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CONTENTS

Sr. No.	TITLE & NAME OF THE AUTHOR (S)	Page No.
1.	IMPROVING THE EFFECTIVENESS OF e-GOVERNANCE PROJECT IN PUBLIC DISTRIBUTION SYSTEM (PDS) OF GUJARAT <i>PARIKSHIT TIWARI & RAVI GOR</i>	1
2.	A SURVEY ON TRUSTBASED SECURE AODV IN MANET: A LITERATURE REVIEW <i>V.VALLINAYAGI</i>	5
3.	A STUDY ON THE PERCEPTION AND AWARENESS OF THE PEOPLE ABOUT THE DIGITAL INDIA INITIATIVE OF THE GOVERNMENT OF INDIA <i>DR. ASHA NAGENDRA, ANUKRITI PANDEY & VISHAKHA BABBAR</i>	8
4.	IMPACT OF ICT & OPENNESS ON STUDENTS' PERFORMANCE IN QUANTITATIVE SUBJECTS <i>SHILPA MUJUMDAR, DR. H. S. ACHARYA, DR. TEJASWINI APTE & VENKATESH IYENGAR</i>	11
5.	RISK ANALYSIS OF EXCESS AND OBSOLETE INVENTORY IN A COMPUTER COMPANY: A CASE STUDY <i>KUSHAL NAGENDRA & DR. ASHA NAGENDRA</i>	17
6.	A STUDY ON PURCHASE BEHAVIOR OF CONSUMERS TOWARDS E-RETAILING <i>DR. G. PRAKASH RAJ, DR. A. PAPPU RAJAN & DR. J. MICHAEL SAMMANASU</i>	20
7.	TRAINING FOR SKILL UP-GRADATION IN SELECTED IT ORGANIZATIONS: A SAMPLE SURVEY <i>S. S. K. SASTRY AKELLA & DR. K. VENKETESWARA RAO</i>	24
8.	INFORMATION TECHNOLOGY AND INDIAN ECONOMY: A DISCUSSION <i>DR. BANDANA PATHAK</i>	30
9.	DIGITAL ACCESS SKILL IN THE WEB AMONG LIBRARY USERS OF PATRICIAN COLLEGE STUDENTS: A STUDY <i>G. MEENAMBIKA, S. MAIDHILI & DR. N. THILAGAVATHY</i>	35
10.	AN APPLICATIONS OF DATA WAREHOUSING <i>PADMANJALI.A.HAGARGI</i>	39
11.	A REVIEW OF E-BANKING SERVICES IN INDIAN BANKING INDUSTRY <i>DR. AVNEET KAUR</i>	44
12.	ASSESSMENT OF TEMPERAMENT, EMOTIONAL STABILITY AND SELF-CONFIDENCE AMONG DEAF AND HARD OF HEARING ADOLESCENT STUDENTS IN VELLORE DISTRICT <i>K. ELAMATHI</i>	48
13.	CONVERGENCE OF IFRS <i>SHAILAJA D.KELSHIKAR & DR. MANOJ D SHAH</i>	54
14.	FARMERS' ATTITUDE AND SOCIO ECONOMIC STATUS TOWARDS DRIP IRRIGATION SYSTEM IN COIMBATORE DISTRICT <i>DR. P. MAHESWARI</i>	58
15.	WATERMARKING USING ARNOLD TRANSFORMATION AND PRIVATE KEY <i>HARJOT KAUR & GURINDER SINGH</i>	61
16.	BARRIERS OF USING AND PRACTICING ELECTRONIC SHOPPING (AN EXPLORATORY STUDY OF VIEWS OF A SAMPLE OF CONSUMERS IN IRAQI KURDISTAN REGION ERBIL CITY) <i>ZANA MAJED SADQ, JAMIL ABDULKARIM ABDULLAH & SAID MOHAMMAD KARIM</i>	66
17.	RELATIONSHIP BETWEEN KNOWLEDGE MANAGEMENT PROCESS AND CREATIVITY AMONG FACULTY MEMBERS: A CASE STUDY OF SAMBALPUR UNIVERSITY <i>SWAGATIKA NANDA</i>	71
18.	RATIO ANALYSIS BETWEEN PRISM AND RAMCO CEMENT <i>INNA YADAV</i>	74
19.	DIGITAL MARKETING AND ITS EFFECTS ON CONSUMER DECISION MAKING PROCESS <i>MONIKA BANGARI</i>	81
20.	A STUDY ON EMPLOYEES' MOTIVATION IN A SHIPPING COMPANY <i>P. ANBANANDAN</i>	84
	REQUEST FOR FEEDBACK & DISCLAIMER	87

