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Table of Contents – September 2007

Editorial

Technology and Change

Donald G. Perrin

Technology is a driving force for innovation and change. Communication technologies shrink time and distance and share information resources at the speed of light. As they become universal, inexpensive and ubiquitous they change the way we work, think, and relate to one another

In 1923, Bela Belazs, a Hungarian writer and philosopher, described the change process:

> The discovery of printing gradually rendered illegible the faces of men. So much could be read from paper that the method of conveying meaning by facial expression fell into desuetude.
>
> Victor Hugo once wrote that the printed book took over the part played by the cathedral in the Middle Ages and became the carrier of the spirit of the people. But the thousands of books tore the *one* spirit, embodied in the cathedral, into thousands of opinions. The word broke the stone into a thousand fragments, tore the church into a thousand books.
>
> The visual spirit was thus turned into a legible spirit and visual culture into a culture of concepts. This, of course, had its social and economic causes, which changed the general face of life. But we paid little attention to the fact that, in conformity with this, the face of individual men, their foreheads, their eyes, their mouths, had also of necessity and quite concretely to suffer a change.
>
> At present a new discovery, a new machine is at work to turn the attention of men back to visual culture and give them new faces. This machine is the cinematographic camera. Like the printing press, it is a technical device for the multiplication and distribution of products of the human spirit; its effect on human culture will not be less than that of the printing press.

The printing press, photography, cinema, radio, television, computers, internet, cell phone and beyond continue to change our world. Electronic communications shrink time and distance and create new relationships between people and cultures. Miniaturization gives mobility; networks give instant access to people and information anywhere-anytime.

In the first half of the twentieth century we developed mass communication technologies like film, radio and television. In the second half we moved increasingly to individualized technologies like computer based training and personal computers. These combined into global networks to launch the Information Age.

Technology changes the way we communicate, the way we live, the way we think, and the way we learn. It is no longer necessary to go to the centers of learning or information repositories or centers of commerce. Much that requires travel is accessible instantly via computer networks and smart cell phones. Each new innovation presents challenges and opportunities to live life more fully as we move into the future.

Bela Belazs, Theory of the Film: Character and Growth of a New Art. 1952
Translated from Hungarian. London: Dennis Dobson Ltd.

Editor's Note: This is a straightforward study using a previously designed and tested instrument with six scales of preference. A generous number of respondents and high statistical reliability provides excellent guidelines for design and implementation of online constructivist learning.

College of Education Faculty Members' Preferences Towards Internet-based Learning Environments

Ismail Sahin

Turkey

Abstract

In an effort to explore College of Education (COE) faculty members' preferences toward constructive Internet-based learning environments, the present study was conducted. The data collection instrument for this study was a survey that was originally developed by Lee and Tsai (2005) to assess high school students' and teachers' preferences toward constructive Internet-based learning environments. The instrument included the following six scales: (1) ease of use, (2) multiple sources, (3) student negation, (4) reflective thinking, (5) critical judgment, and (6) epistemological awareness. Also, faculty preferences of teaching environments were asked. The respondents of the present study consisted of 109 COE faculty members from three recognized universities in Turkey. The results suggested that COE faculty members are either aware or favor distance education teaching environments. The Cronbach standardized item alpha for each scale was high, confirming the reliability of the survey used in the present study. A majority of faculty members reported that each characteristic of the Internet-based learning environments was crucial. All correlations among the variables were statistically significant. Future research may utilize qualitative research methods to provide in-depth insights into faculty members' preferences towards characteristics of constructivist Internet-based learning environments.

Keywords: College of education, Faculty, Distance education, Internet-based learning environments

Introduction

Rapid advances in computer and Internet technologies provide new opportunities to support teaching and learning (Lee & Tsai, 2005; Savery, 2002). An Internet-based-education environment "facilitates student learning without the constraints of time and distance, giving students more opportunities to control their own learning" (Wang, 2007, p.171). Internet-based teaching, "described using terms such as online teaching, networked teaching, e-moderating, e-tutoring and web-based teaching" (Twomey, 2004, p. 452) has become a popular form of education. This type of education is usually learner-centered (Milheim, 2001) and supports knowledge construction and meaningful learning (Wu & Tsai, 2006). However, the role of instructor is still critical in this form of education. In fact, for a distance education program to thrive, it should consider the motivating or inhibiting factors for faculty participation in an online learning environment (Schifter, 2004) and convince them to adopt it (Lindner, Murphy, & Dooley, 2002).

Anderson et al. (2001) list three categories of teaching presence in a distance education learning environment:

- Instructional design and organization
- Facilitating discourse
- Direct instruction

In fact, "design, facilitation, and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes" (Anderson et al., 2001, p. 5) are vital in an online learning environment. Furthermore, the literature suggests organization and reflection are essential for effective online instruction also support traditional teaching (Downing & Chim, 2004).

Although Internet users still encounter some barriers such as a lack of skills, a lack of training, and higher costs for accessing the Internet (Eastin & Larose, 2000; Jones et al., 2002; Olcott & Wright, 1995; Tsai & Tsai, 2003), the uses of the Internet and distance education have become common worldwide (Tsai, 2005). As an alternative learning environment (Milheim, 2001), distance education needs to be integrated partly or completely into education. Especially, college of education (COE) faculty members should have knowledge of the online learning tools and model the effective uses of these technologies in their classrooms.

The characteristics of Internet-based learning environments can be categorized into certain groups. In their study, Lee and Tsai (2005) propose three components of Internet-based learning environments: learner (person), content (system or machine), and activity. In Figure 1, the relationships between these variables are displayed.

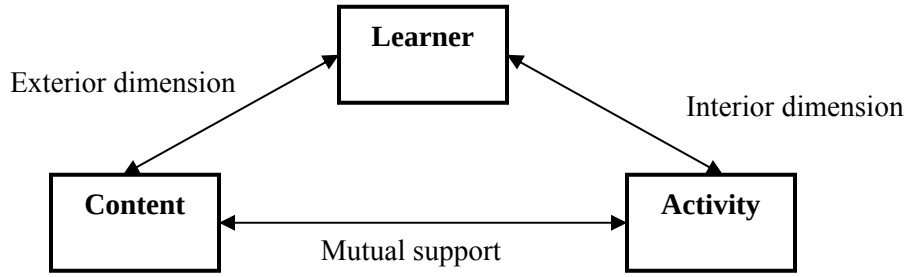


Figure 1. **Three dimensions of Internet-based learning environments suggested by Lee and Tsai (2005)**

As stated by Lee and Tsai (2005), the interior dimension of Internet-based learning environments explains the engagement of an individual in the activity, while the learner-content relationship, the exterior dimension of these learning environments, focuses on the interaction between the learner and system or machine. Based on these two dimensions, Lee and Tsai describe five aspects of Internet-based learning environments: technical, content, cognitive, meta-cognitive, and epistemological. Using these dimensions and aspects as their framework, Lee and Tsai construct the Constructivist Internet-based Learning Environment Survey-Improvement (CILESI). Each CILESI scale is classified, based on these constructs and presented in Table 1.

Before designing online and constructivist learning environments, it is crucial to learn about the preferences of learners (Tsai, 2007 in press) and instructors toward these environments. In fact, "teacher perceptions of learning technologies are likely to be key factors in the successful integration of learning technologies" (Cope & Ward, 2002, p. 72). The literature suggests that attitudes and preferences of learners affect their motivation, interests, and performance in online learning environments (Peng, Tsai, & Wu, 2006).

Numerous researchers have studied university students' preferences toward constructive Internet-based learning environments (Deture, 2004; Sahin, 2007; Tsai, 2007 in press; Tsai & Lin, 2004; Wu & Tsai, 2006). Although the literature stresses the important role of faculty in distance education (Lindner et al., 2002), there is limited research that considers faculty members' preferences toward these environments (Jones et al., 2002). In fact, what the faculty members, as the actual implementers and facilitators of those environments, think is critical for making the

environments more successful and effective. In an effort to explore COE faculty members' preferences toward constructive Internet-based learning environments, the present study is conducted.

Table 1

Classification of each CILESI Scale suggested by Lee and Tsai (2005)

Scale	Dimension	Aspect	Sample Survey Item
1. Ease of use	Exterior	Technical	• When navigating Internet-based learning environments, I prefer they have an interesting screen design.
2. Multiple sources	Exterior	Content	• When navigating Internet-based learning environments, I prefer they can provide a variety of relevant web links.
3. Student negotiation	Interior	Cognitive	• In the Internet-based learning environment, I prefer students can get the chance to talk to other students.
4. Reflective thinking	Interior	Meta-cognitive	• In the Internet-based learning environment, I prefer students can think deeply about how they learn.
5. Critical judgment			• In the Internet-based learning environment, I prefer I can critically evaluate web content.
6. Epistemological awareness	Interior	Epistemological	• When navigating Internet-based learning environments, I prefer they can display the source of knowledge.

Methods

The data collection instrument of this study was a survey originally developed by Lee and Tsai (2005) to assess high school students' and teachers' preferences toward constructive Internet-based learning environments (see Appendix A for the survey items). The instrument, CILESI, included the following six scales: (1) ease of use, (2) multiple sources, (3) student negation, (4) reflective thinking, (5) critical judgment, and (6) epistemological awareness. A five-point Likert-type set of alternatives, ranging from "1=not important at all" to "5=totally important," was used to explore the opinions of COE faculty members on these environments. Higher scores in a certain scale reflected stronger preferences toward constructive Internet-based learning environments. Also, faculty preferences of teaching environments were asked. The respondents of the present study consisted of 109 COE faculty members from three recognized universities in Turkey.

In the current study, factor analysis was used to check if the survey items for each subscale successfully measured each variable. The Cronbach alpha value was used to measure the reliability of each survey scale. Next, correlation coefficients between the survey scales were calculated and interpreted. Statistical analyses were conducted using SPSS (Statistical Package for Social Sciences) 13.0 software.

Findings

Data collected from COE faculty members in Turkey suggest that the CILESI showed a high level of reliability in assessing faculty responses (see Appendix A for the results of mean scores, factor analyses, and reliability tests). As presented in Figure 2, faculty preferences of the teaching environments varied.

