Computer labs as techno-pedagogical tools for learning biology – Exploring ICT practices in India

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Abstract

In Indian secondary schools, as in many countries, Information and Communication Technologies, ICT, are changing the image of learning places, the roles of teachers and students, and often the entire classroom learning ambience. This study investigates current practices for learning biology in school computer labs in India in the light of the existing Indian pedagogical practices. The increasing availability of technology-based learning resources has increased the techno-pedagogical possibilities (i.e. the possibilities for pedagogical use of technology) in biology learning, and many schools are augmenting their ICT infrastructure by setting up fully-equipped computer labs. Nevertheless, the teaching of biology currently continues to be partly in the traditional classroom and partly in the computer labs. In fact, most schools are not yet willing to invest large amounts in computer infrastructure, despite school policies that encourage teachers to make use of ICT learning resources made available out of state-provided funding. In this study, biology teachers' techno-pedagogical perspectives and the nature of secondary school students' ICT skills deployed in computer labs are explored.

In terms of results, we report that teacher ratings on the techno-pedagogical skills they require while teaching biology in computer labs revealed that they were, in fact, well aware of the wide ranging technological possibilities: text processing, website development, spreadsheets, layouts and multimedia. Again, observations of the lab sessions themselves revealed that students were deploying significant ICT skills: text processing, information retrieval, information processing and information gathering. Also, it turned out that the teachers were actually employing the imaginative range of the skills that they had espoused in their chosen ratings. In summary, when computer labs became the sites for learning biology, the combination of the ICT provided, together with the teachers' emerging techno-pedagogical practices, presents heartening possibilities for promoting student learning in India in the future.

Keywords: techno-pedagogy, computer labs, technology in teaching biology, technology-enabled learning environments

Introduction

The development of digital technologies has resulted in wide-ranging possibilities in the learning place. In many places, the school curriculum is undergoing sweeping changes due to technology integration, technology incorporation and technology intervention. This has resulted in emerging-techno pedagogies in varying school systems, curricular contexts and classroom practices. Different learning contexts and learning opportunities have opened up for the learner. Likewise, different or alternative teaching contexts and teaching opportunities have opened up for the teacher. However, case studies (Dabla, 2010, Singh, 2009, UNESCO, 2008, Sharma, 2004) of implementation of Information Communication Technologies (ICT) in schools in a number of countries has indicated that the vision and goals for implementation can vary widely between schools. The Indian National Information Technology (IT) policy has recognized the necessity for students to acquire 21st century skills and has called for efforts to make the school environment more conducive to technology intervention in the instructional process. Apart from government Initiatives like IT@schools, more and more IT companies like the National Institute of Information Technology and Microsoft are working in close association with teacher educators and teacher education institutions in order to find the best IT solutions for the school curriculum.

The United Nations Educational, Social and Cultural Organization (UNESCO), in association with the regional institutes, has framed ICT indicators for different countries. These indicators for defining technology-enabled learning were based on how technology was really being used in the most ideal of curricular practices available. No such indicators have been developed for the Indian educational context. The Department of School Education & Literacy, Ministry of Human Resource Development (MHRD), Government of India, has begun formulated the 'National Policy on ICT in School Education' with a focus on addressing the needs and challenges of teaching and learning in schools using Information and Communication Technology. The Global e-Schools and Communities Initiative (GeSCI) (www.gesci.org), a United Nations ICT Task Force organization, provides strategic assistance to MHRD in the preparation of this policy. GeSCI has partnered with the Centre for Science, Development, and Media Studies (www.csdms.in) to coordinate and facilitate the process of policy formulation. However, in the contexts of limited technology infrastructure, it is unreasonable to expect such fulfillment of standards in Indian classroomsat the moment, where the realization of expected curricular practices is problematic because positive responses to three questions cannot yet be guaranteed, viz.,