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IMPACT OF ICT & OPENNESS ON STUDENTS' PERFORMANCE IN QUANTITATIVE SUBJECTS**SHILPA MUJUMDAR****ASST. PROFESSOR****SYMBIOSIS INSTITUTE OF COMPUTER STUDIES & RESEARCH****SYMBIOSIS INTERNATIONAL UNIVERSITY****PUNE****DR. H. S. ACHARYA****PROFESSOR****ALLANA INSTITUTE OF MANAGEMENT SCIENCE****PUNE****DR. TEJASWINI APTE****ASST. PROFESSOR****SYMBIOSIS INSTITUTE OF COMPUTER STUDIES & RESEARCH****SYMBIOSIS INTERNATIONAL UNIVERSITY****PUNE****VENKATESH IYENGAR****RESEARCH SCHOLAR****SYMBIOSIS INSTITUTE OF MANAGEMENT STUDIES****SYMBIOSIS INTERNATIONAL UNIVERSITY****PUNE****ABSTRACT**

Open education represents a broad movement in educational reform. The openness can be incorporated by allowing students to identify problem from real life and make use of ICT that helps the learning process to get experience within the limited time. Use of ICT in education has positive impact on teaching, learning and attitudes of students'. Problem-based learning (PBL) is well suited for learning real life problems for ICT literate students. The PBL (with openness) and ICT approach was adopted by teacher to find if this mixed approach has helped students better understand the subjects' Statistics and Operations Research than by traditional approach. The authors find most of the evidences point to the fact that traditional teaching, ICT and open education do lead to better learning of the students. The subjects OR and Stats help students' in improving their logical ability and enhancing their overall quantitative skills. But when these subjects are taught by traditional methods, create a feeling of irrelevance among students and result in their low performance. Hence the researchers have studied the impact on performance of students by adopting ICT and PBL to teach Statistics and Operations Research. The sample for the study comprises of students from three different batches of an Indian techno management institute, one control batch and two treatment batches. Data was obtained from two sources: One from students' survey and another students' CGPA obtained at the final exam of semester. CGPA data is collected for all three batches whereas survey data is collected for students of treatment batches only. The results of first, second and third semesters, for control batch and treatment batches are considered for present paper. The final results of treatment batches are compared with results of controlled batch.

KEYWORDS

openness in education, ICT, PBL, statistics, operations research, quantitative skills.

1. INTRODUCTION

Open education represents a broad movement in educational reform. Open education, also known as open classroom, is a type of educational reform [Hein, George E. (1975)]. The open classroom is defined by decentralized learning areas, freedom of movement from area to area, room to room, individual or group activities, and unstructured periods of study. The central tenet of this informal system is that students will learn naturally if left to their own initiative. The openness can be incorporated by allowing students to identify problem from real life and make use of ICT that helps the learning process to get experience within the limited time.

The potential of Information and Communication Technologies (ICTs) is to provide a rich learning environment for learners. The pedagogy, access, management, cost, and the work that engaged in distance education have been significantly impacted by technological changes. As published in UNESCO (2002) information and communication technology (ICT) may be regarded as the combination of 'Informatics technology' with other related technology, specifically communication technology like email. [Cited by Noor (2013)]. ICT helps students' in learning to the extent they use it [Kuh, G. D., & Hu, S. (2001)]. Also use of ICT in education has positive impact on teaching, learning and attitudes of students' [Noor (2013)]. Problem-based learning (PBL) is well suited for learning real life problems for ICT literate students. To empower students to conduct research, apply knowledge and to develop skills to solve a problem, PBL was used [Savery 2006]. It is now recognized as an innovative instructional methodology and is used across all disciplines [Duch, Groh, and Allen 2001].