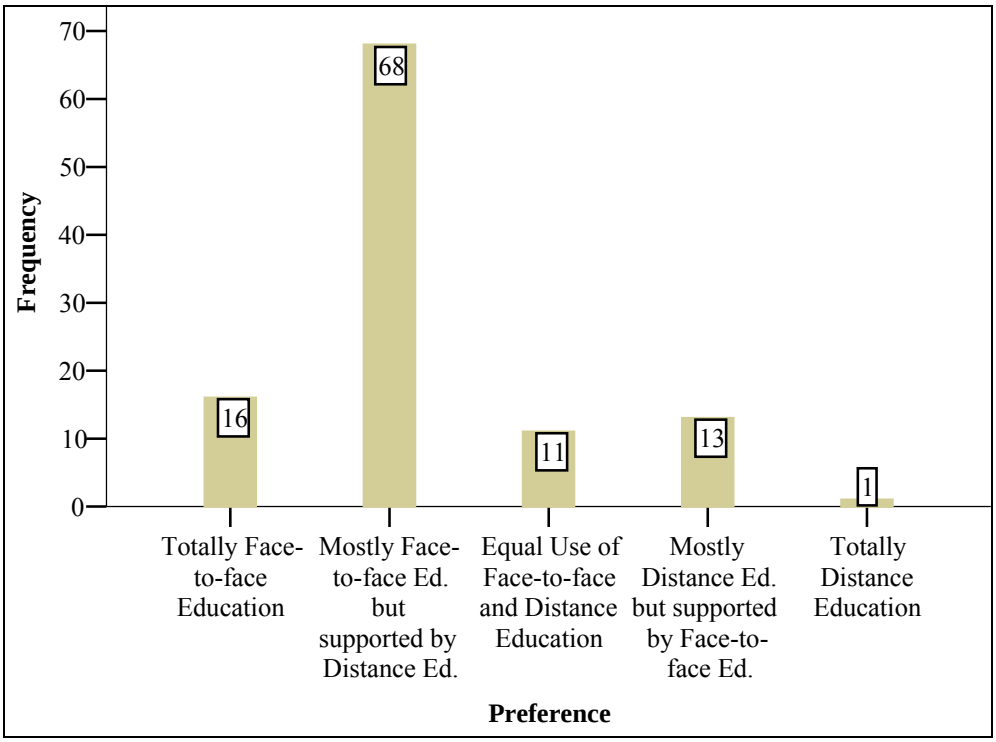


Figure 2. Faculty Preferences of Teaching Environments

The most frequent teaching preference was face-to-face education, but supported by distance education (62%), followed by totally face-to-face education (15%), mostly distance education but supported by face-to-face education (12%), equal use of distance education and face-to-face education (10%), and totally distance education (1%). These results suggest that COE faculty members are either aware or favor distance education teaching environments.

In addition, factor analysis was conducted to reduce the number of variables. As shown in Appendix A, items were loaded on only one factor for each scale. In the factor analysis, the correlation matrix and the component matrix showed positive, high correlations among the items for each scale. Also, the value of the Cronbach standardized item alpha for each scale was high. Overall, the loadings of the six factors were generated from 29 survey items with high reliability (standardized item alpha = 0.93). These results confirmed the reliability of the survey used in the present study. In fact, similar reliability scores were found in the literature (Tsai, 2007 in press).

As seen in Table 2, the scale percents were categorized based on the survey's options. A majority of the faculty members reported that each characteristic of Internet-based learning environments was crucial. For instance, only about 2% of the participants thought that reflective thinking was not an important feature for these environments.

Table 2

Percentage Distribution of Variables Based on Survey Options

Variable	Not important at all	Somewhat important	Important	Very important	Totally important
Ease of use	0.37%	1.87%	14.77%	25.42%	57.57%
Multiple sources	0.37%	2.39%	18.05%	36.10%	42.91%
Student negotiation	0.37%	1.84%	14.73%	32.78%	50.28%
Reflective thinking	0.18%	1.84%	12.71%	37.38%	47.88%
Critical judgment	0.46%	3.90%	22.02%	35.55%	38.07%
Epistemological awareness	0.18%	1.84%	13.63%	36.28%	48.07%

In Table 3, the correlations among the survey scales were presented. All correlations among the variables were statistically significant, ranging from 0.35 to 0.68. For example, COE faculty members, who preferred that navigating Internet-based learning environments should be easy to use, also reported these environments should include multiple sources ($r = 0.50$)

Table 3

Correlations between Variables Used in the Study

Variable	1	2	3	4	5	6
Ease of use	-					
Multiple sources	0.50**	-				
Student negotiation	0.35**	0.39**	-			
Reflective thinking	0.45**	0.54**	0.58**	-		
Critical judgment	0.40**	0.68**	0.54**	0.57**	-	
Epistemological awareness	0.47**	0.48**	0.50**	0.58**	0.68**	-

*: $p<0.05$; **: $p<0.01$

Conclusions

Using instructional technologies and distance education tools, specifically the Internet, in education in part or whole has become inevitable. The integration process of these technologies into education should first involve faculty choices regarding these tools. The literature highlights the crucial effect of learners' perceptions of the Internet on their attitudes toward Internet-based learning environments and, eventually, their performances in these learning environments (Peng et al., 2006). Hence, involving faculty members' preferences toward the characteristics of online learning environments in designing these environments may increase their positive attitudes toward and use of the environments.

In order to meet the emerging demand for distance education courses and to build more favorable settings for these courses, higher education institutions should consider faculty preferences

toward online learning environments. In fact, faculty, who are well-supported by their institutions, have higher commitment and motivation toward distance education (Lee, 2001). As suggested by Wu and Tsai (2006), higher education institutes may increase low levels of their faculty preferences toward online learning environments by organizing faculty training programs.

In the current study, COE faculty members' preferences toward the constructivist Internet-based learning environments were assessed. The present study confirmed the reliability of the CILESI in assessing faculty responses regarding the characteristics of constructivist Internet-based learning environments. Also, a majority of COE faculty reported their teaching preference was mostly face-to face education, but supported by distance education.

In conclusion, COE faculty members expressed strong preferences towards the following features of constructivist Internet-based learning environments: ease of use, multiple sources, student negotiation, reflective thinking, critical judgment, and epistemological awareness. Designers and researchers of distance learning environments should pay more attention to these characteristics when developing and improving Internet-based learning environments. Future research may utilize qualitative research methods to provide in-depth insights into faculty members' preferences towards characteristics of constructivist Internet-based learning environments.

References

Anderson, T., Rourke, L., Garrison, D.R., & Archer, W. (2001). Assessing teaching presence in a computer conferencing context. *Journal of Asynchronous Learning Networks, 5*(2), 1-17.

Cope, C., & Ward, P. (2002).Integrating learning technology into classrooms: The importance of teachers' perceptions. *Educational Technology & Society, 5*(1), 67-74.

Downing, K., & Chim, T.M. (2004). Reflectors as online extraverts? *Educational Studies, 30*(3), 265-276.

Deture, M. (2004). Cognitive style and self-efficacy: Predicting student success in online distance education. *The American Journal of Distance Education, 18*(1), 21-38.

Eastin, M.S., & Larose, R. (2000). Internet self-efficacy and the psychology of the digital divine. *Journal of Computer-Mediated Communication*, *6*(1). Retrieved June 07, 2007 from http://jcmc.indiana.edu/vol6/issue1/eastin.html

Jones, E.T., Lindner, J.R., Murphy, T.H., & Dooley, K.E. (2002). Faculty philosophical position towards distance education: Competency, value, and educational technology support. *Online Journal of Distance Learning Administration, 5*(1). Retrieved June 25, 2007 from http://www.westga.edu/~distance/ojdla/spring51/jones51.html

Lee, J. (2001). Instructional support for distance education and faculty motivation, commitment, satisfaction. *British Journal of Educational Technology, 32*(2), 153-160.

Lee, M., & Tsai, C. (2005). Exploring high school students' and teachers' preferences toward the constructivist Internet-based learning environments in Taiwan. *Educational Studies, 31*(2), 149-167.

Lindner, J.R., Murphy, T.H., & Dooley, K.E. (2002). Factors affecting faculty perceptions of technologically mediated instruction: competency, value, and educational technology support. *NACTA Journal, 46*(4). Retrieved June 25, 2007 from http://findarticles.com/p/articles/mi_qa4062/is_200212/ai_n9151776

Milheim, W. (2001). Faculty and administrative strategies for the effective implementation of distance education. *British Journal of Educational Technology, 32*(5), 535-542.

Peng, H., Tsai, C., & Wu, Y. (2006). University students' self-efficacy and their attitudes toward the Internet: The role of students' perceptions of the Internet. *Educational Studies, 32*(1), 73-86.

Sahin, I. (2007). Predicting student satisfaction in distance education and learning environments. *Turkish Online Journal of Distance Education, 8*(2), 113-119.

Savery, J.R. (2002). Faculty and student perceptions of technology integration in teaching. *The Journal of Interactive Online Learning, 1*(2), 1-16.

Schifter, C. (2000). Factors influencing faculty participation in distance education: A factor analysis. *Education at a Distance, 13*(1). Retrieved June 11, 2007 from http://www.usdla.org/html/journal/JAN00_Issue/Factors.htm.

Schifter, C. (2004). Faculty participation in distance education programs: Practices and plans. In D. Monolescu, C. Schifter, & L. Greenwood (Eds.), *The distance education evolution: Issues and case studies*, 22-39. Hershey, PA: IGI Publishing.

Tsai, C. (2005). Preferences toward Internet-based learning environments: High school students' perspectives for science teaching. *Educational Technology & Society, 8*(2), 203-213.

Tsai, C. (2007 in press). The preferences toward constructivist Internet-based learning environments among university students in Taiwan. *Computers in Human Behavior*.

Tsai, C., & Lin, C. (2004). Taiwanese adolescents' perceptions and attitudes regarding the Internet: Exploring gender differences. *Adolescence, 39*(156), 725-734.

Tsai, M., & Tsai, C. (2003). Information searching strategies in web-based science learning: The role of Internet self-efficacy. *Innovations in Education and Teaching International, 40*(1), 43-50.

Twomey, A. (2004). Web-based teaching in nursing: Lessons from the literature. *Nurse Education Today, 24*(6), 452-458.

Olcott, D., & Wright, S.J. (1995). An institutional support framework for increasing faculty participation in postsecondary distance education. *The American Journal of Distance Education, 9*(3), 5-17.

Wang, T.H. (2007). What strategies are effective for formative assessment in an e-learning environment? *Journal of Computer Assisted Learning, 23*(3), 171-186.

Wu, Y., & Tsai, C. (2006). University students' Internet attitudes and Internet self-efficacy: A study at three universities in Taiwan. *CyberPsychology & Behavior, 9*(4), 441-450.

