

## Usage, Acceptance, Adoption, and Diffusion of Information & Communication Technologies in Higher Education: A Measurement of Critical Factors<sup>1</sup>

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### Abstract

*To properly integrate information & communication technologies (ICTs) in higher educational institutes (HEIs) of Pakistan demands factors which relate with their usage, acceptance, adoption, and diffusion need be analyzed through some appropriate statistical tests before their implementation at ground level. This study measures critical factors such as ZPD (zone of proximal development) gap, difference of perception, issue by issue and on all issues under discussion by participants' at each round of Delphi in order to analyze the difference in perceptions among various higher education (HE) stake holders. It was determined that a significant ZPD gap in ICT usage, acceptance, adoption, and diffusion is present in HEIs of Pakistan as compared to those developed nations. However, no significant difference of thought was measured while measuring issues such as demand & supply of ICTs, causes of deprived standard of HE, ICT integration challenges and their proposed solutions, which reveal that the problems identified and measures suggested need be considered compulsory in design of any future ICT policy. Recommendations as suggested in this study would benefit to Govt. of Pakistan while designing new ICT policies for higher education system (HES) in particular and to other concerned stake holders of less developed countries with similar nature of ICT problems/challenges in their HES. It is suggested that there is an utmost need of robust, effective and target-oriented ICT policy that may work out on issues identified in this study and take actions in timely manner to overcome this situation of dilemma.*

**Keywords:** Pakistan, Delphi method, zone of proximal development (ZPD) gap

### Introduction

Social and economic progress can be achieved through knowledge and its applications and HE is a most powerful tool for the creation of that knowledge and hence the knowledge-based society. Recent research on ICTs in HE recommends robust ICT infrastructure most important factor for knowledge-driven development. Tiene (2002) suggests in his study that ICT integration in HE is very critical for social and economic progress of any country and for a country which go for ICT integration in education, it should consider secondary and tertiary education levels 1st. Rogers (2003), Venkatesh, Morris, Davis, & Davis (2003) and Yi, Jakson, Park & Probst (2006) proclaim

in their studies that a lot of research has been done in order to better understand the usage, acceptance, adoptions and diffusion of ICT tools/applications; because of diversification and development of ICTs that affect many fields. In this study, ICT “usage & need” is highlighted because all the three parameters viz. adoption, acceptance and diffusion are covered under this umbrella. ICT usage depends on whether there are enough ICT facilities available or not; (Mumcu & Usluel 2004; Usluel & Seferoğlu 2004) claim that the significant barriers in ICT use are the lack of ICT facilities at workplace. Gauci (2001) & Nwuke (2001) highlighted in their research that the reason of widening gap between developed and less developed world is the cruel cyclic relationship between ICT skills shortage and a critical shortage of opportunities for skilled graduates in ICT disciplines. Taylor (2003) stated that powerful technical, economic, and social trends facilitated by the internet are revolutionizing the traditional concepts of education, business, and economics – their effects on HE are especially profound; hence due to the increasing competition on a global scale, universities must have to change. A study concludes on people’s perception about ICT that ICT is a driving force behind the quality of education and thus can change a society to a knowledge-based society; but it is the educational goals, needs and careful economics that must drive ICT use (Pelgrum, Law, 2003). Haddad (1999) stated that ICT is only a tool; educational choices have to be made first in terms of objectives, methodologies, and roles of teachers and students before decisions on the appropriate technologies can be made.

ICT integration in education needs proper attention, mechanism, and policy; Edelson (2001) found that ICT resources in educational institutes have been made available without a plan to associate them with curriculum; and it is often considered that once ICT resources are made available in classrooms, changes will eventually occur. However Krumsvik (2004) affirms that such perceptions have never been achieved. Beyond all this, developed world spends large sums of investments for integrating ICTs into their educational system in order to keep in pace with other countries.

ICTs not only help HESs of less developed countries in narrowing the global digital divide and thus producing knowledge-based societies; but also help improve quality of learning and educational outcomes. The state of any education system is determined through quality of its HES; because HES contributes to the development at all levels. Today, the HESs of whole world face diverse set of problems; among those interdisciplinary, global responsibility, and sustainable development are the problems that developed world face; and growth in enrollments, institutional developments, governance (e.g., lack of top-level commitment, lack of awareness & mindset, lack of ownership & creativity), poor & uneven distribution of ICT resources/infrastructure, high cost of the sustainability of technology due to exceptional & multifaceted growth/development of ICTs, defining the role of ICTs as cure-all for organizational transformation, making ICT responsive to the organizational vision & mission, and developing a non-systemic method of implementation of ICTs are the problems that less developed world face. World Bank expects the number of HE students will more than double from 70 million to 160 million by 2025 (Taylor, 2003).

The 21st century demands ICT skills in all fields, most importantly for education, employment and for everyday life. Today employers demand confidence and efficiency in ICT use either they are at academic level or at industry level; because ICT skills are crucial in the context of job skill demand. Thus, this presents an enormous challenge to the educators; since

they are expected to equip students with relevant, up-to-date, and high-quality ICT experience before students emerge into the employment world (Gibson, O'Reilly, & Hughes, 2002). D. Haywood & J. Haywood (2003) while discussing the results of a survey conducted in Europe found that majority of participants consider ICT essential for future professional activities. Billig, Sherry & Havelock (2005) claim in their research conclusions that successful ICT integration can not be achieved suddenly; but it requires effective & proper implementation at ground level.

At this critical stage, when world considers ICT integration in HES a top most issue to be resolved earlier the time possible, task force on HE in Pakistan suggests poor quality of teachers, low student motivation, lack of relevance of the course content to social or economic needs, gender & class disparities, and student discipline etc as factors behind the collapse of HES; unfortunately with no mention of poor ICT infrastructure and policy making.

### **Zone of proximal development (ZPD) Gap**

The concept of zone of proximal development (ZPD) gap introduced/developed by Vygotsky (1978, p. 78) states that there is a gap between what an individual can perform on his own and what he is capable of performing with peer/expert help. It argues that people's individual disordered knowledge can become meaningful as a result of social interaction. (Luckin 2001, p. 57) states in her study that Vygotsky theory can easily be mapped into educational design. Ager (2000) asserted that ZPD gap can be reduced to a minimum and ICT is the only tool that can bridge that gap successfully.

