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# Pedagogic Effectiveness of Print, Interactive Multimedia, and Online Resources: A Case Study of IGNOU

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In the present paper, the authors report on a comparative study on the pedagogic effectiveness of printed self-learning text with face-to-face tutorial support, interactive multimedia CD-ROM and online learning in an introductory computing module at the certificate level offered at Indira Gandhi National Open University(IGNOU), India. The study was based on an analysis of the existing instructional practices in open universities in India in respect of difficulties faced, learner preferences, quality of support structure and services, mode of interaction, instructional and technological ingredients for success in learning. Both descriptive as well as experimental research methods were used. A web server was established for use in the experiment with the students. An achievement test and a Response to Learning Activity Scale were developed and administered on the three groups of learners. The study reports that the use of interactive multimedia CD-ROM was found pedagogically more effective with a variety of learning activities than that presented through print with face-to-face support and that presented through the web with online learner support.

Key Words: Self Learning Materials, Interactive Multimedia Based Learning, Online Learning, Pedagogic Effectiveness, Distance Learning, IGNOU

## INTRODUCTION

There has been phenomenal growth of open and distance learning across the globe during the past few decades. As is widely reported, distance education has progressed through five generations, from print-based correspondence model to the present intelligent flexible learning model dominated by interactive multimedia computer

mediated communications (Taylor, 2001). Starting in 1962, open and distance learning in India registered a phenomenal growth during the later half of the twentieth century; the share of distance education in total student enrolment in higher education increased from about 9 per cent (0.7 million students) in 1985 to 25 per cent (3.6 million students) in 2011. Moreover, its growth rate (16.2%) has been particularly higher than that of the formal system (3.9%). This vibrancy and dynamism is rooted in its capacity to accommodate and absorb accelerated pace of changes taking place in technology. It is now widely accepted that it is possible to develop knowledge, training and skills at any level—from awareness to front-ended areas—through distance mode and online learning.

In India, encouraging developments have been evidenced in the recent years in the use of electronic media and technology like audio and video cassettes, CD-ROM, interactive radio, TV, computers, teleconferencing and video conferencing for quick and effective dissemination of knowledge and for interaction. These tools have ushered in a silent revolution in the delivery of education; learners are expected to get more enriching learning environment and empowered educators to harness technology to deliver online education. However, Indian open universities have been slow to respond; out of a total of 15 open universities (one national and 14 provincial), only four open universities, Indira Gandhi National Open University (IGNOU), Madhya Pradesh Bhoj Open University (MPBOU), Netaji Subhash Open University (NSOU) and Yashwantrao Chavan Maharashtra Open University (YCMOU) provided only six online programmes till 2002 (Panda, 2002). However, the number is now in excess of 40. It was observed that the National Open University, which had been offering online education in information technology and management reverted back to the offline distance education mode. While use of technology accelerates the pace of delivery of education, it is important to assess learner preferences for and pedagogic effectiveness of the form and format of instruction and instructional delivery (Kurbel, 2002; Nilas, 2002; Robertshaw, 2002) so that technology-enabled education can be designed and implemented effectively.

Sulaiman et al. (2002) have reported that male and female distance learners of Universiti Sains Malaysia participated equally in the utilization of networking based computer applications as well as stand-alone applications at home and workplace to support their study needs in distance education. Navarro and Shoemaker (2000) found no statistical difference in the attitude of traditional and cyber-learners towards e-learning; about 44 percent cyber-learners had taken the course for convenience; and lectures based on CD-ROM were considered as the most essential resource, followed by text books, and online learning.

Shammugum's (2002) study on Indian distance learners revealed that those above 35 years of age had more favourable attitude to e-learning than that of those below 20 years. Moreover, urban students with Post Graduate degree had the most favourable attitude to e-learning, followed by urban-bachelor degree holders and rural Post Graduate degree holders. According to Yadav and Sahoo (2002), distance learners, in general, had the most positive attitude towards Fifth generation technology of

intelligent flexible learning; and those with access to cyber café had more positive attitude towards e-learning than those without. In a recent study at IGNOU on faculty attitude, barriers and motivators to online learning, Panda and Mishra (2007) reported that extensive use of computers and e-mail had a high relationship with positive attitude towards e-learning. The most significant barriers perceived by the faculty included poor internet access by the students and lack of training on e-learning. The important motivators included personal interest to use technology, intellectual challenge, and sufficient provision for technology infrastructure. These findings conform with related studies and reports on the Asian region (McDonald, 2009; Belawati et al, 2012; Jehan et al; Khan and Jumani, 2012).