About the Author

Ismail Sahin is an assistant professor in the Department of Computer and Instructional Technologies at Selcuk University in Turkey. He is also vice chair of the same department. (Address: Ismail Sahin, Department of Computer and Instructional Technologies, College of Education, Selcuk University, Meram, Konya, Turkey; isahin@selcuk.edu.tr)

Appendix A

Results of mean scores, factor analyses and reliability tests

Scale	Survey Items		Mean	Std. Dev.	Factor Loadings	Std. Item Alpha
Ease of use	When navigating Internet-based learning environments, I prefer that they…	…have an interesting screen design.	1.84	0.92	0.68	0.77
		…are easy to navigate.	1.27	0.52	0.70	
		…are fun to use.	2.10	0.91	0.75	
		…are easy to use.	1.43	0.72	0.79	
		…take only a short time to learn how to use.	1.45	0.73	0.75	
Multiple sources	When navigating Internet-based learning environments, I prefer that they can…	…provide a variety of relevant web links.	1.94	0.88	0.71	0.81
		…discuss a learning topic though various perspectives.	1.82	0.81	0.79	
		…present a learning topic by different methods.	1.73	0.78	0.78	
		…offer various information sources to explore a learning topic.	1.70	0.75	0.86	
		…connect to rich, relevant web resources.	1.84	0.96	0.67	
Student negotiation	In the Internet-based learning environment, I prefer that…	…students can get the chance to talk to other students.	1.57	0.70	0.83	0.84
		…students can discuss with other students how to conduct investigations.	1.97	0.96	0.79	
		…students can ask other students to explain their ideas.	1.55	0.70	0.72	
		…students can ask other students to explain their ideas.	1.57	0.75	0.85	
		…students can discuss their ideas with other students.	1.81	0.87	0.76	
Reflective thinking	In the Internet-based learning environment, I prefer that…	…students can think deeply about how they learn.	1.73	0.73	0.82	0.86
		…students can think deeply about their own ideas.	1.48	0.69	0.85	
		…students can think deeply about new ideas.	1.52	0.66	0.86	
		…students can think deeply about how to become a better learner.	1.72	0.77	0.84	
		…students can think deeply about their own understanding.	1.99	0.91	0.71	
Critical judgment	In the Internet-based learning environment, I prefer that…	…I can critically evaluate web content.	2.06	0.91	0.81	0.84
		…I can critically judge the value of different perspectives.	1.88	0.81	0.88	
		…I can examine a variety of information and then make my judgment.	1.72	0.86	0.84	
		…I can evaluate the features of various information sources.	2.06	0.95	0.78	
Epistemological awareness	When navigating Internet-based learning environments, I prefer that they can…	…display the source of knowledge.	1.76	0.95	0.53	0.81
		…enable deep exploration about the nature of knowledge.	1.72	0.78	0.80	
		…evaluate the merits of knowledge.	1.71	0.72	0.81	
		…present the process of knowledge development.	1.70	0.70	0.85	
		…display the hidden value of knowledge.	1.60	0.76	0.83	

Editor's Note: This article explores the role of communication, planning, testing, faculty participation, technical support, and facilitation by change agents in successful adoption of a computer based response system. The research is structured on Everett Rogers Five Stages of the Decision Process.

Identifying Key Factors in Adoption of Innovative Practices

Michelle Baron, Charles R. Graham
USA

Abstract

Researchers investigated and discovered better ways to accelerate and improve the adoption of innovative practices in teaching with technology. Researchers focused on Everett Rogers' five stages to the innovation-decision process: knowledge, persuasion, decision, implementation, and confirmation. Researchers interviewed instructors and local change agents in an effort to document the adoption of innovative practices, identify techniques used by change agents to facilitate the adoption process, determine which change agents are most influential in the adoption process, and discover the role of innovation reinvention in the decision making process.

Internal change agents must be more proactive in creating positive experiences via information sources, pedagogical understanding, technical support, and innovative reinvention. By understanding the process of adopting innovative practices, stakeholders can pinpoint the precise areas where faculty support is most needed. Improved support in the adoption process is critical in order to achieve smoother technical and pedagogical implementation of technology in teaching and learning.

Keywords: adoption; technology; innovations; innovative practices; teaching; learning; change agents; reinvention; accelerate; process.

Introduction

Researchers discovered better ways to accelerate and improve the adoption of innovative practices in teaching with technology using Everett Rogers' five stages to the innovation-decision process: knowledge, persuasion, decision, implementation, and confirmation. Researchers interviewed instructors and local change agents in an effort to document the adoption of innovative practices, identify techniques that change agents use to facilitate the adoption process, determine which change agents are most influential to the adoption process, and discover the role of innovation reinvention in the decision making process.

Internal change agents must be more proactive in creating positive experiences via information sources, pedagogical understanding, technical support, and innovative reinvention ideas. Academic support organizations can then provide improved support in the adoption process in order to achieve smoother technical and pedagogical implementation of technology in teaching and learning.

Background

Within an organization, the adoption of innovative practices occurs at varying rates. Because of this, instructional products and practices may become obsolete before being implemented. The challenge is to speed up the adoption process of not only the technological product itself, but the process of developing and implementing innovative practices toward long-term educational goals.

When instructors and support staff combine pedagogy with technological innovations – defined by Rogers (2003) as a new idea or practice, all stakeholders may see a long-term benefit to the

implementation of those technological innovations. These innovations may not effectively stand by themselves, but with proper integration into educational objectives at the school, program, and course level, they can successfully enhance teaching and learning.

The need to support innovations is present in a wide variety of teaching circumstances. The concept of adopting innovative practices involves supporting instructors in developing and utilizing new ways of teaching and learning. Distance learning, instructional projects, and course management systems are just a few examples of the process of adopting innovative practices. By understanding this process, academic support organizations and other education staff can determine where faculty support is needed most and allocate resources accordingly.

One of the most important factors in the development of better instructional practices is the adoption of innovations. Rogers (2003) defines an innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (p. 12). In this context, innovation refers to not only hard technologies such as computers, software, and other electronic devices, but more importantly soft technologies such as pedagogies, problem-based learning, and teaching and learning strategies (Beckwith, 1988; Celsi & Wolfinbarger, 2002). This distinction, combined with the challenges that faculty members face in adopting innovations (Hall & Elliott, 2003; Hedberg, 2006; Henderson & Dancy, 2005; Vrasidas & Glass, 2005), the complexity of the adoption process itself (Rogers, 2003), and the responsibilities of support organizations in the adoption process (Bottomley, Spratt, & Rice, 1999; Clegg, Konrad, & Tan, 2000; Ehrmann, n.d.; Friedman, 2006; Johnson, 2006; Reeves, 2006), all play vital roles in the successful adoption of innovative practices.

TurningPoint (see Figure 1) is a computer-based audience response system that automatically captures audience responses to quiz or exam questions via response devices, and then statistically analyzes that information for use by the instructor. TurningPoint helps instructors engage students in active learning, fosters cooperation among students and between students and instructors, and facilitates the understanding, application, and synthesis of information. Instructors can also use the audience response system to anonymously poll students on controversial or sensitive issues. In this manner, faculty can assess the class understanding at the point of instruction.

Figure 1. **The TurningPoint Audience Response System**
Response card used by student (left) and receiver used by the instructor (right)

The purpose of this research is to discover techniques for accelerating and supporting the adoption of innovative practices in teaching with technology. Researchers interviewed a cross-section of ten instructors who conducted a pilot study with the TurningPoint audience response system, interviewed two local change agents at the Center for Instructional Design (CID), and

analyzed student and faculty surveys administered during the pilot study in an effort to document the adoption of innovative practices with TurningPoint, identify techniques change agents use to facilitate the adoption process, determine which change agents are most influential to the adoption process, and discover the role of innovation reinvention in the decision making process.

Findings

Based on instructor interviews, most change agents were outside of the university context. Primary change agents included associates from other institutions, vendors conducting product demonstrations at conferences, and the instructors themselves conducting personal product research.

The more pedagogical understanding instructors have, they more likely they are to endure implementation hardships in favor of long-term learning. Instructors must be proactive in product and innovation research and consultation with other associates, and have specific pedagogical goals. Support staff must in turn be able to discuss technical implementation and particular innovative ideas for using the product in the classroom.

While the intent of the CID was to implement an unsupported product, the instructors and students needed an active customer service system in place to provide setup, training, and troubleshooting. Numerous technical difficulties stemmed from dysfunctional response devices, the lack of or improper classroom installation, and the lack of training for customer support personnel to handle troubleshooting operations.

How does the Center for Instructional Design (CID) facilitate the adoption process?

Although the CID exerted significant effort to provide technical and pedagogical information to instructors (via an expo event and training demonstrations), many instructors took the search for information even further. They came in contact with vendors and professional colleagues at conferences and seminars who provided more details not only about TurningPoint but about audience response systems as a whole.

Instructors also engaged in personal research in order to find products that support their educational goals and pedagogy (e.g., quizzes, student assessments, peer instruction). They focused n the educational process as a whole more than adopting an individual product. For instructors the product was simply a catalyst to deploy experiences to achieve their learning objectives.

The CID took a detached approach to the implementation process for the audience response systems. Although the CID served as a point of contact for pedagogical questions and a liaison with the vendor for technical issues, instructors were largely on their own with regard to actual product implementation. There was no formal implementation guidance for instructors.

Instructors, on the other hand, wanted and needed an active support system during the entire adoption process – especially during the implementation stage. The lack of background setup before and technical support during the process left a distinct void for the instructors. Unreliable response devices and other technical issues, unwittingly became a deterrent to proper use of the audience response systems. Despite negative experiences with audience response systems, some instructors persevered through the problems and created their own positive experiences. Instructor background research, knowledge, willingness, and possession of long-term goals were keys to success and decisions on future use.

What change agents internal and external to the Center for Instructional Design (CID) are most influential in the adoption process?

Although the CID sought to be an influential change agent by providing technical and pedagogical information to instructors, the CID was only one part of the equation. Instructors conducted individual research on various audience response products, obtained information and guidance from colleagues and other professional acquaintances, and in some cases found outside funding or assistance.

Outside change agents had a much more influential and significant impact on the adoption process than the CID alone. Based on instructor interviews, change agent association often determined credibility and decisions to adopt the audience response system.

The most important change agents during the implementation process undoubtedly were CID and technical support personnel. Although they had a limited knowledge and resources with which to assist in resolving the technical issues, instructors considered them to be crucial in this stage of the adoption process.

Instructors tended to reflect on their implementation experiences, recall initial factors and ideas that contributed to the adoption decision, and reaffirm the knowledge base that went into the decision making process, in deciding whether to continue to employ the audience response system in their educational program. The quality of the events that transpired, including the educational value of the audience response system, ultimately compelled a positive or negative confirmation.

What role does the reinvention ability by the faculty play in the adoption process?

Researchers found no evidence to suggest that reinvention ability played a role in the knowledge, persuasion, or decision stages of the adoption process. Reinvention could be integrated into these stages, however, when change agents take the initiative to promote new ways to use the audience response system.

Researchers found that once instructors worked with the product, they realized the potential for implementation techniques other than those previously determined. Positive reinvention abilities were a significant factor in determining whether the instructor continued to utilize the audience response system. Even though there were other setbacks to the adoption process (i.e. technical difficulties), instructors decided to continue using the product because of the positive experiences they encountered.

Recommendations

One key factor not addressed as thoroughly as necessary was instructor support for the product. While the instructors themselves could be considered the innovators of audience response systems (having first researched and utilized audience response systems independently), their research experiences are strictly independent of the whole program. Adequate identification of the educational needs and goals of faculty campus-wide and inclusion of those needs and goals in the product research may have generated different results.