1. Were computer labs present?

2. Were they being used at least once per week by each class?

3. Were computers used as pedagogical tools?

Background to the study

Many states in India have initiated bold attempts to support schools with IT infrastructures and IT-based learning resources. The increased availability of computers in all government schools nationwide has resulted in sweeping changes with regard to classroom scenarios in various parts of the country. Technology-enabled learning environments, which formerly could only have been dreamt of, have become a reality today. A mitigating factor has been the IT policies framed by various state governments, which have helped in generating funds for setting up school labs with all essential infrastructures. As reported in UNESCO (2008), teachers and facilitators in both formal and non-formal education settings are trying to ensure the effective use of ICT, and teachers and instructors need to re-define their roles. Studies (American Association for the Advancement of Science, 1993; Gordon & Pea, 1995; Dexter, Anderson, & Becker, 1999; Herrington, Oliver, and Reeves, 2003; Becta, 2004) show that the contextual use of technology enhances students' academic achievement, lowers drop-out rates, encourages better attendance, and provides better preparation for college. Teachers need to know several features of word processing software like spreadsheet, database, multimedia presentation softwares which leads to more effective e-learning, increased interaction, and accommodates more fully different learners' preferred e-learning styles. Bransford, Brown and Cocking (1999) suggest that new interactive technologies are now making it easier to create environments in which students can learn by doing, receive feedback, renew their understanding continually, and build new knowledge. Students in technology-integrated environments immerse themselves in the learning activity which in turn individualizes the educational process to accommodate the needs, interest, current knowledge, and learning styles of students (Schacter and Fagnano, 1999). It has been found that such technology-enabled learning environments are effective vehicles for promulgating a host of new instructional practices as well (Nayar and

Barker, 2008). Technology enables students with a variety of learning experiences (Davis, Desforges, Jessel, Somekh, Taylor and Vaughan, 1997; Jonassen and Carr, 2000; Jimoyaiannis and Komis, 2006). It has been reported that ICT-based science instruction enhances conceptual change and levels of achievement (Bayraktar, 2001; Bang, 2003, Baggott la velle et al., 2003; Kahn, 2008; Park, 2002; Kozma and Wagner, 2010). Technology-enabled learning has tremendous potential to provide constructive learning strategies like situated learning, contextual development, an emphasis on social interaction, active learning and metacognition (Lejoie, 2000; O'Neil, 2005; O'Neil and Perez; 2006). Learning with technology opens up new avenues for learners and provides opportunities for enhancing learning skills required for the 21st century, viz., acquiring new knowledge and skills, connecting new information and existing knowledge, analyzing, developing habits of learning and working with others to use new information (Grant, 1996; Valanide and Angeli, 2008).

Educating teachers in effectively integrating technologies into instruction is not a difficult task, provided teachers are made aware of what strategies are available. However, studies have reported that many educational innovations ultimately fail because too little effort or too few resources are devoted to preparing teachers for the innovation (Gess-Newsome et al., 2003; Rohaan, Taconis and Jochems, 2008; and Rohaan et al., 2009).

Surveys in various contexts and various states in India (Bharadwaj, 2007; Dabla, 2010; Singh, 2009) have revealed that ICT infrastructure in schools in India reveals a glaring disparity among schools with regard to the availability of technology. Often, availability is influenced by the school's own policies. Technology presence in schools leaves so much scope for improvement (Bharadwaj, 2007). The present study has been conducted in the southern states of Tamilnadu, Karnataka and Kerala State, where there are impressive public and private partnerships with regard to technology intervention in the schools. The IT@schools projects and the Centre for Development of Information Technology (C-DIT) in Kerala have been instrumental in the preparation of ICT- based learning resources and up-grading of computer labs in schools- 99 % of the high schools have a computer lab with broadband connectivity of their own. In the state of Karnataka the Regional Institute of Education (RIE) is participating in a curricular experimental project initiated by a privately owned IT company which is concerned with preparing the right IT solutions - learner and teacher - for a technology-based learning environment. In the state of Tamilnadu, though, Government initiatives are considerably fewer; many independent initiatives are taken by individual schools which are privately managed.

Setting up of computer labs is undoubtedly cost-effective for schools, relative to the alternative of placing computers in every classroom. However, if a wide range of curriculum subjects (like biology, in the present study) can now be taught for at least part of the time in computer labs, do teachers actually take advantage of the new technologies to promote learning? Or, even when the digital divide has been crossed and computers are available to teachers and students, does a pedagogical divide still exist (Nayar and Barker, 2008) and the new educative possibilities are ignored? That was the focus of the present study.

Objectives and research questions

Almost all high schools in India have computer labs but most schools have only one computer lab. In most schools an IT coordinator is present who is in charge of computer lab. In large schools this is, of course, a severe constraint; typically, a class will be timetabled for only one 1-2 hour session in the computer lab per week. Most computer labs have seating capacity for 35-45 students with 30-40 computers in each lab. The scope of computer labs as technology-based learning environments has been explored. Computer labs in most cases are set up out of funds from the state and central governments and subsequently upgraded with school funds but in some schools, computer labs are used only for Imparting IT education. The role of computer labs in exploiting the techno-pedagaogical prospects has benefitted from the increasing willingness of some educational software companies to collaborate with the schools and charter an IT-based pedagogical solution for the school. These IT companies have teamed up with schools and assist schools in training teachers, preparing technology-based learning materials and upgrading IT infrastructure.