**PEDAGOGIC EFFECTIVENESS REVISITED**

In the past decade, considerable effort was directed on comparison of face-to-face with web-based/online learning (Ary and Brune, 2011; Mcfarlane, 2011; Stone and Perumean – Chaney, 2011; Bethel and Bernard, 2010; Neuhauser, 2002; Arbaugh, 2000; Clark, 1999; Dobrin, 1999; Dutton et al 1999; Trinkle, 1999). These studies revealed online learning to be as effective as or even better than face-to-face learning. The important variables of effectiveness included entry behaviour, learning style, media familiarity, teacher effectiveness, time and task orientation, level of participation, and quality of assignments. One of the most important variables was social presence and social construction of knowledge examined with the help of an interaction analysis model (Gunawadena et al., 1998). Further, collaborative, rather than independent, learning increased completion rate in computer-mediated learning (Cheng et al, 1991). In the study reported in this paper, pedagogic effectiveness of all the three modes of learning has been considered collectively as well as in appropriate combinations in terms of achievement of learners.

The review of available literature revealed mixed findings: while some studies report significant pedagogic effectiveness of various non-print media, others found evidence to reinforce the no significant-difference phenomenon, or prove equal effectiveness of various media/mode of learning. Panda and Chaudhary (2003) have argued that instead of comparing the effectiveness of various media in teaching a subject or topic, it would be better to develop criteria for effective use of those media. And based on these, improve active student learning. While this view is justified in the broader context of decision making for media selection and integration, it is imperative that studies are conducted within the context of distance education and with particular reference to use of web-based learning and interactive multimedia (where print, audio, video, graphics, animation, etc. can be effectively integrated) to know learner choice of media for instructional delivery and learner support; reactions to learning activities provided through different media; and the effect of various media (i.e. print, interactive multimedia, and web-based learning) on their academic achievement.

IGNOU started the virtual campus initiative in 1996 with three online programmes – Certificate in Computing (CIC), Bachelor of Computer Applications (BCA), and Master in Computer Applications (MCA). In the following year, a three-year postgraduate diploma in information technology (in collaboration with the EdExcel,

UK) and a one-year postgraduate diploma in information technology (supported by the Department of Electronics, Government of India), were initiated. These were followed by offer of two more programmes: Master of Business Administration, and Postgraduate Certificate in Participatory Management of Displacement, Resettlement and Rehabilitation. It was subsequently discovered that students faced serious problems with computer education online courses, and some of them even were allowed to shift from online to traditional distance education delivery (Panda, 2002). This posed concerns to further and higher education preferences of students and caused confusion about the most effective media for effective learning.

Though today about 40 programmes are offered online, the present study was the first step towards investigating the pedagogic effectiveness of various technology-mediated learning options, and should be helpful in policy planning of such initiatives in many of the developing countries, including India.

**Objectives**

The main objective of this study was to assess the pedagogic effectiveness of three modes of learning: a self-instructional unit – print, with face-to-face tutorial support, interactive multimedia CD-ROM, and interactive multimedia on the web with online support – assessed in terms of achievement scores and responses to various learning activities (so as to advise open universities and dual mode conventional universities on future developmental directions for development of media and technology). An earlier descriptive study conducted on the learning preferences of learners (Dikshit et al, 2003) formed the basis for designing the self-learning unit and three types of learning modes was used for experimental research in this study.

**Hypothesis**

The sampled student population (N=60), which belonged to a Certificate in Computing programme of IGNOU, was divided into three groups and each group was exposed to respectively three experimental treatments, i.e. print materials, interactive multimedia CD materials, and online learning materials. It was hypothesised that variations in the learning preferences, difficulties encountered, and learning strategies for technology-enabled education may elicit varied responses to the achievement test and the learning activities scale administered for the three categories of experimental treatment.

**METHOD**

Following the admission to the Certificate in Computing programme (a six- month programme comprising 16 credits or 480 hours of student study) of IGNOU, a group of 60 students admitted at the Regional Centre, Delhi was randomly selected and assigned to three groups of 20 each: self learning unit in print (Group I), interactive multimedia CD-ROM (Group II) and online learning with web based support (Group III). The students were asked to go through a specially designed module common to all three groups and do a test and complete a reaction to learning activity scale. In this study, two types of research methodologies were used: descriptive and experimental. These methodologies were selected in view of the two broad objectives of the study: i) to

obtain feedback from the online students on various aspects of interactive multimedia courseware and the technology of online teaching-learning; and ii) to test the effectiveness of print, interactive multimedia CD-ROM, and online learning in terms of learners' scores on an achievement test and reaction to learning activities scale. The two methodologies are briefly described below.

