International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

Effect of Biology Teachers' Domain-Specific Beliefs about the Subject on the Integration of Technology in Instruction in Secondary Schools in Kenya

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Abstract: ***Information and Communication Technology (ICT) has a key role to perform in aiding education deliver its mandate of transforming Kenya into an industrialized nation as envisaged in the Kenya vision 2030. It is therefore essential that it is integrated into the teaching of all subjects in the school curriculum, biology inclusive. Its application in teaching contributes to effectiveness in delivery of the content. However, this is met with many challenges as many teachers do not seem to prioritize the use of technology in biology teaching and instruction based on the teachers' beliefs about the description of the subject and how it should be taught. The beliefs about biology can be categorized into three distinct groups: The Scientific-Innovative, Pedagogical-Innovative, and Scientific-Conventional types. The purpose of this research was to examine the domain-specific beliefs held by the teachers of biology about the nature of the subject and its instruction and the effect of these beliefs on the integration of ICT in instruction in secondary schools in Kenya. The study was conducted in secondary schools located in Bungoma County. The objective of the study was to determine the effect of the three belief categories on the frequency of use of technology. The study was based on the social constructivist learning theory as proposed by Lev Vygotsky. The study adopted descriptive survey design. The study targeted secondary school biology teachers who have received professional training. Stratified and simple random sampling techniques were applied to ensure equal representation of the schools (sub-county, county, extra county and national schools), teachers. Data was collected using questionnaires, observation schedules, and analyzed using descriptive and inferential statistics. The descriptive statistics included means, frequencies and percentages. The data is presented in the form of tables, graphs and pie charts. The study made known the effect of the domain-specific beliefs of biology teachers on the integration of ICT in biology instruction in secondary schools in Kenya. This may pave the way for interventions to facilitate proper integration and meaningful instruction which will lead to acquisition of the pertinent knowledge, skills, attitudes, and competence for further training.***

Keywords: Biology Teachers, Secondary School

1. Introduction

The Kenya Vision 2030 is a national development blue-print formulated in the year 2007 to create a universal competitive and thriving nation with a high quality of life by the year 2030 (RoK,2007). Its purpose is to transform Kenya into an industrialized, middle-income country that will offer a high quality of life to all its citizens with a clean and secure environment. The overall goal is the eradication of illiteracy by escalating access to education, increasing transition rates from primary to secondary schools, and expanding access to university education with prominence on science and technology courses (Ibid).

The vision 2030 rests on six foundations of which Science, Technology, and Innovation (STI) is part. The government is committed to create and implement an STI policy framework to support the realization of Vision 2030. It purposes to commit more resources for scientific research, procedural capabilities of the personnel, and tofoster the quality of teaching Mathematics, Science oriented and Technological studies in Schools, Polytechnics and Universities (RoK, 2007). The other strategies to achieve the vision 2030 goals include reforming secondary education and modernizing teacher training**.** Performance in science subjects is therefore of great concern given that these subjects are essential in the attainment of the national goal of industrialization by year 2030 (KEMI, 2014).

Information and Communication Technology (ICT) has an essential role to play in aiding education deliver its mandate of transforming Kenya into an industrialized nation by year 2030. The ministry of education in Kenya in the Sessional Paper No. 1 of 2005, the current education policy, captures stakeholders' recommendations on how to transform education to be responsive to educational and training needs in the 21st century. The Sessional Paper provides a policy framework for Education, Training, and Research within which incorporation of modern resources in teaching and learning will take place in Kenya. It points out that ICT skills play a crucial role in boosting the economic development of the country (MOEST, 2005). It is noted that investing in ICT capital has massive capacity to reduce costs, enhance productivity, and enhance living standards (Murakami, 1997). It is also noted that from 2001, when the worldwide information technology report was unveiled, information and communication technologies became more powerful, more accessible and extensive. They have enhanced competitiveness, aiding progression and forging progress at all levels of society (WEF, 2015).

Integration of Information Communication Technology

The Sessional paper acknowledges that an ICT knowledgeable work force is the basis on which Kenya can attain the status of a knowledgeable economy. The government intends to make education the actual platform for supplying the nation with ICT skills in order to establish a dynamic sustainable economic progression. The MoE has put in focus the integration of ICT in the school curriculum. The effective introduction and use of ICT in education and training institutions will play a significant role in disseminating skills to the broader society and therefore creating positive impressions in the economy (RoK, 2005).

