

Engineering Quality Learning through ICT An AIOU Model for Online Education and Research¹

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Abstract

Allama Iqbal Open University, initiated higher education programs in Computer Science a decade ago. It however faced problems in sustaining a uniform quality due to rapidly increased enrollment. The major variations were identified in students learning at different locations. This paper discusses some academic issues and focuses on the progressive use of ICT to overcome some shortcomings related to students learning.

It presents AIOU models of ICT based education under the project “Open Learning Institute of Virtual Education (OLIVE)”. It discusses the progressive implementation of OLIVE model initiated for CS/IT education. Initial results are promising. Multimedia materials developed under OLIVE project have proven very effective and nationwide students results have improved and show uniformity. The OLIVE online delivery model has resulted in 33% reduced course cost, small feasible group and increased outreach. Participation of online international faculty is also feasible. Following successful initial implementation, a full one year program in online CS education has been offered.

The paper also identifies future expected problems and potentials related to effective online education, assessment, e-content development etc. The areas of future research and development activities are highlighted. The model can also be applied to successfully other disciplines.

1.0 Introduction

1.1. The University

Allama Iqbal Open University (AIOU) was chartered in 1974 as first (world’s second) Open University in Pakistan. . The university has also flourished as a very successful university. It is recognized as a leading mega university of world [1] with its enrolment touching 5,76,000 students. The out reach of AIOU is nationwide with 34 regional campuses or offices (in large cities) and 86 coordinating contact officials (in smaller cities). The student trend also reflects futuristic national focus on “Education for All (EFA)” model. Present statistics shows that more than 53% students are females and about 58%, students are employed. The University has four faculties and three Institutes. It offers more than 93 programs comprising of about 1000+ courses. The level of academic programs starts from literacy and goes up to PhD. Presently about 15 programs are leading to MS and PhD degrees. Most of these postgraduate degrees are in the science discipline [1].

Financially, the university is strong with more than 1.2 billion in endowment fund reserves. AIOU annual tuition fee collection is more than Rs. one billion. All operational expenses of university are met

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² View expressed in this paper are of author and do not necessarily reflect AIOU policy.

fully from its fees. It only gets about 15% as grants from the Government and other donors. The University spends about Rs.120 millions on development budget. University also regularly invests in Endowment Fund for future needs. The proceedings of the endowment fund are used for infrastructure, laboratories, equipment, education facilities and R&D related expenses.

1.2. The Science Faculty

The science faculty offers undergraduate and post graduate programs in computer science, biology, physics, chemistry, mathematics, statistics, engineering, health sciences, agricultural science and environment. Main focus of the science faculty is on education at postgraduate level. For this purpose, highly specialized and experienced faculty pool has been developed. This is further supported by a 300+ strong national pool of PhD research scholars nationwide. State-of-the-art Open Research Complex with 24 advanced laboratories is being established at campus. Equipment and facilities are being progressively added to improve the capacity of this complex. A multimedia courseware design center, institute of education technology and HEC digital library (access to about 5000 journal) is provided. A fiber optics based campus wide Intranet has been provided. A video conference based live lecture delivery infrastructure is being established to connect main campus class rooms with five regional campuses around the country. TV and Radio programs are broadcasted and cassettes and CD's are supplied in selected courses.

2.0 Background

2.1 Computer Science Education

Computer Science education was initiated in early nineties. Since this education needed extensive laboratory facilities and regular teaching, the university organized a network of approved computer study centers under private and public sector partnership scheme. These study centers were used to conduct formal classes and laboratory session in localities where computer science students were admitted. More than 10 study centers existed in the country. About 700 students were enrolled in all semesters in 1998. In November 1999, Department of Computer Science was established at the university. The drive for high quality education was initiated by extensively modifying the curriculum to international standards and enforcing the new standards of facilities, faculty and teaching methods at all approved study centers. With new better quality programs, better facilities and low fee structure, the admissions were doubled immediately. The government launched a drive to produce more CS/IT graduates in year 2000-2001. As a result, new enrolments in CS/IT grew exponentially.

2.2 Learning Uniformity

To accommodate admissions reaching 2000 students per semester, AIOU increased and enhanced its nationwide coverage to 35 cities. The details of this expansion and effectiveness of program were discussed [2]. This rapid increase in outreach caused some operational as well as academic problems. We will mainly discuss academic nature problems as summarized below:

1. **Less laboratory access:** large student groups required enhanced facilities. Lecture and laboratory facilities were therefore provided in multiple shifts at same study center. New OPEN laboratory was established at each such study center to give additional laboratory access to students of each class. Additionally Library facility was also enhanced.
2. **Faculty shortage:** Many faculty members were teaching many courses. The teaching standard degraded. Teacher student contact after class was compromised at some study

places. There was very little practical solution to this problem because faculty members were in shortage through out the country.

