SCIENCE LABORATORY PRACTICE FOR STUDENTS OF BIOLOGY DEPARTEMENT, FACULTY OF MIPA OF UNIVERSITAS TERBUKA

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Abstract

The term of distance education represents a variety of educational models that have in common the physical separation of the teachers and learners. Those models were very common in nowadays information technology era throughout the world, especially with the coming of "internet" possibilities. Almost all kinds of programs and courses were offered through distance education mode, including science. For some science programs, students were required to master practical laboratory skills as well as the other cognitive aspects. The distance education institution have to provide learners who are not on campus with experiences that are equivalent to those of other learners in fully equipped laboratories as in conventional universities. A valid science laboratory experiences that meets the needs of distance learners were very difficult to provide. Most of them required additional cost, which have to be paid by the students. There were some efforts and strategies of the institutions to fulfill those needs. Among those strategies were developing laboratory kits which contain special equipment and supplies to complete one or more lab experiments. Another option is to conduct lab experiments at one location on an interactive video network. Students at separate sites actively participate by conferring on the steps to be followed, and by observing, interpreting data, and suggesting follow-up activities. Some universities build what they called virtual laboratory, with sophisticated multimedia interactive programs. Others also use off-the-shelf computer simulations, which were increasingly available on the market. Depending on the cost and the hardware requirements, students might either purchase simulations as part of their instructional materials or travel -- either alone or in groups -- to a library or off-campus location to work with computer simulations. The most conventional approach was conducting face-to-face laboratory practice at real laboratory facilities. Students are required to travel to a certain location with laboratory facilities to complete an intensive laboratory experiments over several days or weeks. At Universitas Terbuka (UT), one of the most challenging aspects of supporting students was to provide those laboratory experiences. UT use the most conventional model, which are real laboratory experiment conducted at other local universities and government institutions. In the future, some extend of multimedia products or "dry lab" products could be developed to enhance the learning experience of the UT's biology students.

I. Introduction

Throughout history technology breakthroughs and new social forms have influencing ways of life globally. The newest revolution so called Information and Technology Revolution or Knowledge Revolution during the last decade of the previous century was a result of the convergence of powerful computers and telecommunications technologies. Technological developments in digitization have led to fundamental changes in the production, storage, and dissemination of information and materials. The new digital information and communication technology (ICTs) is the focus of attention nowadays which influenced every organization including higher education institutions.

Many higher education institutions are responding to the challenges that new ICTs bring by embracing the new technologies. These are proven to be more powerful than previous technologies because of its ability to integrate multiple media into educational applications, interactivity, flexibility of use, and connectivity. Texts and full range of media including graphics, speech, sounds, still and moving pictures can all be stored and conveyed into a simple multimedia package. ICTs offer the promise of improving the quality of learning by making it relevant to the skills and knowledge needed in information society (Reddy & Manjulika, 2002).

The new ICTs are also expanding the reach and range of higher education institutions by making it possible to access any course from anywhere in the world at anytime convenient, for full time or part time students. The scope of education is also being dramatically increased from a specialized activity for young people to a lifetime need for everyone. It is for acquiring of knowledge and skills in the pre-work years, in-service training and improvement in the work years, or satisfying the needs for further education after work years.

The new ICTs offer the potential to empower individual learners, to enable education to be learner centered focusing on the needs and demands of learners rather than those of providers. There has been a tremendous growth and diversity in the number and types of learners. To satisfy those needs there are three kinds of campus settings emerge in today education which are: campus based education such as in conventional universities; off campus education such as in open universities and distance education institutions; and global full-electronic campus such as in virtual universities. There are also many kinds of providers from typical single mode and dual mode institutions to corporate houses to upgrade their workforce (Reddy & Manjulika, 2002).

Universitas Terbuka (UT), is the first Indonesian open and distance learning institution since 1984. The main reason of opening it was to accomodate the large

number of students graduated from secondary schools which could not be accommodated by conventional universities (Suparman & Zuhairi, 2004). UT also serve to accomodate students from remote places, and provide in-service training for elementary teachers throughout Indonesia. This is especially needed for Indonesia which consist of 17 thousand islands and 210 million population.