According to CID interviews, the CID conducted initial product research prior to the pilot study *independent* of other faculty or staff. Product decisions and initial ideas for implementation, need to be developed as a university-wide collective body. Academic support organizations need to become stronger facilitators between the instructor and information sources such as vendors, employers, and other education professionals. As instructors become more knowledgeable about technologies and pedagogies, they can make more informed implementation decisions and can become an energetic source of ideas for developing and improving innovative practices.

Instructors need to recognize the firm connection between technology and pedagogy and be able to implement pedagogy in the classroom. Change agents internal and external to the organization must do everything in their power to be a vital link between the user and the innovative practice. While different change agents have varying degrees of authority based on their position in the organizational hierarchy, they can be powerful within their circle of influence.

According to instructor interviews, the majority of the change agents were outside the university. The CID and other support staff must seize the opportunity to *create* change agents within the university, who can in turn relate positive experiences and share new ideas with other faculty in order to develop and reinforce persuasion in favor of an innovative practice.

Support staff must ensure instructor endorsement of the product from the onset of research, testing, and implementation. Including faculty in assessment and determination to use a given technology encourages support for that technology.

Acceleration in the adoption of innovative practices emerges through a combination of elimination or minimization of barriers to implementation, and the constant flow of information and support for the innovation. When instructors observe (via data and human interaction) the degree of importance of this innovation in the overall learning process through active commitment of resources and organizational vision, the instructors in turn develop a better sense of confidence not only about the product itself (through adequate customer service), but more importantly about the process of instructional realization.

In addition to information and understanding, instructors need a solid commitment of technical support from academic support organizations and other staff. Support staff must ensure instructors have the long-term technical support system they need to troubleshoot and fully employ the innovation. This should include vendors, technical staff, and liaisons.

Regardless of the amount of training instructors receive, if they do not have technical support and customer service resources immediately available, then their confidence about the product *and the process* begins to wane. Instructors do not need temporary scaffolding to help them through the initial training and startup; they need reliable technical expertise to provide immediate solutions while in the classroom.

Information systems technicians at the university did not install TurningPoint in all of the necessary tech rooms, requiring instead that instructors use TurningPoint on their own laptops and shuttle the laptop to and from class as necessary. This added to the problem of response system inaccuracy via the lack of recognition and synchronization of the respective audience response systems and devices.

Information systems technicians did not offer much technical assistance, but they did the best they could under the circumstances. The exact reason for lack of technical support was unclear (e.g. employee training, product licensing, contract issues, need underestimation, vendor support).

Based on interviews with the CID members, the adoption process could be accelerated as barriers such as the reluctance to try new innovations and hardware limitations or technical difficulties are removed. The CID is seeking to build innovation evangelists through training and creating positive experiences. Thorough training and testing of the product and the process can result in great strides toward success.

Conclusions

The adoption process will accelerate as all stakeholders are involved and can see the long-term benefit of the innovation as one part of the instructional picture. Users must be persuaded both technically and pedagogically. Support staff must ensure that users have positive experiences in order to create change agents to further allow the adoption to proliferate.

The adoption process will improve as all stakeholders focus on pedagogy in the classroom. Reinvention must be part of the process from the onset of the adoption. Early in the adoption, support staff may be the only change agents. Therefore, they have the responsibility of not only describing what a product does, but what it can do and how that product fits into the curriculum.

By supporting faculty members in adopting innovative practices, support staff can create integrated technological and pedagogical learning environments. These environments are by definition long-term and self-sustaining. Faculty and support staffs need to think of the adoption of innovative practices as a long-term educational outcome process. Faculty and staff must continuously formulate and assess educational goals and the means to achieve those goals. Such means may include adoption of a variety of innovations over the course of the educational outcome process. Faculty and staff must develop a vision of the educational pathway and view technology as an integral part in achieving that vision.

When support staffs provide the scaffolding for faculty implementation of technology in the form of technological and pedagogical training, they allow faculty members to creatively implement an educational environment conducive to long-term teaching and learning. Technological innovations in the long run will not disappear. While each innovation has its time and season for use and benefit, maximum effort must be exerted in order to make that season a success and to build positive experiences for future innovations.

Change agents must play a more active role in the knowledge, persuasion, decision, implementation, and confirmation phases of the adoption process. Advance preparation for the adoption is essential to success. Change agents should seek to provide exceptional product information, pedagogical understanding, and technical support in driving the adoption of innovative practices forward. Academic support organizations such as the CID need to provide instructors with information about, pedagogical understanding intended for, and technical support for the innovation.

References

Beckwith, D. (1988). The future of educational technology. *Canadian Journal of Educational Communication, 17*(1), 3-20.

Bottomley, J., Spratt, C., & Rice, M. (1999). Strategies for effecting strategic organisational change inTeaching practices: Case studies at deakin university. *Interactive Learning Environments, 7*(2-3), 227-247.

Celsi, R. L., & Wolfinbarger, M. (2002). Discontinuous classroom innovation: Waves of change for marketing education. *Journal of Marketing Education, 24*(1), 64-72.

Clegg, S., Konrad, J., & Tan, J. (2000). Preparing academic staff to use ICTs in support of student learning. *International Journal for Academic Development, 5*(2), 138-148.

Ehrmann, S. C. (n.d.). *Technology changes quickly but education changes Slowly: A counter-intuitive strategy for using IT to improve the outcomes of higher education.* Retrieved August 8, 2006, from http://www.tltgroup.org/resources/Visions/Outcomes.html

Friedman, T. L. (2006). *The world is flat* (Updated and expanded.). New York, NY: Farrar, Straus and Giroux.

Hall, M., & Elliott, K. M. (2003). Diffusion of technology into the teaching process: Strategies to encourage faculty members to embrace the laptop environment. *Journal of Education for Business, 78*(6), 301.

Hedberg, J. G. (2006). E-learning futures? Speculations for a time yet to come. *Studies in Continuing Education, 28*(2), 171-183.

Henderson, C., & Dancy, M. H. (2005). Physics faculty and educational researchers: Divergentexpectations as barriers to the diffusion of innovations. *AAPT Physics Education Research Conference,* Salt Lake City, UT.

Johnson, J. A. (2006). Beyond the learning paradigm: Customizing learning in american higher education: 10 bellwether principles for transforming american higher education. *Community College Journal of Research & Practice, 30*(2), 97-116.

Reeves, T. (2006). Changing how we evaluate the impact of computers in education in a flat world. *10th Global Chinese Conference of Computers in Education,* Beijing, China.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Vrasidas, C., & Glass, G. V. (Eds.). (2005). *Preparing teachers to teach with technology*. Greenwich, CT: Information Age Publishing.

About the Authors

Michelle Baron (Ph.D Student)
Instructional Psychology & Technology
150 McKay Building, Brigham Young University, 84602
(801)422-3536 (phone)
(801)422-0314 (fax)
mbaron@byu.edu

Charles R. Graham, Assistant Professor
Instructional Psychology & Technology
150-F McKay Building
Brigham Young University, 84602
(801)422-4110 (phone)
(801)422-0314 (fax)

charles_graham@byu.edu

Editor's Note: Mobile devices play an increasing role in educational communications. Laptops and Personal Digital Assistants (PDAs) are now supplemented by smart phones with internet connectivity. Google projects that Internet searches via cell phones will be a major market in the near future and many companies are developing services to support messaging, video, and other services. This article explores the use of smart cell phones to learn English as a Second Language (ESL) and English as a Foreign Language (EFL).

Mobile Language Class: Language Learning through Mobile Gaming

Shalini Upadhyay, Nitin Upadhyay

India

Abstract

This paper studies how mobile phone can create a better environment for language learning (with emphasis on learning English as a second and foreign language). It focuses specifically on the language skill sets by incorporating lesson on English grammar and vocabulary building. It provides users easy accessibility to deal with the problems of incorrect grammar/usage and wrong choice of words. A case survey is conducted which identifies how mobile phone can be effectively used in imparting language lessons to the students.

Keywords: m-learning, language learning, mobile computing

Introduction

Mobile devices have become pervasive objects as soon as people started using mobile phones, smart phones and PDAs on move "anywhere, anytime". A paradigm shift has been identified from e-learning to m-learning (Upadhyay, 2006). In the recent years, with the shift from an instructional paradigm to a learner-oriented approach towards language learning/teaching and understanding the way person learn, is of crucial importance and is the key to educational improvement. Students seek different modes (text, voice, multimedia etc.,) to understand and comprehend. It is widely believed (Reid, 1987; Celcc-Murcia, 2001) that the different ways of how a learner takes in and processes information are collectively referred to as learning styles or learning preferences. It is believed that emerging wireless and mobile networks will provide new applications in mobile learning (Gayeski, 2002). To improve the effectiveness of students learning, teachers should provide content compatible to various modes with the ways through which learners like to learn the language. Interesting work has been done in suitable educational methodologies and related mobile technology, tools, languages and interfaces for special categories of learners (MobiLearn, 2001), architectures and specifications for m-learning platforms (Simon et, al., 2003; Kurbel and Hilker, 2002), services for learning (Atif , 2003; Simon et, al., 2003) and adaptation of e-learning to m- learning (Andronico, 2003; Trifonova and Ronchetti, 2004).

The present study is intended to investigate the language learning capabilities of engineering students belonging to the central part of India. Specifically, the study seeks answers to these questions regarding language learning via cell phones:

- What are the learning mode preferences of Indian learners?
- Are significant changes identified in development of language skills?
- How and in what manner can language content be delivered to Indian learners?
- Do cell phones make effective use of time in language learning?

Pedagogical Issues

Currently whatever curriculum for language learning is available supports mostly static and non-interactive content. However, mobile phone based curriculum demands effective and comfortable development of platform for teaching and learning along with sound instructional practices. The research on readability and comprehension with small screens (Duchnicky & Kolers, 1983; Dillon et, al. 1990) shows that even for very small displays of only a few lines of text, users can read and understand information well. Following issues have been identified for designing content of language learning through mobile phone.

- Short and crispy sentences for understanding of grammar.
- Sentences showing common errors of English by India students
- Organization of the lesson content in a way that equally emphasizes both receptive and productive skills.
- Voice recordings for clear pronunciation and articulation of words.
- Recorded short stories for developing reading skills.
- Different levels of exercises for evaluating the language proficiency of the users.
- Automated evaluation of pronunciation and speaking
- Interactivity with the content via student's responses.
- Effective learning using multimode applications.

As devices become smaller, modes of interaction other than keyboard and stylus are a necessity. Nonetheless, there is also evidence that to a certain point, the size of the display will impact on the users' performance (**Swierenga, 1990**). In particular, small handheld devices like cell phones and PDAs serve many functions and contain sufficient processing power to handle a variety of tasks.

