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Survey on Student's Perception of Class Room Environment in an Engineering College

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Abstract
Effective learning is possible if students new learning patterns, evolving education technologies and methodologies are better understood by all stakeholders. The man-machine model for a class-room is proposed and analyzed through a case study. The paper focuses on the student's perception of current teaching-learning environment and the issues therein. A questionnaire survey (n=178) is done on the students of one of the engineering colleges in the State of Kerala in India. The factor analysis of the worksystem factors indicated three distinct dimensions, i.e., 'Technology', 'General environment' and 'Work environment', and that for outcome measures indicated the following three dimensions, 'Performance', 'Review effort', and 'Mental & physical strain'. The case study indicated a weak 'Technology' interface, i.e., use of modern IT & Communication facility is low, internet facility is inadequate. In 'General environment' dimension heat-stress, glare and audibility is cause for concern. In 'Work environment' dimension physical configuration due to furniture arrangement is a cause for concern. In 'Review effort' dimension the self-study effort needed is high. Students rating for 'Performance' dimension are largely satisfactory, but their ratings for 'Mental & Physical strain' dimensions indicate they are not satisfied. This calls for 'Technology' improvement by providing stable internet facility and connectivity. The 'Work environment' could be improved through ergonomic design of furniture design and its layout, while 'General environment' could be improved through better air circulation or air-conditioning. Traditional classrooms with rows of desk facing the teacher and the board do not fulfil present day educational needs and expectations; therefore the available space at colleges requires adaptation to new contexts and roles in education. Human factors such as age, experience, motivation and course factors such as course type, content and scheduling needs to be explored so that the nature and impact on the interactions in teaching-learning environment can be better understood. The causal loops of worksystem factors on outcome measures could be studied through a structural equation modelling.
Keywords: Smart class-room, Active learning, Ergonomics, Man-machine interaction, Information technology, Students perception, Factor analysis

1. Introduction

The teaching-learning environment is being influenced by technological advances in information and communication technology domain worldwide, and India is no exception. The concept of 'electronic learning', 'digital class room', 'smart class room' has emerged as a new interactive learning environment. The educational practices are getting transformed by initiatives such as, outcome based accreditation, ensuring richer learning experience through open educational resources, providing mass and flexible learning through distance learning programmes and satellite based course, changes in pedagogical practices from instructor based to student centered learning, evolving classroom configurations, and advances in interaction tools, devices and platforms (Beauchamp and Kennewell, 2010; Baepler et al., 2014; Castro et al. 2010; Dillenbourg and Evans, 2011; Froyd et al., 2012; Ismael and Al-Badi, 2014; Jamil et al., 2013; Lee et al., 2013; Murica, 2012; Smith, 2013; Wegener

and Leimeister; 2012; Yang et al., 2013). The significant advances in technology enabled classroom are related to infrastructural devices, physical and mobile devices, communication and distribution, soft system (Rajesh and Reena, under review). The performance outcomes are, (i) immediate outcome measures such as interaction achieved, clarity, learning satisfaction, cognitive and physical load demanded, discomfort or fatigue experienced; and (ii) long term outcomes such as grades attained, knowledge gained, confidence built, ability to collaborate, industry readiness, carrier opportunities, course workload, course satisfaction, work satisfaction and work stress, dropout and turnover rate, investment and costs, administrative and policy conflicts (Beauchamp and Kennewell, 2010; Becerik-Gerber et al, 2011; Felder, 2012; Fonseca et al., 2014; Freeman et al., 2014; Kim and Frick, 2011; Meydanlioglu and Arikan, 2014; Oh and Reeves, 2014; Singh, and Mohamed, 2012; Tubaishat, 2014; Venkatesh et al., 2014). The changing environment does have significant impact on both the immediate outcome measures and long term outcomes. The technology enabled class room calls for not only the integration of worksystem dimensions, i.e., course, technology, environment and human factors, but also needs to consider the issues pertaining to technology adoption (Ismael and Al-Badi, 2014; Mohammed, 2013; Murcia, 2012; O'bannon and Thomas, 2014; Sharija et al., 2012; Wegner and Leimeister, 2012; Wilson, 2014).