In India most teachers have been trained in ICT skills but at the time of the study, technology intervention in computer labs occurs mainly in only three subjects: science, social studies and mathematics. This may be due to the availability of numerous IT-based learning resources and educational software for these subjects. The higher value accorded to these subjects by school curriculum, teachers, parents and the greater career potential offered may be the reason for educational software companies focusing on these subjects. The nature of technology use by teachers varies in different contexts and is based on the degree of technology-enabling. Teachers have reported pedagogical difficulties and that extra time is required to design technology-based learning activities. Most teachers believe that lab sessions do not help students to succeed in the performance in exams (Siorenta and Jimoyiannis, 2008). Previous studies have reported that there were different levels of technology-enabled classroom environments which reflected different extents of technology-enabled teaching and technology-enabled learning (Nayar and Barker, 2008). The present study focused on computer labs and the nature of biology teachers' pedagogical use of computer labs. Technology in India is transforming learning environments with the result of new objectives and learning outcomes emerging.

Science education is one area in India where efficient ICT applications to promote student learning are available, viz., spreadsheets, databases, simulations and modeling tools, microcomputer-based laboratories (MBL) offering open learning environments that provide students with opportunities for learning. Computer tools such as simulations, web based conferencing systems, multimedia visualizations and modeling tools can be utilized to support inquiry in science teaching and learning (Bransford, Brown and Cocking, 1999; Penner, 2000).

The present study investigates the perspectives of teachers in the use of computer labs as techno-pedagogical tools. The study also explores the nature of ICT skills deployed by students while learning biology using computer labs. The research questions in this study are:

1. What perspectives do biology teachers have on techno-pedagogies?
2. What is the nature of ICT skills deployed by students in learning biology in computer labs?

Methodology

Location

The study, conducted at the start of an academic year, was confined to three states in India, viz., Kerala, Tamilnadu and Karnataka. These states were selected because their schools were frequently undertaking bold and innovative curricular experiments, involving computer labs, technology-enabling ways, and this development had the support of local IT companies. Items are presented in Figure 1.

Sample

Schools. Thirty secondary schools were surveyed to identify the availability of computer labs, the nature of lab use, the nature of learning resources, and to collect information related to their biology teachers' perspectives on techno-pedagogies. These school students were 13-15-year-olds. Every school had one fully-fledged computer lab with 25-30 computers, broadband connectivity and multimedia facility. Only schools which had fully equipped computer labs and where teachers engaged in technology-enabled teaching, were selected for the study. The selected schools differed with regard to the nature of management: five were private schools (managed by private partnerships), ten were aided schools (privately managed schools maintained out of government funds) and 15 were government schools. For collecting data related to students' ICT-based learning skills, five schools were chosen, based on three criteria 1. Schools with computer labs 2. Schools where teachers were competent in use of technology 3. Schools where the teachers used computer based lessons. One was a private school, two were private aided schools and two were government schools.

Students. Two hundred students of Standard 9 (i.e. typically aged 13 years) participated in the study. This level was chosen because they were the most seasoned students with regard to technology use, having used it the previous year. The current ICT skills of students ranged from fundamental ICT literacy (20%) to Digitally proficient (50%). The remaining 30 % belonged to the average group whose ICT skills were not limited to fundamental literacy skills, nor did it extent to social network and collaborative skills.

Teachers. A total of 30 biology teachers (25 female and 5 male) participated in the study. All were highly qualified with postgraduate qualifications in botany/zoology/environmental science (M.Sc) and had undergone secondary teacher education programs (B.Ed). Their teaching experience varied from 3 years to 15 years. The teachers were familiar with technology and had a working knowledge of technology. Although 25 teachers had received training in ICT literacy, only 5 teachers had received training with regard to pedagogical use of technology.

