Interaction Designed Interface for Smart Learning Behavior in Disruptive Environments

Sadia Riaz [1], Arif Mushtaq [2]

[1] Amity University Dubai, [2] HCT Dubai.

Abstract - Smart Learning Environments (SLEs) are designed by integrating Usability design principles, aesthetics and functionalities, however, contextual constituents supporting Smart Learning Behavior (SLB) are rarely considered. Particularly, how Peer-Assisted Learning (PAL) is effective when compared with Faculty-Assisted Learning (FAL) in a VoIP based Disruptive Learning Environment (DLE). Studies report that learners focus on superficial features instead of the underlying principles, concepts, or theories in design-centric SLEs. Likewise, learners acquire individual skills or pieces of knowledge in SLEs that they are unable to apply in user-centric complex contexts. In this paper, a framework is evolved to address the design and development considerations of SLEs with a focus to empirically validate the effectiveness of PAL in comparison with FAL. The study is a Quasi-experimental design with manipulative and controlled non-repeated groups. Disruptive contextual factors (DCF) are believed to be ingredients of SLB and are cross-examined using Univariate-Analysis, Cohen's D, Partial Eta squared values and Standardized Beta Coefficients. The experimental data was analyzed in PASW 2.0. This study empirically validates the effectiveness of DCF and concludes SLB is better supported through PAL than FAL in a SLE. The study findings support institutions of higher learning in the process of transition and transforming old models of university education into SLEs. While HCI researchers may benefit in defining cognitive thought processes behind PAL that support SLB in DLE.

Keywords - Smart learning environments, Smart learning behavior, Disruptive learning, Peer-assisted learning.

I. INTRODUCTION

Smart learning is currently attracting much attention with a potential being backed by global E-learning trends and market, which had a worth of 165.36 billion US dollars in 2016, and 166.6 billion US dollars in 2017 [1]. It is estimated that e-learning market will surpass 243 billion U.S. dollars at a 5.08 percent CAGT in 2022. The ever growing financial value of e-learning is matched only by the swelling numbers of students choosing to follow an online course. The growing use of ICT within educational environment is attributed to high-speed fiber-based broadband. In 2013, the North American e-learning management systems market was worth 1.5 billion U.S. dollars suggesting, an enormous increase in capability of internet services devoted to distance education [2].

The global market for E-learning in 2013 was defined to have three categories: Learning Management Systems (LMS), packaged content, and other services. However, in 2016, leading product categories emerged to be: packaged content, services and platforms. It pointed a dramatic shift in a period of 3 years in E-learning paradigm from LMS to smart learning applications. It is estimated that in 2016 revenue for packaged content was about 33 billion U.S. dollars. In a survey, 67 percent of respondents stated that they used online educational videos in the classroom during a typical week in 2016. Educational applications had a 65 percent weekly usage rate. In the latest Global Shapers Survey of 25,000 young people from across the world, 77.84 percent of respondents reported having taken online courses in the past, based on a smart learning application [3].

Smart learning is attributed to technological advancements in recent times that works through big data, open data, sensors, artificial intelligence and new ways of connectivity and exchange of information like IoTs, RFIDs and Disruptive Innovations [4]. It is argued that smart learning may not be really smart and effective, unless it is backed by synchronization and concerted use of different technologies that constitutes smart behavior [5].

If smart learning behavior is what makes smart learning successful, then understanding contextual factors is imperative for designing smart learning applications. Learning Management Systems (LMS) such as Moodle, Zoom and Blackboard Learn have changed the way how smart learning occurs over the internet medium. There are also numerous studies that report usefulness, selection criteria, learner's perception, expectations, and discuss effectiveness of LMS. However, recent research requires focus on contextual factors that constitute Smart Learning Behavior (SLB) in addition to providing relevance, feedback and various smart functionalities in designing SLEs [6]. Contemporary research is focused on describing phenomenon in Disruptive Learning Environments (DLEs) in the form of case studies or on discussing isolated technological developments. There is lack of empirical research that integrates and compares effectiveness of contextual factors associated with SLB and effectiveness of Moderator (Faculty/Peer) in SLEs. It is, therefore, important to understand contextual factors influencing SLB and

difference in perceptual effectiveness of learners in FAL-versus-PAL to design smart learning applications.

II. LITERATURE REVIEW

In this empirical study, literature review is conducted to validate effectiveness of Peer-Assisted Learning (PAL) versus Faculty-Assisted Learning (FAL) in SLEs for the purpose of studying contextual factors associated with SLB in DLEs.

A. Peer-Assisted Learning (PAL)

Peer-Assisted Learning (PAL) is a kind of cooperative learning where students work in small groups to accomplish shared goals. Students with high ability work together with students with low ability in solving mathematical problems, thus maximizing their own and each other's learning [7]. Much has been written in support of PAL with regard to pedagogical advantages such as improved performance and widening student retention [8]. As Tinto concludes, "Students who are actively involved in learning, that is who spend more time on task especially with others, are more likely to learn, and in turn, more likely to stay." [9]. Benefits of PAL include development of skills, encourages autonomy, gains experience, increased confidence, increased academic performance [10].Increased student retention has also then been demonstrated to have economic benefits to the institution. From a curriculum point of view, cap stick has also undertaken a comprehensive study of qualitative data to conclude positive results for students who have attended PAL in relation to 'meaning-oriented outcomes' (as opposed to solely strategic-orientated/ assessment driven outcomes), understanding course material and enhancing the ability to do well in assessed work [11].

B. Faculty-Assisted Learning (FAL)

There are many studies that explore relationship between faculty teaching practices and student engagement. Findings from various reports suggest that students report higher levels of engagement and learning at institutions where faculty members use active and collaborative learning techniques, engage students in experiences, emphasize higher-order cognitive activities in the classroom, interact with students, challenge students academically, and value enriching educational experiences [12]. As a matter of fact, faculty members create a context for learning, through their behaviors and attitudes that relate to students engagement behaviors, student perceptions of environment, and student self-reported gains. Therefore, role of faculty as mentors is highly significant in a learning environment.