When ICT is appropriately used, it can bring many gains to education, classroom and in the training process. Its use offers new prospects for teaching and learning, increasing chances for student-centered learning, opportunities to reach more students, more opportunities for teacher to teacher, and student to student communication and collaboration.

Studies conducted to identify some of the factors associated with higher student achievement have pointed to the adoption of educational technology in teaching (Ellington, 2004). It is noted that integrating Information Communication Technology in the teaching process enhances learner participation. Because of the correlation between educational, technological adoption and gains, many organizations have recommended the use of educational technology in instruction (National Council of Teachers of Mathematics (NCTM), United States Department of Education, 2004).

In spite of policies at national level that encourage the use of educational technology during instruction, many teachers hardly use it (Barron, Kemker, Harmes & Kalaydjian, 2003). Some of the major hindrances towards the use of educational technology include the readiness and preparedness of teachers to adopt it in their instructional programmes.

Beliefs held by Teachers about Subjects

Central to the successful implementation of educational technological use in schools is the role played by the beliefs held by teachers about the nature of their subjects and the way the subjects should be taught (Brinkerhoff, 2006). This is in view of the challenge it may offer to their already established instructional practices. He argues that teachers' beliefs affect their instructional practices. According to Neuhaus (2012) teachers' beliefs and their content knowledge influence instructional behaviour. The beliefs of teachers lie at the very heart of teaching in various subjects. According to Harste and Burke (1977) as cited by Kuzborska (2011), language teachers' beliefs and understanding of teaching as well as learning plays a critical role in their classroom performance and in their professional progression. They postulated that teachers formulate decisions about classroom instruction according to the theoretical beliefs they have about teaching and learning. Teachers' beliefs guide their targets, materials, procedures, their roles, classroom interaction patterns, the learners as well as the schools in which they work.

A study carried out in Germany by Vogt and Neuhaus (2005), on biology teachers' beliefs classified the teachers of biology into three groups depending on their biology-specific educational beliefs as follows: Pedagogical-Innovative type, the Scientific- Innovative category and the Scientific-Conventional type. According to the study, the teachers of biology subscribing to the three identified groups lay different emphasis on the nature of biology as a subject and how it should be taught. The pedagogical-innovative emphasized the social aspects of learning biology, the scientific-innovative believe in teaching factual knowledge and carrying out laboratory activities, while the scientific-conventional type mainly focused on teaching of factual knowledge.

According to Oladejo, Ojebisi, Olosunde, & Isola (2011), science has been viewed as a foundation on which current day technological advancement is built, currently countries world over notably the developing ones are trying hard to develop technologically and scientifically because the world is becoming more scientific and all major life functions depends intensely on science. Science encompasses the basic disciplines including mathematics, physics, chemistry, and biology. In Kenya, national examination results have revealed that secondary school students are having very low scores in sciences (KNEC report, 2018). Biology, being one of the science subjects is one of the most difficult subjects in the school curriculum. KNEC results for the past five years attest to this. Students' performance in biology in secondary schools in Kenya has been low over the years as evidenced in the Kenya National Examinations Council Analysis revealed in table 1.1(Candidates' Overall Performance in Biology between 2014 and 2018 Nationally) and also reported in the KNEC report 2018.

The Kenyan secondary school curriculum emphasizes on science, technical and practical education. Biology is among the science subjects taught in the secondary school curriculum in Kenya. The study of Biology endeavors toimpart the learners with skills, knowledge, and attitudes needed for controlling and preserving the environment. Besides, the subject is essential as it prepares learners for such fields as agriculture, medicine, and genetic engineering (Wekesa, 2003). Biology is the precursor for biotechnology which is a resource for industrial and technological development (ibid).