Computer labs and laboratory sessions. Though all schools had fully-fledged labs, the nature of laboratory use varied. In some schools the lab use was not time tabled and the teachers operated on a 'Use When Needed' policy. In the larger schools, where the use of laboratory was time tabled, teachers could use the lab only at the specified time. Some schools which had time tabled laboratory use did not enforce its use; it was left to the discretion of the teacher to make use of the laboratory, if it was felt necessary. Five schools were selected for observation of laboratory sessions. The study spread over five schools because laboratory sessions were quite scarce and in many schools computer labs were used to teach biology only rarely. Students of a particular class had one lab session per week. There were 35-45 students per lab session. The sessions were of 45 minutes duration. In most cases the duration of effective instructional practices was 30 minutes. In all, ten laboratory sessions (two observations per school per week) were observed.(For details of Observation matrix see Appendix 2)

Technology-based learning resources. The software used in these biology sessions was produced by the Educational Software Company which was state-owned. The set of technology-based resources had been designed and structured in close coordination with the teachers. The topic being covered during the time of the study was Cell Structure and Function. The four learning concepts comprised: differences between animal and plant cells, parts of the animal cell, types of cells, and identification of the cellular organelles and associated functions. The learning tasks involved locating the particular icon containing the content information, reading the narration, observing the images of animal and plant cells, identifying parts of the cell, identifying the terms, and associating each term with the shape and size of the organelle. The learning also involved web-based resources. (Details in Appendix 1)

Research tools and techniques. To study the secondary school biology teachers' perspectives on techno- pedagogies a 16-item questionnaire was administered to thirty biology teachers. Each item in the questionnaire and the dimensions which need to be tested had earlier arisen from focus group discussions with a group of teacher educators having a teaching experience of 10-15 years. They rated the items in the questionnaire based on suitability for including the item and level of significance of the item. Both construct and face validity was assured by high mean rating scores obtained on the two criteria selected viz., 2.33 for construct validity and 3.20 for face validity (both values fell in the high range level with mean above [Mean + Standard Deviation]). The averages of scores were taken for item analysis. The items in the questionnaire pertained to four dimensions of techno-pedagogies: 1. learning environment 2. learning resources 3. learning tasks 4. teaching process.

To select the ICT skills for observation an observation schedule (see Appendix 2) was used which comprised of a matrix of 9 columns which depicted 9 slots of 5 minutes duration of class and the rows depicted the learning skills identified as most essential for learning using technology. The learning skills were identified by a check list which incorporated a wide range of learning skills and external raters (six teacher educators) selected the most appropriate. The skills which were selected by the majority of the external raters found a place in the rows of the matrix.

Administering the tools. For collecting data pertaining to perspectives of secondary school teachers, they were asked to rate each item against a Likert type scale with scores ranging from Strongly Agree-4 to Strongly Disagree-0. The means and standard deviations of the ratings were estimated individually for each item. Mean scores of ratings for each theme was also calculated to identify the theme which most influenced teachers' perceptions of techno-pedagogies. To study the deployment of students' ICT skills an observation schedule was constructed for observing the laboratory sessions. The observation schedule collected information on student engagement over periods of 45 minutes. The observation schedule helped in recording observations which could be reviewed later. The skills were observed over a period of 10 days with one laboratory session observed each day. To make observation effective, one student was focused on for the whole of a particular session. The learning task and the duration of time was recorded. The instructional tasks and objectives of each lab session are described in Appendix 1. The skills deployed by the students were observed and recorded against a 45 minute time frame. The preliminary skills like getting started, and fundamental keyboard skills were ignored and focus was on the learning aspect – skills like information processing, organizing content, information retrieval, constructing, application of concept learned, collaboration, networking engaging in community learning. In all the total observation period covered 450 minutes.

Findings and discussion of results

Ratings of teachers on perspectives of computer labs

According to Table 1 teachers did not agree strongly about the suitability of the laboratory as a learning environment, nor about the teaching process dimensions. They agreed that computer labs are congenial towards learning resources and the process of learning. The results implied that the physical constraints with regard to use of laboratories as a learning places need to be eliminated. This could be effected by location of computer labs in a centrally localized area with equal accessibility to all students at all levels. The availability of technical support needs to be ensured throughout the working hours of the school. In most of the schools observed, the technical support staff work only part time and are not necessarily available when a technical snag occurs. Many technical support staff problems arise during the classroom sessions during actual working on computers. Teachers' perspective on suitability of learning resources revealed strong agreement. The fact that the learning resources were developed with the collaboration of researchers, educationalists, practitioners and software developers may be the reason for the positive observations. Details are presented in Table 1.