C. Smart Learning Environments (SLEs)

The International Telecommunication Union estimates that there were nearly 7 billion mobile subscriptions worldwide in 2016. This is equivalent to 95.5 percent of the world population. Gartner reported that mobile device (smartphones and tablets) sales are on a continuous rise from year to year, and the future of enterprise applications, both for enterprise workers and consumers, is mobility [13]. Actually, multiple platforms are making mobile devices' markets, at a global scale for all consumers all over the word. In the education field, mobile technologies have been used to enhance learning and teaching experiences in formal and informal context, and a new niche of research on mobile learning has emerged thoroughly as a field in its own right. In this context, a new and growing environment for the design and deployment of mobile learning apps, infrastructures and solutions constitutes promising and unprecedented opportunities for learners, teachers and the entire educational system [14].Existing research on SLEs is classified based on following two perspectives:

C1. User-Centric Studies

Users are key stakeholders when interacting with LMS. Numerous studies are found that support the argument. For example, study on influence of learning value on learning management use report significant influence of performance expectancy, social influence and learning value on students' intention towards LMS and also confirmed the influence of facilitating conditions and behavioral intention on LMS use [15]. Another study on selecting a LMS: advice from an academic perspective argues that although faculty and students are the primary learning management system users, administrators and IT experts often select the system. The paper stresses on the importance of involving all stakeholders in the selection process. It offers a step-by-step guide to LMS selection, and enables readers to develop a customized list of LMS features that may align with their institution's instructional and learning priorities [16]. A case study of a learning management system in a New Zealand secondary school gathered data on user perceptions of the use of the LMS from students, teachers and administration staff through questionnaire, individual interviews and focus group interviews. The findings of this study revealed a number of impediments to the effective use of LMS within the school and made several recommendations as to how these issues might be addressed [17]. Study on LMS: Japanese student perceptions and expectations reported on technical aspects and efficacy of LMS from novice computer users[18].

C2. Design-Centric Studies

Design centric studies focus on design and functionality of SLEs. For example, study investigating usability issues

of e-learning systems: case-study for Moodle learning management system provided possible solution to enhance usability of LMS by developing rich client applications for mobile devices. The findings and results gathered in usability research conducted among students have confirmed in the study that development of eLearning systems needs to have learner in the center of development process [19]. Likewise, study on the design of smart educational environments discusses the key characteristics of smart learning and the main challenges to be overcome when designing smart educational environments to support personalization. The paper emphasizes on smart learning environments sustainability by taking into account perceptions of future users during the design process to increase knowledge of the design and the implementation of new pedagogical approaches in SLEs [20].Study on introduction to smart learning analytics: foundations and developments in video-based learning, examines prospects and drawbacks of smart learning analytics in designing video-based smart learning environments [21].

The argument that learners acquire individual skills or piece of knowledge in SLEs that they are unable to apply in complex contexts, has given rise to more and more *user-centric studies*. Likewise, the argument learners focus on superficial features more instead of the underlying principles, concepts, or theories in SLEs, project the need of *design-centric studies*. The contemporary research adequately fails to bridge this research gap and come-up with an alternative yet innovative solution.

D. Disruptive Technology

Disruptive technology gained popularity as an innovation because it simplified existing products access and affordability to relatively larger population. With disruptive innovations, people could try simple new applications easily. With passage of time, technology tends to evolve and improve to a point that renders the old technology obsolete – all due to disruptive innovations, e.g., a personal computer was a disruptive innovation relative to the main frame because it enabled many people/users with minimal knowledge of computers to have access to digital form of communication. It was based on disruptive innovation of developing microprocessors. Hence, disruptive technologies or innovations are processes where new ground breaking products and services are introduced on a much larger scale than before, essentially replacing the old ways of doing things.

The concept of disruptive technology or innovations, help us understand how markets are transformed, e.g., how new business phone systems were introduced or how new technologies are used to support teaching and learning at schools and at universities. Now a days, smart phones have replaced nearly all hand-held digital devices, such as cameras, MP3 players, calculators, and GPS devices. All these disrupters have one thing in common: they interfered with an old product or service so that something new became accessible to the masses. In other words, through disruptive process, a larger part of the population got access to new and better technical solutions and innovative services.

Voice over Internet Protocol (VoIP): is another perfect example of disruptive technology for a number of reasons. It has evolved over time, replaced an old technique for a lot of people, changed markets and fields, and led to important improvements such as lowering costs and other benefits. A number of LMS have been developed over VoIP to support group based learning with different characteristics and problem solving approach.

1. Moodle is a learning platform or course management system (CMS). It is a free Open Source software package designed to help educators create effective online courses based on sound pedagogical principles.
2. Blackboard Learn is a virtual learning environment and course management system developed by Blackboard Inc. Blackboard Learn helps customers optimize their learning management systems with implementation services and training to create new learning experiences. It is Web-based server software which features course management, customizable open architecture, and scalable design that allows integration with student information systems and authentication protocols.
3. Zoom is the leader in modern enterprise video communications, with an easy, reliable cloud platform for video and audio conferencing, chat, and webinars across mobile, desktop, and room systems. There is a distinct harmony that comes from combining video instruction over Zoom with text-based tools that allows many students to understand the practical nature of the subjects they learn.

Following applications are popular amongst learners for individual or group learning tasks. These applications have packaged content, with free or paid upgrades.

1. YouTube is probably the best thing that ever happened to learning apps. The service is usually for viral videos, music videos, news, and entertainment.
2. Udacity is one of the more intense learning apps on the list. You can enroll in courses and learn new things. Udacity focuses on in-demand job skills such as computer programming, app development, artificial intelligence, machine learning, and more.
3. Solo-Learn is a developer on Google Play. They have a large selection of learning apps that teach computer programming. They support web languages like HTML, more common languages like Java or C++, and even some more specialized stuff like Python.
4. Coursera is an online school of sorts. It has a variety of lessons and classes that you can take. Each one educates

you on a different topic. It boasts well over 1,000 courses ranging from math to science and even technology stuff.