3. **Faculty variation:** Shortage of faculty created problem of teaching quality. Many postgraduates in physics, mathematics and business administration etc. started teaching many CS courses; which they had not studied before. This degraded teaching standards across the country. AIOU students were also affected in regions where monitoring was weak.
4. **Decentralized teaching:** Since teaching was decentralized, many faculty members in different cities were teaching the same subject. The curriculum was same however, teaching style, curriculum coverage and problem solving approach vary a lot. Therefore the central examinations showed non - uniform results of students.
5. **Little out of class support:** Students who missed class or missed part of lecture were left behind and could not cover the material at home. The faculty members were simply too occupied to provide out of class extra support to students. This increased failure ratio of students in early semesters.

2.3 Economic Group and Outreach

There was a problem of feasible group specially at rural locations. A batch of 20 students was normally allowed as economic class in large cities. However, in rural locations a class of 12 could not be maintained and still there were places which were geographically distant but students existed. Specially female students (who were encouraged) could not be given admissions mainly due to small groups.

2.4 Research Faculty Support

Further more it was considered difficult to offer postgraduate programs at approved study centers due to envisaged shortage of experienced faculty. This difficulty was experienced at main campus also. Even though Higher Education Commission (HEC) offered lucrative salaries to acquire support of foreign experienced (specially expatriate Pakistani) scholars, many of them were settled and did not want to return. Therefore an online education model was considered as an alternative to get support of teaching and research faculty from abroad. Therefore ICT based education framework (called OLIVE) was developed which is explained in next section.

3.0 OLIVE an e-Learning Framework

The department was already building its capacity in ICT based education and developed the Virtual University concept in 1999 [3]. Later on the model was modified and named as OLIVE e-learning framework. OLIVE stands for Open Learning Institute of Virtual Education and was conceived as visionary framework for ICT intervention at AIOU. Three main objectives identified as main focus points for ICT based education planning were:

- 1) Quality and uniformity of learning in open and distance education,
- 2) Outreach to rural areas specially to girl at home and
- 3) Support in postgraduate education and research from faculty abroad

However, the OLIVE framework as outlined in Figure 1 was developed. It is envisaged to integrate many online education, teaching, and research, operational and administrative activities which would be needed in future when online student enrolment grows rapidly. The OLIVE model of online education was approved in the Academic Council in year 2000. Multimedia courseware development (high quality electronic content) was considered essential for quality learning and was immediately started.

To date some development work on OLIVE components from serial 1-7 have been performed. Multimedia courseware Design Center project helped to develop components 1,2,4,5 and 6. Where as, the second project IT Services Networking helped to develop components 3, 5, 6 and 7 as shown in the figure. Jica is also helping to enhance Course Production, Electronic Publishing, Multimedia Courseware and Video Conferencing Mechanisms. HEC resources such as PERN and Digital Library and inter University Video Conference systems are also integrated to OLIVE framework to support postgraduate research. Components 8 and 9 are in development stage at present. A funding support from PAN-DLT is received to work on “E-assessment models and methods in Asia”. We will briefly discuss academic service models, multimedia content and Learning Management System in this paper.