2. LITERATURE REVIEW

The concepts learnt in class applied to real life problems [Joerding (2010)] helps in reducing the feeling of irrelevance about the subject. The subjects like Statistics (Stats) and Operations research (OR), when taught to undergraduate management students by traditional method, create a feeling of irrelevance among them [Papejoj (2008), Levin (2006), Kao (1997)]. Hence the article by Kao C. et al (1997) suggests looking into pedagogy and the need of students' realization about the importance of the Statistics (Stats) and Operations research (OR) subjects. These subjects have long been accepted as an inherent part of management studies in the US and hence have been replicated in Asian countries; however, the pedagogy of OR in most of the Asian countries has not received attention. The subjects OR and Stats help students' in improving their logical ability and enhancing their overall quantitative skills [Kao C. et al (1997)]. Hence Problem based Learning (PBL) is one of the approaches that help in learning Operations Research (OR) using real life problems [Chen, Z. (2002)].

3. RESEARCH METHOD

The objective of the research paper is to identify if students learn better when openness is mixed with the traditional teaching methods and ICT. Educating for successful problem-solvers is one of the main goals of PBL [Dochy, Segers, Van den Bossche, & Gijbels, 2003]. Although originally developed for medical training in Canada, the orthodox version of PBL has been modified and applied globally in many disciplines (Gijbels, 1995). [As cited by Gijbels, D.et. al. (2005)]. In PBL, the problems are deliberately ill-structured (or open-ended) and are typically based on real-life situations; they are designed for thoughtful and careful analysis to help improve critical thinking skills by applying the learner’s own expertise and experience to data collection, analysis, and formulation of a solution (Jonassen 1999). [Cited by Macklin, A. S. et. Al. (2008)]

- The PBL was adopted by teacher to help students understand the subjects’. The study was conducted at one of the Indian techno management institute. The sample for the study comprises of students from three different batches, one control batch and two treatment batches. The students’ are taught Business maths (BM), Statistics (Stats) & Operations Research (OR) in first, second and third semester respectively. The present study took place in course of Statistics & Operations Research. Control batch (batch1) students were taught by only traditional method and have not gone through PBL in BM, Stats and OR. As no openness was introduced to batch1 students hence this batch is called as Control batch. Treatment batch (batch2, batch3) students went through PBL in Stats and OR learning. The openness (using PBL) and use of ICT contributes to 20% and Traditional teaching 80%, of total teaching. The instructions for PBL were given during the weekly lectures and through emails. The Google spreadsheet was used to monitor the progress of students. Google spreadsheet shared by teacher with students helped in better communication among them, such as information about groups of students, their domains, selection of appropriate statistical/OR technique to be used for analysis of data. The information, data collected about problem by students was stored in electronic form. Spread sheets and/s/w TORA [Taha 2006] was used by students to compute and data analysis. The analysis was discussed and concluded as report. This was summarized in open office writer/word. These reports were submitted to teacher through mail. Further the students defended results obtained in PBL by giving presentations.
- Out of three batches considered for the present study, final results of treatment batches are compared with results of controlled batch using CGPA in each semester. The students were encouraged towards initiation of the solution for real life challenges (PBL). They were encouraged to move out of the rigid boundary defined by the prescribed syllabus. Marks were allocated to this component and were included as part of the continuous evaluation process.
- The techno management students of all batches learn BM by traditional method in first semester. To differentiate the impact of components openness and ICT in treatment batch from control batch, researchers have considered the final results of each first, second and third semester for all batches (control and treatment batches). Students were asked to form groups of 3 to 5 students for Stats & OR for PBL. All the groups in respective semester were guided by only one teacher. The numbers of students participated in Statistics & OR for PBL are described in Table 1.

TABLE 1: NO. OF STUDENTS APPEARED FOR PBL ACROSS TWO BATCHES AND FOUR SEMESTERS

Semester ↓	Batch (No. of Students) →		
	Control Batch	Treatment Batches	
	Batch 1	Batch 2	Batch 3
Semester 2 (Statistics)	109	81	99
Semester 3 (Operations Research)	111	109	79

4. INSTRUMENTS

Data was obtained from two sources: source one is students’ survey and another source is students’ CGPA obtained at the final exam of each semester. The teacher introduced openness in the learning process by allowing the students to identify real life problems of their choice, collect data, store in electronic form, use software to compute and analyze, interpret and infer (PBL). The data collected by surveying these students, Pre admission performance (12th marks) and their final results as Cumulative grade points (CGPA) are considered for present paper. The questionnaire for survey was designed by teacher to get feedback/response of student after completing PBL. Student attributes like names, their nationality, medium of instruction, pre admission data are collected as part of survey. The variables relating to openness and ICT and their impact are discussed in Table 2

