

Strategies for Research Capacity Building in Local Language Computing: PAN Localization Project Case Study

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Abstract

Strengthening indigenous research capacity versus technology transfer (Harris, 2004; Nokolov and Illieva, 2008) is the most effective process for advancing research, specifically in localization. This paper discusses different strategies undertaken by the PAN Localization project in building research capacity for localization in the partner countries based on principles of capacity building defined in literature.

1 Introduction

The use of ICTs is often accentuated as the most promising and fundamental driver of social and economic development (Lutz, 2003). This is because of its potential to enable the underprivileged to leapfrog the barriers to information access, improve livelihood opportunities and communicate with people across the globe (World Bank, 2002). However, only 21% of developing economies can access information on the internet (ITU, 2011). This digital divide is largely perpetuated due to English, being the lingua franca for ICTs (Pimienta, 2005). This language based digital divide is very pronounced in Asia, where about 2,322 languages are spoken (Lewis, 2009) and only 2% know how to read and write in English, a pre-requisite for ICT usage.

Local language computing also called localization or enabling ICTs in a local language is essential for effective ICT use in Asia (Gul, 2004). This paper presents strategies and interventions by PAN Localization project¹ for building sustainable research capacity in localization, through partnership of 11 Asian countries, since 2004. The paper is organized as follows: Section 2 defines localization and its

related knowledge areas, Section 3 presents capacity building framework and derives the structural levels and principles upon which capacity enhancement initiatives must focus, and Section 4 presents the PAN Localization project and the capacity building interventions that have been carried out through the project following each of the defined capacity building principles. Based on the findings, Section 5 recommends the capacity building strategy. Section 6 concludes the paper.

2 Localization Research

As defined by Hussain and Mohan (2007), localization is “*The process of developing, tailoring and/or enhancing the capability of hardware and software to input process and output information in the language, norms and metaphors used by the community.*” It is a three step process. First, the linguistic analysis is required to document (and standardize) language conventions that are to be modeled. Second, localized applications (both basic and intermediate level) e.g. fonts, keyboard, locale, spell checkers, etc. need to be developed to enable basic input and output of text in a local language. Thirdly to provide comprehensive access and assist content development, advanced applications like translation systems, speech dialogue applications, etc., need to be developed.

Localization therefore requires significant knowledge of linguistics (phonetics, phonology, morphology, syntax, semantics and pragmatics), signal and speech processing, image processing, statistics, computational linguistics and advanced computing (Hussain et al, 2007). This research being language dependent, entails nurturing indigenous *research capacity* (Breen et al, 2004, DFID, 2007) at the levels of individuals, organizations, and systems to sustain.

¹See www.PANL10n.net.

3 Research Capacity Building Models

Research capacity building (RCB) frameworks define levels and set of practices that help build capacity. RCB frameworks available in literature (Cooke 2005, Neilson and Lusthaus 2007, Wignaraja 2009) largely recommend three structural levels and six basic principles upon which capacity building must be designed as discussed in the sub-sections below.

3.1 Structural Levels of RCB

Structural level of RCB defines the point of view upon which capacity development initiatives must be targeted. They include individual, organizational and system levels (Neilson and Lusthaus 2007, Breen et al, 2004). Some frameworks follow a hierarchical categorization of these levels (Potter and Brough, 2004) and others form a phase-wise development plan (Wibberley, Dack, & Smith, 2002, Breen et al, 2004) where capacity building at certain prior level necessitates capacity development at the next level. Interventions however cannot be carried out at a certain level in isolation. Every activity accomplished at a certain level has impact on the other levels.

3.2 Principles of RCB

Cooke (2005) recommends six principles of capacity building that include focusing interventions on: skill development; focus on close to practice research; establishment of linkages, partnerships and collaborations; development of capacity for dissemination and impact; sustainability and continuity of research and development of infrastructure. Each principle is briefly described below.

3.2.1 Skill Development

RCB requires a multi-faceted skill development process through training and supervision to primarily develop technical, managerial, and publishing skills (Harris 2004, Raina 2007). Skill development can also be viewed in the context of career development and generating opportunities to apply research skills in practice (Rhee and Riggins. 2007).

