

1) Tool (mediating artifact) – e-learning access medium such as internet enabled devices (infrastructure).
2) Subject – student or leaners.
3) Rules – learning conditions or rules governing class and course administration.
4) Community – all e-learning stakeholders (students, faculty and administrators).
5) Division of Labor – division between students and faculty.
6) Object (activity) – access to course content or class materials.
7) Outcome – meeting learning objectives.

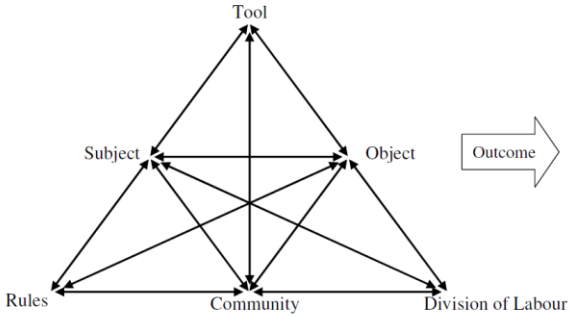

Figure 2: Engeström Expanded Activity Theory Model (Engeström, 2001)

Learning occurs through interaction between learners and learning tasks (Shih & Mills, 2007), technology infrastructure facilitates and enhances communication

exchanges between the students and the lecturers. Activity Theory's emphasizes how the tool and activities are mediated to shift attention from the interactions between access device such as computer, to the activity as a whole.

Ergonomicsis a term associated with human factors. A definition by Chapanissays that, ergonomics is the discovering and applying information about human behavior, abilities, limitations, and other characteristics to the design of tools, machines, systems, tasks, jobs, and environments for productive, safe, comfortable, and effective human use (Sanders & McCormick, 1993). Traditionally, ergonomics was composed of three main specialization areas namely, physical, cognitive and organizational. These factors play an important role during the development lifecycle of e-learning systems or products.Other elements that affect e-learning outcomes are contributed by human factors such as *computer literacy*, *course design*, and *lecturer student dialogue*.

Computer literacy in context of the traditional knowledge, was knowing how to read and write and one was then considered to be literate. Computers were by then used for teaching aids or self-study tools. Computer literacy era is not complete if a person is not able to access and create digital information, manage technical device, communicate and collaborate online information. Therefore, it is paramount to focus on computer literacy in education and e-learning. The e-learning literacy measures the extent to which someone is able to participate in e-learning activities. E-learning literacy therefore, refers to skills, knowledge, attitudes and behavior sets that are necessary to participate in a partial or full online learning programs and classes (Hong and Jung, 2010). E-learning requires the capability to identify and organize information through the use of information and communication technologies for learning purposes (Di Sessa, 2001). When weaker students of e-learningliteracy slacks behind class work, the overall performance depreciates. This would also demotivate the students and change their attitudes towards e-learning.

Course design is the initial step in any formal lecture. According to Moore (1991), the course structure expresses the rigidity or flexibility of the program's educational objectives, teaching strategies, and evaluation methods, and describes the extent of an education program accommodation or how individual learner's needs will be met.A course design is the planning and design of the course structure. It includes the processes, engagement, interaction, and evaluation aspects of the course.

Effective learning requires ***lecturer student dialogue.*** The relationship between lecturer and student through interactions and learning outcomes is well documented in traditional classrooms (Powers &Rossman, 1985). This therefore means that, the interactions with lecturers would be equally important online. Picciano (1998) found that lecturer's activitieswere related to students' perceived learning in online education courses. In Richardson and Ting (1999) study, perceptions of two groups of students were compared in asynchronous learning. The study found that, students learning through written correspondence with instructors were more concerned with lecturer feedback, whereas students learning online felt that all interactions with lecturers including lecturer's participation in class discussion, mattered. According to Jiang and Ting (1998), they found correlations among students' perceived interactions with lecturers and the average numbers of responses per student that lecturers made and the average numbers of responses students themselves made in course discussions.

5. Methodology

The methodology entails the intended study design, the techniques that will be used for data collection and data analysis as well as statistical analysis based on the population and sampling methodologies.

Research Design

A research design is an arrangement of conditions for data collection and analysis in a manner that aims to combine relevance to the research goals with economy in procedure (Kothari, 2004). The study used a ***descriptive*** research method with a mix of qualitative and quantitative techniques. The descriptive method offered insights into the subject of who, what, when, where and how these are linked by the study objective. The data analysis was done using SPSS (Statistical Package for the Social Sciences) software.