**Descriptive and developmental research**

At the initial stage of the study, the status of information and communication technology (ICT) used by various open universities and other distance teaching institutions in India was reviewed and analysed. It facilitated location of the problem and formulation of the objectives of the study. For this task, institutional reports, research studies, and related articles were consulted, and personal visits to selected open universities were made to ascertain facts. This analysis, coupled with the review of related research studies, formed the basis of the design of the survey aspect of the study. Descriptive research methodology enabled us to obtain the views of the learners through a questionnaire, comprising 60 questions, on their preferred mode of study and various aspects of web-based/online learning. The results obtained from this survey which had earlier been published (Dikshit et. al, 2003) facilitated the design of the self-learning module on "Computer Networks" (i.e., Block 3, Unit 2, C/C – 02 from the Certificate in Computing programme)in three different modes – print material with face-to-face support, interactive multimedia CD-ROM, and online learning with online learner support.

The module was restructured, revised and converted into a self-learning module in print comprising three small units (equivalent to 15 hours of study) and renamed as "Computer Networks". The same content of the module was then converted into an interactive multimedia CD, and was also web-enabled with built – in discussion forum and posted on a specially designed website for online learning.

The various learning activities were integrated in to all the three types of treatments – print, IMM, and web-based learning. These are listed in Table 1.

Table 1: Integrated learning activities

| *Learning activity* | *Print* | *IMM-CD* | *Web-learning* |
|---|---|---|---|
| Module pre-test | Print | CD | VirtualCampus.org |
| Induction to study | Classroom | CD | VirtualCampus.org |
| Objectives and study guide | Print | CD | VirtualCampus.org |
| Self assessment questions and activities | Print | CD | VirtualCampus.org |
| Discussion and counselling | Classroom | - | Discussion forum |
| Chat | Classroom | - | Chat room |
| Module summary | Print | CD | VirtualCampus.org |
| Module review questions | Print | CD | VirtualCampus.org |
| Module post-test | Print | CD | VirtualCampus.org |
| References/further readings | Print | CD | VirtualCampus.org |
| Additional reference materials | Print | - | VirtualCampus.org |
| Web-based resources | - | - | VirtualCampus.org |
| Glossary | Print | Print | VirtualCampus.org |
| Module pre-test | Print | CD | VirtualCampus.org |

A personalised web server was then established for carrying out the experiment on online students. An Achievement Test consisting of 40 questions and a Response to Learning Activity Scale comprising effectiveness of learning through interactive multimedia CD (vis-à-vis face-to-face classroom teaching and learning), online learning, and learning through printed self-learning module. Statements were developed to assess respectively the achievements of the students, and reactions to various learning activities. Content validity was established through putting those two instruments to experts from the field who concurred that they were valid.

**Experimental research**

The second broad objective of the study was to assess the effectiveness of the self-learning module on 'computer networks' in terms of student achievement through a pre-test - post-test design. Three groups, comprising 60 sampled students of Certificate in Computing Programme, were randomly selected to administer the experimental treatments. Group I (N=20) was asked to go through the self-learning print material at home with some learner support at a designated study centre; Group II (N=20) studied the interactive multimedia CD-ROM-based module at a designated tele-learning centre nearer to their home; and Group III (N=20) studied the materials through web-based online learning (at a virtual learning environment) with online mentor support at two designated telelearning centres nearer to their home. Each student, on an average, put in about 3 hours a day for 5 days, leading to 15 hours of study. The Achievement Test was administered pre-test as well as post-test. Also, on the 5$^{th}$ day, the Response to Learning Activity Scale was administered on all the students, and the data were tabulated for Achievement Test and Response to Learning Activity Scale separately for the three groups.

Online testing of the Virtual Learning Environment (VLE, i.e. VirtualCampus.org) and cyber class for the online module was conducted for five days at two designated telelearning centres in which 20 students (10 students at each centre) participated. A complete schedule for every activity was drawn for all the five days. The minimum duration for active online participation was kept for three hours each day. The following activities were included for the students:

- going through the day's time-table (5 minutes);
- going through the contents of the topic to be covered (30 minutes or more depending on the topic);
- browsing through the web site for further reading of the units (50 minutes or more depending on the topic);
- participation in online quizzes given at the end of every topic (20 minutes or more depending on the length of the quizzes);
- participation in chat session (40 minutes or more); and
- participation in discussion forums (the next full 24 hrs).

Provision was made for two mentors at the server-end, where chat and group discussions were facilitated. The mentors were responsible for assisting learners in accessing the Virtual Learning Environment, cyber class, framing relevant questions related to the topics, etc and participation in discussion. The detailed activities for students for day one and a few of the activities for day four are shown in Figure 1 and Figure 2 respectively.