3.2.2 Training on Close to Practice Research

A foremost principle of RCB is in directing researchers' ability to produce research that is useful for informing policy and practice (Cooke,

2005). Thus capacity building interventions ensure that research is "close to practice" such that new knowledge generated can directly impact development.

3.2.3 Development of Linkages

Developing linkages, partnerships and collaborations is a reciprocating process of involving organizations in the knowledge information chain for fostering development and diffusion of quality research (Wignaraja 2009, Breen et al 2004). It also harnesses an increased knowledge base for research development and enhancement.

3.2.4 Dissemination and Impact

Dissemination of research, through peer reviewed publications and presentations at academic conferences, is essential for sharing knowledge (Harris 2004, Breen et al 2004). Capacity building for wider research dissemination incorporates instruments of publicity through factsheets, the media and the Internet (Cooke 2005) for a variety of stakeholders, including public, policy makers and the relevant research community.

3.2.5 Sustainability and Continuity

RCB must ensure strategies for maintenance and continuity of the acquired skills and structures to undertake research. Wignaraja (2009) defines capacity development as a process of transformation that emerges from within the individuals, organizations and systems. Long term sustainable capacity development requires consolidation of local systems and processes through practice.

3.2.6 Infrastructure Development

Rhee and Riggins (2007) defines infrastructure as a set of structures and processes that are set up to enable the smooth and effective running of research projects. These include availability of technical resources including equipment, books, connectivity, etc. as well as sound academic and managerial leadership and support for developing and sustaining research capacity.

Based on the above categorization, the following section describes strategies undertaken by PAN localization project 2004-2013 for fostering localization research capacity in the partner countries.

4 PAN Localization Project

PAN Localization project (www.pan110n.net) is a regional initiative to develop local language computing capacity in Asia. The project involved partnership of 21 organizations across Afghanistan, Bangladesh, Bhutan, Cambodia, China (Tibet Autonomous Region), Indonesia, Laos, Nepal, Mongolia, Pakistan, Sri Lanka, for conducting research on fifteen local languages spoken across developing Asia.

4.1 Strategies for Localization Capacity Building

Prior to initiating the capacity development program, baseline study of the existing research capacity in partner countries was conducted to help in devising the strategies (Hussain, 2004). The study showed that while teams had very limited experience in basic localization (except in a couple of countries) and many countries had no work done in localization policy development and development of intermediate and advanced localization. Also there was hardly any experience in inter-disciplinary research and development across computing, engineering and linguistics. Regarding team management, only two country team leaders had experience in running long-term multi-disciplinary projects.

Faced with the above capacity challenges, appropriate measures had to be undertaken, focusing across the six principles of research capacity building to target holistic improvement. Specific interventions for each of the principle are discussed in the section below.

4.1.1 Skill Development

Skills development through the project has been focused on building technical skills to conduct and publish localized research outputs. Strategies practiced in this context are explained below.

4.1.1.1 Undertaking Localization Research

Foremost strategy employed for technical skill development has been to require each project team to deliver specific research outputs. This strategy served as a persistent capacity building process that enabled researchers to work on real problems and find research solutions through involvement in problem identification, project designing, implementation, quantitative and qualitative analysis. Working directly to address the technical, linguistic, social and managerial challenges also developed lasting confidence to

undertake further work in the future. The following table presents the comparative figures for assessment of their teams' capacity by the project leaders from each partner country. The levels are on a scale of 1-5, collected at the beginning of project Phase 2 in 2007 and towards the end of this phase in 2009. These figures are derived from a more detailed survey done for the 11 partner countries.

Capacity Building Target Area	Year 2007	Year 2009
Project development	2	5
Project design	3	5
Problem identification	3	5
Project implementation	3	5
Analysis Ability	3	4
Communication Ability	2	4
Multi disciplinary research Ability	2	4
Quantitative analytical skills	2	4
Qualitative analytical skills	2	4

Table 1: Progression of Capacity Building of Teams in Local Language Computing

This process also trained the researchers to work in multi-disciplinary team comprising of computer scientists, linguists, sociologists, stenographers, within each partner. Where the project teams were challenged and stopped short of skills to meet the planned research outputs, short term training or mentor placement programs were initiated as explained in the following section.