Devices in a technology enabled classroom can be divided into two categories: infrastructure-devices and mobile-devices. The infrastructure-devices are stationary in each classroom, and provide the necessary information to the mobile-devices. The mobile device belongs to the students and the instructor. Using these mobile devices, the instructor and the students can actively interact among themselves in a classroom. Current teaching practice are predominantly instructor based approach, but they are now challenged by advances in educational technologies and the needs placed by the different stakeholders. The current approaches in integrating technology in instruction, learning, and performance should be determined by considering the potential pedagogical effectiveness of a technology in relation to specific teaching, learning and work contexts (Eunjung et al., 2014). Interaction quality is a major factor in deciding the students perception of quality of educational service (Jain et al., 2013; Kashif and Basharat, 2014) and calls for enhancing interaction quality. Today's higher education institutions and workplaces have highly diverse worksystem characteristics, and it is important to factor in the multiple dimensions of the worksystem (Figure 1) while redesigning the classroom or while considering change management.

Worksystem outcomes are numerous and needs to be carefully studied to understand the role and effect of the different worksystem dimensions. The review of Rajesh and Reena (under review) provides an insight on the different worksystem dimensions relevant for a learner-centered classroom. The review provides a human factor/ergonomic analysis using a man-machine model (Bridger, 2009) for digital class room (see Figure 1). The components of the worksystem are work environment, general environment, humans and course through which the teaching-learning occurs. The terms man-machine interaction, human-machine interaction and worksystem interaction have been synonymously used in this paper to signify how each task elements are processed and transformed through the work system components. The man-machine interactions are made feasible by a set of actions consisting of display, sensory mechanism, central processor, effector mechanism and controls. The commonly used display devices include black/white boards, laptops and projection screens. Controls here refer to devices through which the teaching-learning process or activities are controlled. This shall include chalk-pen-pencil, keyboards-keypads, electronic had held devices. The senses are the means by which we are made aware of our surroundings, i.e., sight, hearing, touch, taste and smell. They receive the signals (i.e., audio, video or vibration signals) from control-display devices, and send them to central processor. Central processes involve two fundamental activities, i.e., energy generation and information processing. The sensory signals actuate the three primary effectors, i.e., hands, feet and voice. Through voice or hand activations controls could be executed. The work environment is decided by the physical configuration of room furniture, controls and display devices. The general environment is decided by temperature, air, light and sound settings within the room. Apart from the work environment, the human factors such as motivation, skill set and knowledge level, nature of course and its content influences the nature of teacher-student interaction. The immediate positive outcomes include enhanced active learning, and lower review effort, while negative outcomes include poor clarity, boredom or disinterest, mental and physical strain. The long term positive outcome is better grades, carrier opportunities and course expertise, while negative outcome include psychological stress.