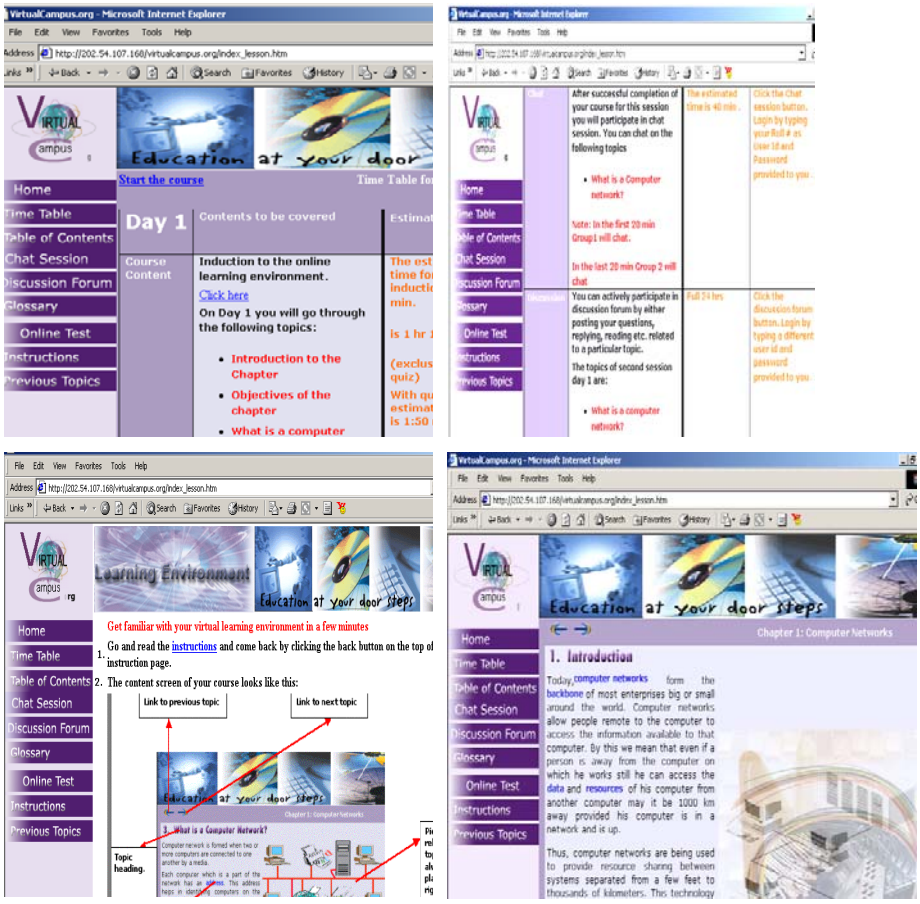



Figure 1: Sampled activities for Day 1

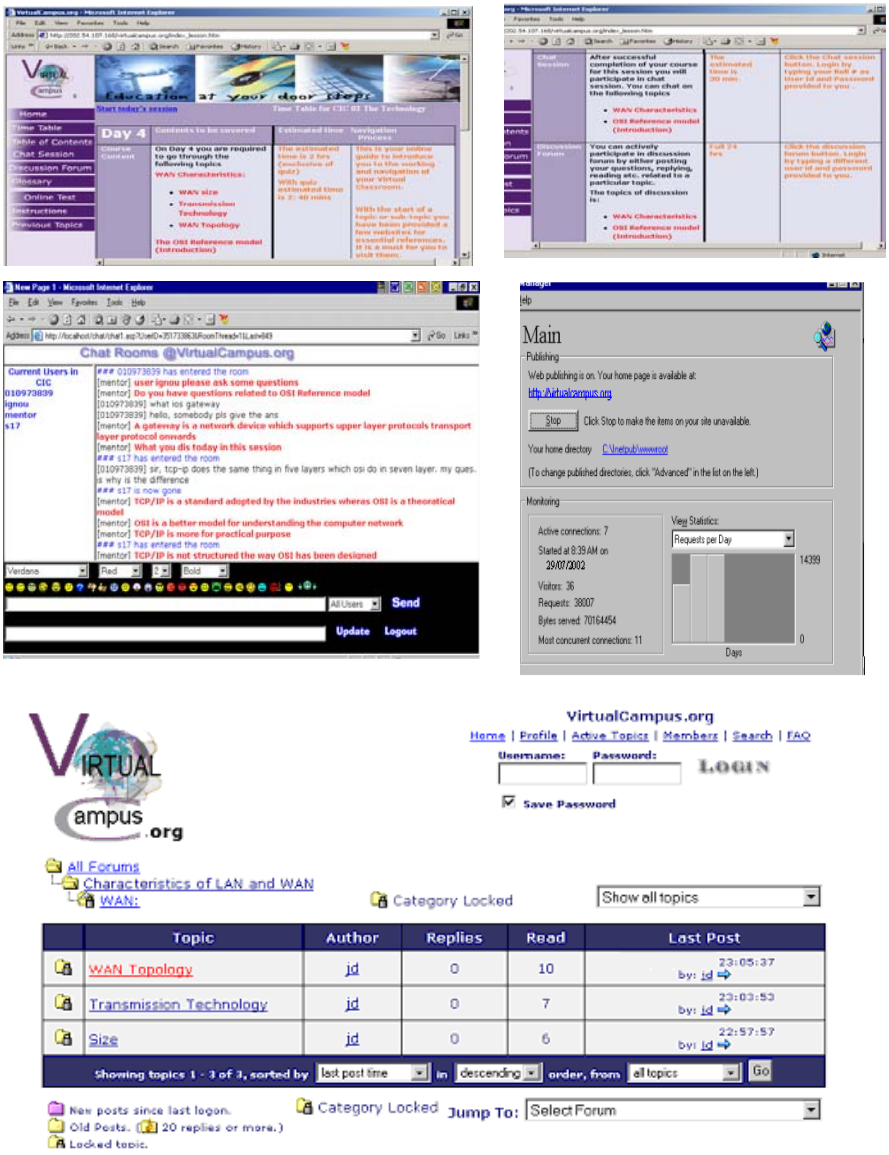



Figure 2: A few typical sampled activities for Day 4

**Development of achievement test**

To test the comparative effectiveness of print, interactive multimedia , and web-based learning (in terms of pre-test and post-test learner scores on the Achievement Test), one

achievement test comprising 50 multiple-choice questions based on the contents of the module was developed by the researchers for all the three groups of learners. These questions were different from the self-assessment questions given in the text of the module and quizzes or review questions given at the end of each unit of the module. To establish content validity of the test, the achievement test along with the module on computer networks was sent to five experts in IT with a request to suggest additions/deletions/ modifications. On the basis of suggestions received from them, a few questions were modified / deleted / added, and the achievement test comprised 45 questions. The modified achievement test was administered on a randomly selected ten Certificate in Computing graduates of IGNOU; their responses and suggestions led to further modifications resulting in a final test of 40 questions. The test, with 40 questions and a total score of 100, was further administered on a randomly selected 15 Certificate in Computing graduates of IGNOU twice with a gap of two weeks. The statistical analysis suggested a test-retest reliability of 0.82, which was quite high.