4.1.1.2 Short Term Training

Short term training was a skill building strategy that was designed normally as a week-long activity targeting training on a certain research area. In addition to building individual's capacity, this strategy would also help build institutional capacity. Trainees receiving the short term training were not limited to project staff only but would also include additional relevant staff where this training was organized. Six short term training were conducted during the project, covering a varied set of topics, for example, FOSS localization, OCR development,

linguistics and monitoring and evaluation using outcome mapping framework.

4.1.1.3 Mentor Placement Program

Where the country team required longer training to address capacity challenges, mentor placement programs were initiated, which provided technical and management support to partner countries. Two different models have been adopted in this context. In first model (referred to as mentor Placement I in Table 2), a mentor from within the partner countries was sent to partner needing support. Three such mentor placements were conducted from 2004-2007, and 2 were held during the second phase of the project. In second model (referred to as mentor Placement II in Table 2) respective country component nominated one or two persons from team to stay with mentoring organization for the training duration. One such placement was initiated in the project's first phase of the project, while 5 such placements were done in the Phase 2. Both models have been worked out equally well. An extension of first model has also been tried by providing the remote mentoring facility after completion of training, which has also proved effective in achieving the research outcomes.

4.1.1.4 Summer School in Local Language Computing

The project further initiated an innovative form of technical training called Summer School in local language computing. This was a semester equivalent (three month long) extensive academic program with credit for five graduate courses in linguistics and computational linguistics that were not offered in the partner countries. The credit hours earned through the semester were transferrable in any other graduate program. The course instructors selected to teach these courses were experts in their fields chosen from around the world. This helped quickly boost the capacity of the partner teams, enabling the transition from undertaking research in localization in Phase 1 to more advanced research in language computing in Phase 2.

4.1.1.5 Support for Higher Studies

As a strategy for continued and advanced training in local language computing, the project provided completed or partial scholarships for many team members for pursuing higher studies in disciplines related to localization research. Specific researchers were funded in Bangladesh,

Cambodia, Indonesia, Mongolia, Pakistan and Sri Lanka, to accomplish their academic research through working on Project. In addition, project facilitated these team members by providing time for studies and examinations and in certain instances by supporting the tuition fee for their degree program. This support for higher studies was also used as a strategy for retention of researchers, as these team members would remain with the Project until degree completion.

4.1.1.6 Presentation at Workshops and Conferences

A number of researchers from different partner countries participated and presented their work at national and international workshops and conferences. This was a testimony of the maturity of their research skills developed during the project. As an incentive for producing publishable research the project supported their travel and participation expenses.

The following table summarizes the number of times each type of strategy is employed during the respective project phases.

Training Strategy	Phase 1 (2004-07)	Phase 2 (2007-10)
Short Term Training	6	-
Mentor Placement (I)	3	2
Mentor Placement (II)	1	5
Summer School	1	-
Support for Higher Studies	5	9
Conference Participation	12	40

Table 2. Capacity Building Interventions During Project Phases 1 and 2

The table shows that Phase 1 focused on short training and mentor placements I. As the teams had acquired reasonable competence, during Phase 2 strategies targeted collaborations, e.g., Mentor Placement II, summer school and conference participation, and longer term impact, e.g. through support for higher studies.

4.1.2 Training to Conduct Close to Practice Research

Research work is more useful if its outputs can directly provide socio economic benefit to the communities. Following this motivation, the project instituted the following strategies.

4.1.2.1 Partnerships for Outreach

An outreach component for the project research work was specifically implemented with most of its project partners during the second phase of the project, while the first phase had focused on development of the technology. For this purpose, in the second phase the project also developed partnerships with civil society organizations to specifically focus on dissemination of technology to end users in the partner countries, with explicit funding allocations to support the partnerships. For example, Nepalinux developed by Madan Puraskar Pustakalaya (MPP) was used by E-Network Research and Development (ENRD) to train five rural communities around Nepal, which included farmers, mothers' group, and retired army men. They used the Nepali language applications to communicate with their relatives abroad and to develop online community portals. Similarly, Pakistan component collaborated with District Governments of Sargodha, Chakwal and Attock to deploy localized open source applications in ten rural schools, training more than 200 school students and teachers on information access, communication and content generation.