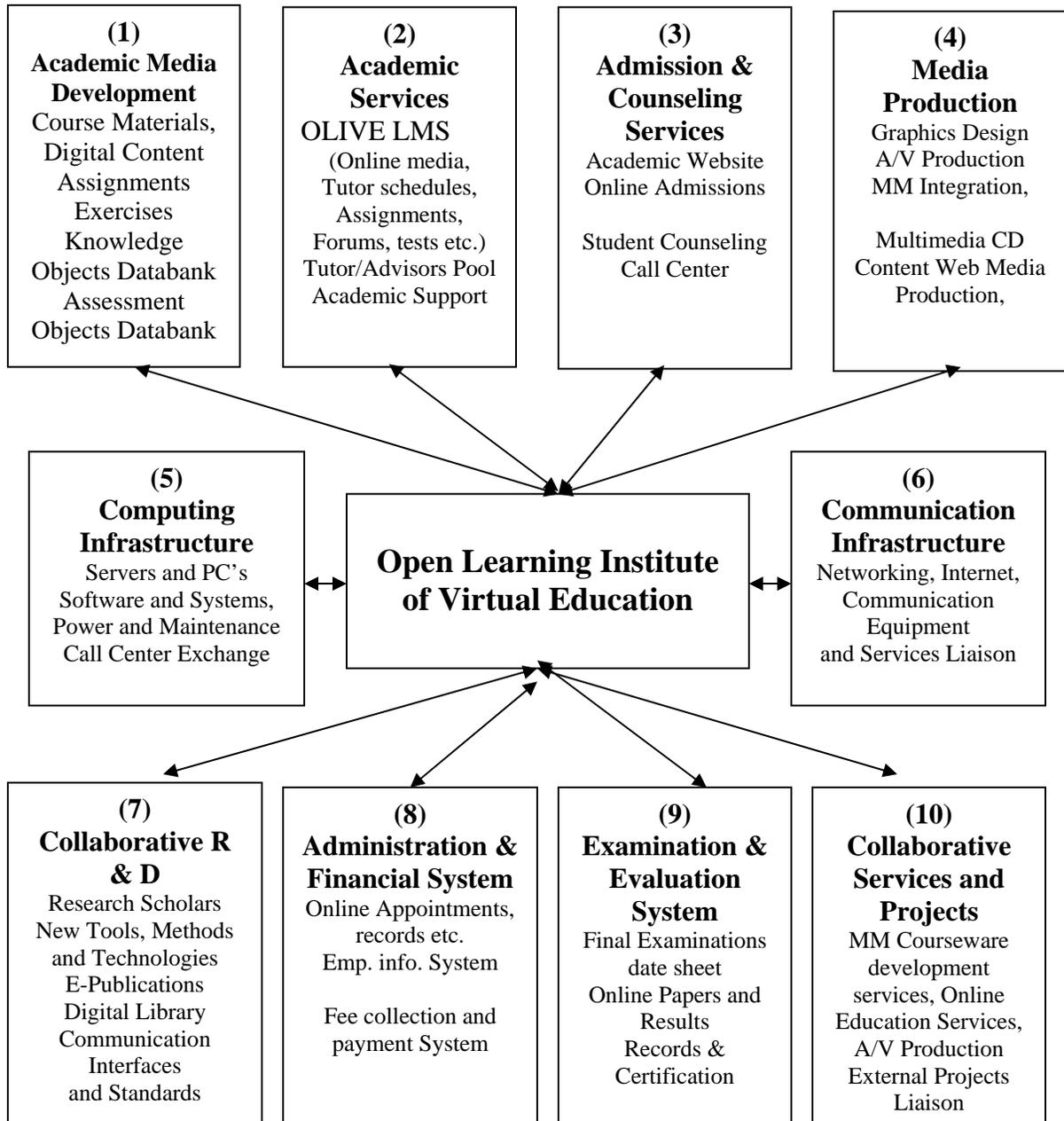


Figure 1 Components of OLIVE E-Learning Framework

3.1 OLIVE Academic Service Models

Following approval in statutory bodies, development work was initiated on various OLIVE components simultaneously. Since, AIOU provides education facilities to a large number of geographically scattered students nationwide (a limited presence of AIOU programs also exists in some Middle East countries). A majority of these students live in villages and small towns. The Internet and computing facilities available to these students vary from far-existence to full and fast Internet access at home or office. Keeping in view this fact and the Internet infrastructure in Pakistan, three delivery models of distance learning were proposed. Figure [2] illustrates these e-learning models under OLIVE framework which are briefly explained below. Detailed information can be obtained from University reports [4] [5]. Initial experiments were conducted to test technology, multimedia materials and faculty input. All three models are now being used at AIOU.

3.1.1 Model A- Regional Study Center Student

This delivery model is practiced where class size is economic and study center exists in a community. The students are encouraged to attend various courses at a selected study centre close to their place of residence. The students are provided; high-speed Internet connectivity, laboratories, classrooms, library and trained faculty at each computer study center. Developed multimedia courseware is streamed to local server of the study centres. The students attend each lecture under the supervision of the tutor. The assignments are submitted to instructors. Examinations are conducted offline.

Presently, the student also has an online access to main campus server or regional server for additional open self learning sessions. Group forums and other online asynchronous facilities (provided in LMS) are available to students. However, students are not allowed to participate in online sessions since they have been provided teaching support at the study center. It is planned that Internet will be used for enhancing online assignment submission/checking process, conducting mid term class tests and additional on-line (video conference based) special/guest lecture sessions at study centers. Model A is also useful for partially supporting scattered enrolment in courses where economic group is small. In that case teacher interactions are conducted over Internet as in Model B explained below.

3.1.2 Model B- Internet Based Student

The second delivery model (Model B) focuses on the students who have access to the Internet (office/homes). The class size in any city (or country) may also be geographically scattered. The multimedia course is available to them online. The Internet is used for online assignment submission and additional on-line lecture sessions. Video conference recorded lectures can be played by students who have no access to live video conference lectures. In addition to Internet based live sessions with teacher, students also attends workshop to meet expert teachers and perform laboratory work.