In this paper the ZPD gap is measured to understand the difference between actual state (of various matters under discussion in this study) and required state of matters. The issues: ICT use, demand & supply of ICTs, rely on ICTs and help provided by ICTs are considered. The results of this evaluation are discussed in terms of the confidence level of university personnel in using ICTs in their job related tasks.

### **Analysis of perceptions of Delphi participants through Z Test**

Z test measures if population parameter  $\mu$  is equal to another population parameter  $\mu_0$ . Z test is calculated by comparison of means between two samples whose sample distribution is normal under null hypothesis.

In this paper, Z test is calculated to measure difference in perceptions of participants of any two categories regarding 13 collective issues under discussion in this study.

### **Analysis of perceptions of Delphi participants through ANOVA**

ANOVA test is used to measure the difference in means of more than two groups for data to be analyzed in perspectives of similarities and differences.

In this paper, this test is calculated to measure difference in perceptions of participants on all 13 collective issues using data of Round-1 and round-2 of Delphi study.

## **Research Framework & Methodology**

### **Model and Hypotheses**

For this study, a 35-item questionnaire instrument developed for Delphi study conducted in Pakistan by Shaikh & Ahmed, (2009) is chosen as a research model; which is based on diverse set of issues concerning ICT use in HE, ICT related problems & challenges, demand & supply of ICTs, causes of deprived standard of HE, and suggestions for ICT-enhanced HE.

The following four hypotheses were proposed:

- H1. There is no significant ZPD gap in issues regarding common/educational ICT tools/application that Faculty/Students/Staff use in their diverse set of job-related tasks.
- H2. There is no significant ZPD gap in issues: Rely on ICTs, help by ICTs, use of ICTs, ICT demand and supply, and problem of attitude in HEIs of Pakistan.
- H3. There is no significant difference in perceptions of Delphi participants regarding any of 13 collective issues under discussion in this study, both category-wise and round-wise.
- H4. There is no significant difference in perceptions of Delphi participants regarding any of 13 collective issues under discussion in this study, at overall level.

### **Research Method, Participants & Instrument**

In this study, the authors (Shaikh & Ahmed, 2009) have used normative Delphi method (electronic survey research) in order to measure expert views of participants regarding how effectively ICTs can be integrated in HES of Pakistan. The Delphi questionnaire instrument was sent to participants through emails. Research group consisted of 30 personnel (both male and female) from five categories viz. Faculty members, Students, Parents, Admin staff, and ICT policy makers. Questionnaire instrument was initially composed of 32 questions in Round-1 but with an addition of three more questions as suggested in Round-1 responses, it became a 35-item questionnaire instrument (Shaikh & Ahmed, 2009).

### **Discussion & Analysis of Data**

The aim of this Delphi study conducted by Shaikh & Ahmed, (2009) was multipurpose and multi perspective. With the help of some appropriate statistical tests on output data of that study; this paper measures critical factors such as (1) ZPD gap in order to know how much less ICT tools/applications that Faculty/Students/Staff of our HEIs use today as compared with use in their counterparts in developed countries; (2) to know and analyze the difference of perception (if exists) among Delphi participants on each collective issue under discussion both round-wise & category-wise; and (3) to know and analyze the difference of perception on all issues among all participants. In this study, MS Excel the most popular academic and research tool for calculating statistical tests is used for calculation & analysis of data. Collective issues for measuring critical factors were:

1. ICT tools/applications usage by Faculty/Students/Staff of HEIs of Pakistan in their job-related tasks (Questions 1-10 → (1-7,8-10));
2. Usage of Common ICT tools/applications (Question 11);
3. Usage of educational/research ICT tools/applications (Question 12);
4. How much should Faculty/Students/Staff rely on ICTs (Question 13);
5. How much should Faculty/Students/Staff use ICTs (Question 14);
6. How much help does Faculty/Students/Staff get by ICTs in their job-related tasks (Question 15);
7. Causes of deprived standard of HE of Pakistan (Question 16);
8. ICT integration challenges in HEIs of Pakistan (Questions 17-20 → (17-18,19-20));
9. Reasons for delay in integration of ICTs in HEIs of Pakistan (21-25);
10. Suggestions for ICT-enhanced HES of Pakistan (26-32);
11. How much is ICTs demand in HEIs of Pakistan (Question 33);
12. How much ICT is supplied in response to ICT demand (Question 34); and
13. Attitude problem (Question 35).

## Discussion

1. The existence or non existence of ZPD gaps for issues 1 to 15 & 33 to 35 is calculated in Table 1 (see appendix). Optimum level of ZPD is set to 5 because mean scores were calculated by assigning values from 5 to 1; with 5 being strongly agree and 1 being strongly disagree.
2. Z test was applied on the results (mean & variation) of both rounds of Delphi to test the hypothesis “there is no significant difference of perception between any one category of Delphi participants (say Faculty) with another category (say Students) regarding each of 13 collective issues under discussion in this study”. Z-critical value at 95% significance level (0.05 level) uses 1.96 and at 99% significance level (0.01 level) uses 2.576. In hypothesis testing; significance level is the criterion used for rejecting or not rejecting the null hypothesis. The computed Z test value is compared to the significance level; if the value is less than or equal to the significance level, then the null hypothesis is not rejected. The lower the significance level, the more the data must diverge from the null hypothesis to be significant. Therefore, the 0.01 level is more conservative than the 0.05 level. Table 2 (see appendix) shows the results of Z test.
3. Z test was again applied to test the hypothesis “there is no significant difference in the perceptions of any one category of Delphi participants (say Faculty) with another category (say Students) regarding future use of ICT tools/applications by Faculty/Students/Staff of HEIs of Pakistan in their job-related tasks”. Table 3 (see appendix) provides the results of calculations.
4. Analysis of variance (ANOVA) was applied on all data collected through 35-item questionnaire to measure the hypothesis “there is no significant difference in perceptions among Delphi participants regarding all issues under discussion, collectively” in both rounds of Delphi. Table 4 (see appendix) describes the details about data (mean scores) used for calculation, Table 5 (see appendix) calculates Round-1 results while Table 6 (see appendix) calculates Round-2 results.