## RESULTS

### Chat sessions

For all the five days chat sessions of one hour duration were conducted in the two tele-learning centres for various topics of the online module as given in Table 2. As may be noted, the number of hits ranged from 200 to 500 and the number of questions ranged from 10 to 25. The level and quality of the questions was low on Day 1, but improved gradually and was quite high on Day 5. The initial problems encountered in chat interface were completely overcome from Day 3 onwards. The web-presence of the mentor was felt more prominently in the chat sessions on Day 1 and Day 5, i.e. the beginning and the end of online learning.

Table 2: Data on chat sessions for five days

| *Parameter\Days* | *Day-1* | *Day 2* | *Day 3* | *Day 4* | *Day 5* |
|---|---|---|---|---|---|
| Topic of chat | Introduction to the computer networks; What is a computer network? | Types of computer networks | Characteristics of LAN & WAN | Characteristics of WAN and OSI reference model | OSI reference model and module summary |
| No. of centres | 2 | 2 | 2 | 2 | 2 |
| No. of students | 20 | 20 | 20 | 20 | 20 |
| No. of hours | 1 | 1 | 1 | 1 | 1 |
| No. of questions asked | 10 | 15 | 12 | 20 | 25 |
| No. of hits | 200 | 300 | 250 | 400 | 500 |

| *No. of sub-topics chatted* | *Computer networks; Importance of computer networks* | *About LAN, WAN, MAN* | *LAN / WAN – size, transmission technology and topology* | *WAN – size, transmission technology and topology*<br><br>*OSI RM – Peer communication, headers* | *OSI RM – Protocols, layers of physical, data link, network; Transport, session; Presentation and application and data transmission process* |
|---|---|---|---|---|---|
| General questions | 7 | 4 | 2 | 4 | 1 |
| Quality of questions | Low | Medium | Medium | Medium | High |
| Level of questions in chat | Low | Low | Medium | Medium | High |
| No. of connections failure | NIL | NIL | NIL | NIL | NIL |
| Problems regarding chat interface | 5 | 3 | NIL | NIL | NIL |
| % of mentor role in chat | 100% | 70% | 80% | 80% | 100% |