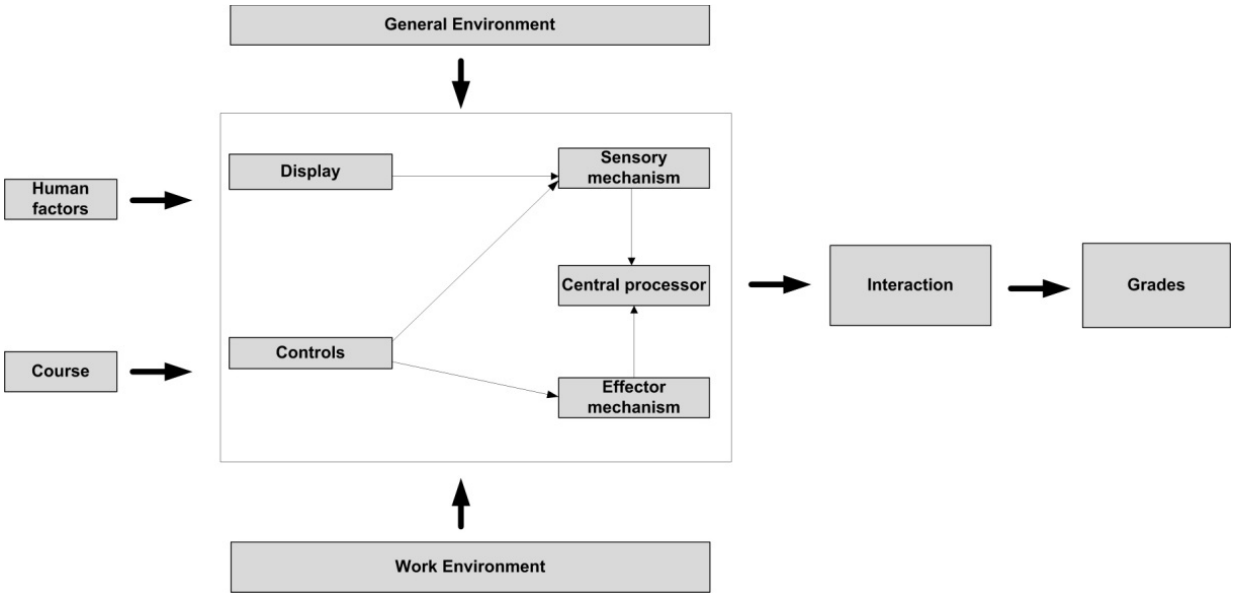


Figure 1: Worksystem dimensions and interactions for class room teaching

The objective of this paper is to undertake a survey on student's perception of class room environment in an engineering college in India, and highlight the lacunae in the current teaching-learning environment from an ergonomic perspective. The methods section describes the details of the questionnaire and the survey conducted. In the next sections, the results and discussion from the survey are presented. Finally, Section 4 presents conclusion drawn from the survey.

2. Method

Literature on teaching-learning practices and developments in smart-classroom is reviewed. The significant factors that affect quality and effectiveness of a classroom are determined from this literature survey (see Section 2.1). This survey was planned based on the braining storming sessions with a 10 member panel consisting of four student project members, two post-graduate students and four faculty members. The larger focus in this survey was on physical configuration. It was decided to consider 'Course' and 'Storage' in the next stage of this survey after conducting a workshop on technology enabled classroom and its impact. A questionnaire is prepared after a series of brain-storming discussions involving this panel. A three part questionnaire was prepared (see section 2.2) and a pilot survey was conducted (n=178) and its validity is statistically analyzed. Data analysis includes testing questionnaire validity through cronc-back alpha, descriptive statistics of each of the questionnaire component, and Factor analysis through SPSS software.

2.1 Class-room factors

Figure 2 shows the various factors that affect the interactions in a teaching-learning environment. This include factors relating to 'Student' (i.e., Adaptability to changes, Interest in learning, Inter relationships, Emotions, Level of knowledge), 'Faculty' (i.e., Training, Interest in teaching, Dedication, Experience), 'Storage' (i.e., Digital storage, Tools storage, study material), 'Connectivity & Internet', 'Communication Facility' (i.e., audio signal, video signal), 'Environment' (i.e., Lighting, audibility), 'Course' (i.e., nature of subject, credits, evaluation), 'Space' (i.e., Arrangement, Movements, Dimension of classroom), 'Time' (i.e., duration, schedule, rest intervals, refreshment), 'Furniture' (i.e., postures for writing-reading-physical activity), 'Security and safety' (i.e., Fire safety, theft).

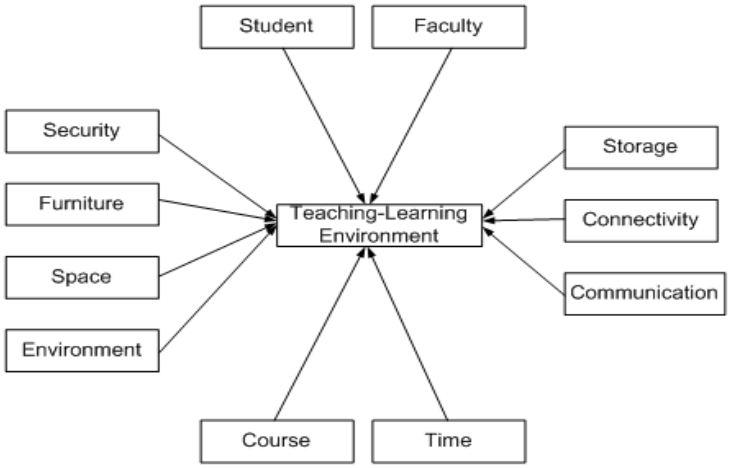


Figure 2: Factors affecting teaching-learning environment

2.2 Questionnaire Survey

The case study institution is a well know engineering college in south India which is undergoing institutional transformation towards outcome based education. Initiatives towards infrastructure, faculty training and administration reforms have been undertaken with active participation by different stakeholders, i.e., students, staff, management, academic bodies and government. This study focuses on the students voice with respect to their classroom.