The partnerships have enabled partners focusing on outreach to appreciate technical challenges and helped the technical partners to appreciate the end user dissemination and adoption challenges. Both lessons significant for planning research they would undertake in the future.

4.1.3 Development of Linkages

Research groups often operate in isolation, limiting the scope and success of their work. The project has been focusing on collaborative learning. Experiences of researchers who are working successfully under similarly resource-constrained conditions engender trust and motivation. To ensure the project teams are well knit into the localization domain, the project implemented multiple strategies.

4.1.3.1 Inter-Disciplinary collaborations within teams

As local language computing requires research in linguistics, technology and user adoption, partners were encouraged to develop multi-disciplinary teams both at advisory and implementation levels. This included computer science professional working directly with linguists and sociologists, these researchers coming from a very different work cultures. Many of the partner countries did not have such collaborations earlier and thus developed individual and institutional capacities and also larger context, where the conventional circles for the communities could see possibilities and benefits accrued.

4.1.3.2 Inter-Disciplinary Collaborations Across Teams

Partner teams were encouraged to establish partnerships and collaboration with institutions that had more expertise in a specific field. These collaborations enabled the partners to collectively plan the technical and financial details, exchange data and technology and discuss and formalize shared intellectual property regimes, building institutional capacities in the context. For example, in Bhutan, Department of IT, the primary partner institute of the PAN L10n project collaborated with Dzongkha Development Authority, their national language development and language standardization authority to develop the technical terminology translations for the software. The advantage of those collaboration was that once the terminology was developed by DDA, it would become a national standard for such terminology translation. In Cambodia the PAN Cambodia collaborated with Institute of Technology, Cambodia (ITC) that had professors working on localization research and students taking up localization research projects in their BS final year projects. Such examples were practiced in all partner countries.

4.1.3.3 Regional and International Collaborations

As a strategy to develop international collaborations, the project has been organizing regional training, conferences and workshops, in which experts from the region are invited. These have provided opportunities to meet and discuss opportunities for collaboration. As a salient example, project partners have been interacting

with NECTEC, Thailand, which have eventually resulted in formal bi-lateral and multi-lateral partnerships. The project has also worked with researchers from Korea, India, Japan and regional organization like Asian Federation of Natural Language Processing. Such interactions have also resulted in direct partnerships between Microsoft and country partners resulting in the development of Language Interface Packs (LIP) for MS Office and Windows in Urdu, Pashto, Bangla, Sinhala, Khmer, and Lao, by the project partner countries.

4.1.3.4 Online Research Networks

The project teams have been participating in online research networks, discussion groups, communities and forums for collaboration, knowledge sharing and learning. The work they have performed have given them confidence not only to learn but also contribute on these online forums. The project created an online support network to encourage project partners to be a part of an online learning culture. The project partners have been participating on this forum, sharing their project experiences with each other. At the beginning of the project, this network was enrolled by 11 researchers with grew to 110 researchers from 25 different countries by the end of project phase 1 in 2007. Nepal and Bangladesh team discussed their challenges in developing spell checker for open source software for Brahmic scripts. The solution based on HunSpell by Nepalese helped the team develop Bangal spell checker in Bangladesh.

4.1.4 Dissemination and Impact

Dissemination is an essential part of undertaking research. The project used a variety of strategies to focus on distributing its outputs to a wide variety of stakeholders. Some of the activities are described below.

4.1.4.1 Project Websites

The main and sustained source of information and outputs of the project has been the project website. The core site has been maintained by the project's regional secretariat, though the project required each country team to nominate one person from their team to act as a website coordinator and provide local content for the centrally maintained multilingual website www.pan110n.net. In addition the teams also hosted their separate websites providing detailed information about their respective research

groups, hosted by their organizations, that are linked from the main website as well. This has given global access to project outputs.