The objectives of teaching biology are to enable learners to transmit biological information in an accurate, clear and logical way; advance comprehension of the interrelationships involving plants and animals and between humans and their environment, incorporate the knowledge attained to foster and maintain the well-being of the individual, family and the community; examine and distinguish features of familiar and unfamiliar organisms, document observations and draw conclusions about the roles of parts of organisms; foster positive attitudes and interests on biology and related practical skills; illustrate

ingenuity, applicable technical skills and scientific judgments necessary for economic progression; design and conduct experiments and strategies that will enable them understand biological concepts and acquisition of a firm foundation of relevant knowledge, skills and attitudes for further education and training in related scientific fields among other objectives (KIE, 2006). To be able to achieve these objectives, teachers of biology need to develop projects and investigations and provide conditions that encourage learners to be actively involved in the learning process. Integration of information communication technology is one of the ways through which learners can be actively involved in the learning process.

According to Ngesu, (2014), performance in biology depends largely on effective teaching and learning processes through discussion methods and practical sessions.

Student achievement in biology is a matter that has drawn increased attention. Low academic achievement in the subject could be attributed to many factors among which teaching methods are considered to be important. This implies that the mastery of biology concepts may not be fully achieved without proper teaching methods. The methods need to be more learner centered allowing active involvement of learners in the learning process. The teaching of biology without the active involvement of the learners in the learning process may certainly lead to low academic achievement.

For the effective acquisition of biology skills, knowledge, attitudes, and values, it is recommended that teachers use empirical methods when possible so as to engage the learners and maintain their interests in the subject. However, between 2014 and 2018, students' performance in biology nationally has continued to be of great disquiet to education stakeholders. It has dropped to below average both at the national and county levels.

2. Statement of the Problem

Biology is a fundamental science subject in the secondary school curriculum that has a role to play in enabling learners to acquire skills, knowledge, and attitudes needed for monitoring and conserving the environment. It plays a significant role in preparing doctors, technologists, genetic engineers, environmentalists, among other professionals. Given that the subject prepares learners who can pursue courses that require the use of technology, there is need to integrate technology in classroom instruction to enable them to develop the pertinent knowledge, skills and competence for further training.

However, this is met with many challenges as many teachers do not seem to prioritize the use of technology in classroom instruction. One such challenge could be the beliefs held by the teachers of biology about the subject which can be categorized into; pedagogical-innovative, scientific-innovative and scientific conventional. It is against this background that this study sought to investigate if the beliefs of teachers of biology about the nature of the subject and how instruction should be conducted play a role in the overall integration of information and communication technology in the classroom instruction in secondary schools in Kenya.

3. Purpose of the Study

The purpose of the research was to investigate the domain-specific beliefs held by the teachers of biology about the nature of the subject and how it should be taught and the effect of these beliefs on the integration of ICT in biology instruction in secondary schools in Kenya.

4. Objective of the Study

The objective of the study was to determine the effect of the three belief categories of pedagogical-innovative, scientific-innovative, and scientific-conventional of biology teachers on the frequency of use of technology in instruction.

Research Hypothesis

The study was to test the following null hypothesis;

HO1: There is no statistically significant difference among the biology teachers subscribing to the three belief categories about biology and the frequency of their use of technology in teaching biology.

5. Research Design and Methodology

The descriptive survey design was utilized in the study. This design enabled the researcher to determine the effect of the three belief categories of biology teachers; pedagogical-innovative, scientific-innovative, and scientific-conventional types on the frequency of use of technology in instruction.

The Sample

A total of thirty one schools were selected from Bungoma County using stratified and simple random sampling to ensure equal representation of national, extra-county, county and sub-county, mixed, girls' and boys' secondary schools respectively as shown in table 1.

Table 1: Categories of Schools by Classes and Gender

Category of school	Boys'	Girls'	Mixed	Total
National	1	1	-	2
Extra-County	3	3	-	6
County	3	3	3	9
Sub-County	4	4	6	14
Total	**11**	**11**	**9**	**31**

Bungoma County has only two national schools, both of which participated in the study. Ten percent of schools from each of the remaining categories were sampled for the study. This enabled the selection of six Extra-County schools, Nine County, and fourteen Sub-County schools as shown in the table 1 above.