To sum up, literature review elaborated concepts pertinent for this study such PAL, FAL. Disruptive learning and highlighted studies on various SLEs that are either User-centric or Design-centric. Literature review also highlighted disruptive innovation as a new trend in SLEs and presented an argument that LMS are expensive and are faculty moderated (Moodle, Zoom and Blackboard Learn), While, smart learning applications such as YouTube, Udacity, Solo-Learn etc. are inexpensive, yet they provide packaged content, with no real-time interaction and feedback to learners. Moreover, there is lack of empirical evidence in existing research to validate the effectiveness of FAL-versus-PAL to support SLB in a disruptive environment. Literature review on constructs of SLB in a disruptive environment are covered under Research Methodology chapter.

This study empirically compares effectiveness of FAL and PAL and validates contextual disruptive factors that support SLB in a SLE. It is argued that SLB is better supported through PAL than FAL in a SLE and a framework is developed to test various hypothesis related to SLB and effectiveness of FAL and PAL in a disruptive environment.

III. RESEARCH METHODOLOGY

A Quasi-experiment, with non-repeated measures including controlled and manipulated variables was designed. VoIP was selected as disruptive innovation and application known as SKYPE was used to run the experimentation. VoIP is fully compatible with internet and it supports, email, web-surfing and customer databases. It takes messages like an answering machine, send instant messages (chatting person to person)

A. Learning Content

Learning content was designed based on learning objectives of the course. The study topic was to elaborate Heuristics in Usability Engineering and prepare students for an Objective-Test. The entire learning session was held online, using disruptive medium. Time required to finish learning session was 45 min for each moderator.

B. Selection of Participants

The learners participating in the experiment were carefully chosen. Students with High, Medium and Low CGPA were carefully selected and equally divided in two groups. The students were informed in advance that they have to rate content of learning session. Both group members were emailed the procedure including time and protocol to participate in the experiment. Hawthorne Effect was monitored and controlled in designing study.

C. Groups Formation

Groups were formed for this study with following composition and characteristics:

1. roup 1 subjected to skype based group learning environment moderated by a faculty member with adequate knowledge, background and teaching experience in HCI.
2. Group 2 subjected to skype based group learning environment moderated by a peer (trained by faculty member).

D. Selection of Peer-Moderator

Perquisite of student selection included, having more than CGPA of 8.5 (chosen by faculty member) and at least one face-to-face session and one online interaction training session with faculty for preparing material and clearing doubts.

E. Research Framework

Research framework was evolved to address the design and development considerations to empirically validate effectiveness of FAL-versus-PAL using contextual disruptive factors.

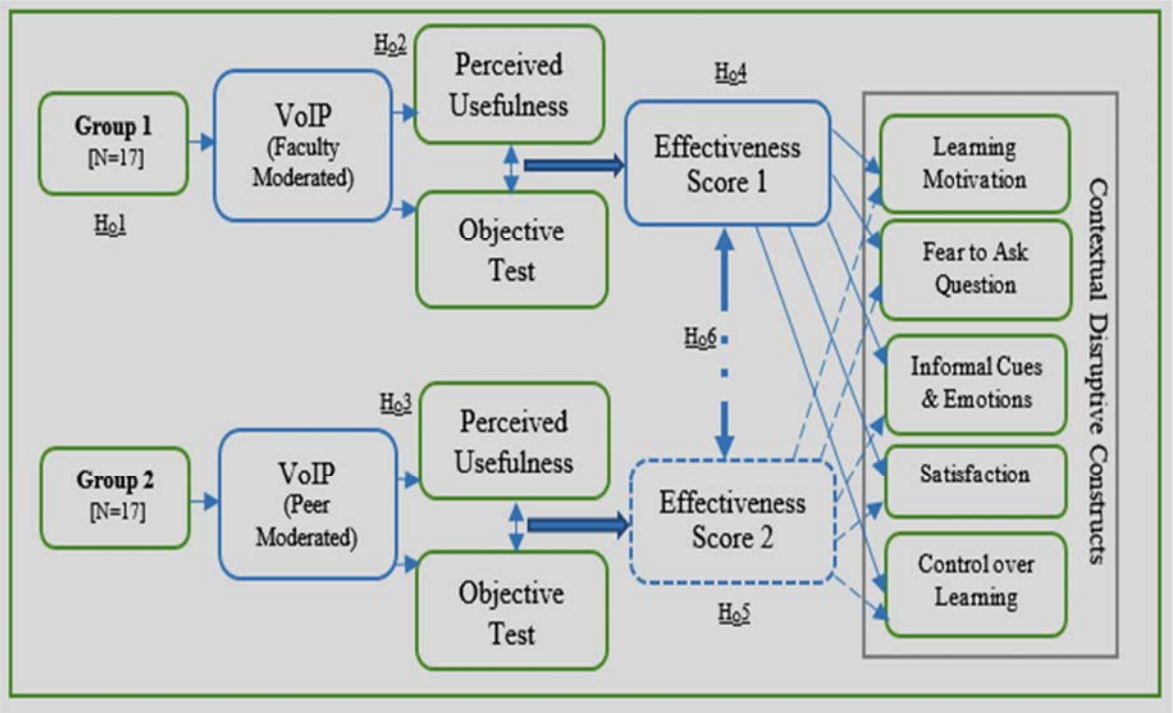

Figure 1. Quasi-Experimental Non-Repeated Measure Design

F. Study Constructs

1. **Perceived Usefulness** (PU) is a construct designed to assess perceived usefulness of the interaction by learners FAL and PAL Environments to determine effectiveness.
2. **Objective Test** (OT) is a construct designed for self-reflection by students so they were able to give feedback clearly at the end-of-session. The Test was common for both groups.
3. **Effectiveness Score** (ES) is computed by combining constructs, Perceived Usefulness and Objective Test. (ES = PU + OT)
4. **Contextual Disruptive Factors (CDF)** is a consortium of five independent variables that are hypothesized to be ingredients of Smart Learning Behavior (SLB).