Presently, this model is used for online education. In future, this model will be extended to many overseas students. More than 60 students are enrolled in a first semester taking five courses each. With two tutors (teacher student ratio 1:30) in each course, the OLIVE Learning management System is servicing 10 sessions per week. Besides, low enrolment at study centers (failure/re-continued students) is serviced through this model.

3.1.3 Models C- Girl at Home

The Model C focuses on the students who do not have access to Internet. It is referred to as “Girl at home” model. These students are supplied self learning multimedia courseware on CDs. They are also provided reference material at their home. The students assigned a tutor and are allowed to visit a study centre or main campus to discuss their academic needs and complete their programming assignments. The online assignment submission or sending a hand written assignment by post is allowed for such students. These students can submit their assignments online using the Internet facilities available either at the main campus, study centers or any public/private Internet café. In many cases, the students use hybrid methods and combine model B and C as suits to them.

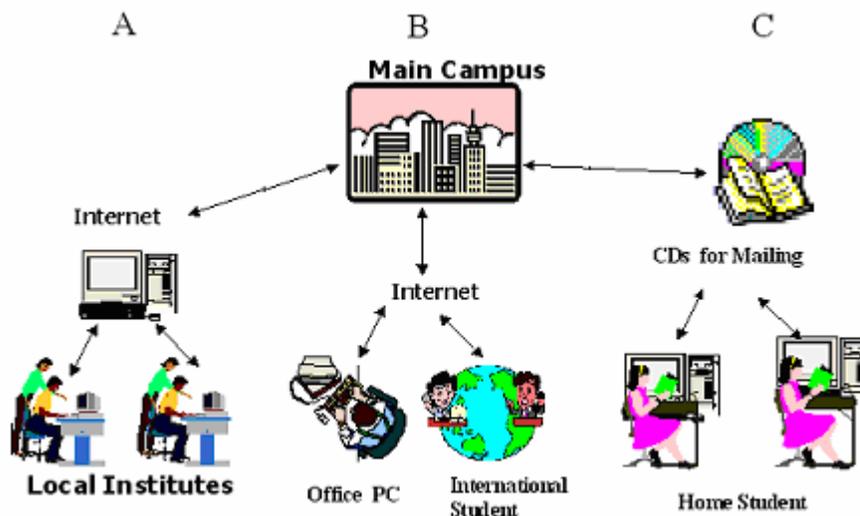


Figure 2 OLIVE Academic Service Delivery Models at AIU

A strong synchronous web site and asynchronous LMS are accessible by students of all categories. As a teacher, the author has tested the interaction sessions from different countries, different locations in a country and different Internet access points during last three years. Except occasional disconnection, power breakdowns, no major difficulty in using the Internet was reported by the students.

3.2. Multimedia Courseware Content

For quality of education and better learning, the use of multimedia courseware is considered an essential ingredient of OLIVE. AIU started this activity at an early stage with grant from IT Ministry. A brief review of multimedia courseware and its effectiveness in education is reproduced here [6].

It has been widely recognized that the use of multimedia and Internet technologies would create a major shift in the educational service paradigm that promises major advantages over the present distance learning and face-to-face systems [7]-[8]. Radical changes in the computing infrastructure, spurred by multimedia computing and advanced communication technology will make the lecture theatres and laboratories much more accessible and effective [9]-[5]. While the multimedia and Internet provide many opportunities but they also pose many challenges to the courseware developers. Indeed, course development is not an easy task. A common illusion in open and distance learning is that it is sufficient to take a course syllabus and course material from on-campus teaching and deliver it to students via

CDs or WWW [10]. But to be effective, one needs to understand that the multimedia courseware development requires a methodology suitable for the specific subject to be taught, the audience to be addressed, and acceptable for a specific learning environment [11]. A detail discussion on multimedia instruction design and its development process and e-learning models is given in many other references.

Considering it important to develop the multimedia and web content in a way which suits the specific learning environment, subject areas, and the audience capacity, the multimedia content at AIOU was conceptualized, designed and developed using the models discussed above. Three problems (uniformity in decentralized teaching, faculty variation, and faculty shortage) discussed earlier in section 2.2 were considered key effectiveness areas. Therefore courses were designed in such a way that key objectives are satisfied. However, the models allow a flexibility to apply multimedia content in a variety of ways. Thus flexibility of application and quality of content were kept two important additional requirements [6] during development of courseware.