Sample size

Table 2: Sample Size

Respondents	N	n	%	Type of Sample
Teachers	350	70	20	Random

The table 2 above shows that the sample size comprised of seventy (70) biology teachers drawn from the sampled thirty-one schools. Simple random sampling techniques were used to select the teachers. From the sampled Sub-county schools which have one or two streams, one teacher of biology was selected from each sampled school giving fourteen (14) teachers, four teachers were selected from National schools, amounting to eight teachers (8), four from each Extra-County school giving twenty (24) teachers, in six of the County schools, at least three teachers participated in the study while three of the County schools were represented by two teachers each giving a total of six teachers hence bringing the number of teachers from County schools to twenty four (24). Therefore, seventy teachers participated in the study, which constitutes 20% of the total number of biology teachers in the county.

Research Instruments and Data Collection

Data was gathered through biology teachers' questionnaire (BTQ). The questionnaire was utilized for data collection as it provided substantial benefits of administration. The teachers' questionnaire contained six sections; Section A, had question items which sought to establish the teachers personal details while section B addressed the teachers belief about the nature of the subject and how it should be taught.

6. Results and Discussion

The objective of the study was to establish how the teachers' beliefs about biology affected the frequency of utilization of technology in the instruction of biology. The first item was to establish the availability of various resources that may enhance ICT incorporation in the teaching of biology. Respondents were to indicate their availability and usage in instruction. The following resources; printers, printed charts, calculators, and smart phones were available and used, radios, computers, televisions, overhead projectors, software programs, internet and electric power were available in 27(87 %) of the schools. In 20(64.5%) of the schools, they were used while in 7(22.5%) of schools they were not used. Computers were only found in27 (87%) of the schools. In the schools where computers were available, they were used in 24(77.4%), but not used in 3(9.6%) schools. Liquid Crystal Display (LCD) projectors were not found in any school. 5(16.1%) of the schools lacked internet accessibility, while 2(6.45%) lacked hydro-electric power. The schools which lacked hydro-electric power did not have other power sources such as solar power or generators. In the schools that had the internet access and hydro-electric power, results indicated that they were used.

Frequency of Use of ICT Resources versus Biology Teachers' Beliefs

The researcher was set to find out the relationship between the biology teachers' beliefs and the frequency of use of ICT resources in the instruction of the subject. The results are shown in table 3.

Table 3: Frequency of Use of ICT by Biology Teachers in the three Belief Categories

Teachers' beliefs	Frequency of use of technology				
	Very often	Often	Rarely	Never	Total
Pedagogical-innovative	2	12	5	2	21
Scientific-Innovative	7	16	12	5	40
Scientific Conventional	0	1	4	1	6
Total	**9**	**29**	**21**	**8**	**67**

The results in table 3indicate that for the respondents subscribing to the pedagogical-innovative belief category majority of them either used the ICT very often or often with very few indicating they rarely used the ICT or never using it at all. The same trend is observed for respondents subscribing to the scientific innovative belief category. However, for the teachers who subscribe to the scientific conventional belief category a majority of them indicated rarely or never using the ICT in classroom instruction.

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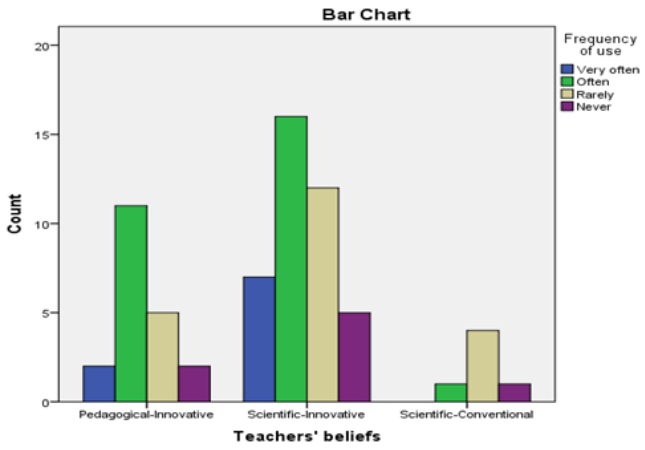

Figure 1: Frequency of Utilization of ICT by Biology Teachers in the three Belief Categories

Inferential statistics were used to test the null hypothesis touching on the teachers' beliefs and the utilization of technology in classroom instruction. The null hypothesis was stated as;

HO1: There is no significant difference among the biology teachers subscribing to the three belief categories about biology and the frequency of their use of technology in teaching biology