4.1.4.2 Awareness Seminars

The project has organized awareness seminars to disseminate and publicize research results to local community. These seminars have been attended by a large number of participants from academia, public and private sectors. Through these seminars partner institutions have been regularly presenting their work to the key stakeholders from government, IT industry, academia, media, and end user communities. 4 such seminars were conducted in project phase 1, while there are funds for conducting 16 more seminars by the end of project's phase 2.

4.1.4.3 Promotional Material

Development of promotional material has been an integral strategy for research dissemination. In addition to publicity project flyers, teams have distributed CDs containing project outputs such as NepaLinux, Dzongkha Linux. For example, an estimated 3000 copies of CDs/DVDs have been distributed to various stakeholders. The videos about the project have also been produced and uploaded online for global audience.

4.1.4.4 Participation in Events and Competitions

Many of the project outputs have been presented at national and international forums and have also been awarded. For example, NepaLinux has been displayed at annual exhibitions like Info Tech organized by the Computer Association of Nepal (CAN) for the last four years. The national and international awards, including APC Chris Nicol FOSS Prize, Manthan awards, have also contributed to propagating the work to relevant research communities.

Project partners have been involved in designing, developing and disseminating the material developed, which has contributed to mutual capacity to disseminate research.

4.1.4.5 Planning and Evaluating Impact

Six of the eleven country partners initiated an outreach component of research in their projects, gaining insight on challenges in technology adoption and experience in designing, implementing and evaluating such interventions, also developing their capacity to reflect on

technology design and implications in the context. The focus was firming up by explicit training of the partners to plan, monitor and evaluate impact on society using formal framework of Outcome Mapping (Earl *et al.*, 2001). There was also an explicit focus on Gender, developed with collaboration with Gender Evaluation Methodology (GEMII) project, which resulted in the development of the Gendered Outcome Mapping Framework (Shams *et al.* 2010), practiced in the program. An online tool has been developed to put the training into practice and is being used to collate and publish data regarding the project's outcome challenges and progress markers.

4.1.5 Sustainability and Continuity

PAN Localization project has taken specific measures at individual, organizational and policy levels for building sustained indigenous research capacity to carry out local language computing in partner countries. Some of the specific strategies undertaken in this regard have been as follows.

4.1.5.1 Building Indigenous Localization Research Capacity

The project has focused on development of indigenous human resource capacity for localization by engaging twenty one partner organizations, in eleven different countries, working on fifteen different local languages. A significant number of technical developers, linguists and social scientists have been trained through the project. The following table gives the numbers of people engaged and trained through the project.

	Mgmt	Tech	Lang	Social Sc.	
Af	2	2	3	0	7
Bd	3	10	3	6	22
Bt	1	8	4	0	13
Kh	7	39	13	3	62
Cn	4	11	3	0	18
Id	3	3	12	0	18
La	5	9	6	3	23
Mn	3	15	9	0	27
Np	6	12	4	9	31
Pk	6	27	7	4	44
Sl	3	7	3	1	14
	43	143	67	26	279

Table 3. Number of Researchers in the Project

4.1.5.2 Advancing Research Capacity

For sustainability and advancement of localization research, country projects were housed within universities and government institutions that would continue the research beyond the project duration. Dedicated research centers were established through the project, for example. Center for Research in Bangla Language Processing, in Bangladesh, Language Technology Research Center in Sri Lanka, R&D Division within Department of IT, Bhutan, Language Research group in National Agency for Science and Technology, Laos, Language Technology Research Lab at National University of Mongolia, Center for Language Engineering at University of Engineering and Technology, Pakistan and Language Technology Kendra in Nepal. This has instigated further localization collaboration and research. The following table presents the localization research outputs successfully implemented in the partner institutes showing the research maturity that they have gained through the project.