The term of distance education represents a variety of educational models that have in common the physical separation of the teachers and learners. There are some advantages in using the distance education mode for it can be accessed by a great number of students, from different area, and from remote area. In addition, people who already employed full time can also be benefited since they don't have regular time to attend regular university.

Many kinds of programs and courses were offered by UT through distance education mode, to meet the needs of the society and to promote learning, including science programs. For the science programs such as biology, students are required to master practical laboratory skills as well as the other cognitive aspects. Some specific skills in science have to be achieved through laboratory experiences. The distance education institutions including UT, have to provide learners who are not on campus with experiences that are equivalent to those of other learners in fully equipped laboratories as in conventional universities.

A valid life science laboratory experiences that meets the needs of distance learners were very difficult to provide. Some skills might be delivered through interactive multimedia, but some others should be learned face to face using real laboratory experiments. Most of them required additional cost, which have to be paid by the students. There are some efforts and strategies of the institutions to fulfill those needs. It has its strength and weaknesses. Every institution has its strategy to fulfill the needs depends on its resources.

For the Departement of Biology in Faculty of Mathematics and Science UT (FMIPA UT), the most challenging aspects of supporting students is to provide those laboratory experiences. UT used the most conventional model, which were real laboratory experiment conducted at other local universities and government institutions. To provide those services UT establish collaboration and networking with other institutions, especially who owns laboratory facilities throughout Indonesia. The laboratory practices for the students are fully assisted by local tutors or lab assistants.

FMIPA UT has open diploma program for Agricultural Extension Worker (D3 PTPL) since 1992, and then the bachelor degree program (S1) in Biology since 2002. For both program laboratory works are required in the curriculum. The D3 PTPL courses mostly use laboratory works (about 35% of the course load) for it is an in-service training to improve skills and knowledge of extension workers under the

Department of Agriculture. In the S1 Biology program the amount of laboratory works is about 10% of the total course load.

This paper discuss the experience of FMIPA UT in conducting those lab practices especially for the D3 PTPL program. We want to share those experiences in order to get some input for the improvement of the practice, and to find other efective ways to conduct the learning process. In the future along with the advancement of technology, it seems that what is called virtual biology lab is a promising alternative.

II. Overview of Laboratory Practice in Distance Education Institutions

Experimentation is inseparable to scientific investigation. Student's practice of experimentation is needed to understand science, because educational abstractions alone are not enough. Experimentation is usually done in laboratory or field work setting. In addition to other laboratory goals, it is crucial that this skill be communicated to the students through the lab experience (Forinash & Wisman, 2004).

Providing lab experience for a student, especially to one not physically present, is problematic. One of the challenging aspects of distance education is to provide students who are not on campus with experiences that are equivalent to those of other student in fully equipped laboratories. Therefore some aspects should be considered in the choice of delivering this kind of learning instruction.

Most colleges that offer distance education have been unable to provide valid biological science laboratory experiences that meet the needs of the distance learners. The result is that thousands of students fail to take a life science laboratory course at the college level, or experience difficulty due to the requirement to attend a campus based lab or a designated site of lab in other institution at night or during the vacation, or utilize science lab in a box. These practices might meet minimal course requirements, but on site attendance negates the purpose of distance learning, and acquiring a lab kits is often expensive for distance learner (Boehler, *et al.,*1997).

A critical initial step is for faculty to determine how crucial a hands-on experience in laboratory setting is in ensuring that students achieve the desired learning objective. It is possible to design activities that teach students the skills of close observation without conducting lab-based experiments. When alternative activities to lab experiences are not suitable, one or more of the following solution might be appropriate (IDE, 1997).

1. Lab Kits. Some institutions develop lab kits that contain the special equipment and supplies students need to complete one or more lab experiences and written directions that outline the assignments and list the

other materials students will need to complete the assignments. For example, the University of Maine sends out a kit containing a fetal pig for dissection.