Table 4: Relationship between teachers' beliefs about biology on the use of overhead projectors/slide projectors

Symmetric Measures					
		Value	**Asymp. Std. Error[a]**	**Approx. T[b]**	**Approx. Sig.**
Interval by Interval	Pearson's R	.444	.072	7.298	.000[c]
Ordinal by Ordinal	Spearman Correlation	.348	.073	5.474	.000[c]
N of Valid Cases		219			

Relationship between teachers' beliefs about biology on the use of calculators

The researcher then sought to establish the relationship involving teachers' beliefs about biology on the use of calculators. The study indicated a coefficient of correlation (r) as .363, P<.01.

Table 5: Relationship between teachers' beliefs about biology on the use of calculators

Symmetric Measures					
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	.363	.131	3.214	.002[c]
Ordinal by Ordinal	Spearman Correlation	.358	.121	3.158	.002[c]
N of Valid Cases		70			

Relationship between teachers' beliefs about biology on the use of video cameras

The researcher also investigated the relationship involving teachers' beliefs about biology on the use of video cameras. The study established a coefficient of correlation (r) as .375, P<.01. This indicates that there is a significant relationship between teachers' beliefs about biology on the use of video cameras.

Table 6: Relationship between teachers' beliefs about biology on the use of video cameras

Symmetric Measures					
		Value	**Asymp. Std. Error[a]**	**Approx. T[b]**	Approx. Sig.
Interval by Interval	Pearson's R	.375	.113	3.340	.001[c]
Ordinal by Ordinal	Spearman Correlation	.379	.114	3.382	.001[c]
N of Valid Cases		70			

Relationship between teachers' beliefs about biology on the use of storage devices

Looking at the relationship between teachers' beliefs about biology on the use of storage devices, the research indicated a coefficient of correlation (r) as .131, P>.01. This shows that there is no significant relationship between teachers' beliefs about biology on the use of computers.

Table 7: Relationship between teachers' beliefs about biology on the use of storage devices

Symmetric Measures					
		Value	**Asymp. Std. Error[a]**	**Approx. T[b]**	Approx. Sig.
Interval by Interval	Pearson's R	.131	.119	1.094	.278[c]
Ordinal by Ordinal	Spearman Correlation	.130	.118	1.081	.283[c]
N of Valid Cases		70			

Relationship between teachers' beliefs about biology on the use of software programs

The researcher also investigated the relationship between teachers' beliefs about biology on the use of software programs. The study established a coefficient of correlation (r) as .234, P>.01. This indicates that there's no significant relationship between teachers' beliefs about biology on the use of software programs.

Table 8: Relationship between teachers' beliefs about biology on the use of software programs

Symmetric Measures					
		Value	**Asymp. Std. Error[a]**	**Approx. T[b]**	Approx. Sig.
Interval by Interval	Pearson's R	.234	.120	1.982	.052[c]
Ordinal by Ordinal	Spearman Correlation	.218	.121	1.844	.070[c]
N of Valid Cases		70			

Relationship between teachers' beliefs about biology on the use of smart phones

The researcher also investigated the relationship between teachers' beliefs about biology on the use of smart phones. The study established a coefficient of correlation (r) as .166, P>01. This shows that there is no significant relationship between teachers' beliefs about biology on the use of smart phones.

Table 9: Relationship between teachers' beliefs about biology on the use of smart phones

Symmetric Measures					
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	.166	.130	1.391	.169[c]
Ordinal by Ordinal	Spearman Correlation	.157	.127	1.309	.195[c]
N of Valid Cases		70			

Relationship between teachers' beliefs about biology on the use of internet

Looking at the relationship between teachers' beliefs about biology on the use of internet, the research indicated a coefficient of correlation (r) as .310, P<.01. This shows a significant relationship between teachers' beliefs about biology on the use of internet.

Table 10: Relationship between teachers' beliefs about biology on the use of internet

Symmetric Measures					
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	.310	.124	2.693	.009[c]
Ordinal by Ordinal	Spearman Correlation	.314	.122	2.730	.008[c]
N of Valid Cases		70			

Relationship between teachers' beliefs about biology on the use of power

The researcher then investigated the r relationship between teachers' beliefs about biology on the use of power. The study established a coefficient of correlation (r) as .410, P<.01. This shows that a teachers' belief is related to the use of power.