	Basic		Inter-mediate		Advanced	
	Ph 1	Ph 2	Ph 1	Ph 2	Ph 1	Ph 2
Afghanistan	*	*		*		
Bangladesh	*		*	*	*	*
Bhutan	*	*	*	*		*
China		*		*		*
Cambodia	*	*	*	*		*
Indonesia						
Laos	*		*	*		*
Mongolia		*		*		*
Nepal			*			*
Pakistan		*		*		*
Sri Lanka	*		*	*	*	*

Table 4. Research Outputs of Country Teams in Project Phase I & II

4.1.5.3 PAN L10n Multilingual Chair in Local Language Computing

To sustain and consolidate the regional momentum of localization research capacity building initiated through the project, a permanent research chair for multilingual computing has been established at the project

regional secretariat in Pakistan funded by International Development Research Center (IDRC), Canada. Establishment of this research chair would provide a sound foundation to sustain, nurture and grow the network of localization researchers, and to provide direct support in language computing community, including researchers and policy makers.

4.1.6 Infrastructure Development

Lack of appropriate infrastructure for conducting research including equipment, books, journals and inability to support the recurring administrative expenses may become an impediment to conduct scientific research. Thus appropriate localization research infrastructure has also been established at partner countries. In addition the project also provided support for buying books and journals, and specialized software for localization research in the partner countries. The following table summarizes the interventions conducted by the project at each of the structural levels.

Principles of RCB	Ind.	Org.	System
Skill Development	4.1.1.1	4.1.1.2	*4.1.1.6
	4.1.1.2	4.1.1.3	*4.1.3.3
	4.1.1.3		
	4.1.1.4		
Close to Practice Research	4.1.2.2	4.1.2.1	
		4.1.2.2	
Development of Linkages	4.1.3.1	4.1.3.1	4.1.3.2
	4.1.3.4	4.1.3.2	4.1.3.3
Dissemination and Impact	4.1.4.2	4.1.4.2	4.1.4.1
			4.1.4.2
			4.1.4.3
			4.1.4.4
Sustainability and Continuity	*4.1.1.5	4.1.5.1	4.1.5.3
		4.1.5.2	
Infrastructure Development		4.1.6	

Table 5. RCB Interventions at Structural Levels

Interventions marked with asterisk (*) in the table above signify that project strategies had a cross-cutting effect across all structural levels. E.g. strategy for supporting higher studies (4.1.1.5) not only served to build their skills but also helped to sustain the researcher at individual level

5 Discussion

Though the six principles of RCB holistically address the challenge of RCB in localization, however appropriate sequencing within the six principles must be done in order to foster maximal impact (Potter & Brough, 2004). Based on the project experience RCB for localization must follow a developmental cycle within the defined capacity building principles.

Initially *Skill Building* and *Infrastructure development* must form the focus of RCB interventions for localization. Different countries require different research skills and infrastructure needs owing to the existing competencies. Thus a participatory need analysis should be performed to ensure skill development is based on national priorities and capacity. Based on the identified RCB needs, appropriate mentorship structure and organizational resources may be planned to ensure development of the research base.

Secondly, localization RCB can be built to carry out *close to practice research*, of direct benefit in practice, after development of technology the basic and intermediate levels of localization research as a pre-requisite, only then can the research be conducted that harness solutions that can be readily used by the benefitting populations. At the same time, capacity building initiatives must target to form *linkages and partnership* with relevant academic, policy making, regional standardization bodies, and public and private sector bodies. This would follow skill development at level 1 as synergetic and mutually benefitting collaborations can only be developed if the local teams are able to contribute back to the knowledge network.

Finally, *research dissemination and sustainability* must be targeted as these RCB dimensions provide research maturity to publish in technical forums, and compete for funding.

6 Conclusion

ICT human resource capacity indicators signify a steep demand for localization skills in ICT professional with the increasing ICT diffusion in the Asia Pacific (Rhee and Riggins, 2007, Raina, 2007). UN-APCICT/ESCAP (2010) speculates that existing institutions for ICT education and training in the regional cannot fulfill this demand. Therefore localization RCB must be taken up as a national and regional priority in

order to bridge the demand supply gap of the required localization RCB in developing Asia.