3.2.1 Course Organization

Presentation of each semester course is organized in nine units each (one unit to be covered in approximately two weeks). Each course may contain all related information including, reading materials, solved examples, self learning exercises, self assessment quizzes, and general information or help tips. Topic wise content segments are well supported by animated slides and supported by audio explanation or some video clips. The animations follow a teaching sequence and student could replay any segment at any time. The design template is very open to accommodate future modifications easily. The process of development and quality assurance of the course materials has been discussed in detail in paper [6].

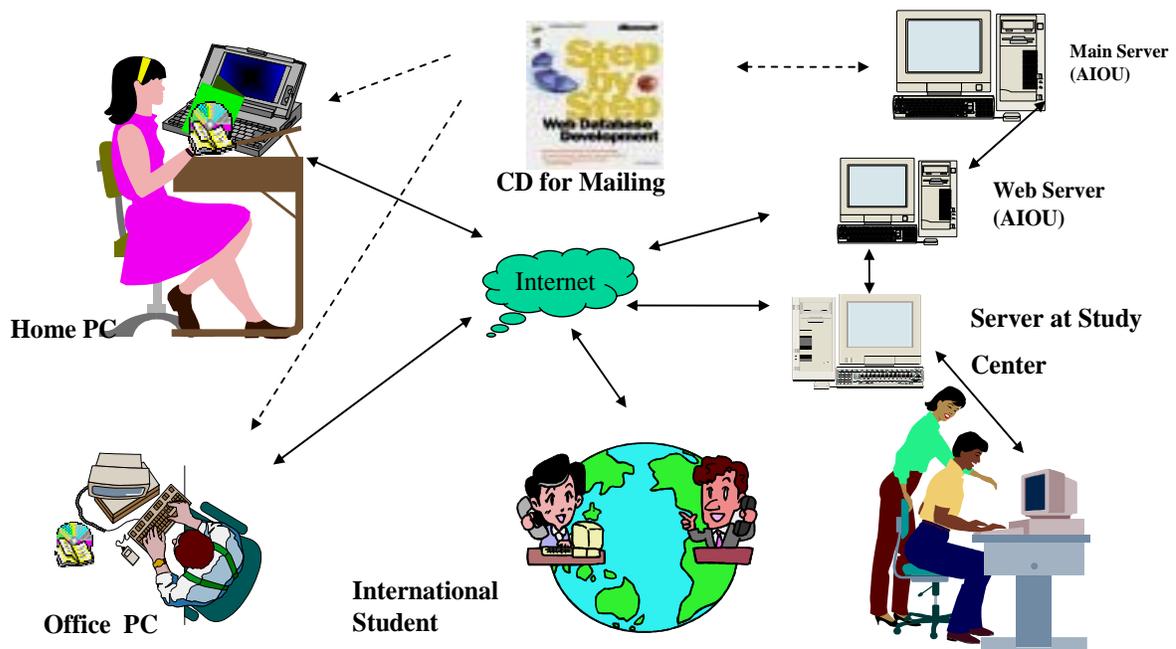


Figure 3 Application of each multimedia course in OLIVE models (dashed line show no Internet).

3.2.2 Course Application

During development it was decided that international standard courseware with multimedia mode of presentation shall be maintained. Therefore each course was organized in self learning segments. This allowed the highest level of application usage by students (see Figure 3). The priority was given to courses at postgraduate level or senior undergraduate students, owing to the fact that students were considered more mature, likely employed and having access to Internet. This group was considered as mature enough to learn difficult concepts in self learning mode with a reduced teacher interaction. However, the design and delivery methods allowed their use in a classroom presentation mode or self study at home. Both under graduate and postgraduate courseware developed and deployed.

3.2.3 Multimedia Courses on Web

The design of the multimedia components was less data intensive and had least use of video clips [6]. This allowed replica web version development very easy. Streaming technology was used to create short identifiable segments of multimedia content to be placed on an OLIVE web site using OLIVE LMS. Courses can be easily down loaded from website. Therefore all three models were supported. The multimedia courses were also used by the Internet based tutor.