a. **Learning Motivation** is an internal drive that activates behavior and gives it direction [22]. It is hypothesized that learning motivation would be significantly different for learners in PAL and FAL Environments, effecting SLB differently.

b. **Fear to Ask Question** is a research term used in this study; originating from concept reluctance to ask [23]. Reluctance to participate or clear doubts in a smart learning environment may have deep psychological influences. It is therefore hypothesized that learners will have significantly different psychological support systems to ask questions in PAL and FAL Environments, effecting SLB differently.

c. **Informal Cues & Emotions** is a research term used in this study, originating from the concept Emoticons [24]**.** Use of slangs and emoticons is a form of expression and display of once ongoing state of mind in a virtual environment. It is hypothesized that learners will significantly differ in terms of using emoticons in PAL and FAL Environments, effecting SLB differently.

d. **Satisfaction** is fulfilment of one's wishes, expectations, or needs, or the pleasure derived from this [25]. It is hypothesized that learners will have significantly different satisfaction in PAL and FAL Environments, effecting SLB differently.

e. **Control over Learning** is a research term used in this study, originating from the concept cognitive learning control [26]. It is hypothesized that learners will significantly vary in terms of being in control and aware of their learning outcomes in PAL and FAL Environments, effecting SLB differently.

G. Hypotheses Testing & Techniques

1. H_O1 – CGPA variance within Group 1 and Group 2 will not be same for comparable inferential treatment

H_A1 – CGPA variance within Group 1 and Group 2 will be same for comparable inferential treatment

Technique to test Ho1: Levene's Test for Equality of Variance

2. H_O2 – Perceived Usefulness of Group 1 will not correlate significantly with Objective Test Score

H_A2 – Perceived Usefulness of Group 1 will correlate significantly with Objective Test Score
Technique to test Ho2: Pearson Correlation Coefficients

3. H_O3 – Perceived Usefulness of Group 2 will not correlate significantly with Objective Test Score
HA3 – Perceived Usefulness of Group 2 will correlate significantly with Objective Test Score Technique to test Ho3: Pearson Correlation Coefficients

4. H_O4 – Effectiveness Score of Group 1 (FAL) will not vary significantly across Contextual Disruptive Factors in Disruptive Environment
HA4 – Effectiveness Score of Group 1 (FAL) will vary significantly across Contextual Disruptive Factors in Disruptive Environment.
Technique to test Ho4: General Linear Modeling for Variance Analysis

5. H_O5 – Effectiveness Score of Group 2 (PAL) will not vary significantly across Contextual Disruptive Factors in Disruptive Environment
HA5 – Effectiveness Score of Group 2 (PAL) will vary significantly across Contextual Disruptive Factors in Disruptive Environment.
Technique to test Ho5: General Linear Modeling for Variance Analysis

6. H_O6 – Effectiveness Score of Group 1 (FAL) and Group 2 (PAL) will not vary significantly in terms of Magnitude in Disruptive Environment
H_A6 – Effectiveness Score of Group 1 (FAL) and Group 2 (PAL) will vary significantly in terms of Magnitude in Disruptive Environment
Technique to test Ho6: Partial Eta^2 and Adjusted R^2

7. H_O7 – There will be no difference in Standardized Beta Coefficients of Contextual Disruptive Factors impacting effectiveness of FAL and PAL in a Disruptive Environment
HA7 – There will be difference in Standardized Beta Coefficients of Contextual Disruptive Factors impacting effectiveness of FAL and PAL in a Disruptive Environment
Technique to test Ho7: Standardized Beta Coefficients (Regression)

IV. DATA ANALYSIS AND FINDINGS

The study is Quasi-experimental design with manipulative and controlled non-repeated groups. Five disruptive contextual factors are identified to be constructs of SLB in research framework and are cross-examined using Univariate-Analysis, Cohen's D, Partial eta squared values and Standardized Beta Coefficients. The experiment data was analyzed in PASW 2.0 and findings are reported below.

A. Mean Estimation and Data Normality

Figure 2 shows trend analysis in a line chart of Learners Objective Test Score in FAL and PAL Environments. The mean score of students in Objective Test under FAL Environment was 7.66, while for PAL Environment was 7.83. Trend line depicts that score of students in a PAL Environment was relatively higher than the FAL Environment. The shape of trend line appears almost identical at some points. However, in PAL Environment, dips in trend line are delayed, longer but smooth, while for FAL Environment dips are continuous and short-lived.

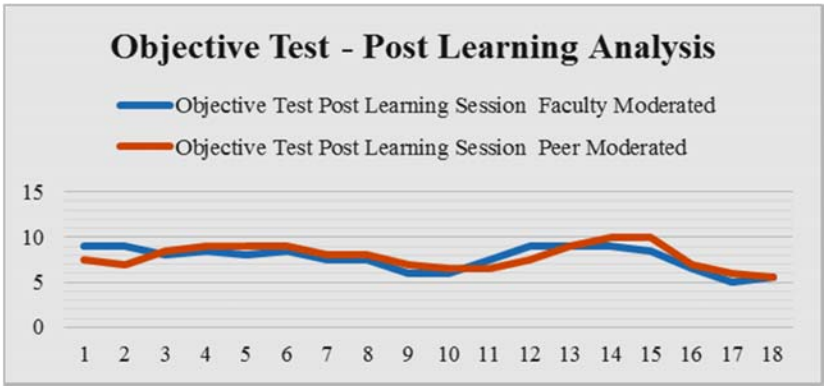

Figure 2: Objective Test Post Learning Analysis

Trend analysis was further investigated using Scatter-Dot Plot. As shown in Figure 3below, Perceived Usefulness in PAL and FAL Environments is plotted against Objective Test Score by students in respective environments. It shows trend is observed to be upward and moderately linear for FAL, while for PAL it is sloping positively uphill and strongly linear.