Based on the brain-storming sessions a 3 part questionnaire was developed. The three parts A, B and C are explained below. Part-A consists of 12 questions for the assessment of current teaching-learning environment that accounts for factors such as connectivity & internet, space, lighting, communication facility etc on a five point likert scale (e.g., A1). Part-B is a checklist based questionnaire eliciting responses from on the typical issues faced in the current environment. It contains 7 questions (e.g., B1). Part-C consists of 8 questions to assess the outcome measures such as active learning achieved, academic grades and health issues (e.g., C1).

A1. Knowledge of modern IT & Communication tools and technique by faculty
(Note: Projector, Connectivity, Internet, Digital library, etc)
1 – poor 2 – fair 3 – good 4 – very good 5 – excellent or exceptional
B1. Which of the following issues are prevalent in the class-room
a. zig-zag furniture arrangement b. awkward placement of boards/displays
c. short pathways d. long class-room e. rigid furniture
C1. Postural stress experienced on body due to physical demand in a class-room
(i.e., discomfort or pain on arm, shoulder, neck, back and legs)
1 – Very high 2 - High 3 - Light 4 - Comfortable 5 - Very comfortable

A pilot survey of the questionnaire prepared was administered randomly to 40 final year students (10 each from 4 different classes). The analysis of pilot survey indicated a low value of cronbach's alpha (0.542) for Part C, but acceptable value (0.78) for Part A. The likert scale for the stress related questions in Part C were modified, and a second pilot survey was done to test the questionnaire. An acceptable chronbach's alpha (>0.7) for the Part C was obtained. Next the main survey was conducted.

The population considered is 1500 from six engineering branches having four batches corresponding to 1st year, 2nd year, 3rd and 4th year and with a class strength of 60-70 students each. A random sampling was done with an expected proportion of 0.1 from the population and at 95% confidence level. Two methods were adopted to conduct the survey, (i) direct method: printed questionnaires were issued in various classes; (ii) online method: the final questionnaire was uploaded and developed an online form through Google Docs which could be filled by the students from anywhere. The direct URL was made for the form as www.tinyurl.com/smartclassrit. The poster was created and shared through social networking sites like Facebook for campaigning students to respond to the questionnaire. The response data collected were recorded in spread sheet. The response obtained was 178. The chronbach's alpha obtained from the final survey data analysis is > 0.85, so the reliability of the questionnaire is good.

3. Results & Discussion

3.1 Class-room factors

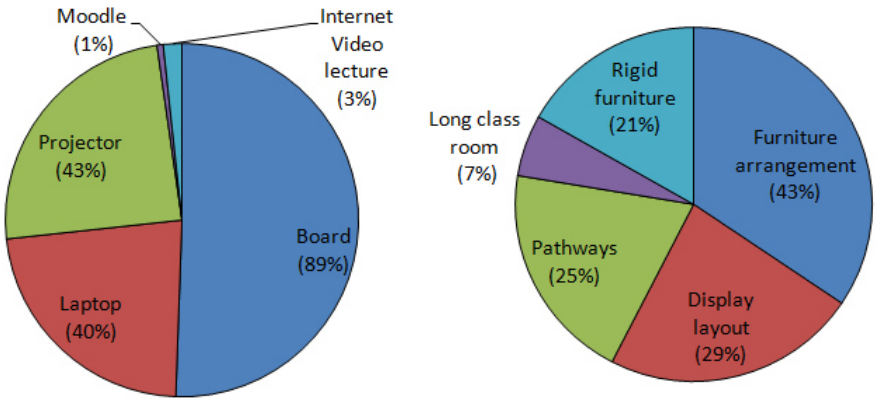
Table 1 shows the mean responses of the Part-A containing the dimensions of the teaching-learning environment. More than 50% were not satisfied (i.e., below good rating) on some of the factors such as 'internet

connectivity' (Q3- Availability of connectivity & internet facility for students in class room and Q4 - Use of connectivity & internet facility by students within class-room) and furniture design (Q7- Availability of class room furniture and its features to accommodate student's requirements). Amoung the rest of the questions, lighting conditions (Q8-Availability of adequate lighting system and visibility level in the classroom) had better ratings.