## Findings

Findings recorded are described below:

1. Significant ZPD gaps ( $\geq 2$ ) in both rounds of Delphi regarding present use of ICT tools/applications (Issue 1) were calculated in tasks: Planning, developing & organizing instructions, assessing student learning, academic research, and group discussion/supervision/training (see appendix: Table 1).

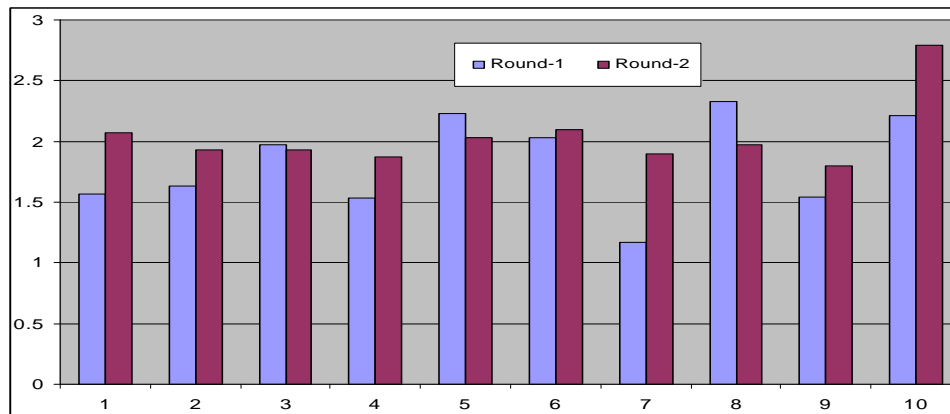


Figure 1. Showing ZPD gaps in present use of ICT tools/applications

2. Significant ZPD gaps ( $\geq 1.5$ ), in both rounds of Delphi, in use of educational/research ICT tools, rely on ICTs, demand & supply of ICTs (Issues 11-15 & 33-35) were calculated (Table 1).

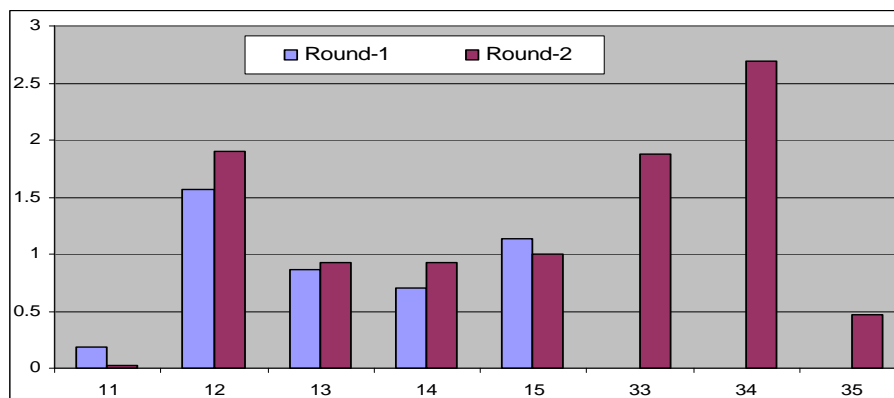


Figure 2. Showing ZPD gaps in issues (11-15 & 33-35)

Although a little difference in perceptions was calculated in almost all issues; the issues with most significant differences are further discussed here. Z test results to test the hypothesis “there is no significant difference in the perceptions of Faculty members & Students regarding 13 collective issues” yielded significant difference in 1<sup>st</sup> Round of issue-10; but in Round-2, it came under acceptance level ( $1.96=0.05$  level &  $2.576=0.01$  level) (Table 2).

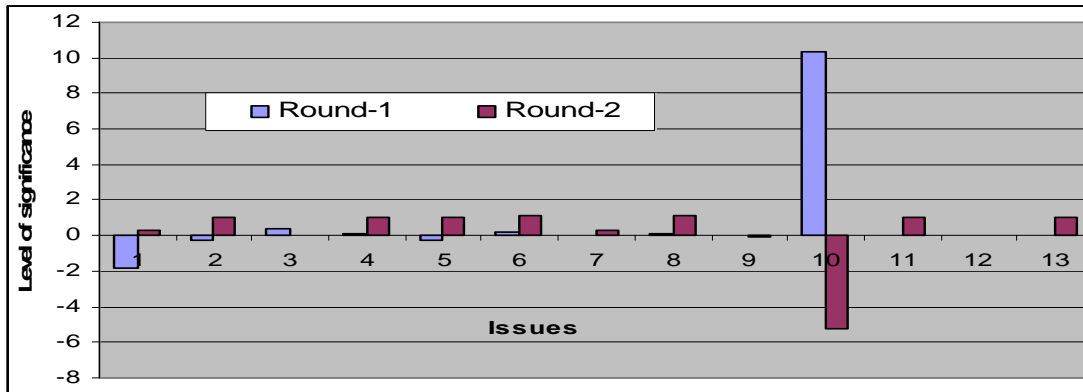


Figure 3. Showing difference in perceptions (Faculty & Students)

- Z test results to test the hypothesis “there is no significant difference of perception between Faculty members & Admin staff” yielded a significant difference (4.36) in 2<sup>nd</sup> Round of issue-8 (Table 2).

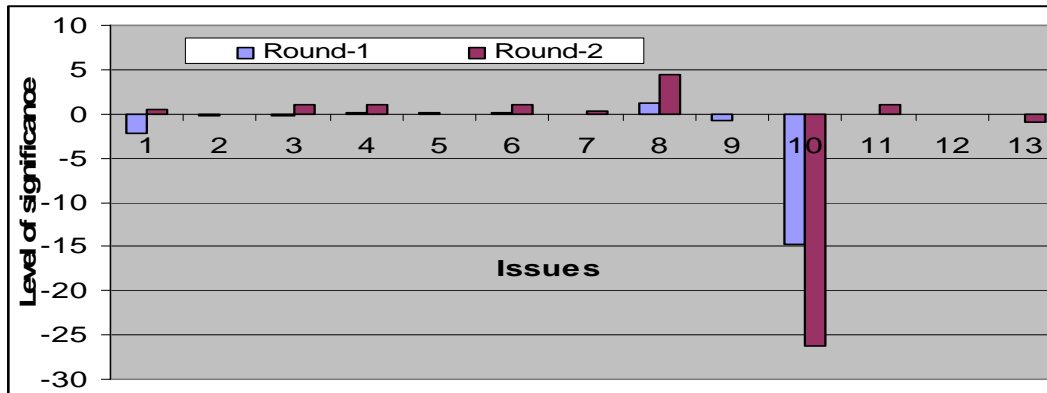


Figure 4. Showing difference in perceptions (Faculty & Admin staff)