TABLE 2: VARIABLES DESCRIPTION IN RELATION TO OPEN & ICT COMPONENT

Variable	Impact	Percentage of Students from batch2		Percentage of Students from batch3	
		Stats	OR	Stats	OR
1 Use of Internet for Course Material	Self-learning habit -ICT attitude	40%	25%	48%	33%
2 Freedom availed to select the domain	Self-learning habit & willingness to think beyond boundary of syllabus	95%	98%	96%	97%
3 Use of internet for Data Collection	Extraction from right sources, ICT and PBL	94%	2%	96%	1%
4 Store data in electronic form,	ICT – awareness	100%	90%	100%	81%
5 Use of computer (software) for Data Analysis	ICT –attitude	92%	84%	92%	72%

The students were asked questions related to variables 1-5 and responses were collected from students as response “yes/no” to the questions asked. The percentages of students answered “yes” are shown in Table 2. Researchers observe that students’ are willing to use ICT for storing data in electronic form and its analysis. In stats students’ are willing to use internet for data collection but for OR PBL, students need to visit organization to gather information hence very few students are using internet for data collection in OR PBL. The percentage corresponding to Freedom availed to select the domain reflects majority of students’ are willing to think beyond boundary of syllabus and take up a new problem on their own.

Use of ICT essentially included, encouraging students to use Spread sheets [Levine (2006)] for organizing data and letting them make use of library functions for statistical data analysis. In case of Operations Research, students were encouraged to use spreadsheets or application software TORA [Taha]. Students were asked to articulate their experiences in word file and asked to present and defend their findings using Power Point presentations. Limited use of open source lecture management system also added up to the ICT component of the treatment. Use of shared Google docs, communication through emails and submission of reports in electronic form were the other aspects of ICT implemented by teacher.

The methodology of adopting PBL in teaching Statistics & OR was supported by Cochran (2009). He says that while operations research pedagogy was relatively static for several decades in the early life of the discipline, the landscape has changed rapidly and dramatically over the past two decades. Until approximately 1990 introductory operations research courses generally featured a heavy focus on the mathematical underpinnings of solution algorithms for various classes of problems but there are new approaches adopted like Active learning, Co-operative learning, Cases, Projects, Interdisciplinary course development, Software, Support Initiatives adopted by instructors in different institutions. The deep and long-lasting understanding of students’ takes place when they explain and defend their ideas [Joerding, (2010)]. Hence students were asked to present their work done in PBL. The evaluation components adopted for three batches are depicted in following table.

TABLE 3: EVALUATION PATTERN FOR STATS AND OR ADOPTED FOR TWO BATCHES

Batch	Internal Evaluation Components							External Evaluation Result
	Sem 1 Business Maths		Sem 2 Statistics		Sem 3 Operations Research		Weight-age	CGPA
	PBL	Present-action	PBL	Present-ation	PBL	Present-ation	(Int. to Ext. Marks)	
Control Batch (Batch 1)	N	N	Y	Y	Y	Y	60:40	Available for all three semesters
Treatment Batch (Batch 2)	N	N	Y	Y	Y	Y	60:40	Available for all three semesters
Treatment Batch (Batch 3)	N	N	Y	Y	Y	Y	40:60	Available for all three semesters

Y- YES, N- NO, Int. - Internal, Ext. - External

The Table 3 shows that Batch one did not have PBL (open) and ICT component. Hence plays the role of Control in determining the contrasts. Batch one, two and three had the same teacher for stat and OR. Batch two and Batch three had PBL and ICT components incorporated. Batch two and Batch three participated in Post survey regarding their experience (as per response form designed by the teacher). Batch two and Batch three had PBL components and hence internal evaluation patterns differed from Batch 1 as indicated in Table 3. The internal to external weights changed from 60:40 to 40:60 only for the third batch. The Tables 4, 5 show distribution of domain of data collected, Distribution of Techniques used for Statistical Analysis by students' group for treatment batches.