Table 1: Descriptive statistics of worksystem factors (Part A)

Factor (Question No)	Mode	Mean	Std. Deviation	% below acceptable (< 3)
Faculty skill in IT (Q1)	3	2.67	0.87	43.3
Use of IT (Q2)	2	2.48	0.99	52.2
Connectivity (Q3)	1	2.01	1.39	72.5
Use of internet (Q4)	1	1.98	1.34	75.3
Space availability (Q5)	2	2.69	1.09	46.6
Layout (Q6)	3	2.62	0.98	44.9
Furniture flexibility (Q7)	2	2.47	1.03	51.7
Lighting & Visibility (Q8)	3	2.93	0.94	28.7
Sound (Q9)	3	2.54	0.94	48.3
Temperature and air quality (Q10)	2	2.59	1	48.9
Safety and security (Q11)	3	2.65	1.11	40.4
Duration (Q12)	3	2.6	0.81	42.1

The pie chart shows (Figure 3) the students perception about the issues about their teaching-learning environment. The Part-B complements the factors in Part-A. The common interactions tools used include board, laptops and projectors (Figure 3(a)). Though Faculty does have ability to use information and communication technology (Table 1, Q1) there is paucity of actual use of internet and internet resources because of information technology infrastructure recourses (Table 1, Q3 and Q4). The spatial and general environment is examined through questions 2 to 6 of Part B (see Figure 3(b)-(d)). There appears to be low interactions leading to outcomes such as boredom, lack of concentration and clarity (Figure 3(g)). Furniture layout, glare, faculty audibility and heat are among the major issues highlighted by the respondents. Figure 4 (a) shows the current furniture design, and Figure 4(b) shows the layout in the classroom. Some of the issues related to furniture design include congested sitting space, poor desk slope and insufficient desk width, and zig-zag arrangement. Though response to light settings (Q8) is more than acceptable the issue of glare is one of the influencing visibility issue. The glare issue arises due to bad arrangement and orientation of display devices, and lighting interference from within and outside (Figure 4(b)). Classrooms appear to be secure as per student's response (Table 1, Q11). Nonetheless, with respect to safety/security issues prevalent in classroom most of the respondents indicated 'misplacement' and 'material damage' as a cause for concern.



(a) (b)

Figure 3: (a) Interaction tools used, (b) Class room layout

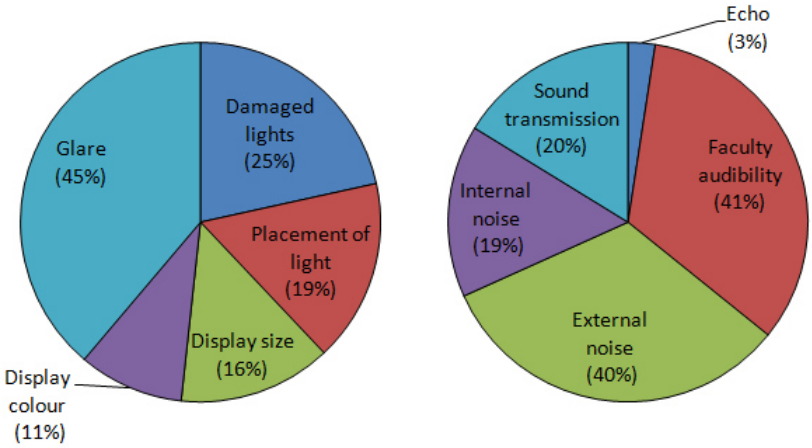


Figure 3: (c) Lighting environment, (d) Sound settings

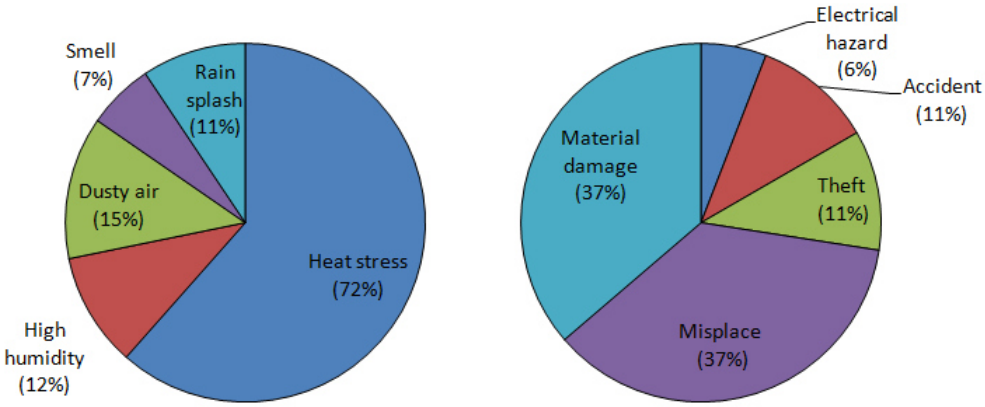


Figure 3: (e) General environment, (f) Safety and Security.