4. Z test results to test the hypothesis “there is no significant difference of perception between Parents & Policy makers” yielded a significant difference (19.38 in Round-1 & 24.39 in Round-2) of issue-10; other issues remained under acceptance level (Table 2)

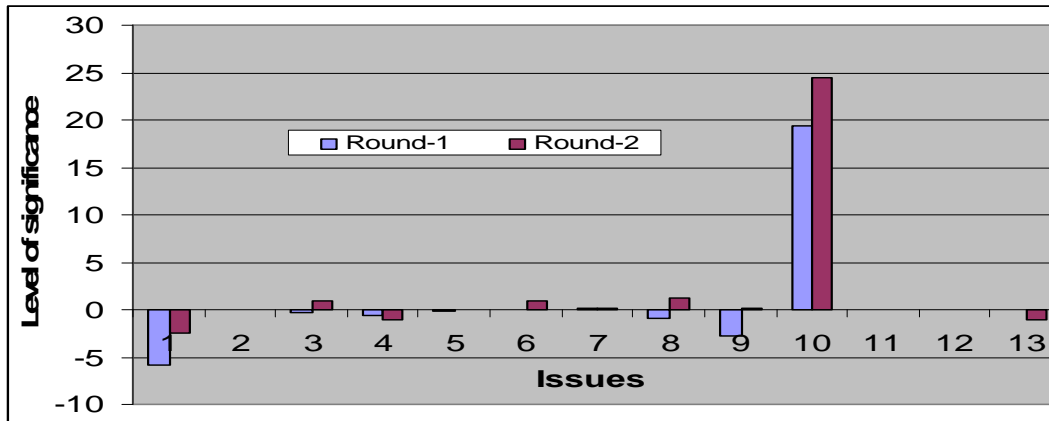


Figure 5. Showing difference in perceptions (Parents & Policy makers)

5. Z test results to test the hypothesis “there is no significant difference of perception between Admin staff & Policy makers” yielded a significant difference (9.69 in Round-1 & 21.3 in Round-2) of issue-10; other issues remained under acceptance level (Table 2).

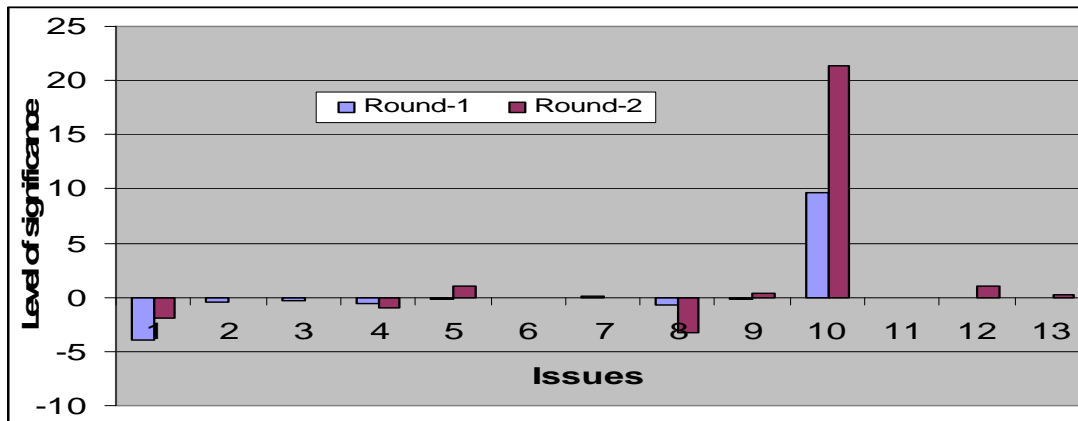


Figure 6. Showing difference in perceptions (Admin staff & Policy makers)

6. Difference of perception when testing the hypothesis “there is no significant difference of perception between Faculty members & Students on future use of ICT tools/applications” calculated was significant (31.5) in Round-1 but in Round-2, that (0.87) fell down under acceptance level (Table 3).

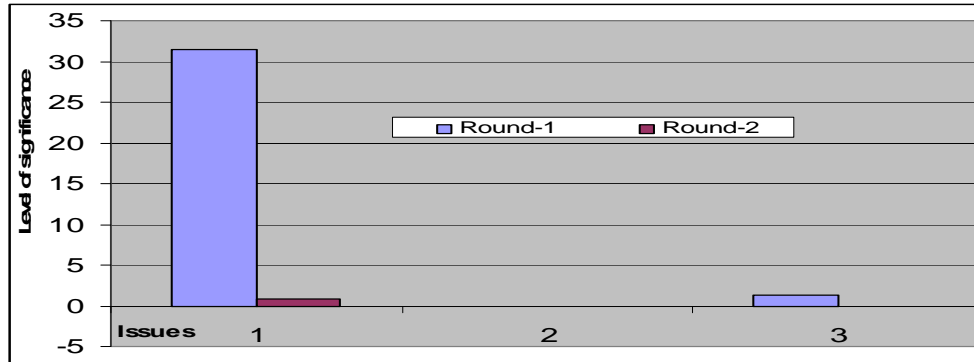


Figure 7. Showing difference in perceptions (Faculty & Students) on future use of ICT tools/applications

- ANOVA test results for testing the hypothesis “there is no significant difference of perception among Delphi participants regarding all 13 collective issues of Delphi instrument” show no significant difference in both rounds of Delphi. Furthermore, in Round-2 of ANOVA, the results are reduced to much lower level (Table 4, 5 & 6).