Figure 1. Multi modes: touch screen, text and voice interaction

Developing Mobile Language Class

To evaluate the learning language capability of students using mobile phones initially a pilot project, with two games, is developed – Match Game, and Word Game. For developing mobile language learning games J2ME and NetBeans software environment are used. Figure 2 shows the general architecture to deal with language learning.

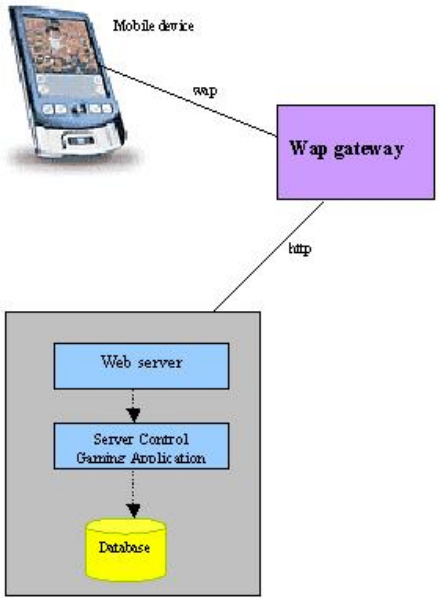


Figure 2. Architecture for Mobile Language Class

The user interacts with the mobile phone to play interactive games for language learning. The server (web server) maintains the database for contents and exercises. Through web gateway user connects to web server for accessing contents and exercises.

Mobile Application

Word game

In this game the user will be shown synonyms and antonyms questions for vocabulary building one at a time and he has to type the answer in the provided text box. If he answers correctly, next question will be displayed. There are few sets of the questions stored in the database each set contains five questions. These sets are organized on level-basis. The complexity of the levels increases as the user keeps on answering. If the user is not able to answer any question, the game is over and he will be shown the solution. The screen shot for the game is shown in figure 3.

Figure 3. Screen shot of WORD game.

Match Game

The game consists of exercises on English Grammar. The first section includes a series of sentences, which do not follow correct sentence construction. With each word in a sentence a unique integer is attached. The user is required to arrange these integer values in a proper manner to match it with the correct sentence pattern. The second section includes sentences, which are grammatically incorrect. The user's job is to select the integer with incorrect word/phrase. The

pop-up window appears as soon as the user clicks the mobile button corresponding to integer. This pop-up window contains various options out of which the user has to choose one for correctness. The screen shot for the game is shown in figure 4.

At the end of the entire exercise, a feedback mechanism is generated.

Figure 4. Screen shot of Match game.

Case Study: Result and Discussion

Results of some of the items in the questionnaire are presented in this section. This result support the assumption that technology based teaching helps most the low skilled pupils (**Sinko & Lehtinen 1999**). Some of the responses received rendered significant results, while some others did not. A sample of 200 students from the central part of India participated in the case study. Each player was allowed to play both the games. The questions asked and the answers obtained are briefed below.

1) **Students were asked to express view on selection of learning modes, table 1, in various contexts.**

Table 1

Selection of Learning Modes in Different Contexts

Context	Modality		
	Text	Voice	Touch
Train	80%	2%	18%
Bus	73%	1%	26%
Walking	2%	88%	10%
Shopping Mall	-	98%	2%
Cinema	10%	1%	89%
Car	-	100%	-
Airport	22%	-	78%
Between Meetings	-	-	-
At Home	55%	25%	20%
Public Place	13%	-	87%

The result of this question clearly indicates, Figure 5, 6, and 7, that the students selected different learning modes in different contexts. For example maximum number (%) favoured text while traveling in train or bus and at home. Voice interaction received maximum support by the users while walking and in the shopping mall as listening and speaking activity can go together with

walking and shopping in the malls. Touch interaction got maximum favour in cinema halls, airport and public places where speaking is practically prohibited.

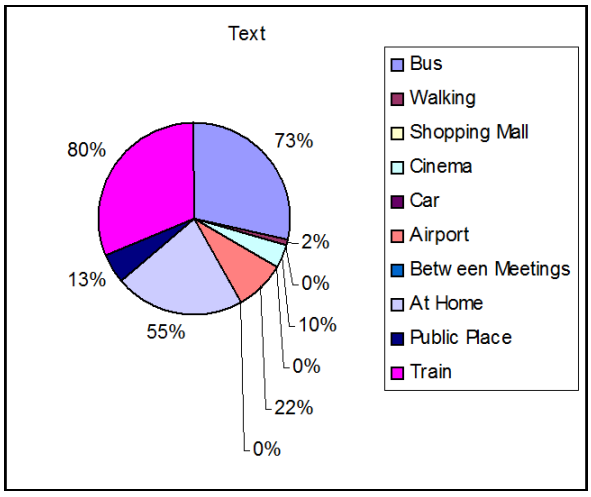


Figure 5. Text in different contexts

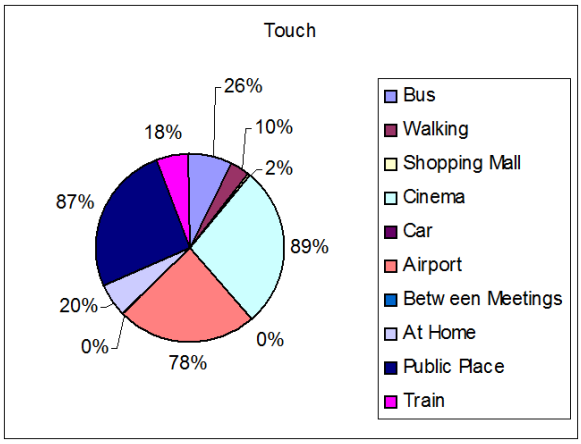


Figure 6. Touch in different contexts.

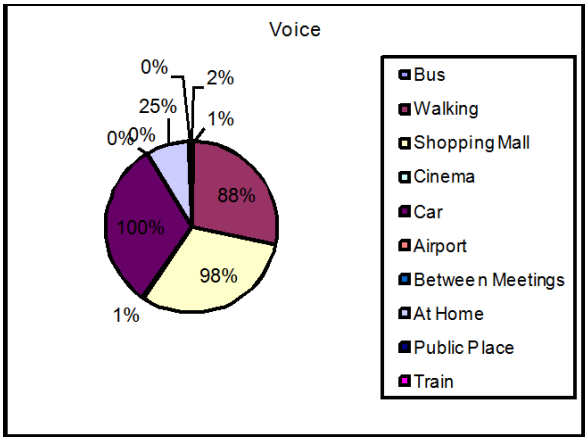


Figure 7. Voice in different contexts.

2) What do you prefer among the following – m-learning, e-learning and distance learning (d-learning)?

m-learning:-88%.

The students said since m-learning involves portable devices like cell phones, PDA, etc. One can get any information anytime and anywhere.

e-learning :- 10%.

The students said since the screens of the portable devices mentioned above is small it may not be as user friendly as the desktop PC's. There could also be more network connectivity problem in m-learning than in e-learning.

d-learning: 2%.

The materials may not reach in time. There could be communication gap between the source and the receiver. It is also more expensive than the other two forms of learning.

The overall percentage of response is shown in figure 8.

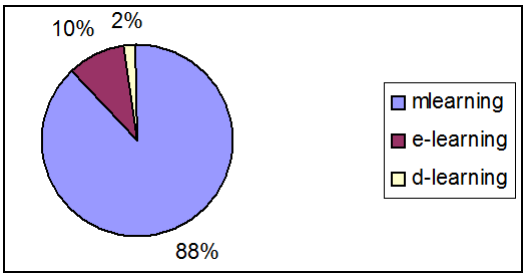


Figure 8. Learning preferences.

3) Are the exercises having different levels effective for understanding rules of Grammar?

a. yes
b. no
c. can't say

Figure 9 shows the overall percentage of response.

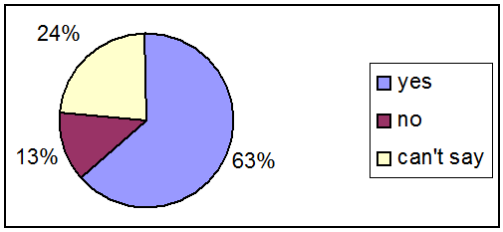


Figure 9. Learning rules of grammar.

Yes: 63%

These students found the exercises on understanding rules of grammar to be effective because in mobile screen voluminous discussion on the rules of grammar could not be discussed and only most accurate and precise information regarding grammar could be given in short sentences along with relevant and interesting exercises. In this process learning becomes effective.

No: 13%

These students wanted to have elaborate discussion on the basic rules of grammar, which seems to be a cumbersome process in mobile application.

Can't say: 24%

This lot of students got confused. They were used to traditional modes of instruction and were apprehensive about the use of mobile devices as substitutes to traditional modes. However, they could also foresee that sooner or later technology would have its say in every sphere of life.

4) To what extent word game is useful in improving vocabulary.

a. basic level
b. moderate level
c. advanced level

The overall percentage of response is shown in figure 10.

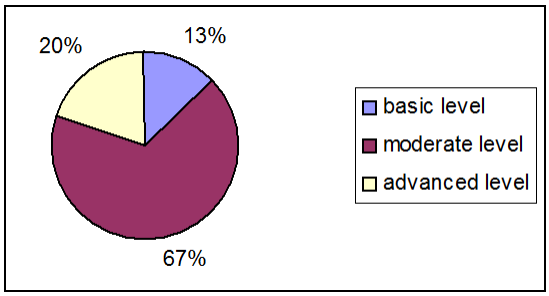


Figure 10. Word games to improve vocabulary.

basic level: 13%

These students voted for the basic level as they already had sound language background and possessed good word power. These students were incidentally aspirants preparing for various MBA programmes across the country.

moderate level: 67%

These students selected the moderate level and expressed their desire for more levels before reaching the advanced level.

Advanced level: 20%

Remaining students found the vocabulary content of advanced level as they lacked good language skills.

5) Language teaching and learning through mobile learning environment is

a. effective and easy
b. complex and effective
c. easy but not effective

Figure 11 shows the overall percentage of response.

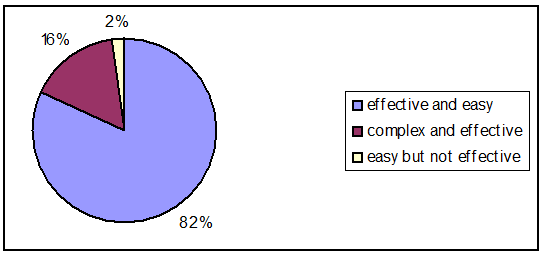


Figure 11. Ease of Learning

Effective and easy: 82%

The students said language learning is effective and easy: Students could learn language anytime anywhere. This gives the freedom of language learning and helps them to overcome the behavioural constraints such as shyness, nervousness and lack of confidence, which arise due to poor language skills. Since mobile phones is the most attractive and popular gadget among students they found language learning easy and effective through simple gaming techniques.