## DISCUSSION

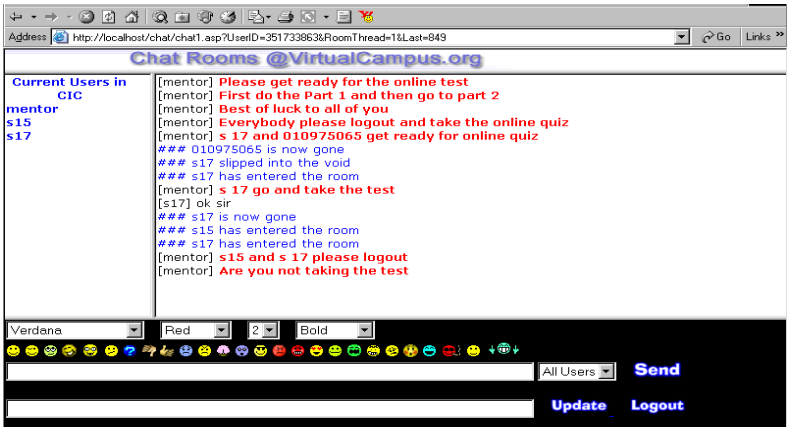
Table 3 presents data on discussion forum made available to each of the two centres for all the five days. The number of questions posted increased from 4 on Day 1 to 20 on Day 5 and all the questions were responded to by the mentors. Both the quality and level of questions increased gradually. While no difficulty in respect of discussion interface was experienced, the interventions of the mentor declined on Day 3 and Day 4. This was most likely due to the fact that the students got involved more in the discussion forums on those days, leaving less questions for the mentors to deal with.

Table 3: Data on discussion forum for five days

| *Parameter\Days* | *Day 1* | *Day 2* | *Day 3* | *Day 4* | *Day 5* |
|---|---|---|---|---|---|
| Topic of discussion | Introduction to the computer networks; What is a computer network? | Types of computer networks | Characteristics of LAN and WAN | Characteristics of WAN and<br>OSI reference model | OSI reference model and module summary |
| No. of centres | 2 | 2 | 2 | 2 | 2 |
| No. of students | 20 | 20 | 20 | 20 | 20 |
| No. of hours | 24 | 24 | 24 | 24 | 24 |
| No. of questions posted by students | 4 | 7 | 10 | 15 | 20 |
| No. of questions answered per day | 4 | 7 | 10 | 15 | 20 |

| No. of sub-topics chatted | Computer networks; Importance of computer networks | About LAN, WAN, MAN | LAN/WAN – size, transmission technology and topology | WAN – size, transmission technology and topology<br><br>OSI RM – peer communication, headers | OSI RM – Protocols, layers of physical, data link, network, transport, session, presentation and application and data transmission process |
|---|---|---|---|---|---|
| General questions | 2 | 2 | 1 | 4 | 5 |
| Quality of questions | Low | Medium | Medium | Medium | High |
| Level of questions in discussion | Low | Low | Medium | Medium | High |
| No. of connections failure | NIL | NIL | NIL | NIL | NIL |
| Problems reg. discussion interface | NIL | NIL | NIL | NIL | NIL |
| % of mentors role in discussion | 100% | 100% | 75% | 60% | 100% |

As may be seen from Figure 3, the skills developed in the learners through the chat sessions began to influence online chat during administration of the achievement test online. The mentors immediately noticed this and strict participation was ensured and monitored. This initial tendency by the online students got eliminated subsequently.



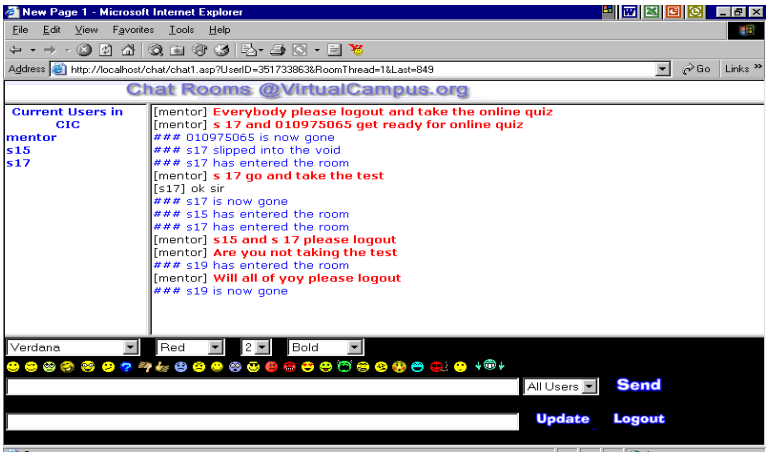



Figure 3: Reflections of online quiz on chat sessions

**Analysis of achievement test scores**

The three groups of sampled students (N=20 in each group) were given three treatments : Group I studied the module through printed self-learning materials with one face-to-face tutoring contact; Group II studied through interactive multimedia CD-ROM; and Group III studied through web-based learning at the telelearning centre with online support through discussion forum, chat etc. At the end of the 5-day experiment, all the three groups were administered the Achievement Test (40 questions with a total score of 100). Their scores are tabulated in Table 4.