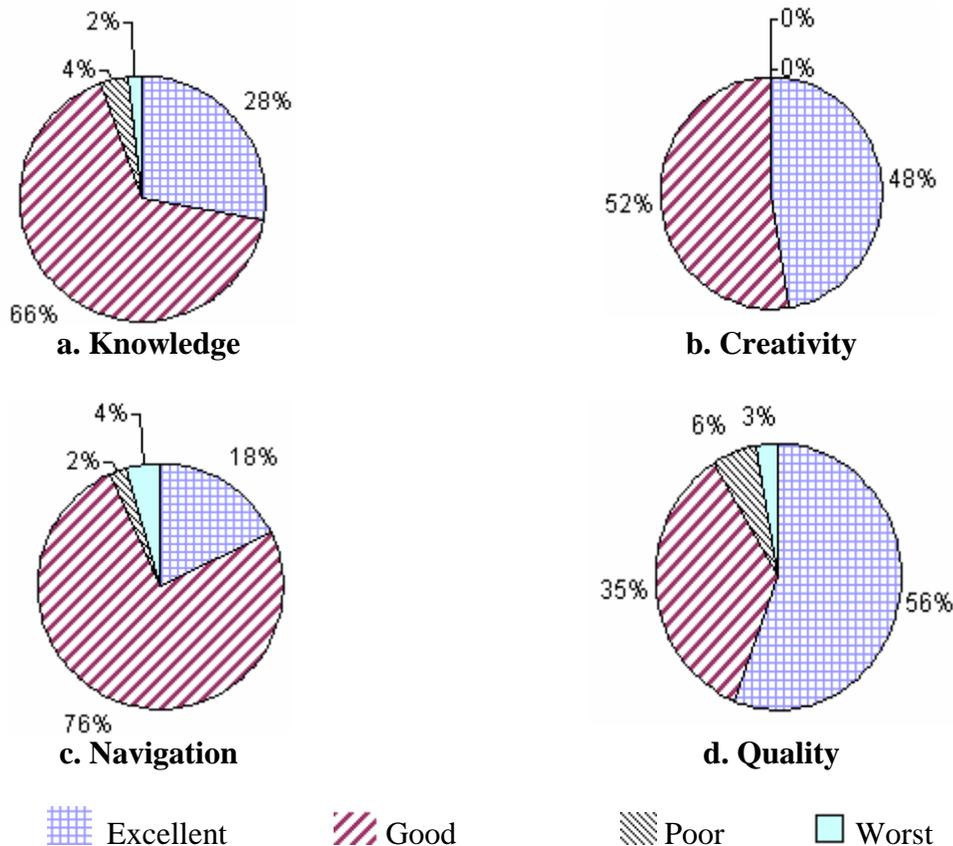


Figure 4 Quality Assurance Pre-release Field Test Sample

3.2.4 Course Quality, Costs and Development Effort

a) Course Quality

The quality of the courses was continuously monitored during course design and development stages [6]. The courses were tested with actual audience of students and faculty members before being finally released. Respondents were asked to give their opinion on four factors; knowledge, creativity, quality and navigation ease of each course. Figure 4 shows sample results of such an evaluation. The excellent and good ratings are; Knowledge 94%, creativity 100%, navigation 96% and quality 91% respectively. Field discussions with faculty members have also confirmed the good quality of courseware. The effect of courseware on student results is discussed later in the paper.

b) Course Costs

The multimedia courseware application reduced input from instructor and lower cost of electronic copy replication. Therefore operational cost was reduced to about 33% in all online courses. Interestingly cost of development of multimedia content was found to be low as compared to video production based courses developed at AIOU.

c) Development Effort

Courseware was developed with team effort. The effort involved was slightly variable for each team. Initial learning time for each team was also variable. An average time of about 12 weeks was considered sufficient for development of a one semester course. Teams worked on two courses at a time for effective use of resources at AIOU. In all about 12 new courses and six adopted/modified courses were developed. These courses are now offered using various OLIVE academic delivery models.

3.3 OLIVE Learning Management System

Initially different delivery mechanisms were tested using an internal pilot version of OLIVE LMS. These were however replaced by customized LMS software which is presently used. This new software is based on Moodle - an Open Source learning management system widely appreciated in e-learning community [See <http://en.wikipedia.org/wiki/Moodle>]. Facilities for synchronous and asynchronous learning mechanisms have been provided on this software. Live lecture delivery component has been developed locally however owing to low band width at students end; this has been disabled in operational software. Schedules, Quizzes, course materials download, presentation display, question answer and web search facilities are provided in synchronous mode. In asynchronous mode, assignments are submitted or downloaded in electronic form on the LMS website, students messaging, e-mails, announcements and forums etc are available in asynchronous mode. Many administrative facilities for teachers and system administrators are provided.

3.4 OLIVE – Other Software

In addition to OLIVE LMS, software suites have been developed so that students can also register themselves using online admissions software. This allows easily predicting students' response for a particular course and making necessary tutor and session analysis/decisions well in advance. Similarly new tutors can also register themselves using online tutor registration system.

In order to accommodate the students non academic interaction (fee queries, books requests, admission/examination/address correction requests, scholarships, visits etc.) two interconnected software have been developed. First software provides online database and structured guidance to students to record their queries and requests on database. This software filters and sends these requests to concerned university desk mailbox. The software keeps track of it until it is resolved going through

all concerned sections/desks and back to student. Therefore all queries and requests are tracked for administrative control and research purposes. The second software keeps a web database of employees and their present positions, current responsibilities and authorizations to modify database components. It gives them access to their official mail boxes so that they can access electronic mail and respond to students' queries and requests. All software is in place for pilot use and had been very much appreciated by relevant employees.