TABLE 4: DISTRIBUTION OF TYPES OF DATA COLLECTED BY STUDENTS FOR PBL IN STATS

Type of Data↓	Control Batches→		
	Batch 2	Batch 3	Total No. of Students' group
General data	18	2	20
Time Series Data	20	18	38
Total No. of Students' group	*38	*20	*58

TABLE 5: DISTRIBUTION OF STATISTICAL TECHNIQUES PREFERRED BY STUDENTS' GROUP

Technique used↓	Control Batches→		Total No. of Students' group
	Batch 2	Batch 3	
Data Collection Only	1	0	1
Basic descriptive statistics	22	10	32
Basic descriptive statistics, Correlation, Regression & Time Series	15	10	25
Total No. of Students' group	*38	*20	*58

* for statistical analysis spreadsheet was used by all groups of students

TABLE 6: DISTRIBUTION OF NO. OF GROUPS ACCORDING TO DOMAINS FOR PBL IN OR ACROSS BATCHES

Domain selected for PBL in OR ↓	Control Batches→		Total No. of Students' group
	Batch 2	Batch 3	
Restaurant	14	5	19
Medicine	2	2	4
Auto mobile	1	5	6
Education	1	1	2
Software company	1	0	1
Jewelry	1	1	2
Petroleum	0	1	1
Clothing	0	2	2
Super shop	0	1	1
Total No. of Students' group	20	18	38

TABLE 7: DISTRIBUTION OF TOOLS USED IN OR

Tool Used in PBL for OR↓	Batches→		Total No. of Students' group
	Batch 2	Batch 3	
Spreadsheet	4	13	17
TORA	16	5	21
Total No. of Students' group	*20	*18	*38

The problems undertaken by students' were analyzed as represented in cross tables (Table 4 to Table 7) and following hypotheses were formulated: (i) H1: There is no significant difference between the choices of data in PBL for Stats (general & time series data, Table 4). (ii) H2: selection of techniques for PBL in Stats by students across batches is not significant (Table 5), (iii) H3: There is no significant difference between the choice of domain for PBL in OR across the batches (Table 6) (iv) H4: There is no significant difference between the choice of software for PBL in OR across the batches, (Table 7). The first, second and third hypotheses relate to measure openness and fourth hypothesis relates to use of ICT. Further the descriptive statistics of CGPAs is shown in Table-8. The comparison of past and present students' performances are shown in figures 1(a) to 1(e) using histograms.

TABLE 8: DESCRIPTIVE STATISTICS OF CGPAs (FINAL RESULTS) OF STUDENTS'

Descriptive Statistics↓	Batches→								
	Control Batch			Treatment Batch					
	Batch 1			Batch 2			Batch 3		
	Sem I	Sem II	Sem III	Sem I	Sem II	Sem III	Sem I	Sem II	Sem III
AM	2.29	2.52	2.78	2.37	2.41	1.96	2.47	2.29	2.69
Median	2.50	2.71	3.01	2.59	2.52	1.98	2.67	2.46	2.84
SD	1.20	1.02	0.85	1.02	1.00	1.26	1.04	1.17	0.93
CV (%)	52.34	40.37	30.84	43.24	41.53	64.54	42.29	51.28	34.5
Skew ness	-0.34	-0.64	-1.09	-0.71	-0.33	-0.10	-0.50	-0.29	1.01
Kurtosis	-1.156	-0.31	1.03	-0.40	-0.69	-1.48	-0.83	-1.24	0.9