Study population and sample size

The subjects under study is referred to study population (Cooper and Schindler, 2001). The researcher has used a study population of 43 lecturers and 107 students from various schools within Rongo University, Main Campus. The schools are; school of infocoms, school of science technology and engineering, school of education, school of business management and school of arts. The subgroup of the population chosen for participation in the study was 150 people. The sampling method used was stratifiedpurposively for selection due to the constraints of time.

Data Collection

Data was collected using a questionnaire instrument administered to teaching staff (faculty) and students. The data was both ordinal to include the determining characteristics of the respondents and their perceptions towards e-learning.The comprehensive questionnaire consisted of two parts. One, investigated demographic details such as, gender, interviewee age profile, faculty or school, highest academic qualifications (year of study for students). Two, included questions relating to e-learning. These included devices used, computer literacy, self-motivation, learner's discipline, course content and psychological effects.

6. Results and Discussion

Data analysis was carried out using SPSS to attain 95.0% confidence level for the strata variables. The result shows that the students and faculty correlated significantly with each other across schools with course content being the main factor at a mean score of 8.60 for faculty and 21.40 for students as shown in table 2.

Table 1: Bootstrap Specifications

Sampling Method	Stratified
Number of Samples	150
Confidence Interval Level	95.0%
Confidence Interval Type	Percentile
Strata Variables	Faculty, Students

Table 2: Descriptive Statistics

		Statistic	Bootstrap[a]			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Faculty	N	5	0	0	5	5
	Sum	43				
	Mean	8.60	.00	.00	8.60	8.60
Students	N	5	0	0	5	5
	Sum	107				
	Mean	21.40	.00	.00	21.40	21.40
Valid N (listwise)	N	5	0	0	5	5

Table 3: Respondents by School

School	Faculty	Students
School of Infocoms	11	24
School of Science	10	30
School of Business	8	18
School of Education	9	19
School of Arts	5	16
Total	43	106

Table 4: Respondents percentages by faculty

School	Frequencies	Percentages
School of Infocoms	11	25.58
School of Science	10	23.26
School of Business	8	18.60
School of Education	9	20.93
School of Arts	5	11.63
Total	43	100

Faculty of infocoms had the highest percentage of respondents followed by the school of science technology and engineering. This can be attributed to the fact that, these schools offer computational science courses and therefore has some greater exposure to technology. A similar pattern can also be observed table 2, table 3, table 4 and figure 3 and figure 4.

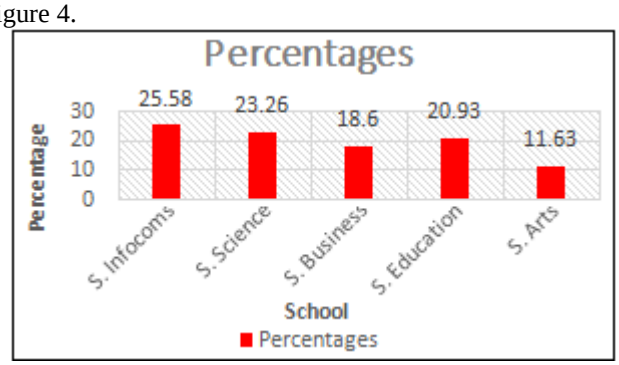

Figure 3: Descriptive Statistics–Percentages

Table 5: Respondents by schools

Stratum	Frequencies	Percentages
School of Infocoms	24	22.43
School of Science	30	28.04
School of Business	18	16.82
School of Education	19	17.76
School of Arts	16	14.95
Total	107	100

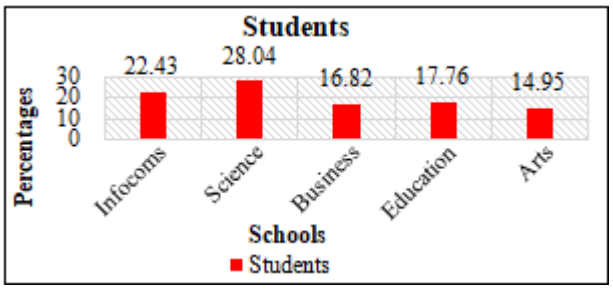

Figure 4: Descriptive Statistics – students

Regression Analysis for Faculty and Students

Table 5: Model Summary

Equation 1	Multiple R	.747
	R Square	.558
	Adjusted R Square	.411
	Std. Error of the Estimate	1.767

The R square value of 0.558 indicates the variance is 55.8%. This R Square gives statistic that shows some information about the goodness of fit of a model. The R Square coefficient in regression analysis gives statistics that determines a statistical measure of how well the regression line approximates the real data points. Elfving and Whitlock (1950), Ury (1968), Quade 1974), Reynolds (1974), and Korn(1984), suggested the useof weighted sum of Kendall's tau, across the blocks to test associations. An alternative to Kendall's tau is the Spearman's rho, it can be used for testing association too. Kendall (1970), claimed that, tau is preferable to rho because of the many practical and most theoretical points of view. When estimating correlation, the population parameter being estimated has a simpler interpretation and this is one of the reasons for tau preference.