Table 1. Mean scores of ratings of teachers on perspectives of computer labs (N= 30)

1. Learning Environment	**Mean (M)**	**Standard Deviation (SD)**
1.1 Technical support is more readily available in computer labs	3.43	1.2
1.2 location of labs ideal	2.63	1.58
1.3 learning becomes more focused in computer labs	3.2	0.98
1.4 Full justice to the instructional session	3.43	1.12
Total mean score for Learning Environment -	3.18	1.22
2. Learning Resource		
2.1 learning resources relevant	3.6	0.66
2.2 resources are interactive	3.1	1.45
2.3 resources offer enrichment	3.3	1.22
2.4 flexible and dynamic learning opportunities	3.03	1.43
Total mean score for Learning Resource -	3.26	1.19
3. Learning Process		
3.1 learning becomes interesting	3.2	0.87
3.2 students are engaged throughout the instruction time	3.27	1.18
3.3 learning activity is independent	3.67	0.65
3.4 students look forward to lab sessions	3.83	0.37
Total mean score for Learning Process -	3.49	0.77
4. Teaching Process		
4.1 time constraint	3.1	1.45
4.2 requires a great deal of planning	2.73	2.73
4.3 problems of management	2.37	1.6
4.4 problems of indiscipline	2.53	1.52
Total mean score for Teaching process -	2.68	1.53

(Mean Rating scores of Teachers on a scale of 0-4: Strongly agree-4 and Strongly disagree-0)

With regard to the teaching dimension the combined mean score for the themes identified revealed that teachers' perspectives on learning aspects were more favorable and in more agreement than with teaching and environment. This suggested that teachers faced certain constraints in teaching when technology was used in computer labs. Teachers would have preferred the familiarity of the classroom. It also implies that for teachers who are not so competent with technology, computer labs tends to be strange and unfamiliar places. It can be deduced that it takes a great deal of confidence to handle teaching outside the classroom. This also is true for undertaking field trips and activity oriented classrooms. Most teachers believed that students generally looked forward to lab sessions more than classroom sessions. The 45 minutes allocated was often not considered adequate as only a few ICT learning opportunities could be made use of. The number of lab sessions allotted for biology (one per week) was also considered inadequate. This may be because the number of biology teachers in a secondary school is limited to one or two, and the time allotted for biology is restricted to two instructional sessions per week for each class.

The nature of the learning skills deployed by students

Results in Table 2 suggests that most of the potentialities of the computer were utilized in the laboratories for learning the biology topic Cell Structure. Indeed, the computer laboratory offered tremendous opportunities for deploying student technology skills. Computer graphic skills requiring them to identify and label parts, and making presentations required higher order ICT skills.

Table 2 Learning skills deployed by students in computer labs.

Number Observed (out of 10 observations)	Learning Skills	Learning Task Observed
7	Getting started and keyboard skills	Basic knowledge of computer and electronic communication
7	Organizational skills	Process-oriented work and text processing
7	Information gathering skills	Information retrieval in database and data processing
2	Digital literacy skill	Basic internet use
nil	Computer application skill	Use of spreadsheets

8	Computer graphic skills	Layouts and pictures communication
5	Communication skill and organizational skill	Screen presentation
nil	Collaborative skills	Use of community networks

However, use of the internet was observed on only two occasions and opportunities for collaborative skills were not observed. Collaborative e-learning activities enhance student motivation to learn about a topic and also have benefits in terms of improving written expression, developing technical skills and promoting international understanding and tolerance (Meleisea, 2007). Bransford, Brown and Cocking (1999) suggest that new technologies which are interactive make it easier to create environments in which students can learn by doing, receive feedback, continually renew their understanding and build new knowledge. Studies in technology-integrated environments have reported that students can become immersed in the learning activity which in turn individualizes the educational process to accommodate the needs, interest, current knowledge, learning styles of students (Schacter and Fagnano, 1999). It has been found that such Technology Enhanced Learning Environments (TELE) are effective vehicles for promulgating a host of new instructional practices as well. There are studies (Baltrus, 2002) that report that the effectiveness of technology integration into education is largely independent of its ability to engage students into learning; it is the teacher's creativity that drives their use into the curriculum.