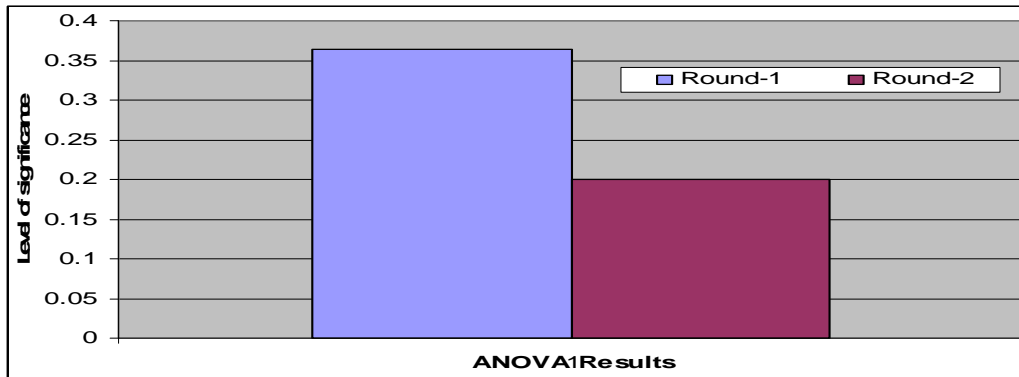


Figure 8. Showing difference in perceptions among all participants (ANOVA results)

### Conclusions

The following conclusions have been drawn. Inferences regarding ZPD gap, Z test and ANOVA test have been made in respect of the perspective in which these tests are used.

- Almost all areas concerning with current usage of ICT tools/applications by Faculty/Students/Staff in HEIs of Pakistan show higher ZPD gaps from optimum level of 5, but the areas Planning, developing and organizing instructions, Assessing student learning, Academic research, and Group discussion/supervision/training as shown in Figure 1 above are some with significant gaps. These gaps may be due to lack of training to teaching/support staff, poor or unavailability of ICT infrastructure, and lack of effective ICT policy for HE.

2. Similarly, higher gaps from optimum level of 5, in issues such as Use of educational/research ICT tools, demand & supply of ICTs show lacking in training, infrastructure, and policy (Figure 2).
3. Value of Z test calculated to compare the perceptions of Faculty members & Students regarding use of ICT tools/applications in Group discussion/supervision/training was higher than the table value in Round-1, but consequently in Round-2 it came under acceptance level; hence the hypothesis cannot be rejected (Figure 3).
4. Value of Z test calculated to compare the perceptions of Faculty members and Admin staff regarding use of ICT tools/applications for using social networks/forums in quest of knowledge remained higher than the table value in final round (Round-2), therefore the hypothesis is rejected. This is due to an indication of significant ZPD gap which shows less use of educational/research tools (Figure 4).
5. Value of Z test calculated to compare the perceptions of Parents and Policy makers regarding use of ICT tools/applications in Group discussion/supervision/training was higher than the table value in both rounds of Delphi, therefore the hypothesis is rejected. This is due to an indication of ZPD gap which shows less ICT use in group discussion/supervision/training (Figure 5).
6. Value of Z test calculated to compare the perceptions of Admin staff and Policy makers regarding use of ICT tools/applications in Group discussion/supervision/training was higher than the table value in both rounds of Delphi, therefore the hypothesis is rejected. This is due to an indication of ZPD gap which shows less ICT use in group discussion/supervision/training (Figure 6).
7. Value of Z test calculated to compare the perceptions of Faculty members and Students regarding future use of ICT tools/applications by Faculty/Students/Staff of HEIs of Pakistan in their job-related tasks was higher than the table value in Round-1, but finally it came under acceptance level in Round-2; hence the hypothesis can not be rejected (Figure 7).
8. Value of ANOVA test calculated to compare the perceptions of Delphi participants regarding all issues of Delphi instrument was less than the table value at both 0.01 and 0.05 levels. Hence the hypothesis is not rejected. (Figure 8).
9. Z test results either of Round-1 or Round-2 further confirm the flaws as were identified in ZPD gap analysis.

### **Recommendations**

On the basis of conclusions and findings, some recommendations are made:

1. Although higher ZPD gaps were calculated in almost all areas related with ICT integration in HE and present & potential future use of ICT tools/application, but the areas in which this gap is greater than 1.5 should be given high priority in terms of any future developments regarding training program, infrastructure or policy planning.
2. A ZPD incidence development strategy may be designed/formulated that not only workout to help reduce such pronounced gaps but also recommend actions for proper ICT integration in HEIs of Pakistan on regular basis.
3. There is a need to pay full attentions on issues of conflict among Delphi participants of this study (i-e use of ICT tools/applications, demand & supply of ICTs etc) as identified in Z test analysis, and a mechanism may be formulated that may inline them with other issues.

4. There is a need to come up with robust, effective and target-oriented ICT policy for HES of Pakistan earlier that may work out on recommendations given in this study and take actions in timely manner to overcome this situation of dilemma.
5. ANOVA results reveal the fact that Delphi participants pledge full consensus on issues related with betterment of HES of Pakistan.
6. In order to take measures for enhancement of HES of Pakistan in future; these recommendations may be helpful.

#### **Recommendations for future research:**

1. Since the scope of this research was limited to Pakistani perspective, a bigger & full length study can be conducted that may identify problems at global level and provide solutions.
2. A strategy can be formulated that work on how such big ZPD gaps can be reduced to lower possible level for demand of ICTs in HEIs of Pakistan.
3. It is further suggested that an ongoing process of research and development in ICT and HE at local level should be started earlier that recommend actions on regular basis pertaining any major changes in world's HES.