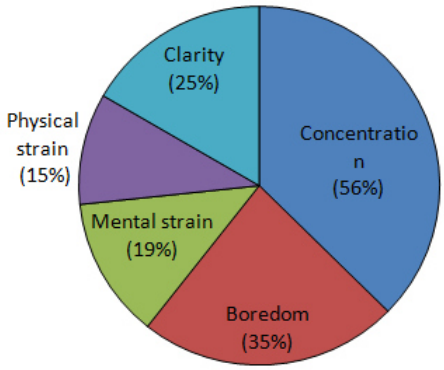


Figure 3: (g) Interaction dependent outcome

(a) (b)

Figure 4: (a) Current furniture design and layout, (b) Current class room layout

3.2 Outcome measures

Table 2 provides the summary of outcome measures surveyed. The 56.2% of students perceive their classroom provides satisfactory 'active interaction and learning' environment, indicating the need for improving the interactions. Only 37.6 % of the students perceive that the efforts in the classroom engagement are enough to achieve adequate grades. The causal factor for the low rating needs to be explored. Only 53.4 % and 60.1 % of the students perceived a favourable performance in internal and external evaluations respectively. In this study, the role of 'active interaction & learning' or 'self study effort' on outcome measures 'internal' and 'external' has not been explored. It is hypothesised that increased 'active interaction & learning' would lower 'self study effort' needed and improve the 'internal' and 'external' evaluation scores.

Table 2: Descriptive statistics of performance measures (Part C)

Outcome measure	Mode	% response
Active interaction & learning (Q1)	3	56.2 for good to excellent
Self-study effort (Q2)	2	37.6 for moderate to none
Internal evaluation (Q3)	3	53.4 for good to excellent
External Evaluation (Q4)	3	60.1 for good to excellent
Eye and Head stress (Q5)	3	79.8 not comfortable
Hand stress (Q6)	4	59 not comfortable
Whole body stress (Q7)	3	70.8 not comfortable
Environmental stress (Q8)	2	80.3 not comfortable

A large percentage of students do perceive cognitive and physical stress due to class-room engagement. This includes, 79.8 % do have cognitive stress (eye strain, head ache, poor focus or attention, boredom), 59% do have physical strain on hand (finger, palm and hand), 70.8 % do have postural stress (discomfort on arm, shoulder, neck, back and legs) and 80.3 % do feel environmental issues (due to heat, humidity, light, noise, air). The natures of stress were examined further through non-parametric tests. There was a statistically significant difference in students stress perception due to cognitive stress, whole body postural stress and environmental stress, $\chi 2(2) = 7.995$, $p = 0.018$. Post hoc analysis with Wilcoxon signed-rank tests was conducted with a Bonferroni correction applied, resulting in a significance level set at $p < 0.017$. Median (interquartile range) perceived rating levels for the cognitive stress, whole body stress and environmental stress were 3 (2 to 3), 3 (2 to 4) and 3 (2 to 3), respectively. Students perceive a light stress condition due to both cognitive and whole body postural demands, but a Wilcoxon Sign-Rank Test indicated they were not statistically different ($Z = -1.19$, $p = 0.234$). Further, whole body postural stress was significantly different from environmental related stress ($Z = -3.079$, $p = 0.002$), and students perceive greater environmental stress than whole body stress. Wilcoxon Sign-Rank Test was used to examine hand stress vis-a-vis whole body postural stress rating. The non-parametric test indicated that hand stress and whole body stress were statistically different ($Z = -3.588$, $p = 0.000$), and their median ranks indicate students perceive greater whole body stress than hand stress.

3.3 Factor analysis

Table 3 shows the factor analysis done on the worksystem factors through SPSS Promax procedure with Kaiser normalization. The three distinct factors are factor-1 corresponding to 'Technology', factor-2 corresponding to 'Work environment' and factor-3 corresponding to 'General environment'. The amount of variance explained is 60.4%. Table 4 shows the factor analysis done on the outcome measures through Promax procedure with Kaiser normalization in SPSS software. The amount of variance explained is 67.7%. The three distinct factors are

factor-1 corresponding to 'Mental and physical strain', factor-2 corresponding to 'Performance' and factor-3 corresponding to 'Review effort'. The loading plots along with the three factors identified are shown in Figure 5.