4. Learning Quality Improvement

In this section we will discuss the improvement in student learning before and after induction of Multimedia Courseware at BS and PGD level courses. Additionally a general feedback from students and faculty members is presented.

4.1 Quality Improvement –Multimedia Courseware

The multimedia courseware CD's were distributed nation wide in about 25 cities where students were studying under different OLIVE delivery models. These students include male, female, urban and rural students. Students pass percentage is considered a measure of their learning. Figure 5 shows a very positive comparison in students overall learning in four selected courses.

This is overall result comparison for student population for the courses A (195 students), Course B (703 students) and course C (484 students) and course D (381 students) respectively. In all cases, the student learning ability has increased. Since data represents all country data, it can be safely said that use of multimedia courseware has significantly increased the learning of students nationwide. In some cases, results were further improved for students who used Multimedia CD in their earlier courses.

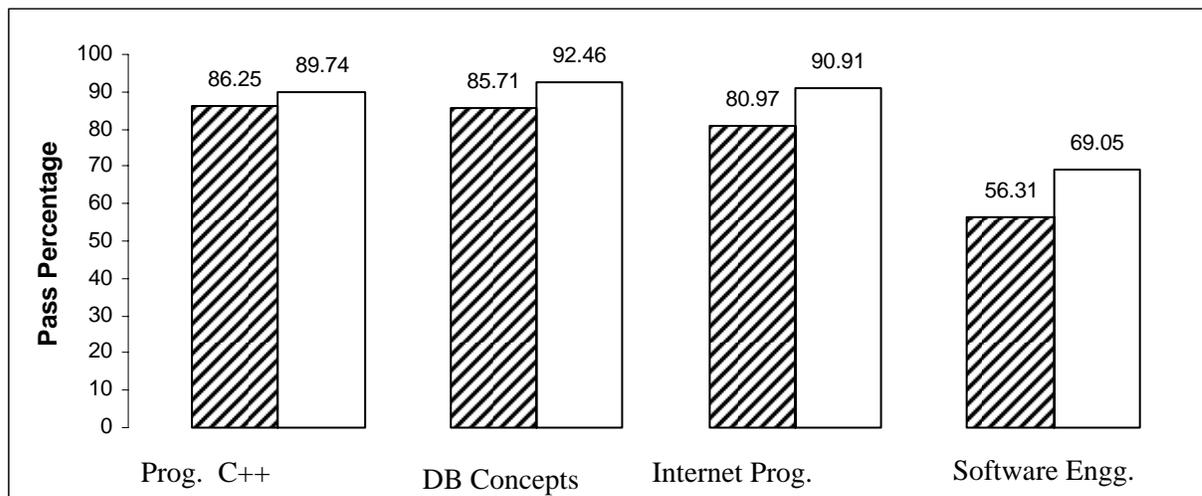


Figure 5 Comparative students results before and after multimedia course induction.

The results were all positive in all other courses where CD's were distributed. Only a percentage of improvement differs in different courses. The students have also performed even better in courses which were traditionally considered difficult to learn by the students. For example, in Data Communication and Software Engineering courses, pass percentages have improved to about 8.12%

and 12.74 % respectively. In fact, the pass percentage ratio will further improve if we consider the number of students who did not sit in examination (included in failures).

The other feedback received from student during monitoring interactions was also very encouraging. Both students and faculty members who used the course materials have given many positive remarks. Many other Universities also acquired copies of our courseware CD's for their internal use. It is worth noting that some model C students (senior postgraduate students) also used these CD's at their homes. Interestingly, so far (in last three years) we have not seen a single student repeating the CD based course in a distance learning mode. Their response has been very positive. Many female/rural students were highly motivated to buy their own computers. They have also demanded more multimedia course CD's in their other study packages. A detail analysis is being initiated to see the results trend in historical perspective, urban and rural groups and male and female groups.

4.2 Online Faculty Provision

As discussed earlier, OLIVE was conceived with three delivery models to cater needs of most of AIOU students. While Multimedia courseware was developed, some experiments were also conducted in parallel with delivery mechanism. In a pilot phase, two postgraduate courses (3523 and 3519) were selected to be conducted using OLIVE model B. This exercise was done with out use of Multimedia component. It was repeated in four semesters to get a good feedback of students, teachers and technological issues related to use of technology and outreach.