Table 4: Achievement scores of the students of three treatments (post-test)

| *Descriptive Statistics* | *Interactive multimedia-CD* | *Print* | *Online* |
|---|---|---|---|
| Mean | 61.85 | 56.3 | 49.10 |
| S.D. | 7.09 | 12.05 | 9.56 |

These results suggest that while there was no significant difference in the academic achievement means scores between those who studied through CD and through print, and between those who studied through print and through online, the means of online (Mean = 49.10) and CD (Mean = 61.85) groups differed significantly. Since the mean of CD group was higher than that of the online group, it may be concluded that self-learning through interactive multimedia CD resulted in higher academic achievement (and was more pedagogically effective) than online self-learning with online mentor support.

Table 5: Annova test results

| *Source of* | *Variation* | *SS of Dev.* | *d.f* | *MSS* | *F- Ratio* |
|---|---|---|---|---|---|
| Between | SSC | 1634.7 | 2 | 817.35 | 8.53* |
| Within | SSE | 5458.55 | 57 | 95.76 | |
| Total | SST | 7093.25 | 59 | 120.22 | |

*P< .01

The F-ratio being significant at .01 level suggested that there existed significant independent and interaction effects of three modes of learning on achievement test scores of the students. To know the significant differences in the group means, the statistical technique of t-test was applied three times: CD vs. Print, Print vs. Online, and Online vs. CD. The results of t-tests are given below:

CD vs. Print : $t_1 = 0.08$

Print vs. Online : $t_2 = 0.03$

Online vs. CD : $t_3 = 5.37$

The statistical table with 19 df (N-1) suggested that t of 2.86 was required to be significant at 0.05 level. The above t results indicated that while the t–ratio for CD vs Print and Print vs Online were not significant, the $t_3$ of 5.37 was higher than the table value of 2.86, and was therefore significant. The Mean of 61.85 for interactive multimedia-CD being higher than the Mean of 49.10 for Online, those studied through interactive multimedia -CD achieved higher achievement scores than those studied online.

**Learning activity scale**

A few common learning activities were built into the contents of the module developed for all three experimental treatments. It was intended to discover learner responses of the three treatments/groups on the effectiveness of the learning activities (like objectives, study guide, activities, discussion, module review, glossary, etc.) and how these compared with face-to-face learning. The learner perception on those activities (their preference and perceived pedagogic effectiveness) is crucial in making decisions on both media choice as well as media -based content design for effective student learning.

In this study, various learning activities were integrated into one platform of interactive multimedia and subsequently into web-based learning. There were thirteen learning activities for all the three modes of learning put together; eight were common to all the three modes. All 60 students were administered the reactions to learning activity scale soon after obtaining their responses to the achievement test. The reactions to learning activity scale contained the activities, and the students were required to respond on a 3-point scale from 'more effective' to 'less effective' for each activity. The students of each experimental treatment (for example, WBL) were given the reactions to learning activity scale to react to the perceived effectiveness of the treatment that they had just gone through in comparison to face-to-face classroom teaching-learning. Further, they were also asked about the perceived effectiveness of the other two treatments in comparison to face-to-face teaching-learning if they would have gone through such a mode of study. Their responses are given in Tables 6, 7, and 8.

It may be noted from Tables 6 that Group I (i.e. printed module) students felt that, in comparison to full face-to-face teaching-learning, print was more effective for induction to study and discussion, and somewhat effective for self assessment questions

and activities, objectives and study guide, module pre-test and the module as a whole. However, for summary it was considered less effective. If the same module could have been provided through CD, it would have been more effective for module pre-test, induction to study and module post-test and somewhat effective for study guide activities, and module summary. Further, if it were given as online learning, it would have been more effective for induction and module post-test, and somewhat effective for module pre-test, induction to study, study guide, self assessment questions and activities, summary and discussion. The online learning was not considered that effective for module post-test, induction to study and objectives and study guide.