#### **References**

- Ager, R. (2000). *The Art of Information and Communications Technology for Teachers*. David Fulton, London: UK.
- Akbulut, Y., Kesim, M., & Odabasi, F. (2007). Construction validation of ICT indicators measurement scale (ICTIMS). *International Journal of Education and Development using Information and communication technology*, 3(3), 60-77.
- Billig, S. H., Sherry, L., & Havelock, B. (2005). Challenge 98: sustaining the work of a regional technology integration initiative. *British Journal of Educational Technology*, 36(6), 987-1003.
- Edelson, D. C. (2001). Design research: What we learn when we engage in design. *Journal of the Learning Sciences*, 22(1), 105-121.
- Esnault, L., & Daele, A. (2003). *Higher Education and ICT: Questions to Design Successful Pedagogical Scenarios to Improve the Learning Process*. World Conference on E-Learning in Corp., Govt., Health, & Higher Education, Phoenix: Arizona.
- Gauci, A. (2001, November). Reforms in higher education and the use of information technology. *Issues in Higher Education, Economic Growth, and Information Technology*, Ad-hoc Expert Group Meeting, 19-21, Nairobi, Kenya.
- Gibson, I. S., O'Reilly, C., & Hughes, M. (2002). Integration of ICT within a project-based learning environment. *European Journal of Engineering Education*, 27(1), 21-31.
- Haddad, W. (1999). *If Technology is the Solution Where Is the Problem?* Retrieved from TechKnowLogia, [http://techknowlogia.org/TKL\\_active\\_pages2/CurrentArticles/main.asp?IssueNumber=2&FileType=PDF&ArticleID=35](http://techknowlogia.org/TKL_active_pages2/CurrentArticles/main.asp?IssueNumber=2&FileType=PDF&ArticleID=35).

- Haywood, D., & Haywood, J. (2003). *ICT Skills of Students in European Universities: SEUSSIS Project Final Report*. School of Education, University of Edinburgh.
- Hussain, T. (2008). Dilemma of Higher Education in Pakistan and Role of World Bank. X International Summer School. In *Lifelong Learning: Participatory learning, citizenship and Identity*. Denmark: Roskilde University.
- Khan, A. M., & Shah, Q. A. (2004). *Study on Impact of Information and Communication Technology on Decent Work in Pakistan*. Islamabad: Pakistan Manpower Institute, Ministry of Labour Manpower & Overseas Pakistanis, Government of Pakistan.
- Jayson, W. R. (2008). ICT in Education Reform in Cambodia: Problems, Politics, and Policies Impacting Implementation. *Information Technologies and International Development*, 4(4), 67–82.
- Krumsvik, R. (2004). ICT and community of practice. 32<sup>nd</sup> Nordic Educational Research Association Congress: *The Positioning of Education in Contemporary Knowledge Society*. Iceland.
- Luckin, R. (2001). Designing Children's Software to Ensure Productive Interactivity through Collaboration in the Zone of Proximal Development (ZPD). *Information Technology in Childhood Education Annual*, 1, 57-85. VA: AACE.
- Mumcu, K. F., & Usluel, K. Y. (2004). Mesleki ve teknik okul öğretmenlerinin bilgisayar kullanımları ve engeller. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 26, 91-100.
- Nwuke, O. K. (2001, November). Reforms in higher education and the use of information technology. *Issues in Higher Education, Economic Growth, and Information Technology*, Ad-hoc Expert Group Meeting, 19-2. Nairobi, Kenya.
- Pelgrum, W. J., & Law, N. (2003). *ICT in education around the world: Trends, problems and prospects*. Paris: UNESCO.
- Rogers, M. E. (2003). *Diffusion of Innovations* (5th Ed.). New York: The Free Press.
- Shaheeda, J., Dick, N., & Laura, C. (2007). The role of ICTs in higher education in South Africa: One strategy for addressing teaching and learning challenges. *International Journal of Education and Development using Information and Communication Technology*. 3(4), 131-142.
- Shaikh Z. A., & Ahmed Z. (2009). ICT for Shaping the Future of Higher Education in Pakistan. Accepted for publication in the Proceedings of the WorldComp09 FEC09 Conference on Frontiers in Education: Computer Science & Computer Engineering, Las Vegas, Nevada. Retrieved from <http://docs.google.com/fileview?id=F.b8b3101a-295e-492a-b436-21a57cf168a7>
- Taylor, J. C. (2003, May). *Higher Education Challenges and Solutions*. Presentation at Microsoft Executive Breakfast.

- Tiene, D. (2002). Addressing the global digital divide and its impact on educational opportunity. *Educational Media International*, 39(3-4), 211-222.
- Tinio, V. L. (2003). *ICT in Education: e-Primers for the information economy, society and policy*. United Nations Development Programme, New York.
- Usluel, Y. K., Asker, P., & Bas, T. (2008). A structural equation model for ICT usage in higher education. *Educational Technology & Society*, 11(2), 262-273.
- Usluel, Y. K., & Seferoğlu, S. S. (2004). Obstacles that faculty members face while using information technologies, solutions they propose and their computer self-efficacy. *Educational Sciences and Practices*, 6, 143-157.
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 426-478.
- Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. USA: Harvard University Press.
- Wieringen, F. V., Sellin, B., & Amsterdam, G. S. (2002). *Future education: learning the future scenarios and strategies in Europe*. Max Goote Expert Center, Amsterdam University.
- Wong, K. (2008). School-based technology coordinators and other human factors in the implementation of ICT in primary schools: A comparative study. *International Journal of Education and Development using ICT*, 4(1).
- Yi, M. Y., Jackson, J. D., Park, J. S., & Probst, J. C. (2006). Understanding information technology acceptance by individual professionals: Toward an integrative view. *Information & Management*, 43, 350-363.

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### Appendix (Tables)

Table 1. Statistics for questions measuring ZPD gap (Source: Shaikh & Ahmed, 2009)

#	ISSUES		ROUND-1		ROUND-2	
			Mean	ZPD Gap	Mean	ZPD Gap
1.	Planning, Developing and Organizing instruction	Present	3.43	1.57	2.93	2.07
		Future	4.87	0.13	5	0
2.	Housekeeping and Record keeping Tasks	Present	3.37	1.63	3.07	1.93
		Future	4.87	0.13	5	0
3.	Managing Student Conduct	Present	3.03	1.97	3.07	1.93
		Future	4.73	0.27	4.97	0.03
4.	Presenting Subject Material / Teaching	Present	3.47	1.53	3.13	1.87
		Future	4.87	0.13	4.97	0.03
5.	Assessing Student Learning	Present	2.77	2.23	2.97	2.03
		Future	4.63	0.37	4.87	0.13
6.	Academic Research	Present	2.97	2.03	2.9	2.1
		Future	4.83	0.17	5	0
7.	Administrative Support	Present	3.83	1.17	3.1	1.9
		Future	4.73	0.27	4.9	0.1
8.	Using Social networks / forums in quest of knowledge	Present	2.67	2.33	3.03	1.97
		Future	4.73	0.27	5	0
9.	Database / Library Research & Information e.g. IEEE, ACM	Present	3.46	1.54	3.2	1.8
		Future	4.85	0.15	5	0
10.	Group Discussion / Supervision / Training	Present	2.79	2.21	2.21	2.79
		Future	4.41	0.59	4.93	0.07
11.	Common ICT tools/applications	Present	4.82	0.18	4.97	0.03
		Future	4.8	0.2	5	0
12.	Educational/Research ICT tools: Scholarly search, encyclopedia, satellite imaginary, programming...	Present	3.43	1.57	3.1	1.9
		Future	4.7	0.3	5	0
13.	Rely on ICTs		4.13	0.87	4.07	0.93
14.	Use of ICTs		4.3	0.7	4.07	0.93
15.	Help by ICTs		3.87	1.13	4	1
33.	ICT Demand in HEIs		--	--	3.12	1.88
34.	ICT Supply in HEIs		--	--	2.31	2.69
35.	Problem of Attitude. Grabbing resources & misuse them.		--	--	4.53	0.47