FIG. 1 (A): FREQUENCY DISTRIBUTION OF MATHS MARKS OF STUDENTS IN 12TH

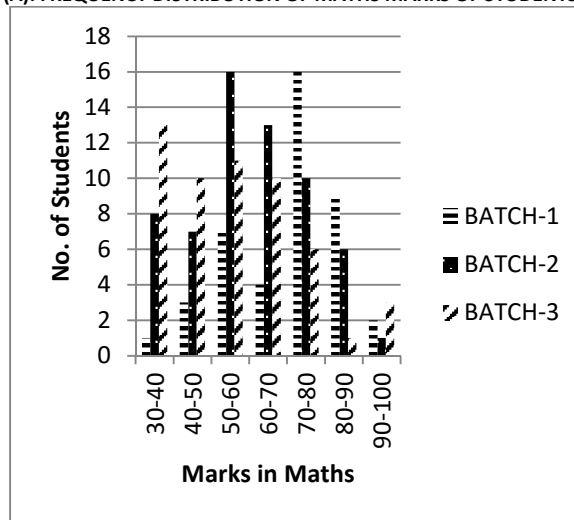


FIG.1 (B): FREQUENCY DISTRIBUTION OF AGGREGATE % OF STUDENTS IN 12TH

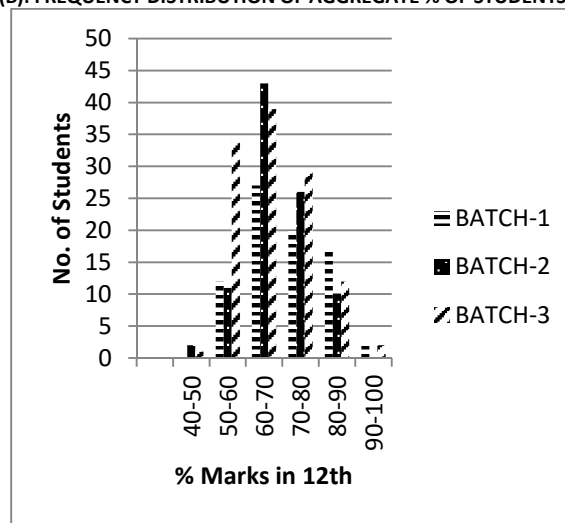


FIG. 1 (C): FREQUENCY DISTRIBUTION OF CGPA FOR CONTROL BATCH 1

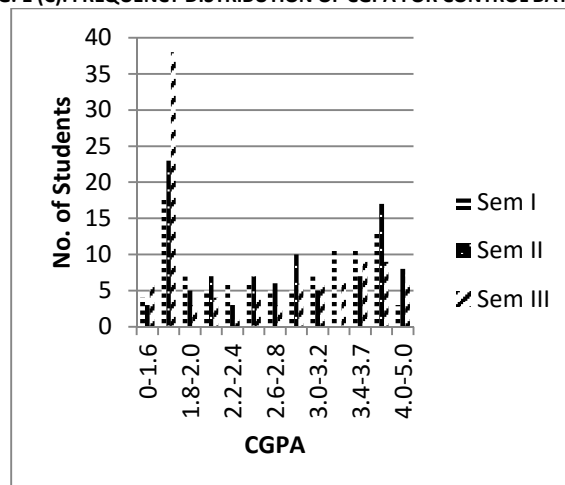


FIG. 1 (D): FREQUENCY DISTRIBUTION OF CGPA FOR TREATMENT BATCH 2

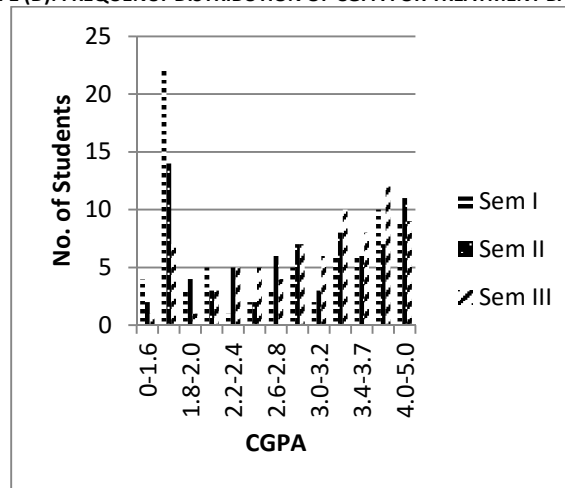
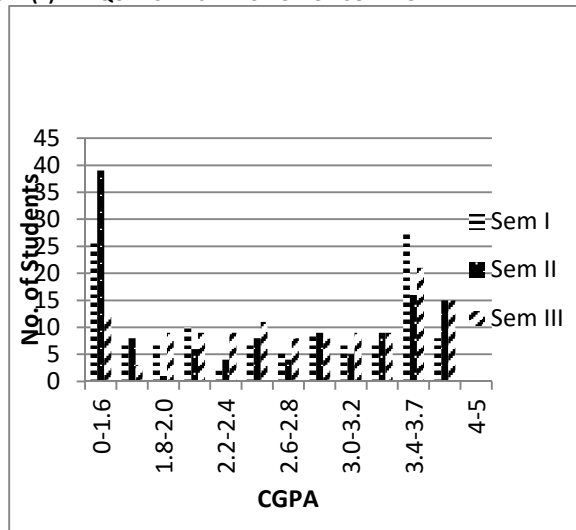