Table 3: Structure matrix for 3 extracted components from worksystem factors

Worksystem factors	Component		
	1	2	3
Faculty skill in IT (Q1)	**0.727**	0.307	0.319
Use of IT (Q2)	**0.781**	0.276	0.231
Connectivity (Q3)	**0.857**	0.358	0.294
Use of internet (Q4)	**0.818**	0.422	0.293
Space availability (Q5)	0.531	**0.758**	0.405
Layout (Q6)	0.293	**0.877**	0.403
Furniture flexibility (Q7)	0.355	**0.843**	0.411
Lighting & Visibility (Q8)	0.283	0.507	**0.652**
Sound (Q9)	0.106	0.422	**0.72**
Temperature and air quality (Q10)	0.251	0.208	**0.75**
Safety and security (Q11)	0.291	0.512	**0.629**
Duration (Q12)	0.487	0.288	**0.636**

4. Discussion

With respect to man-machine model shown in Figure 1, 'Work environment', 'General environment' and 'Technology' are the three dimensions contributing to the class-room interaction. It appears that 'Human factors', 'Course' and 'Display-Control devices' in the man-machine model are represented by the 'Technology' dimension here. In this study, the physical configuration of the furniture and its layout in the available space of the classroom is represented by 'Work environment'. The limited survey conducted in this case study has provided an opportunity to explore the worksystem characteristics further. For example, the characteristics of 'Human factor' such as anthropometry or motivation or skill set or age, 'Course' such as content or type, 'Work environment' such as layout of display and control devices or space design, 'General environment' such as air-conditioning or sound proofing needs to studied further. The teaching-learning interaction leads to three distinct outcome measures, i.e., 'Review effort' required, 'Mental and Physical strain' caused, and 'Performance' achieved (Figure 6). The framework in Figure 6 needs to be examined further for causal relationship between the various dimensions of the worksystem by considering some of the specific characteristics within each dimension. The study provides directions to undertake the following interventions;

Table 4: Structure matrix for 3 extracted components from outcome measures

Outcome Measures	Component		
	1	2	3
Active interaction & learning (Q1)	.226	**.639**	.307
Self-study effort (Q2)	.198	.060	**.954**
Internal evaluation (Q3)	.053	**.841**	.027
External Evaluation (Q4)	.034	**.848**	-.063
Eye and Head stress (Q5)	**.792**	.223	.191
Hand stress (Q6)	**.782**	.072	.426
Whole body stress (Q7)	**.793**	.086	.199
Environmental stress (Q8)	**.763**	-.022	.007

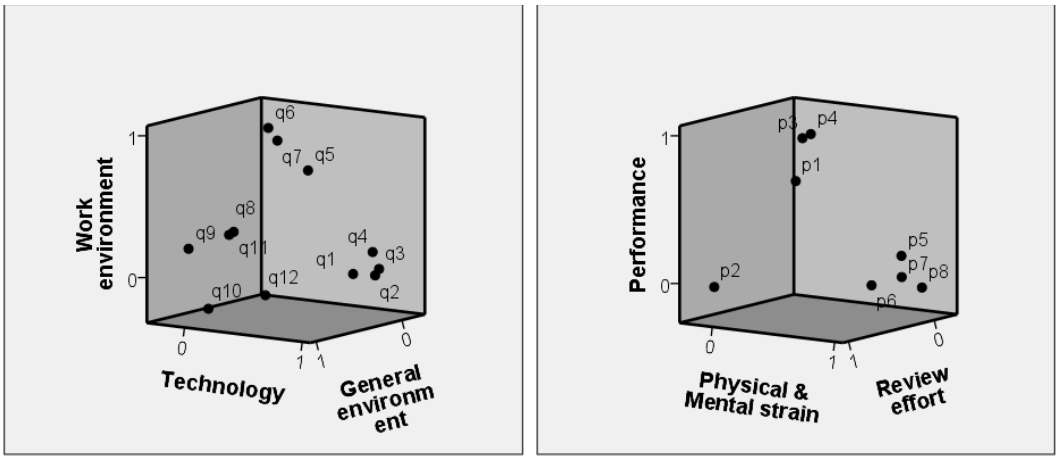


Figure 5: (a) Loading plots for 3 extracted components from worksystem factors, (b) Loading plots for 3 extracted components from performance measures