Table11: Relationship between teachers' beliefs about biology on the use of power

Symmetric Measures					
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	.410	.111	3.704	.000[c]
Ordinal by Ordinal	Spearman Correlation	.387	.112	3.463	.001[c]
N of Valid Cases		70			

Therefore, conclusively it was established that the teachers' belief category influenced their frequency of use of technology in classroom instruction of biology as a subject. Therefore the null hypothesis that indicated that there is no statistically significant difference among the biology teachers subscribing to the three belief categories about biology and the frequency of their use of technology in teaching biology was rejected.

7. Suggestions for Improving ICT Integration

The last item on the teachers' questionnaire under section G required the respondents to give suggestions that would enhance and improve ICT integration in their teaching subjects. The following were suggestions to improve to ICT integration.

There should be full implementation of the ministerial policy on ICT integration through proper supervision, monitoring, and evaluation of its implementation. Government should make it mandatory for all school principals to have well equipped ICT laboratories. Ministry of education should also ensure that all schools are networked to access the internet. The government should regularize power supplies so that lessons do not get stuck due to power surges and cut off.

County governments in liaison with the central government should allocate funds to enable schools purchase and provide enough ICT facilities and resources, i.e. source for more ICT equipment to be used during teaching. They should also put in place measures should be put in place to facilitate the installation and use of ICT in all subjects. This should be more so for the upcoming schools, the Sub County or CDF schools. They are the worst hit.

Government should mount in-service training through seminars and workshops to train and arm teachers with ICT knowledge and skills and update teachers with knowledge on new technologies, and ICT integration in the instruction and learning process. Programs like SMASE to be intensified and content to be streamlined to capture ICT integration.

Students should be sensitized on importance and relevance of ICT to develop in them a positive attitude towards ICT knowledge and skills.

ICT to be integrated at all levels of learning. Government should make ICT an examinable subject in schools.

8. Conclusions

The objective of the study was to determine the effect of the three belief categories of pedagogical-innovative, scientific-innovative, and scientific-conventional of biology teachers on the frequency of use of technology in instruction**.** The study established that there is a significant relationship between the teachers who belonged to the three domain specific belief categories and ICT integration. The belief category influenced the frequency of integration of ICT in biology instruction.

9. Recommendations

Basing on the findings of the study, the following recommendations are made.

1.There is need to fully implement the ministerial policy on ICT integration through proper supervision, monitoring, and evaluation. The government through the ministry of education and in liaison with the County governments should allocate funds to enable schools acquire enough ICT facilities and resources. They should also put in place measures to facilitate the installation and use of ICT resources in all subjects. This should be more so for the upcoming schools, the Sub County or CDF schools. They are the worst hit. Ministry of education should also ensure that all schools are networked to access the internet.

2. More teachers should be trained to take computer as a teaching subject. Government should also mount in-service training through seminars and workshops to train and arm teachers with ICT knowledge and skills and update teachers with knowledge on new technologies, and ICT integration in the instruction and learning process. Programs like SMASE to be intensified and content to be streamlined to capture ICT integration. It is noted that ICT integration is currently treated as a facet for a few outgoing individuals, only a few teachers per subject are picked for training and it is not well passed on to other colleagues. All teachers should be trained in ICT integration.

3.Power supplies should be regularized so that lessons do not get stuck due to power surges and cut offs. Electric sockets should be installed in every class in the schools so that ICT lessons can be taught effectively.

4. Students should be sensitized on the importance and relevance of ICT to develop in them a positive attitude towards ICT knowledge and skills. The students should also be allowed to operate the computers by themselves so that they can work with them in the absence of the teachers

5. ICT should be integrated at all levels of learning. Government should make ICT an examinable subject in schools.

6. Schools should establish a one-stop ICT centre and ensure internet connectivity. The schools should also hire ICT lab technicians and experts to help teachers in their preparation of ICT lessons.

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(IOSR-JRME) e-ISSN: 2320–7388, p-ISSN: 2320–737X Volume 1, Issue 4 (May. –Jun. 2013), PP 03-08 www.iosrjournals.org
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