Complex and effective: 18%

This group of students found language learning to be complex due to constraints of small screen and resolution. They found viewing inconvenient and straining. However, they still felt that language teaching and learning through mobile e-learning environment was effective due to the fact that mobile devices do not come under the constraints of time and distance. Hence they could learn language as and when they felt like doing so.

6) Did you find Mobile Language class effective?

a. yes
b. no
c. partly

The overall percentage of response is shown in figure 12.

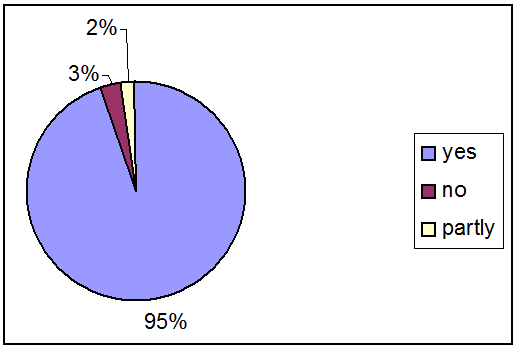


Figure 12. Effectiveness of mobile language class

yes: 95%

A remarkable result is the outcome of this question in which maximum students favoured for the effectiveness of the language content.

no: 3% and partly: 2%

These students upheld the view that the proper mechanism of feedback and interaction could not be generated through a mobile device. Moreover it also lacked that personal and informal; touch which is very much prevalent in face-to-face communication.

Conclusion

It may be inferred from the above discussion that Indian students found mobile technique for language learning effective and easy as the mobile device is quite a popular gadget; language learning through games generate interest and makes the process simple; mobile learning techniques involves the principle of 'anytime anywhere', which makes it available to the user as and when required. It is also observed that since students lacking language skills suffer from behavioural complexes such as shyness, hesitation and nervousness, they could easily overcome these complexes, as mobile language class did not involve participation of a teacher and other students. How the language contexts can be delivered to Indian students should be based on the pedagogical issues identified in the paper. It should be noted that the mobile phone is one device that effectively utilizes time and the user is not bound by time constraints. A mobile language class supports a variety of learning styles in a timely and interactive fashion. It is a paradigm shift from e-learning to m-learning. The influence of technology on current academics is such that in near future the whole context of learning will come under single umbrella of m-learning.

The research is undergoing to implement the various modalities such as touch and voice interactions to make the mobile language class more effective. The results of this research will be reported in subsequent publications.

References

Andronico, A., Carbonaro, A., Colazzo, L., Molinari, A., Ronchetti, M., and Trifonova, (2003) A. Designing Models and Services for Learning Management Systems in Mobile Settings. Mobile HCI 2003 Intl.Workshop, LNCS 2954.

Atif, Y., Benlamri, R., and Berri, J. (2003) Learning Obejects Based Framework for Self Adaptive Learning, Education and Information Technologies 8:4, Kluwer Academics.

Celce-Marcia, M. (2001). *Teaching English as a second or foreign language* (3rd ed.). Dewey Publishing Services: NY.

Dillon, A, Richardson, J & McKnight, C (1990) "The Effect of Display Size and Text Splitting on Reading Lengthy Text from the Screen," *Behaviour and Information Technology*, 9(3):215-227.

Duchnicky, R. L. & Kolers, P. A. (1983) "Readability of text scrolled on visual display terminals as a function of window size," *Human Factors*, 25:683-692.

Gayeski, D., (2002) *Learning Unplugged:Using Mobile Technologies for Organizational Training and Performance Improvement*, AMACOM, New York.

Kurbel, K., and Hilker, J. (2002) Requirements for a mobile e-Learning Platform. Intl.Conf.on Communications, Internet and Information Technology, US Virgin Islands.

MobiLearn (2001), The MobiLearn project, IST 2001-3787. http://www.mobilearn.org.

Reid, J. M. (1987). The learning style preferences of ESL students. *TESOL Quarterly, 21,* 87-111.

Simon, B., Miklos, Z., Nejdl, W., Sintek, M., Salvanchua, J. (2003) Smart Spaces for Learning: A Mediation Infrastructure for Learning Services. WWW 2003 Intl.Conference.

Sinko, M. & Lehtinen, E. (1999) *The Challenges of ICT*. Jyvaskyla, Finland: Atena kustannus.

Swierenga, S. J. (1990) "Menuing and scrolling as alternative information access techniques for computer systems: interfacing with the user," *Proc. Human Factors Society* 34th Annual Meeting, 1:356-359.

Trifonova, A., Ronchetti (2004) M.A General Architecture to Support Mobility in Learning. 4th IEEE ICALT 2004- "Crafting Learning within Context", IEEE Comp Soc.

Upadhyay, N (2006). M-Learning - A New Paradigm in Education. *International Journal of Instructional Technology and Distance Learning*. 3(2), pp. 31-34.

About the Authors

Dr. Shalini Upadhyay is a Lecturer in the Languages Group at BITS-PILANI GOA CAMPUS. She holds a Ph.D. in English Literature. She is a reviewer of various international journals of repute which includes Interdisciplinary Journal of Knowledge and Learning Objects, USA, Interdisciplinary Journal of Doctoral Studies, USA, InfoLit Book, Informing Science Institute, UK. She is an active member of Association for Business Communication, USA. Her areas of interest includes: Business Communication, Soft Skills, Pedagogical Issues in Instructional Technology, Non-verbal communication, Technical Communication and Personality Development

Email: shaliniu16@gmail.com

Nitin Upadhyay is an acknowledged teacher and prolific writer. He is currently working as Faculty in the Department of Computer Science and Information Systems, BITS, PILANI-GOA Campus. He has created a definite niche for himself in the field if Computer Science by contributing eight books. His research and creative zeal has enabled him to contribute research papers for journals and conferences. He is involved with a number of internationally acclaimed journals and professional bodies in the capacity of editor/reviewer/member.
Email: upadhyay.nitin@gmail.com

Nitin Upadhyay
Computer Science & Information Systems Group
Birla Institute of Technology and Science (BITS), Pilani-Goa Campus
NH-17B Bypass Road
ZuariNagar, Goa-403726
INDIA

Editor's Note: This article is *IJITDL – the Next Generation*. Four students at the Netaji Subhas Institute of Technology in India pooled their knowledge of emerging technologies to solve a number of problems experienced by students, teachers, and parents. They devised a system that integrates Short Messaging Service (SMS), search engines, encyclopedias, mobile phones and visual recognition with computers to support anywhere-anytime learning.

Using Technology to Automate Education

Ankur Verma, Ankur Arora, Vishal Gupta, Mandeep Singh

India

Abstract

The quest to improve teaching and learning is supported by information and communication technologies. These include new methods of finding and processing information without restriction of time and place.

This paper describes an Automated Education System (AES) designed to integrate various technologies and ideas that have never been combined before to provide education and related info0rmation and communication services to students. It solves the need felt by students for a system that would provide to information of our interest whenever and wherever required.

Keywords: Automated Education System, Short Messaging Service, Distant education through Mobile Phones, Automated Attendance, Principal Component Analysis, Linear Discriminant Analysis, Haar Detection Method

Introduction

"The essence of intelligence is skill in extracting meaning from everyday experience"

Never in the history of education there has been a technology so widely available to students as mobile technology. Nearly all of the students enrolled in higher educational institutions carry sophisticated communication device which they use constantly in every way imaginable. Isn't it strange they do not use to benefit their education?

The Automated Education System (AES), which incorporates powerful *Short Messaging Service* (SMS) technology, has the potential to solve many technical problems existing in the present education system. Major problems faced by the students, teachers and parents in the present education system that can be solved by AES are:

- Save time wasted taking student attendance and maintaining records.
- Enable prompt delivery of important notices and circulars issued by institution authorities. Students who do not receive the information face problems leading to waste of time and energy.
- Monitoring children's activities. In today's fast-paced world where everyone is running short of time, parents generally do not have time to keep check on their ward's activities which may lead to undesirable results.
- Access to internet everywhere with powerful search systems to find specific answers to queries. (The need for efficient and fast searching led to the birth of *Google*).
- Obtain up-to-date (even up-to-the-minute) information without the need to go to a library building.

- Setting up appointments and meeting schedules (e.g. student meeting with teacher or counselor).

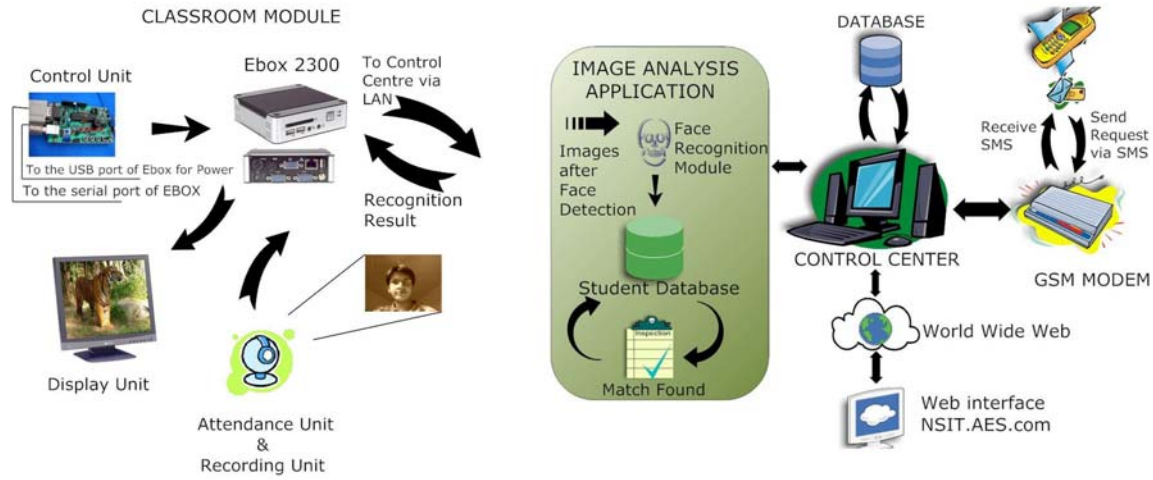
AES includes Classroom module comprising of a unit for taking attendance, recording lectures, displaying presentations and a controller board to switch between all these units. It also comprises Control Center used as Data Repository, GSM Module Handler and Advanced Image Analyzer (facial recognition). The uniqueness of the concept lies in the fact that the most widely used technology by students is used to solve the problems faced by them. SMS technology has never been used before so effectively and the solution provided by it seems promising. Parental care is a major issue, which is being targeted, which wasn't given much attention before. This will have a major impact leading to better results. Every effort is made to make the system cost effective and as far as possible autonomous or should require minimum supervision and upkeep thus making the system user friendly.

The paper is structured as follows: Section 2 provides the Overview of the system, its Commercial feasibility and research conducted which gave us the motivation for developing the system; Section 3 gives the technical details of the system explaining components in detail; Section 4 describes the methodology adopted for designing the system, Section 5 provides results after testing the system and finally, in section 6 conclusions and further research issues are briefly presented.