2. Videotape. Videotape the experiments and edit them, using graphics to pose questions of the viewer as the experiment progresses: What do you think will happen next? Why did such-and-such happen? Which of the following explanations are consistent with the data? This kind of approach has been used extensively in the field of health services for nurse in United States.
3. Interactive video conferencing. Another option is to conduct lab experiments at one location on an interactive video network. Students at all sites actively participate by conferring on the steps to be followed, and by observing, interpreting data, and suggesting follow-up activities.
4. Computer simulation program. Off-the-shelf computer simulations are increasingly available. Depending on the cost and the hardware requirements, students might either purchase simulations as part of their instructional materials or travel -- either alone or in groups -- to a library or off-campus location to work with computer simulations.
5. Real laboratory practice. Students are sometimes required to travel to a central location with laboratory facilities to complete an intensive lab module over several days or weeks. Similarly, they might travel to decentralized locations -- study centers or regional campuses -- to do lab assignments over a week or several weekends.

III. Laboratory practice for students of Agricultural Extension Worker Program (D3 PTPL) UT

Since 1993, UT in cooperation with Indonesian Department of Agriculture have offered diploma study program (D3) for agricultural extension workers. It is a professional degree program to increase knowledge and skills of extension workers throughout Indonesia. Students who are employed by Department of Agriculture are given scholarships and study through distance education mode so that they still can do their job among farmers in rural areas. Therefore, a curriculum was developed to meet their special needs. There are three specialization which are agriculture, animal husbandry, and fishery.

In this program laboratory practices or experiments are done together with tutorial, since the lab instructor is also function as a tutor. There are three kinds of practices which are laboratory practice, in-classroom practice, and field work practice. Around 82% of the courses offered should have done with one of those practices which mean about 35% of the total course load.

Table 1. Total Load of Courses with Lab Practice

Specialization	Number of Courses Offered			Number of Obligatory Courses		
	Without practicum	With practicum	Total load (sks)	Without practicum	With practicum	Total load (sks)
Agriculture	13	42	136	9	39	119
Animal Husbandry	13	41	133	9	39	119
Fishery	14	36	127	10	36	119

Laboratory practices are dealing with lab experiments or observations such as in plant physiology. In-classroom practice is done by means of discussion lead by tutors such as in basic sociology or participatory rural appraisal. Materials discussed can be articles or case study given by tutor, or problems faced in the field by the students. On the other hand, field work practice is application of knowledge and skill in real field. Students are dealing and communicating with farmers directly about agricultural problem specific to the local area. The practice can also in the form of survey research.

In doing the practice students follow the practicum guidelines printed in the back page of each course material. According to the content of the practicum, there are practice which should be done step by step in the rigid procedural form, and practice which can be done topic by topic without any pre-requisite (Capita Selecta). For every practice students are required to write report to the tutor. For tutors there are special guidelines with consist of practicum procedure and marking scheme for students report.

The facilities for conducting practicum are chosen according to the availability of equipments, instructors, and convenient location for groups of students. Tutors and laboratory instructors are lecturers and researchers of in-house training institutions (STTP /APP, BLP, SPP and other extension of BLP). In certain cases laboratory practice is also conducted in local university lab. There are 9 students for each group of practice.

This study program is developed according to the need of the Dept of Agriculture; therefore some students (about 40%) are selected by their offices and receive fellowships. It seems that more extension workers are also interested in this program and they are willing to spend their own money to join the study program. The total number of students is about 11 thousands during 1992 until 2004, and about 6500 students have graduated since then.

Table 2. Total Number of New Student (First registration) of D3 PTPL 1996 – 2003

Year	1996	1997	1998	1999	2000	2001	2002	2003
Total Number	302	326	341	8008	1491	532	84	82

Table 3. Total Number of Alumni of D3 PTPL 1998 – 2003

Year	1996	1997	1998	1999	2000	2001	2002	2003
Total Number			55	126	158	132	3106	1736 (1^{st} smt)

Students who receive fellowship are distributed among 10 provinces or 13 UT's regional centres, which are Bengkulu, Palembang, Surakarta, Lampung, Bandung, Semarang, Purwokerto, Makasar, Pontianak, Bogor, Jambi, Kendari, and Jayapura. Other students are distributed in wider area throughout Indonesia.