Results revealed that though students were the ones using technology in computer labs, it also required ICT skills on the part of the teacher. Student queries often centered around the teacher's knowledge and expertise on ICT skills, ranging from basic ICT skills involving browsing and retrieving data to higher order skills like computer graphic skills, hyper linking, uploading files and downloading information. It was also observed that skills in website design and preparation were also required. Feedback collected from the teachers after the laboratory sessions revealed that most of them were optimistic about computer labs as offering excellent opportunities for ICT in the learning of biology

Implications of the Study

This study explored the possibilities of computer labs as learning places to realize the techno-pedagogical applications. Teacher perspectives revealed optimism as well as pessimism with regard to the prospects explored. Grounds for optimism derived from impressive student learning, often involving higher order activities (analysis, complex information retrieval, problem-solving, and rewarding in-depth discussion), relevancy of learning resources; and pessimism centered around constraints related to the teacher, and the teaching and learning environment. Admittedly, this situation has arisen under a set of specially favorable conditions: a liberal state-facilitated supply of computer labs, intense commercial interest in the supply of software (including the subject under consideration, cell biology), good servicing of the laboratories by technical staff, and a cohort of knowledgeable and pedagogically adventurous and open-minded teachers who are persuaded of the value of ICT in teaching and learning. The latter point would appear to be crucial – this research confirms earlier studies (Baltrus, 2002; Jonassen,1999; Gils, 2005) that showed that teachers themselves need to be confident and creative if they are to inspire their students to be the same. Providing individual teachers with their own laptop is clearly one way of promoting the necessary easy expertise among teachers by giving them opportunities to enhance familiarity by private exploration prior to teaching (Cowie et al., 2008).

Computer laboratories are clearly an intermediate stage in the successful integration of ICT into learning. If conditions are favourable, access to the computer laboratory can provide occasions of rich, intense and highly motivated learning, Nevertheless, the necessarily restricted access (because of the need to share the resource) poses an ultimately insurmountable barrier to the overcome, namely, having students undertake prolonged investigation of complex meaningful problems, which may often originate from students themselves and/or are being constantly refined by them. But until the time comes when ICT is freely and permanently available in classrooms, the present study has suggested that computer labs have ah heartening potential to promote quality and, curriculum-required learning.

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Appendix

Appendix 1- Instructional objectives, instructional tasks and instructional activities

Lab session	Objectives	General Instructional tasks
School 1 lab session 1 Introduction to cell, structure of a cell, cell theory School 1 lab session 2 Types of cells, and differences between animal and plant cells,	1.To develop understanding of concept of cell and cell theory 2.To identify structure of cell 3.To differentiate between cell structure of plants and animals 4.To associate cell structure with function	Intranet materials based on the topic were browsed by the students. The intranet materials could be referred to as 'advance organizers' which contained information to provide facts related to the concept 'cell'. The intranet materials were of the Tutorial type serving as information providers – students read the content, attempted to understand the content and answered questions at the end of the lesson. There was a large pool of resources saved and downloaded and students were free to use the related content. The skill was to select and identify the most suitable resource and answer the questions at the end of the lesson within the prescribed time. For each lesson topic a list of 3 questions was given for students to answer at the end of 30 minutes. They were free to use any resource present in their computer which was uniform and the same in all computers
School 2 lab session 1 Differences between different cells in size, shape and function School 2 lab session 2 Types of cells, and identification of the cellular organelles	1.To identify shape of different cells in human body 2.To associate cell function with structure of cell and to develop understanding of differences of cell and cell theory 3.To Identify cellular organelles	
School 3 lab session 1 Function of cellular organelles School 3 lab session 2 Observation of cellular movements	1.To develop understanding of relationship between structure and function of various cellular organelles 2.To Identify structure of cell 3.To observe movements of cells within the body.	
School 4 lab session 1 Cellular processes – facts School 4 lab session 2 Cellular process in action	1.To develop understanding of cell processes 2.To observe cellular process of transport of materials into and out of the cell 3. To understand concept of cellular transport	
School 5 lab session 1 Cell division School 5 lab session 2 Cell-related diseases	1.To develop understanding of cell division 2.To associate cell mechanisms and onset of diseases	

Appendix 2 – Observation Matrix

Learning Skill / lapse of time since commencement of class	0-5 mts	6th- 10th mts	11th- 15th mts	16th- 20th mts	21st- 25th mts	26th- 30th mts	31st- 35th mts	36th- 40th mts	41st to 45th mts
Basic knowledge of computer and electronic communication									
Process-oriented work and text processing									
Information retrieval in database and data processing									
Basic internet use									
Use of spreadsheets									
Layouts and pictures communication									
Screen presentation									
Use of community networks									