Market Overview

System Overview

The System comprises of the following major components:



SYSTEM OVERVIEW

1. **The Classroom module**: It includes four units: Attendance Unit (AU),Recording (AR) Unit, Display Unit and a Control Unit comprising of ICOP Ebox2300, Logitech Web Camera, Monitor and a Controller Board to be operated by the user. Camera captures the image frames and records the lectures. Ebox2300 does preprocessing before sending the captured images and streams the video to the Control Center. The monitor is used to display presentations and also the students' attendance log.

2. The **Control Center:** A server or a PC does following tasks:

- **Data repository**: It stores the School Database (Attendance record, Test Results etc), Search Database and Recorded Lectures.
- **GSM Module**: It handles SMS Requests from the end-user and replies them accordingly.
- **Advanced Image Analyzer**: The images received from the Ebox2300 are further processed by Image Recognition algorithm to mark the attendance of the students in the database.

3. The **Mobile Units** through which the end-user can send SMS Request to the Control Center. Requests can be classified as Search, Attendance, Result, Appointment, notices or dues queries.
4. The **NSIT.AES.com** module is the front-end to the system. It is built around the www.NSIT.AES.com website that provides friendly user interface to upload any notices or other information.. The teachers can log in to the website to get access to recent request for appointments and can provide any information they need to convey to the students. The students get access to the recently recorded lectures via the Student Web page.

Performance Requirements

The following performance parameters were kept in mind during the design of the project:

- **Autonomous**: The System should be autonomous or should require minimum supervision and upkeep.
- **Cost effective**: The System should be within the reach of its intended target audience. We are using SMS technology, which is a cheap way of communication.
- **Recognition Accuracy**: The Facial Recognition algorithm should be able to mark the attendance of the student. The algorithm needed to be highly efficient with an accuracy of 95-100 percent.
- **Lecture Recording**: The Teacher must have the option of recording the lecture on his/her wish using the control unit.
- **SMS Reply**: The user must get back the answer to his SMS Query in nearly real-time. Sending SMS messages with a mobile phone or GSM modem has a drawback - the SMS transmission speed is low. As SMS messaging becomes more popular, it has to handle a larger amount of SMS traffic thus, putting a considerable load on the GSM modem. To obtain a high SMS transmission speed, a direct connection to an SMSC or SMS service provider is needed.
- **Search Results**: Due to the limit in number of characters in SMS, the SMS results should be appropriate according to the need of the user. It should be relevant even in limited space and more importantly user should be satisfied.

Commercial Feasibility

During the development of AES, we had consulted several teachers in various Educational Institutions and they showed great interests in our system. The deployment of AES in the school is a One-time Investment which is meager as compared to the advantages it is providing. And most important of all it requires Mobile Phones, which according to the statistics, is owned by 98% of the students in the age group between 16-24 `[1]. Further AES does not require any drastic change in the present education system. For taking attendance we thought of many alternatives such as using Finger print sensors, swipe card, bar code reader etc. Finger print sensor based attendance was discarded as it was costly. Swipe card based attendance was

inefficient as there was a chance of proxy. Moreover we were using web camera for recording purposes, so it was feasible to use the same web camera for taking attendance provided the recognition algorithm accuracy was very high.

System was tested with a GSM AT compliant mobile phone. But in actual practice a direct connection to SMSC or SMS provider would provide much faster access with large SMS Requests. Taking into account the cost factor occurring to students for their SMS Requests, We talked to Bharat Sanchar Nigam Limited (BSNL, India's Largest Telecom Company) and they put forth us the following proposal:

> "It is possible to enter into an agreement with a private provider for sponsorship of SMSs. Within this contract the institution would be entitled to 2,000,000(say)"free" (sponsored) SMSs each year. These sponsored SMSs allow the institution to use 120 of the available 160 characters, while the remaining 40 are used by sponsors for information purposes (for advertisements purposes related to education). Once the Institute Control Center number is registered with the company, all the incoming SMS requests will be rendered free. Thereby, the students are entitled to free message requests to the Control Center."

The domain of AES is not restricted to institute level but it can expand to various other areas such as offices, security purposes etc.

Costs Incurred

COST ESTIMATION				
	Device Name	Purpose	Price	Num
Class Room Module	Web Camera	Image and Video Capture	40$	1
	Monitor	Displays Presentation and Attendance	75 $	1
	Microcontroller PCB Board,LED,Switches,Buzzer etc	Control the Classroom Module	2 $	1
Processing Centre	GSM AT Compliant Mobile Phone*	Sends and Receives SMS Requests	70 $	1
	TOTAL COST		187$	

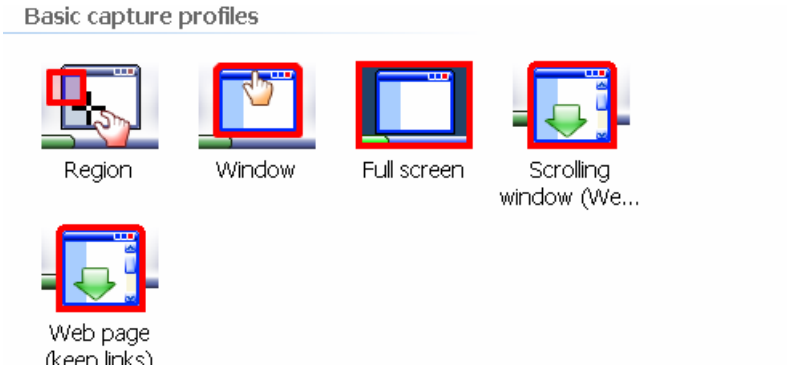
* It was used for Testing Purpose.Its cost can be excluded in the actual deployment as explained above
The Prices indicated are converted from Indian Rupees to US Dollars approximately
The cost of the system will decrease with large scale production .

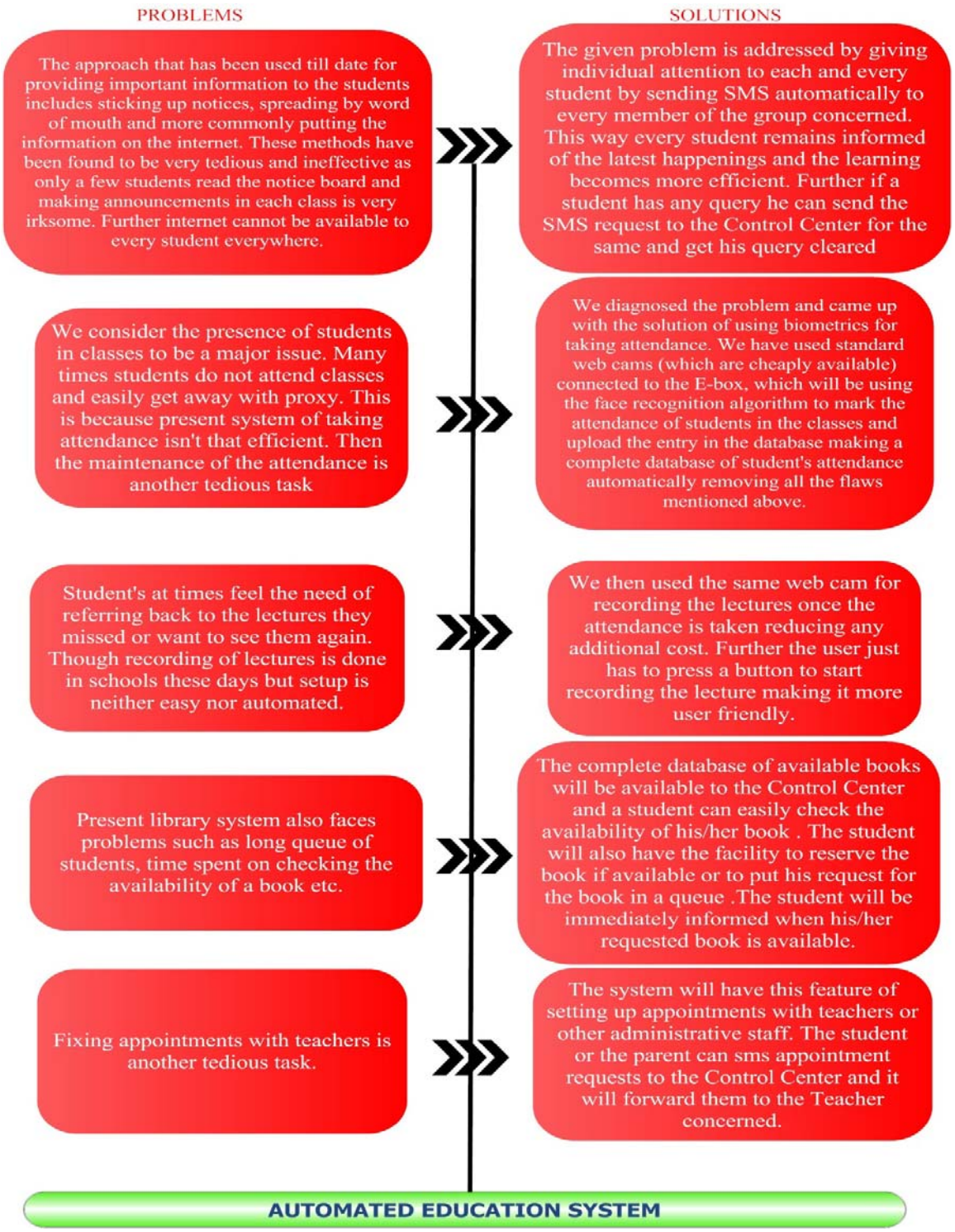
AES Cost Analysis

Each Unit comprising of an ICOP Ebox2300 (Costing 150$ Not included in the above figure), Web Camera and Microcontroller Kit is deployed in the classroom. The server is connected to the GSM AT Compliant Mobile Phone for Sending and Receiving SMS (in our prototype). An Personal Computer with sufficient amount of hard disk space and enough RAM can serve the purpose of the Server.

Research Conducted

The research conducted by our team aimed at finding different methodologies used worldwide in various schools/educational institutions for providing education and to investigate the issues relating them.