References

- Bali moune-Lutz, Mina. 2003. *An Analysis of the Determinants and Diffusion of ICTs in Developing Countries*. Information Technology for Development 2003, 10:151–169
- Breen, C. M., Jaganyi, J. J., Van Wilgen, B. W., and Van Wyk, E. 2004. *Research Projects and Capacity Building*. Water SA, 30(4):429-434.
- Cooke, Jo. 2005. *A Framework to Evaluate Research Capacity Building in Health Care*. BMC Family Practice, 6(44)
- Department for International Development (DFID). 2008. *DFID Research Strategy 2008-2013. Working Paper Series: Capacity Building*. Accessed from http://www.dfid.gov.uk/r4d/PDF/Outputs/Consultation/ResearchStrategyWorkingPaperfinal_capacity_P1.pdf
- Earl, Sara., Carden, Fred. & Smutylo, Terry. 2001. *Outcome Mapping: Building Learning and Reflection into Development Programs*. Ottawa, Canada: International Development Research Centre
- Gul, Sana. 2004. *Dilemmas of Localisation in Asia*. I4D Online, 2(12)
- Harris, Eva. 2004. *Building Scientific Research Capacity in Developing Countries*. European Molecular Biology Organization Reports 2004, 5(1):7-11
- Hussain, Sarmad. 2004. *Developing Local Language Computing*. I4D Online, 2(6)
- Hussain, Sarmad and Gul, Sana. 2004. *Localization in Pakistan*. Localisation Focus: An International Journal for Localization, 3(4)
- Hussain, Sarmad, Gul, Sana and Waseem, Afifah. 2007. *Developing Lexicographic Sorting: An Example for Urdu*. ACM Transactions on Asian Language Information Processing (TALIP), 6(3)
- Hussain, Sarmad and Mohan, Ram. 2007. *Localization in Asia Pacific*, in Librero, Felix (eds), Digital Review of Asia Pacific, 2007-08 Sage Publications India Pvt. Ltd.
- International Telecommunication Union (ITU), 2011. *The World in 2010, ICT Facts and Figures*. Accessed from <http://www.itu.int/ITU-D/ict/material/FactsFigures2010.pdf>
- Lewis, M. Paul. 2009. *Ethnologue: Languages of the World*. SIL International.
- Neilson, Stephanie and Lusthaus, Charles. 2007. *IDRC Supported Capacity Building: Developing a Framework for Capturing Capacity Changes*. Universalia.
- Nikolov, Roumen and Illieva, Sylvia. 2008. *A Model for Strengthening the Software Engineering Research Capacity*, SEESE'08, Germany.
- Pimienta, Daniel. 2005. *Linguistic Diversity in Cyberspace – Models for Development and Measurement*, in UNESCO Institute for Statistics (eds), Measuring the Linguistic Diversity on the Internet, UNESCO
- Potter, C. and Brough, R. 2004. *Systemic Capacity Building: A hierarchy of Needs*. Health Policy & Planning, 19(5):336-345.
- Raina, Ravi. 2007. *ICT Human Resource Development in Asia and the Pacific: Current Status, Emerging Trends, Policies and Strategies*. UN-APCICT. Accessed from <http://www.unapcict.org/ecohub/resources/ict-human-resource-development-in-asia-and-the>
- Rhee, Hyeun-Suk and Riggins, Frederick J. 2007. *Development of a Multi-Factor Set of Country-Level ICT Human Resource Capacity Indicators*. UN-APCICT. Accessed from <http://www.unapcict.org/ecohub/resources/development-of-a-multi-factor-set-of-country-level>
- Shams, Sana, Hussain, Sarmad. and Mirza, Atif. 2010. *Gender and Outcome Mapping*, in Belawati, T. and Baggaley, J. (eds) Policy and Practice in Asian Distance Education, Sage Publication India Pvt. Ltd.
- United Nations Asian and Pacific Training Centre for Information and Communication Technology for Development (UN-APCICT/ESCAP). 2010. *ICT Human Capacity Building for Development*. UN-APCICT-ESCAP 2009.
- Wibberley, C., Dack, L. M. F., and Smith, M. 2002. *Research-minded Practice in Substance (mis) Use Services*. Journal of Substance Use, 7(1):19-23.
- Wignaraja, Kanni. 2009. *Capacity Development: A UNDP Primer*. Accessed from http://content.undp.org/go/cms-service/download/asset/?asset_id=2222277
- World Bank. 2002. *Information and Communication Technologies: A World Bank Group Strategy*. World Bank Group.