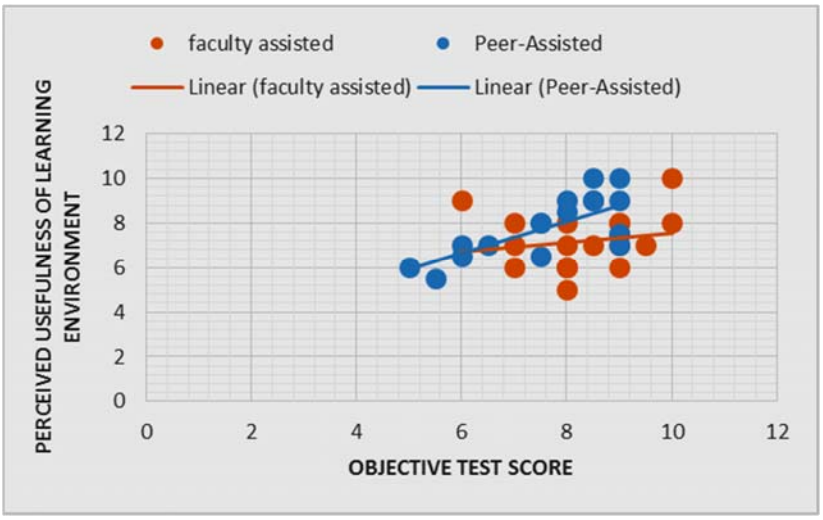

Figure 3: Scatter-Dot Plot of FAL and PAL on Objective Test

B. Homogeneity of Variance Testing

H_o1–CGPA variance within Group 1 and Group 2will not be same for comparable inferential treatment

H_A1–CGPA variance within Group 1 and Group 2 will be same for comparable inferential treatment

Levene's test is the test to see whether the variances for two or more groups are equal in a population. It is an important assumption to be met and to ensure no violation of variance appears when comparing two or more than two groups.

Group 1 (N = 17) subjected to FAL was associated with an average CGPA M= 7.63 (SD = 1.06). By comparison, Group 2 (N=17) subjected to PAL was associated with a numerically smaller average CGPA M = 7.29 (SD = .95). To test the hypothesis that Group 1 and Group 2 are associated with statistically different mean CGPA, an independent sample T-Test was performed.

Group 1 and Group 2 mean distributions were sufficiently normal for the purpose of conducting T-Test (i.e., skew < [2.0] and kurtosis < [0.9]; Schmider, Ziegler, Danay, Beyer, & Buhner (2010). Additionally the assumption of homogeneity of variance was tested and satisfied via Leven's F Test, F (32) = .17, p = .679. The independent sample T-Test was associated with a statistically significant effect, t (32) = 3.09, p = .004. Hence, we failed to reject null hypothesis but satisfied an important assumption for subjecting data to further inferential treatments.

Further analysis showed that Group 1 which was subjected to FAL had statistically significant and marginally higher average CGPA than PAL Group 2. Cohen's d was estimated at 0.03 which is a small effect based on Cohen's (1992) guidelines. Cohen suggested that d=0.2 be considered a 'small' effect size, 0.5 represents a 'medium' effect size and 0.8 a 'large' effect size. This means that if two groups' means do not differ by 0.2 standard deviations or more, the difference is trivial, even if it is statistically significant. The results indicate that homogeneity of variance assumption has not been violated and Group 1 and Group 2 are comparable, even though a smaller effect of difference exist.

C. Perceived Correlation of Learning through Disruptive Medium with Objectivity Test

H_o2– Perceived Usefulness of Group 1 will not correlate significantly with their Objective Test

H_A2 – Perceived Usefulness of Group 1 will correlate significantly with their Objective Test

A Pearson product-moment correlation coefficient was computed to assess the relationship between perceived usefulness of Group 1 with their Objective Test. There was a positive correlation between the two variables, r = 0.721, n = 16, p = 0.036< 0.05 (one tailed).

Since strong, positive correlation between Perceived Usefulness of Group 1 with Objective Test was reported; therefore null hypothesis H_o2 is rejected and alternativeH_a2 is accepted.

H_o3- Perceived Usefulness of Group 2 will not correlate significantly with their Objective Test

H_a3 – Perceived Usefulness of Group 2 will correlate significantly with their Objective Test

A Pearson product-moment correlation coefficient was computed to assess the relationship between perceived usefulness of Group 2 with their Objective Test. There was a positive correlation between the two variables, r = 0.802, n = 16, p = 0.003 < 0.01 (one tailed).

Since strong, positive correlation between Perceived Usefulness of Group 2 with Objective Test was reported;

therefore null hypothesis H_o3 is rejected and alternative H_a3 is accepted.

D. Univariate Analysis

H_O4 – Effectiveness Score of Group 1 (FAL) will not vary significantly across Contextual Disruptive Factors in Disruptive Environment

H_A4 – Effectiveness Score of Group 1 (FAL) will vary significantly across Contextual Disruptive Factors in Disruptive Environment

H_o4 was tested with Univariate Analysis (General Linear Modelling) since it is a method for analyzing data on a single variable at a time. There was a significant main effect of FAL on Effectiveness Score of Group 1 in a VoIP based Disruptive Learning Environment, $F = 5.43$, $p < .01$, and a significant interaction, $F= 3.53$, $p < .05$. Partial eta squared was 0.42 for this interaction effect.

Contextual Disruptive Factors that support SLB were also examined and results reported: *Fear to ask question* ($M = 8.11$, $SD = 4.32$) and *Use of informal gestures* ($M = 15.2$, $SD = 6.32$) predicted significant variance $F = 8.90$, $p = .011$ and $F= 8.66$, $p = .009$ respectively towards Effectiveness Score in a Faculty-Assisted Learning Environment. The pairwise comparison of remaining three Disruptive Contextual Factors, *Control over learning outcomes*, *Learning motivation* and *Satisfaction* with Effectiveness Score in a Faculty-Assisted Learning Environment, was found to be non-significant.