Table 2. Statistics for issues measuring Z test between categories

Categories	Issues / Rounds	1	2	3	4	5	6	7	8	9	10	11	12	13
<i>FACULTY</i> <i>VS</i> <i>STUDENTS</i>	Round-1	-1.82	-0.22	0.38	0.09	-0.29	0.23	0.00	0.11	0.00	10.33	---	---	---
<i>FACULTY</i> <i>VS</i> <i>PARENTS</i>	Round-2	0.32	1.00	0.00	1.00	1.00	1.15	0.29	1.09	-0.10	-5.25	1.00	0.00	1.00
<i>FACULTY</i> <i>VS</i> <i>ADMIN STAFF</i>	Round-1	-1.62	-0.22	-0.29	0.08	0.20	0.06	-0.22	1.05	0.66	-14.00	---	---	---
<i>FACULTY</i> <i>VS</i> <i>POLICY MAKERS</i>	Round-2	1.21	0	0.00	1.00	1.00	0.00	0.00	0.72	0.10	-43.11	1.00	1.00	0.17
<i>FACULTY</i> <i>VS</i> <i>STUDENTS</i>	Round-1	-2.25	-0.19	-0.29	0.09	0.20	0.12	-0.13	1.24	-0.83	-14.82	---	---	---
<i>FACULTY</i> <i>VS</i> <i>PARENTS</i>	Round-2	0.42	0	1.00	1.00	0.00	1.00	0.25	4.36	-0.09	-26.21	1.00	0	-1.00
<i>FACULTY</i> <i>VS</i> <i>ADMIN STAFF</i>	Round-1	-4.56	-0.22	-0.63	-0.20	0.00	0.12	0.00	0.33	-1.51	-2.42	---	---	---
<i>FACULTY</i> <i>VS</i> <i>POLICY MAKERS</i>	Round-2	-1.42	0	1.00	0.00	1.00	1.00	0.17	2.40	0.27	-21.51	-1.00	0	-1.25
<i>STUDENTS</i> <i>VS</i> <i>PARENTS</i>	Round-1	0.71	0.00	-0.71	0.00	0.38	-0.19	-0.16	0.75	0.78	-22.24	---	---	---
<i>STUDENTS</i> <i>VS</i> <i>ADMIN STAFF</i>	Round-2	1.17	-1.00	0.00	0	0	-1.15	-0.29	-0.89	0.19	-20.32	0.17	1.20	0.17
<i>STUDENTS</i> <i>VS</i> <i>POLICY MAKERS</i>	Round-1	-1.55	0.38	-0.71	0.00	0.38	-0.12	-0.10	0.77	-1.12	-29.08	---	---	---
<i>STUDENTS</i> <i>VS</i> <i>ADMIN STAFF</i>	Round-2	0.18	-1.00	1.00	0	-1.00	-1.25	0.12	0.31	0.00	-20.39	0.18	-1.00	1.00
<i>STUDENTS</i> <i>VS</i> <i>POLICY MAKERS</i>	Round-1	-5.52	0.00	-1.07	-0.63	0.19	-0.12	0.00	0.11	-1.30	-19.38	---	---	---
<i>STUDENTS</i> <i>VS</i> <i>ADMIN STAFF</i>	Round-2	-2.05	-1.00	1.00	-1.00	0	-1.25	0.00	-0.73	0.36	-7.75	0	0	-1.00
<i>STUDENTS</i> <i>VS</i> <i>POLICY MAKERS</i>	Round-1	-1.90	0.38	0.00	0.00	0.00	0.06	0.05	-0.28	-2.61	9.69	---	---	---
<i>STUDENTS</i> <i>VS</i> <i>ADMIN STAFF</i>	Round-2	-0.92	0	1.00	0	-1.00	1.00	0.25	4.59	-0.17	-16.32	-1.00	1.00	0.25
<i>STUDENTS</i> <i>VS</i> <i>POLICY MAKERS</i>	Round-1	-5.86	0.00	-0.36	-0.63	-0.19	0.06	0.14	-0.94	-2.80	19.38	---	---	---
<i>STUDENTS</i> <i>VS</i> <i>ADMIN STAFF</i>	Round-2	-2.53	0	1.00	-1.00	0	1.00	0.17	1.20	0.17	24.39	0	0	-1.15
<i>STUDENTS</i> <i>VS</i> <i>POLICY MAKERS</i>	Round-1	-3.97	-0.38	-0.36	-0.63	-0.19	0.00	0.10	-0.66	-0.19	9.69	---	---	---
<i>STUDENTS</i> <i>VS</i> <i>ADMIN STAFF</i>	Round-2	-1.96	0	0	-1.00	1.00	0	-0.09	-3.27	0.32	21.30	0.00	1.00	0.25