Students felt excited to learn CS /IT courses in online mode supported by a teacher interaction using Internet. Teachers had independence to conduct online sessions over Internet. Specially experienced and busy teachers liked it very much. They were able to take classes from home, office, airport lounge or even from abroad. Same independence was liked by students as well. Technologically there was no problem using OLIVE LMS but there were problems of access when we used proprietary LMS. Client side licensing and version collaboration on different public Internet Café posed major difficulties. A difficulty of Internet access was however experienced for a small number of students who live in hilly areas where Internet facility is slow and usually available a few kilometers from home. Some times weather conditions restrict student travel (often female students) in such areas.

5.0 OLIVE – Present Utilization

Following successful initial implementation, a full one year program in online CS education has been offered at AIOU in collaboration with other researchers abroad. There are 60 students enrolled in this online program. They come from more than 20 cities altogether. The student response however is highly encouraging. The LMS has built in features to provide different offline statistics. Since present semester is continuing therefore such statistics will be reported in future.

Outreach problem and economic groups' size problems were overcome by using Internet based LMS following OLIVE delivery model B. Some faculty problems have also been reduced. In present course two sections of one course are being taught by a foreign faculty member from abroad. In one incident the student also attended sessions from abroad.

There is very little difficulty now to use foreign faculty in our postgraduate programs specially in research work and supervision of research work. AIOU has built an encouraging e- learning environment for research with the support of many donors. It is extensively being used by the department of Computer Science. As a pilot, a local (five) language based e-book, "Pakistani Adab" has been developed for a bachelors level course .This course is used using Model C of OLIVE. The

demand to develop six new courses in Urdu and other regional languages speaks of popularity of this course among faculty and students.

6.0 Future Development

As shown in section 5 above, ICT interventions conceptualized and designed under OLIVE worked well. Multimedia courseware content which was a core development effort was quite effective in increasing students learning. The learning management system and other associated software have also proved to be very useful to students' community. It is however desired that originally conceived complete model of OLIVE need to be developed and formally implemented in all departments of the University. Several components of the model are already developed in parallel and being used by the department. Future work is needed in areas of component integration, content enhancement, new course areas and extension of access to other regions.

It is also desired that the content shall be now developed using learning objects []. For this purpose the department is providing a technical support and collaboration to University of Terbuka, Indonesia (Principal Development Institution) and institutions in Thailand (GMU, Thailand) and Cambodia. This project is a part of Pan Asia Network named PANDORA under the funding of IDRC, Canada.

Some work has been completed on a multilingual multimedia course, "426 Pakistani Adab". More effort is needed to convert existing material in to electronic multimedia format and extend it to students in such courses.

Another significant future development work is to design and develop an E-Assessment mechanism and software. This is very important piece of research work which requires to carefully deal with organizational rules, technology and knowledge measurement without allowing any "unfair electronic means" This research and development work has been placed on priority. This is also being done under PAN DLT network (under IDRC funding) in collaboration with School of Computing, University of Colombo, Sri Lanka. There is also a need for access and communication infrastructure development in the country. So that benefits could be provided to unprivileged rural population specially female students in remote areas.

7.0 Conclusions

In this paper we identified a problems associated with student's academic learning arising from expansion in a newly emerging scientific subject matter such as computer science. The problems associated with learning quality out reach to rural and female students were addressed through ICT interventions by using multi media courseware and OLIVE learning models. These proved to be successful and student learning, operational cost and outreach problems have been better addressed. Additionally, the OLIVE model which is progressively being implemented has shown promising results in addressing issues related to academic quality, cost and outreach in ICT based distance learning. Its extension to address access issues, administrative issues and teacher resources will help ICT education to flourish at AIOU and other countries. There is a need to carefully develop e-assessment module to OLIVE model. These developments will lead to a qualitative, comprehensive, better and reliable ICT education model. The models developed have been used to other disciplines and can be extended to other disciplines.

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Authors Profile

Dr. Nazir A. Sangi received his Bachelors in Engineering in 1981 and PhD in 1989. He obtained two gold medals; “First Position” and “Best Graduate” He was awarded Masson Bibby Award by Liverpool University, UK. Dr. Sangi has also won a prestigious National NCR IT Excellence Award 2004. Dr. Sangi is working at Allama Iqbal Open University. He developed ICT projects including “Open Learning Institute of Virtual Education (OLIVE)”, Multimedia Electronic Courseware Design Centre (MECDC), IT Services Networking Project (ITSN), E-Assessment methods and model for students in Asia (an IDRC PAN DLT Project). His contribution in ICT research has resulted in an improvement of quality of learning of CS graduates nationwide. The cost of ICT based online education has reduced to about 33% and overall learning of students nationwide has improved to about 12% in many cases.

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