Table 6: Anova table for Faculty

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	21.200	4	5.300	.	.
Within Groups	.000	0	.		
Total	21.200	4			

Table 7: Anova table for Students

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	127.200	4	31.800	.	.
Within Groups	.000	0	.		
Total	127.200	4			

Table 8: Descriptive Analysis for Faculty and Students

Valid N (listwise)	Students	Faculty		
5	5	5	Statistic	N
	14	6	Statistic	Range
	16	5	Statistic	Minimum
	30	11	Statistic	Maximum
	107	43	Statistic	Sum
	21.4	8.6	Statistic	Mean
	2.522	1.03	Std. Error	
	5.639	2.302	Statistic	Std. Deviation
	31.8	5.3	Statistic	Variance
	1.029	-1.033	Statistic	Skewness
	0.913	0.913	Std. Error	
	0.075	1.129	Statistic	Kurtosis
	2	2	Std. Error	

Weighted Kendall's tau's and weighted sum of Spearman's rho's, are two commonly used nonparametric methods of testing association between two variables in the presence of a blocking variable and also, their use is restricted to a single block.The two essentially have the same power with the optimal choice of weights. In case of a tie, the weighted sum of Spearman's rho's takes precedence because it's variance is in a much simpler form.

Table 9: Correlation Analysis for Faculty and Students (2-tailed)

Correlations				
			Faculty	Students
Kendall's tau_b	Faculty	Correlation Coefficient	1.000	.800
		Sig. (2-tailed)	.	.050
		N	5	5
	Students	Correlation Coefficient	.800	1.000
		Sig. (2-tailed)	.050	.
		N	5	5
Spearman's rho	Faculty	Correlation Coefficient	1.000	.900*
		Sig. (2-tailed)	.	.037
		N	5	5
	Students	Correlation Coefficient	.900*	1.000
		Sig. (2-tailed)	.037	.
		N	5	5
. Correlation is significant at the 0.05 level (2-tailed).				

Table 10: Correlation Analysis for Faculty and students (1-tailed)

Correlations				
			Faculty	Students
Kendall's tau_b	Faculty	Correlation Coefficient	1.000	.800*
		Sig. (1-tailed)	.	.025
		N	5	5
	Students	Correlation Coefficient	.800*	1.000
		Sig. (1-tailed)	.025	.
		N	5	5
Spearman's rho	Faculty	Correlation Coefficient	1.000	.900*
		Sig. (1-tailed)	.	.019
		N	5	5
	Students	Correlation Coefficient	.900*	1.000
		Sig. (1-tailed)	.019	.
		N	5	5
. Correlation is significant at the 0.05 level (1-tailed).				

7. Conclusion

There is an indicator that the university ought to integrate or improve e-learning strategic plan into the main stream planning. Top leadership should have this in their radar by including the integration of e-learning into the annual work plans, performance contracts, development of a clear policy and funding of e-learning initiatives. There is a need for overall sensitization workshops for management and staff. With this, there will be visibility of e-learning programs to attractallocation of more resources in support of e-learning.

General computer literacy should be improved to increase the probability of e-learning uptake and reduce the psychological stress associated to human ergonomics whilst using computers to access content. Computer literacy training for faculty and students should target all schools e-learning concept is still low. Despite the overall infrastructural challenges and power issues, computer literacy should be made compulsory to demystify anxiety associated with the use of computers. The prominent issues affecting e-learning are; psychological, self-regulation, course content, computer literacy and lack of discipline from the e-learners. observed that the level of e-learning awareness at Rongo University is very low at less than 2%. The number of student and faculty correlated significantly to each school with course content being the main factor.

8. Future Scope

The study did not go into the depth of ergonomics issues of the physical challenges, cognitive delimiters and touched briefly on organizational challenges. Further research is needed to understand the impact of computer design and exposure hours' impact to the well-being of human health based on age set.

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