Adjusted R squared indicates about 54.4% of the variance in Effectiveness of VoIP based Disruptive Learning Environment is attributable to the five Contextual Disruptive Factors, indicating average to moderately strong relationships between Contextual Disruptive Factors and Effectiveness Score of FAL Environment.

In view of above findings, we have partially failed to reject null H_o4 and partially accepted alternative H_a4.

H_O5 – Effectiveness Score of Group 2 (PAL) will not vary significantly across Contextual Disruptive Factors in Disruptive Environment

H_A5 – Effectiveness Score of Group 2 (PAL) will vary significantly across Contextual Disruptive Factors in Disruptive Environment.

H_o5 was tested using Univariate Analysis and significant main effect of PAL on Effectiveness Score of Group 2 in a VoIP based Disruptive Learning Environment, $F = 2.03$, $p < .01$, and a significant interaction, $F= 3.11$, $p < .05$ is reported. Partial eta squared was 0.26 for this interaction effect.

Pairwise comparison of Contextual Disruptive Factors with Effectiveness Score of Group 2 in a PAL Environment predicted significant variance. *Fear to ask question* ($M = 4.02$, $SD = 2.12$), $p < .01$, *Use of informal gestures* ($M = 7.31$, $SD = 4.02$), $p < .05$, *Control over learning outcomes* ($M = 5.53$, $SD = 1.05$), $p < .05$, *Learning motivation* ($M = 8.65$, $SD = 6.44$), $p < .01$ and *Satisfaction* ($M = 5.28$, $SD = 0.25$), $p < .05$.

Adjusted R squared indicates about 62.3% of the variance in Effectiveness is attributable to the five Contextual Disruptive Factors, indicating moderate to strong relationships between Contextual Disruptive Factors and Effectiveness Score in a PAL Environment

In view of above, statistical findings were there to reject H_o5 and accept H_a5.

E. Magnitude of Effectiveness Score

H_O6 – Effectiveness Score of Group 1 (FAL) and Group 2 (PAL) will not vary significantly in terms of Magnitude in Disruptive Environment

H_A6 – Effectiveness Score of Group 1 (FAL) and Group 2 (PAL) will vary significantly in terms of Magnitude in Disruptive Environment

Eta squared measures the proportion of the total variance in a dependent variable that is associated with the membership of different groups defined by an independent variable. Partial eta squared is a similar measure in which the effects of other independent variables and interactions are partial out.

Partial eta squared for PAL Environment is 0.64and for FAL Environment is 0.52 in VoIP based Disruptive Learning Environment. The relative magnitude of effect or impact of Peer-assistance in a VoIP based Learning Environment is more than Faculty-assistance in VoIP based Learning Environment. Hence, we reject H_o5 and accept H_a5.

F. Analysis of Standardized Beta Coefficients

After the evaluation of the F-value and R^2, it is important to evaluate the regression beta coefficients. If the beta coefficient is positive, the interpretation is that for every 1 unit increase in the predictor x variable, the outcome y variable will increase by the beta coefficient value.

H_O7 – There will be no difference in Standardized Beta Coefficients of Contextual Disruptive Factors impacting effectiveness of FAL and PAL in a Disruptive Environment

H_A7 – There will be difference in Standardized Beta Coefficients of Contextual Disruptive Factors impacting effectiveness of FAL and PAL in a Disruptive Environment

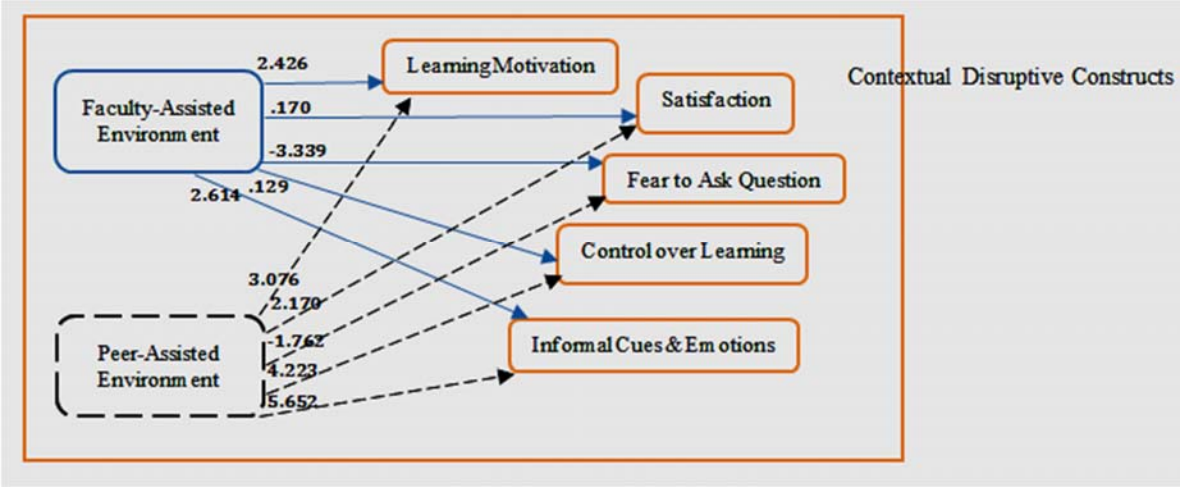

Figure 4: Contextual Disruptive Factors Model Parameters (Standardized Beta Coefficients)

The Model Parameters based on Standardized Regression Beta Coefficients are examined:

F1. Contextual Disruptive Factors supporting SLB in a FAL Disruptive Environment

1. Learning Motivation (T = 2.426) makes significant contribution towards predicting Effectiveness of FAL in VoIP based Learning Environment at p = .004 < p = 0.01 level, two tailed.
2. Satisfaction (T = .170) makes non-significant contribution towards predicting Effectiveness of FAL in VoIP based Learning Environment at p = .644.
3. Fear to ask question (T = -3.339) makes significant negative contribution towards predicting Effectiveness of FAL in VoIP based Learning Environment at p = .018 < p = 0.05 level, one tailed. High fear of asking questions in FAL is associated with lesser effectiveness of VoIP learning environment.
4. Control over learning outcomes (T = .129) makes non-significant contribution towards predicting Effectiveness in FAL in VoIP based Learning Environment at p = .307.
5. Informal Cues & Emotions (T = 2.614) makes significant contribution towards predicting Effectiveness in FAL in VoIP based Learning Environment at p = .040 < p = 0.05 level, one tailed.