While providing lab experiences are difficult enough for distance education institution, assessment of skill achievement is more difficult. In the mean time UT relay on tutors and lab instructors to assess those skills. UT provides guidelines for the assessment and tutors send the final marks to UT. Lab practice marks will contribute about 30% to the final grade of the course.

To ensure the quality of the practice, UT monitors them through report written by the tutors and administrators from every lab sites. There are several problems in conducting the lab practices. According to regular reports it stated that there are some delays in sending the practicum results on time so that the final grade for the course also delayed. It seems that the administrators in local lab have found some difficulties due to time limitation. Effective semester time for UT is relatively short (about three to four months), and it is difficult to arrange the practicum on that short amount of time since the facilities are also used for other purposes. When the result are late, the final grade for the course become late, and those limited the number of courses could be taken by the student for the next semester. It makes students can not finish the program on time. In addition, there are also several problems in following the procedures of practice, mostly technical in nature such as the availability of materials to be used in practicum. In that case some adaptations are made as long as it is still relevant with the learning purposes. For all those practices, students should pay extra cost, which varies according to localities.

IV. Lesson learned

From the experiences of conducting laboratory practice for the D3 PTPL, lessons are learned to improve the program and also to be applied in other program which are S1 degree program in biology and S1 degree program in agricultural communication and extension. It seems that in classroom practice and tutorials quite run very well. But improvement and adjustment should be made for laboratory practice and field works. Guidelines and instructions for laboratory practice should be improved so that tutors can make some adjustments according to local conditions. For several cases tutors can write additional guidelines when needed and encourage students to work more independently.

Due to time limitation, team work and time management should be very effective. Preparation and scheduling should be carefully planned. Tutors should encourage students to form groups for lab practice ahead of time.

For fieldwork practices, students who are also extension worker can combine their everyday task with the learning tasks. Problem solving and discussion can be done by involving the farmers in their real life experiences.

Some lessons learned from the management of lab practice in those program could be applied to other science study program such as BSc (S1) degree in Biology. To overcome the problem of time limitation, some flexibility in managing the courses and lab works can be done. The theory and lab practice can be separated so that lab practice can be done long after the theoretical part is finished. This is so done in S1 Biology program. The theory and the lab practice are given separate course code so that it is not necessarily registered in the same semester. Laboratory works are done after students have passed the theory. Consequently, there are separate marks for theory and lab work.

In addition, due to the availability of the lab facilities of other local universities which can only be used by UT students during weekends or vacation, effective semester for lab work can be lengthen. Students are required to form a group which consists of at least 8 members to be able to do lab works. To serve this purpose, UT regional centres provide students with information about their peers, so that students can form group for doing laboratory work.

Since laboratory practice is quite complicated for distance learners for it requires special time and additional costs, so it is convenient that lab works are as minimal as possible. Therefore, it should be carefully determined which competencies are really should be achieved by using real experiment in lab setting. For other competencies perhaps could be learned by means of other media. For some biology courses such as human anatomy, and plant taxonomy, the use of graphics supplement might be appropriate. For Genetics and Microbiology, video or computer animation could be

more enhancing. In the future, the virtual or "dry" laboratory facilities which consist of computerized interactive programs through the internet are very promising.

V. Conclusions

Providing high quality laboratory practice for distance education students can be very complicated. Skills and competencies which really need lab practice should be determine in advance and keep it as minimal as possible. Other skills and competencies which could be learnt through media should be delivered through media. Guidelines for laboratory works should be prepared clearly well and helpful. The administration of the lab practice especially in the management of time should be flexible. It is convenient for the students when the practice can be done separately after the theoretical part of the courses are taken. The lab practice conduct by other institution should be monitored regularly to ensure the quality, so that students of UT receive the most benefit sufficiently.

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