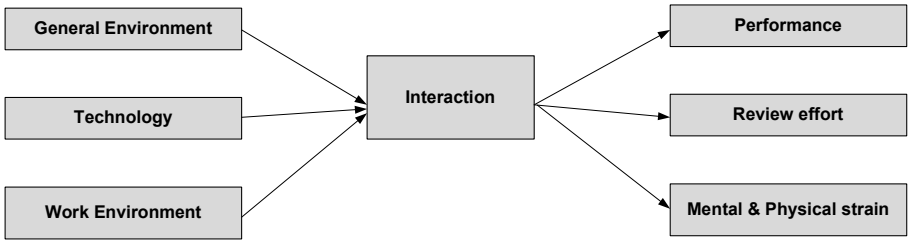


Figure 6: Worksystem dimensions and Outcomes for a class-room

- Improvement of 'Technology' dimension through better connectivity, internet access to digital multi-media and display devices. The operational parameters such as 'reliability' and 'availability' is critical for connectivity, and the choice of service provider (e.g., IT suppliers, networking managers, and internal maintenance cell) or the operational clauses of the exiting information technology service providers needs to be redefined. Studies by Tyagi (2012), Gupta and Fisher (2012), Chawala and Joshi (2012), Vasant and Mehta (2015) are cases on technology enabled teaching-learning environment and its impact. Such studies indicate improvement in class participation and examination results. The issues of technology adoption is primarily related to Human factors such as age, gender, perceived behavioural control, previous exposure or skill possessed, and organizational factors (Dhanarajan and Abeywardena, 2013; Harishankar et al., 2013; Patra, 2012; Rastogi and Malhotra, 2013), such as resource allocation, educational practices and policies, assessment methodology, stakeholder perceptions and influences, and University regulations or Academic bodies regulations. The intervention calls for enhanced funding for technological infrastructure upgrading through active commitment by the College Management.
- Improvement of 'Work environment' dimension by undertaking a detailed anthropometric study, followed by ergonomic design of the furniture and space configuration (Asif et al. 2012; Castellucci et al., 2014; Cheryan et al., 2014). The intervention calls for active participation by the College Management and Furniture designers.
- Improvement of 'General environment' dimension through better air-conditioning and sound proofing (Bluyssen, 2014; Cheryan et al., 2014; Catalina and Iordache, 2012; Yang et al., 2014; Xiaoyu et al., 2011). The intervention calls for enhanced funding for physical infrastructure by the College Management.

Some of the limitations of the study include,

- The human dimension consists of student and staff. In this study, staff perception is not accounted for within the worksystem model considered.
- Only limited numbers of factors within each worksystem dimensions are considered.
- Causal loop and interrelationships between workstsystem dimensions are not explored.
- There is likely to be bias in students perception of their internal (Part C, Q3) and external (Part C, Q4) evaluation. Instead, the use of actual marks obtained could be realistic.

5. Conclusion

The man-machine model for a class-room is proposed and analyzed through a case study. The case study

indicated a weak 'Technology' interface, i.e., use of modern IT & Communication facility is low, internet facility is inadequate. In 'General environment' dimension heat-stress, glare and audibility is cause for concern. In 'Work environment' dimension physical configuration due to furniture arrangement is a cause for concern. Since Faculty has good knowledge in information and communication tool, it is likely that a 'Technology' intervention would provide better class-room interaction. In 'Review effort' dimension the self-study effort needed is high. For 'Performance' dimension the students rating is largely satisfactory, but their ratings for 'Mental & Physical strain' dimensions indicate they are not satisfied.

The lacunae in the worksystem dimensions were indentified and three interventions have been suggested. The study calls for 'Technology' improvement by providing stable internet facility and connectivity. The 'Work environment' could be improved through better furniture design and layout, while 'General environment' could be improved through better air circulation or air-conditioning. It is hypothesised that better class-room interaction would help in improved 'Performance' and lower 'Review effort'. The causal loops of worksystem factors on outcome measures could be studied through a structural equation modelling. Human factors such as age, experience, motivation and course factors such as course type, content and scheduling needs to be explored so that the nature and impact on the interactions in teaching-learning environment can be better understood.

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