Table 6: Reactions to learning activities (Print)

| *Type of test* | | *More effective than face-to-face teaching* | *As effective as face-to-face teaching* | *Less effective than face-to-face teaching* |
|---|---|---|---|---|
| Printed self learning text vs face-to-face CRL | Mean | 28.75 | 50 | 21.25 |
| | S.D. | 15.52 | 20.7 | 9.91 |
| Interactive multimedia-CD vs face-to-face CRL | Mean | 30 | 50 | 20 |
| | S.D. | 16.03 | 16.9 | 10.69 |
| Online vs face-to-face CRL | Mean | 30 | 60 | 10 |
| | S.D. | 16.9 | 20 | 10.69 |

Table 7 suggests that those who studied the module through interactive multimedia CD (Group II) felt the module as a whole on the CD was more effective than face-to-face teaching-learning, printed module with face-to-face support and online learning with online support. However, print would be more effective for pre-test, post-test and summary, and online learning for post test. Moreover, online is somewhat more effective for pre-test, summary, induction to study, study guide and activities.

Table 7: Reactions to learning activities (CD)

| *Type of test* | | *More effective than face-to-face teaching* | *As effective as face-to-face teaching* | *Less effective than face-to-face teaching* |
|---|---|---|---|---|
| CD vs face-to-face CRL | Mean | 30 | 46.25 | 23.75 |
| | S.D. | 20.7 | 10.6 | 22.63 |
| Online vs face-to-face CRL | Mean | 32.5 | 55 | 15 |
| | S.D. | 15.81139 | 14.14214 | 10 |
| Printed self learning text l vs face-to-face CRL | Mean | 38.75 | 35 | 26.25 |
| | S.D. | 21.67124 | 16.03567 | 16.85018 |

Those who studied exclusively online/through the web (Group III) pointed out that WBL was more effective than face-to-face for the module as a whole, for discussion, module pre-test, induction to study, self assessment questions and activities, objectives and study guide, summary, and module post-test (i.e. all the eight learning activities) in comparison to face-to-face teaching (Table 8). Also, they suggested that, if given in interactive multimedia CD mode, it will be equally effective, but less than web based learning in respect of study guide, activities, and module post-test. Further, if given as a printed self-learning material, the effectiveness will be reduced for activities, discussion, study guide and summary.

Table 8: Reactions to learning activities (Online)

| *Type of test* | | *More effective than face-to-face teaching* | *As effective as face-to-face teaching* | *Less effective than face-to-face teaching* |
|---|---|---|---|---|
| Online vs face-to-face CRL | Mean | 60 | 18.75 | 21.25 |
| | S.D. | 7.55 | 8.34 | 6.408 |
| IMM-CD vs face-to-face CRL | Mean | 58.75 | 25 | 16.25 |
| | S.D. | 8.34 | 11.95 | 7.440 |
| Printed self learning text vs face-to-face CRL | Mean | 30 | 52.5 | 18.75 |
| | S.D. | 18.51 | 14.88 | 15.52 |

## DISCUSSION

This study found that, in general, instructional content provided through interactive multimedia CD-ROM for self-learning was more effective than printed module and online learning. However, print was preferred for pre-test, post-test and summary, and online for activities and discussions. Those who studied exclusively online through the web pointed out that they perceived that web based learning was more effective than face-to-face for the content as a whole, for discussion, content pre-test, induction to study, self assessment questions and activities, objectives and study guide, summary, and content post-test (i.e. all the eight learning activities). Also, learners indicated that an interactive multimedia CD should be equally effective, but less than web based learning, for study guide, activities, and post - test. The following two findings are important:

- Though print scored more points than online in achievement test, they perceived the activities to be more effective through CD-ROM (study guide, activities, module summarisation) and online (induction to study, module pre-test, study guide, module summary and post-test).
- Those who studied though CD thought that if online support was extended for pre-test, induction, activities, summary, and post-test are available as printed material, they will learn better than what they had learnt through CD.

These findings suggest that while there is no significant difference in the academic achievement mean scores between those who study through CD and through print, and

between those who study through print and online; the mean score of CD group was higher (61.85) than that of print (56.30) and online (49.10) groups. From this we may conclude that self-learning of content through exclusive interactive multimedia CD results in higher academic achievement (and is more pedagogically effective) than self-learning exclusively through print with face-to-face support or web-based learning with online learner support. These findings need to be seen in relation to the attitudinal and motivating factors reported in Panda and Mishra (2007), and design issues and preferred multimedia platform and multimedia content reported in the Indian context in Dikshit et al. (2003).

The results of this study suggest that adoption of a blended learning design strategy where students could be provided learning modules through interactive multimedia CD-ROM, and supported by printed booklets, and discussion forums and activities through World Wide Web will be more beneficial. Occasional face-to-face support for discussion and clarification of doubts is also a desired activity. Further policy initiatives and concomitant design for learning may be guided by these research findings. Also, further studies are needed into the effectiveness of different formats of learning within print-based learning, multimedia-based learning and online learning.

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