F2. Contextual Disruptive Factors supporting SLB in a PAL Disruptive Environment

1. Learning Motivation (T = 3.076) makes significant contribution towards predicting Effectiveness of PAL in VoIP based Learning Environment at p = .031 < p = 0.05 level, two tailed.
2. Satisfaction (T = 2.170) makes non-significant contribution towards predicting Effectiveness of PAL in VoIP based Learning Environment at p = .203.
3. Fear to ask question (T = -1.762) makes significant negative contribution towards predicting Effectiveness of PAL in VoIP based Learning Environment at p = .006 < p = 0.01 level, two tailed.
4. Control over learning outcomes (T = 4.223) makes significant contribution towards predicting Effectiveness of PAL in VoIP based Learning Environment at p = .027< p = 0.05 level, two tailed.
5. Informal Cues & Emotions (T = 5.652) makes significant contribution towards predicting Effectiveness of PAL in VoIP based Learning Environment at p = .002 < p = 0.01 level, two tailed.

Statistical evidence was found to report difference in Standardized Beta Coefficients related to Contextual Disruptive Factors impacting differently SLB and effectiveness of FAL and PAL in Disruptive Environment, therefore, H_o7 is rejected and H_a7 accepted.

V. CONCLUSION

The existing literature on designing effective SLEs support integration of basics of functionality, usability and aesthetics. This study however makes significant contribution towards designing SLEs by examining the constructs of SLB which are cross-examined for their Effectiveness in PAL and FAL in aVoice controlled, disruptive learning environment.

- *Findings of this study empirically validate effectiveness of Disruptive Contextual Factors and conclude SLB is better supported through PAL than FAL in SLEs.*

1. Learners today are smart in many ways, likewise their behavior is cognitively smart as they tend to perceive

effectiveness differently of PAL and FAL Environments in general as well as Disruptive Contextual Factors associated with SLB. In PAL and FAL Environments, the trend based on mean estimation was observed to be uphill with moderate to strong linearity. The study constructs suggested the learners in Group 1 and Group 2 benefited with positive influence on their learning outcomes. However, for the Group 2which was PAL, results were marginally higher than FAL.

2. The overall contribution of five Contextual Disruptive Factors to support SLB was significant to determine the effectiveness of PAL and FAL as significant amount of variance was predicted.
3. Individual contribution was examined using regression technique, Standardized Beta Coefficients. First factor, Learning Motivation, as an intrinsic factor was significant in PAL and FAL Environments, while Satisfaction as second factor was related to an end-learning reflection, and was found to be non-significant in PAL and FAL. Fear to ask question as third factor was found to be significant in PAL and FAL with negative coefficient values. It was higher in negative coefficient under FAL (T = -3.339) than PAL (T = -1.762) which indicated students experienced more reluctance to ask questions, raise their doubts and clear ambiguity in FAL than in PAL. Fourth factor, Control over learning was non-significant for FAL but significant for PAL suggesting students were relatively more in charge of their learning outcomes and objectives, which may be because they experienced lesser inhibitions in PAL in terms of emotions and expressions. Fifth factor, use of Informal Cues and Emotions was found to be significant in PAL and FAL, both with relatively higher contribution in PAL.
4. Furthermore, Partial eta squared for PAL and FAL was 0.64 and 0.52, respectively. It suggested relatively higher magnitude of effect for PAL based on five Contextual Disruptive Factors supporting SLB than FAL.

- *The study findings support institutions of higher learning in process of transition and transforming old models of university education into SLEs. While, HCI researcher may be benefitted in defining cognitive thought processes behind PAL that support SLB in Disruptive Learning Environment.*

1. The study concludes that new applications to support SLB may integrate informal design features such as learn emoticons. They should be specific in reflecting learning behavior of students. There is a need to undertake research on designing of such emoticons that may be universally accepted and with integrative formats across platforms. In FAL students particularly experienced higher fear to ask question, which showed negative influence on their learning. Thus, use of emoticons will ease in expressing any such discomfort, ambiguity or difference of opinion.
2. Functionality option be included in application that may report overall learning temperature (average). Higher learning temperature may signify the overall involvement of students to the moderator. If it falls below certain level, the moderator may consider talking to students or changing learning material or use another methodology to gain students interest.
3. To enhance functionality of smart learning applications, simplest features of gestural interface be included because esoteric gestures enhance the usability of an application and sometimes remain unexplored by users in early years of their usage.
4. There is no denying the fact that learning based on disruptive technology provides mobility to learners, as they are able to use it in a calmer context. Today learning occurs in multidisciplinary platforms, so applications should be designed with broader definition of platform accessibility.
5. It is also important to base new applications design on a realistic model of learning through disruptive technology. The study concludes that functionality be incorporated to break learning sessions for a short period. Today students do not sit for an hour going through a full-blown learning content course. Their attention span is smaller and they squeeze their learning segment between other activities. It is concluded that learning activities be designed with shorter bursts using micro-learning and micro-instructions, which are ideal for informal learning and learning augmentation.
6. The learning applications should include minimal functionality with simplest user interface as many people designing for learning applications pack in the functionality.
7. Less functionality should translate into a simple user interface that users can easily perceive and understand. For example, a micro-lesson might provide topic navigation from a list, a way to navigate through the lesson and links to a glossary.
8. Information should be structured so it can be easily accessed.
9. When designs lack efficiency, people are believed to be using that application less. Likewise, there are certain visual design principles to help ensure users do not misinterpret the cues on the screen. For example, keep the screen uncluttered as much as possible to promote clarity. This means thinking through which features and content are extraneous and which are essential.
10. In addition, take advantage of the human inclination to see relationships in groupings. When items are close together or bounded by a border, people assume they belong together.