FIG. 1 (E): FREQUENCY DISTRIBUTION OF CGPA FOR TREATMENT BATCH 3



5. DATA ANALYSIS

The data analysis followed two steps process. First the survey data collected in response to PBL was tabulated in cross-tables. The Chi-square test was applied to test the hypothesis H1 to H4. The results obtained are summarized below in Table 9:

TABLE 9: RESULTS OF CHI-SQUARE TEST

Hypothesis	H1	H2	H3	H4
p-value	0.004	0.506	0.009	0.0012

The hypothesis H1, H3 and H4 are rejected at 5% level of significance. Hence it is concluded that (i) There is significant difference between the ways students choose data at 5% Level of significance for Stats PBL. (ii) There is no significant difference in selection of techniques for PBL for Stats by students across batches (iii) There is significant difference between the choice of domain for PBL in OR across the batches (iv) There is significant difference between the choice of software for PBL in OR across the batches. The Chi-square test applied to Hypothesis H1 to H4, helps to find students response towards openness in education. The Chi-square test applied to H4 finds use of ICT by students'. Descriptive statistics of CGPAs is discussed below.

The patterns of performance of the candidates prior to the admission at Techno management institute (Fig 1a,1b), and current performance using histograms (Fig 1c,1d,1e) noted the following interesting facts. Histograms of all past performances (Fig 1a, 1b) are all almost normal, with single mode and not very skewed. Histograms of CGPA, statistics and OR were mostly bimodal in all semesters and batches. Batch 1 happens to be the control. Batch 2 and 3 are the ones which were treated with allocation of independent projects.

Histograms show that of all three semesters for Batch 1 has maximum number of students scoring CGPA between 1.6 to 1.8. The variation in CGPA is least in Sem II and largest in Sem III. CGPAs are negatively skewed and platykurtic in nature for all semesters. In case of all three semesters for Batch 2, most number of students have got CGPA between 1.6 to 1.8 in Sem I, but in Sem II and Sem III maximum number of students have got CGPA between 3.7 to 4. There is reduction in variation as semester progresses and variation in CGPA is least in Sem III. CGPAs are negatively skewed and platykurtic in nature for semesters I and II, whereas negatively skewed and leptokurtic for semesters III. For two semesters of Batch 3, most number of students have got CGPA between 1.6 to 1.8 in Sem I but in Sem II maximum number of students have got CGPA between 3.7 to 4. The variation in CGPA of Sem III is larger than Sem II. CGPAs are negatively skewed and platykurtic in nature for both semesters.

Hence the past performances are almost symmetric distributions close to a normal distribution. However, the distribution of CGPA, an indicator of the total performance at techno management institute, is non symmetric and bimodal under the newer system of education (in Sem II & Sem III). The authors find most of the evidences point to the fact that traditional teaching, ICT and open education do lead to better learning of the students. Use of ICT in education helps to enhance performance of the student [Zahariev, P. et. Al. (2013), Vaičiūnienė, V. (2012), Morris, H. (2009, March) Macklin, A. S. (2008)].

The findings of this study indicated that when using a PBL approach to teach and reinforce ICT skills, students were able to formulate more sophisticated problem representations than they did on their own by sharing experiences and prior knowledge. Despite the fact that the sample size was small, students collectively Demonstrated a shift from weakly defined information goals, to well-articulated research needs, [Macklin, A. S. (2008)].

6. CONCLUSION

The results of the experiment have produced quite a few evidences in support of the argument that students learn better when openness is mixed with the traditional teaching methods and ICT. The researchers have observed use of ICT acts as a strong catalyst, especially when the students are comfortable with use of computers and naturally accept the assistance provided by the software. Software libraries provided a larger set of functions to choose from and students learn more by using rather than reading about them. However, attributing the changes only to openness and ICT may not be complete truth for better learning. The students' background, irrelevance feelings regarding quantitative subjects among students need to be considered along with PBL and openness to identify better learning.

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