Z-critical value at 95% significance level = 1.96

Z-critical value at 99% significance level = 2.576

Table 3: Measuring Z test for future use of ICT tools/applications

Categories	Issues/ Rounds	1	2	3
<i>FACULTY VS STUDENTS</i>	Round-1	31.50	-0.15	1.25
	Round-2	0.87	0	0
<i>FACULTY VS PARENTS</i>	Round-1	1.75	-0.11	1.25
	Round-2	-6.72	0	0
<i>FACULTY VS ADMIN STAFF</i>	Round-1	-4.53	-0.07	1.67
	Round-2	-10.08	0	0
<i>FACULTY VS POLICY MAKERS</i>	Round-1	-11.09	-0.15	1.00
	Round-2	-33.60	0	0
<i>STUDENTS VS PARENTS</i>	Round-1	-14.48	0.50	0.00
	Round-2	-1.18	0.00	0.00
<i>STUDENTS VS ADMIN STAFF</i>	Round-1	-8.80	0.77	0.36
	Round-2	-0.86	0.00	0.00
<i>STUDENTS VS POLICY MAKERS</i>	Round-1	-9.83	0.00	-0.36
	Round-2	-1.72	0.00	0.00
<i>PARENTS VS ADMIN STAFF</i>	Round-1	-4.48	0.38	0.36
	Round-2	-0.17	0.00	0.00
<i>PARENTS VS POLICY MAKERS</i>	Round-1	-5.52	-0.38	-0.36
	Round-2	-1.03	0.00	0.00
<i>ADMIN STAFF VS POLICY MAKERS</i>	Round-1	-1.03	-0.77	-0.71
	Round-2	-0.86	0.00	0.00

Z-critical value at 95% significance level = 1.96

Z-critical value at 99% significance level = 2.576

Table 4. Data (mean scores) for measuring ANOVA test

I	ROUND-1					ROUND-2				
	Faculty	Students	Parents	Admin Staff	Policy Makers	Faculty	Students	Parents	Admin Staff	Policy Makers
1.	3.00	3.50	3.50	3.83	3.33	2.67	3.00	3.00	3.17	2.83
2.	3.33	3.17	3.17	3.17	4.00	2.83	3.00	3.00	2.83	3.67
3.	2.83	3.00	3.17	3.17	3.00	3.33	3.00	2.83	3.17	3.00
4.	3.83	3.33	3.33	3.17	3.67	3.33	3.17	2.83	3.00	3.33
5.	2.33	2.67	2.83	2.83	3.17	2.83	3.00	3.00	2.83	3.17
6.	2.67	3.17	3.17	2.83	3.00	3.00	2.83	3.00	2.83	2.83
7.	3.83	3.83	3.50	4.00	4.00	3.17	3.17	3.00	3.17	3.00
8.	2.50	2.67	3.00	2.50	2.67	3.00	2.83	3.33	3.17	2.83
9.	3.50	3.00	2.50	3.50	3.67	3.33	3.17	3.00	3.17	3.33
10.	2.67	2.67	2.50	2.83	2.83	2.17	2.17	2.00	2.17	2.17
11.	3.33	4.83	4.83	4.67	4.83	5.00	4.83	5.00	5.00	5.00
12.	3.33	3.17	3.50	3.50	3.67	3.17	3.17	3.17	3.00	3.00
13.	4.17	4.00	4.00	4.00	4.50	4.17	4.00	4.00	4.00	4.17
14.	4.33	4.50	4.17	4.17	4.33	4.17	4.00	4.00	4.17	4.00
15.	4.17	3.50	4.00	3.83	3.83	4.17	3.67	4.17	4.00	4.00
16.	4.00	4.00	4.50	4.33	4.00	4.67	4.50	4.67	4.33	4.50
17.	4.33	4.33	4.33	4.00	4.17	4.50	4.50	4.50	4.00	4.50
18.	4.17	4.17	3.33	3.50	4.00	4.33	4.33	3.50	3.50	4.33
19.	4.50	4.67	4.00	4.00	4.33	4.50	4.67	4.50	4.33	4.33
20.	3.00	2.67	2.17	2.67	3.00	4.00	2.83	4.17	3.50	3.83
21.	4.50	4.33	3.83	4.33	4.50	4.67	4.50	4.33	4.33	4.50
22.	4.17	4.00	4.67	4.67	4.50	4.50	4.67	4.67	4.67	4.50
23.	4.50	3.83	4.50	4.83	4.50	4.50	4.33	4.50	4.83	4.50
24.	2.67	3.17	1.67	2.83	3.50	2.50	2.50	2.33	2.33	2.17
25.	4.00	4.50	3.83	4.17	4.00	4.17	4.50	4.33	4.33	4.17
26.	4.33	4.17	4.83	4.67	4.67	4.50	4.17	5.00	5.67	4.67
27.	4.50	4.50	4.50	4.50	4.33	4.50	4.67	4.67	5.50	4.50
28.	4.17	4.17	4.33	4.50	4.33	4.17	4.33	4.83	5.67	4.67
29.	4.50	4.50	4.50	4.50	4.33	4.50	4.83	4.67	5.50	4.50
30.	4.67	4.17	4.83	4.67	4.67	4.67	4.67	5.00	4.83	4.83
31.	4.67	4.67	4.83	4.67	4.67	4.67	4.67	4.83	4.83	4.83
32.	4.67	4.50	4.83	4.67	4.67	4.67	4.83	4.83	4.83	4.83
33.	--	--	--	--	--	3.83	3.83	4.50	4.33	4.00
34.	--	--	--	--	--	4.33	4.50	4.83	4.50	4.50
35.	--	--	--	--	--	3.50	3.67	4.50	4.83	4.50

Table 5. Showing results of ANOVA test (Round-1)

Sources of variance	Degree of frequency (df)	Sum of squares	Variances	F
Between samples	$K - 1 \rightarrow 5 - 1 = 4$	0.773503	0.193376	
Within samples	$N - k \rightarrow 160 - 5 = 155$	82.51094	0.532329	0.363264
Total	$N - 1 \rightarrow 4 + 155 = 159$	83.28444	0.725704	

Table value 0.01 level = 3.41

Table value 0.05 level = 2.42

Table 6: Showing results of ANOVA test (Round-2)

Sources of variance	Degree of frequency (df)	Sum of squares	Variances	F
Between samples	$K - 1 \rightarrow 5 - 1 = 4$	0.570666	0.142667	
Within samples	$N - k \rightarrow 175 - 5 = 170$	121.5227	0.714839	0.199578
Total	$N - 1 \rightarrow 4 + 170 = 174$	122.0934	0.857506	

Table value 0.01 level = 3.41

Table value 0.05 level = 2.42