REFERENCES

[1] Reuters, Global E-Learning Market 2017 to Boom $275.10 Billion Value by 2022 at a CAGR of 7.5% – Orbis Research, [online] available at:https://www.reuters.com/brandfeatures/venture-capital/article?id=11353

[2] Statista, Size of e-learning learning management system (LMS) market in 2013 and 2016, by region (in million U.S. dollars), [online] available at: https://www.statista.com/statistics/501118/worldwide-learning-management-systems-market-size-by-region/

[3] World Economic Forum, Is online learning the future of education?[online] available at: https://www.weforum.org/agenda/2016/09/is-online-learning-the-future-of-education/

[4] i-Scoop, The underestimated impact of the convergence of AI, IoT and big data analytics,[online] available at: https://www.i-scoop.eu/convergence-ai-iot-big-data-analytics/

[5] ResearchGate, Smart Sustainable Cities: Definition and Challenges,[online] available at:https://www.researchgate.net/publication/310403759_Smart_Sustainable_Cities_Definition_and_Challenges

[6] Springer, Smart Learning in Smart Cities, [online] available at: http://www.springer.com/978-981-10-4342-0

[7] Springer Link, The Effect of Peer-Assisted Learning Strategies (PALS) on Preparatory Students in Mathematics,[online] available at: https://link.springer.com/chapter/10.1007/978-981-10-1458-1_58

[8] Black, M. F. and MacKenzie J. 2008.Quality Enhancement Themes: The First Year Experience, Black, F. M. and MacKenzie, J., 2008. Peer support in the first year,[online] available at: http://www.enhancementthemes.ac.uk/documents/firstyear/PeerSupport_FinalReport. pdf.

[9] Tinto, V., 2006. Taking Student Retention Seriously,[online] available at:http://www.mcli.dist.maricopa.edu/fsd/c2006/docs/takingretentionseriously.pdf

[10] Rodger, S. and Tremblay, P.F. (2003). The effects of a peer mentoring program on academic success among first year university students, Canadian Journal of HigherEducation, 33 (3), p. 1-18.

[11] Capstick, S., 2004. Benefits and Shortcomings of Peer Assisted Learning (PAL) in Higher Education: an appraisal by students,[online] available at: http://pal.bournemouth.ac.uk/documents/Bnfts%20%26%20Shrtcmngs%20%20of%20P AL3.pdf

[12] Umbach, D.P. and Wawrzynski, R.M. (2004). Faculty Do Matter: The Role of College Faculty in Student Learning and Engagement,[online] available at:http://nsse.indiana.edu/pdf/research_papers/faculty_do_matter.pdf

[13] ITU – Statistics, Global ICT developments,[online] available at:https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx

[14] Springer, Smart Learning Environments Thematic series on "Mobile Learning and Smart Learning", [online] available at:http://static.springer.com/sgw/documents/1525570/application/pdf/SLE_SI_MLSL_20160320.pdf

[15] Ain, N.,Kaur, K. and Waheed, M. (2015). The influence of learning value on learning management system use - An extension of UTAUT2, [online] available at:http://journals.sagepub.com/doi/abs/10.1177/0266666915597546

[16] Wright, C., Lopes, V., Montgomerie, T., Reju, S. and Schmoller, S. (2014).Selecting a Learning Management System: Advice from an Academic Perspective, [online] available at:https://er.educause.edu/articles/2014/4/selecting-a-learning-management-system-advice-from-an-academic-perspective

[17] Stevens, N. (2011). A Case Study of a Learning Management System in a New Zealand Secondary School (Thesis, Master of Science (MSc)). University of Waikato, Hamilton, New Zealand. Retrieved from https://hdl.handle.net/10289/6032

[18] Hirata Y., Hirata Y. (2012) Learning Management System: Japanese Student Perceptions and Expectations. In: Li K.C., Wang F.L., Yuen K.S., Cheung S.K.S., Kwan R. (eds) Engaging Learners Through Emerging Technologies. ICT 2012. Communications in Computer and Information Science, vol. 302. Springer, Berlin, Heidelberg.

[19] Minović M., Štavljanin V., Milovanović M., Starčević D. (2008) Usability Issues of e-Learning Systems: Case-Study for Moodle Learning Management System. In: Meersman R., Tari Z., Herrero P. (eds) On the Move to Meaningful Internet Systems: OTM 2008 Workshops. OTM 2008. Lecture Notes in Computer Science, vol. 5333. Springer, Berlin, Heidelberg.

[20] Gros, B. (2016). Smart Learning Environments – The design of smart educational environments, [online] available at: https://slejournal.springeropen.com/articles/10.1186/s40561-016-0039-x

[21] Giannakos, M.N., Sampson, D.G. and Kidziński, L. (2016). Smart Learning Environments – Introduction to smart learning analytics: foundations and developments in video-based learning, [online] available at: https://slejournal.springeropen.com/articles/10.1186/s40561-016-0034-2

[22] Study.Com. The Importance of Motivation in an Educational Environment , [online] available at: https://study.com/academy/lesson/the-importance-of-motivation-in-an-educational-environment.html

[23] Collins - Definition of reluctant, [online] available at: https://www.collinsdictionary.com/dictionary/english/reluctant

[24] Ken, Y. (2007).The History of Smiley Marks (English),[online] available at: Whatjapanthinks.com.

[25] Cambridge Dictionary. Satisfaction,[online] available at: https://dictionary.cambridge.org/dictionary/english/satisfaction

[26] Collins A.G. and Frank M. J. (2013). Cognitive control over learning: creating, clustering, and generalizing task-set structure, [online] available at: https://www.ncbi.nlm.nih.gov/ pubmed /23356780

.