Basic capture profiles
Region
Window
Full screen
Scrolling window (We...
Web page (keep links)



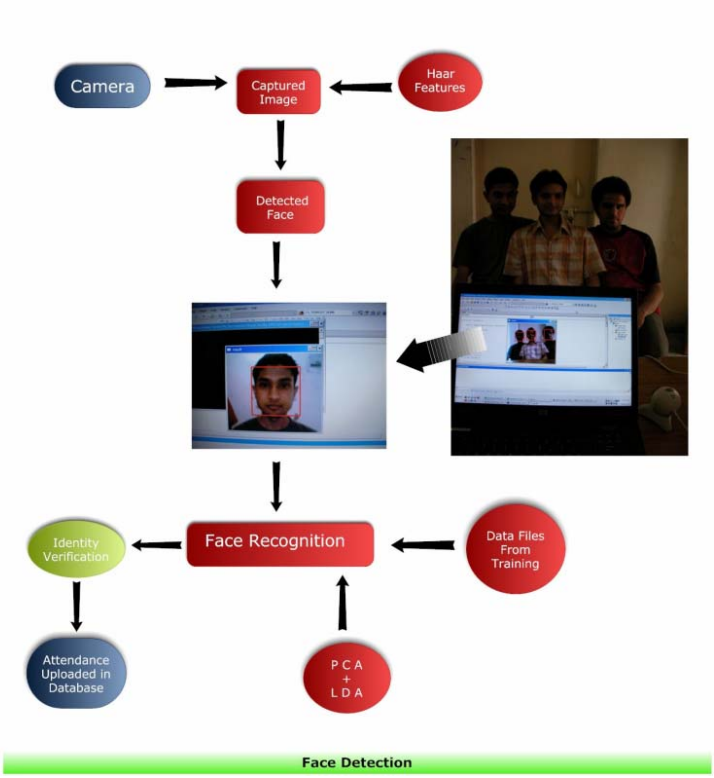
Technical Overview

Classroom Module

We envisioned the classroom module as a multi-tasking autonomous system that consists of ICOP Ebox2300 as the major component. It comprises of Attendance Unit (AU), Recording Unit (RU), Display Unit (DU) and Control Unit (CU), which perform their tasks as mentioned below.

Attendance Unit (AU)

This unit captures the images using the web camera attached to the Ebox2300 through USB port. It detects the presence of face in the captured images using a application running on Ebox2300 and then transfers the images on to control center where these filtered images are further processed for face recognition to mark attendance in the database. At the end of the class, teacher can view the log of the present students on the monitor via the Control Unit.



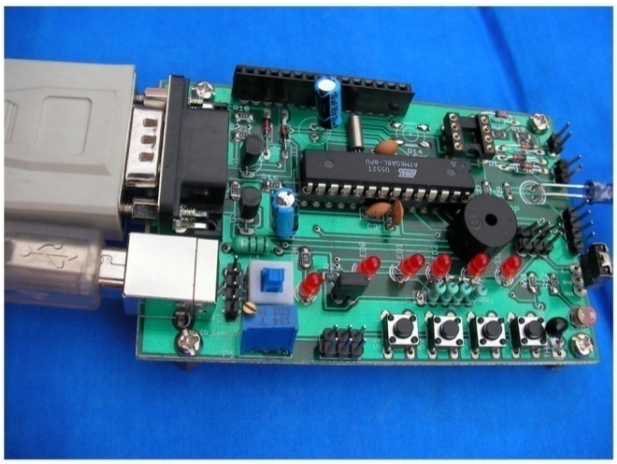
Face Detection

Face Detection Algorithm

We have used Haar-like features that encode the existence of oriented contrasts between regions in the image, thus making recognition process more efficient. A set of these features can be used to encode the contrasts exhibited by a human face and their spacial relationships. A classifier is trained with a few sample views of a particular object that can be applied to a region of interest in an input image. The classifier outputs a "1" if the region is likely to show the object (i.e., face) and "0" otherwise.

Recording Unit (RU) and Display Unit (DU)

The RU performs the task of recording the lectures upon receiving the teacher's request from the control board. The recorded lectures (taken from the web camera) are transferred on to the control center. Display Unit comprises of a monitor attached to VGA port of Ebox2300. It performs the task of displaying presentations and attendance log.



Control Board

Control Unit(CU)

CU provides an interface for taking input from the teacher and controls all other

units of the classroom. The main component of the Control Unit is an Atmega8 Microcontroller.

Depending upon the mode selected by the Teacher, the switches are used to control all other units. The Control Unit made by us is for the substitution of a Keyboard which we normally use with a computer as we needed only 4 inputs from the user and the rest were unused.

The Control Center

The Control Center is a Server Machine or a PC connected to Internet. It features software that communicates with all the other parts of the system acting as the main information repository and dispatcher. These applications can be deployed on different machines for scalability.

GSM Module

An application is used to communicate with the GSM Modem attached to the Serial Port of the Control Center. It enables Control Center to handle the SMS requests and replies. Control Center can handle the SMS requests received in either of the following sample forms. These can be increased as more functionality is added in our system.

- SEARCH 'Keyword': When the End-User (Student or Teacher) send a message with [search 'keyword'], Our Search Algorithm will search for the keyword and return the result.
- NOTICES 'Roll No.': When the End-User want to want to know about the latest notices and happenings in the institution he will SMS NOTICES 'Roll No.' and he will get back the result on his mobile via SMS.
- DUES 'Roll No.': It will SMS back any pending dues of the student if they exists (like Mess Dues, Hostel Fees Dues, Fine) etc.
- ATD 'Roll No.' 'Date': The student will get back his attendance from the specified date to the present date.
- RESULT 'Roll No.': When the student wants to know about his results, he can send SMS to the server and get back the latest results.
- APPT 'Teacher Name' 'Roll no.': If a parent want to set up a meeting with a teacher, he has to send a SMS to the server and the request will automatically be forwarded to the Teacher's web page from where he can mention the time and then the allotted time will be replied back to the parent via SMS. Earlier we thought of sending the meeting time directly from teacher to parent via SMS but it creates a lot of burden on their part. It was rather easy for the teachers to fill the appropriate time on the web page rather than replying back via SMS.
- BOOK 'NAME' 'AUTHOR': The request for the specified book will be forwarded to the Library server for further action.
- Control Center will send the SMS in the following situations:

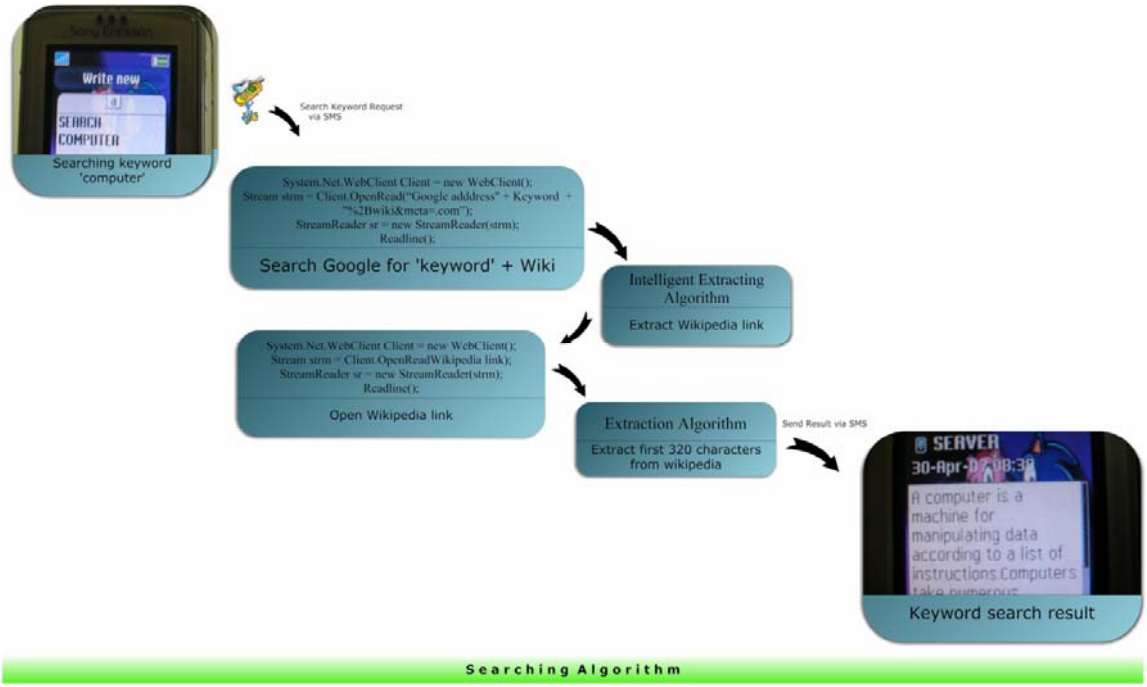
Search Results: Replying back to the SEARCH queries.

1. Group Messages: In case of any change in schedule, class/individual notice, information of release of various forms etc ,a group message will be sent. These can be fed directly to the website by the authorities concerned.
2. Attendance: Sends SMS to the student concerned and his parents, if ward's attendance is found below a requisite level.

3. Other Requests like Results, Appointment Timings and Dues will be SMSed back to the student upon his request.

Mobile Searching

The search engine allows one to ask for content meeting specific criteria (typically those containing a given word or phrase). But the irony with the present search system is lack of preciseness. In response to a simple query a search engine returns links to millions of web pages many of which are generally unsolicited and useless for the user. Student's basic queries are related to technical topics and dictionary words. We found that Wikipedia, with its huge database is sufficient to provide a great help to students, gives precise and related results.



At first, we searched our 'Keyword' on Wikipedia directly but with every keyword the web page HTML address was different.

e.g. For keyword Computer, the HTML address was http://en.wikipedia.org/wiki/Computer
And for keyword ftp, the address was http://en.wikipedia.org/wiki/File_Transfer_Protocol
The page address for ftp was.../File_Transfer_Protocol rather than.../ftp.

It was not offering a generic way to search for the keyword. Then we found an innovative way to link our Keyword with the web page's HTML address. The Keyword along with the Description will then be stored in the database so that next time our application will directly pick it from database rather than referring to the web. Use of SMS may appear outdated here but since SMS message have the advantage of being "stored", helps user in referring to past notices and searches without browsing or sending SMS again. Further, all phones don't come with web services support built in, thus proving worthiness of SMS in AES.

Library Center

Library is 'brain' of any institution .We generally face two big problems here, first standing in queue for issuing books and second locating if a particular book is there in library (or the day it will be returned if already issued). Our college library has a server, which gives access to the books available and also book search by Title or/and author's name. We connected our Control

center to the library server, which forwarded Book Issue SMS Request from the Student to the Library Server for further processing. If the book is available in the Library then the Library Server will return the result to the Control Center, which will forward the result to the student asking him whether he wants to issue it. Student thus can book it by adding Y or N to the received message and again sending it to the control center. If the student does not issue the book within a day after booking through SMS the book will be marked available.

In the case of unavailability of book requested, the queue number and the expected date of availability of the book will be returned.

Advanced Image Analyzer

The Control Center is a specialized server machine that aggregates the images sent by all the Classroom Units. Its main function is to process the images and recognize them for marking attendance in the Database. In order to accomplish that, the Control Center runs a Facial Recognition application. The Algorithm selected for Facial Recognition is Principal Component Analysis followed by Fischer's Linear Discriminant Analysis as it provided us great efficiency, which was needed in our System.

The algorithm extract the relevant information in a face image, encode it efficiently and then compare one face encoding with a database of models encoded similarly. After capturing the variation in a collection of face images, independent of any judgment of features and this information was used to encode and compare individual face images.

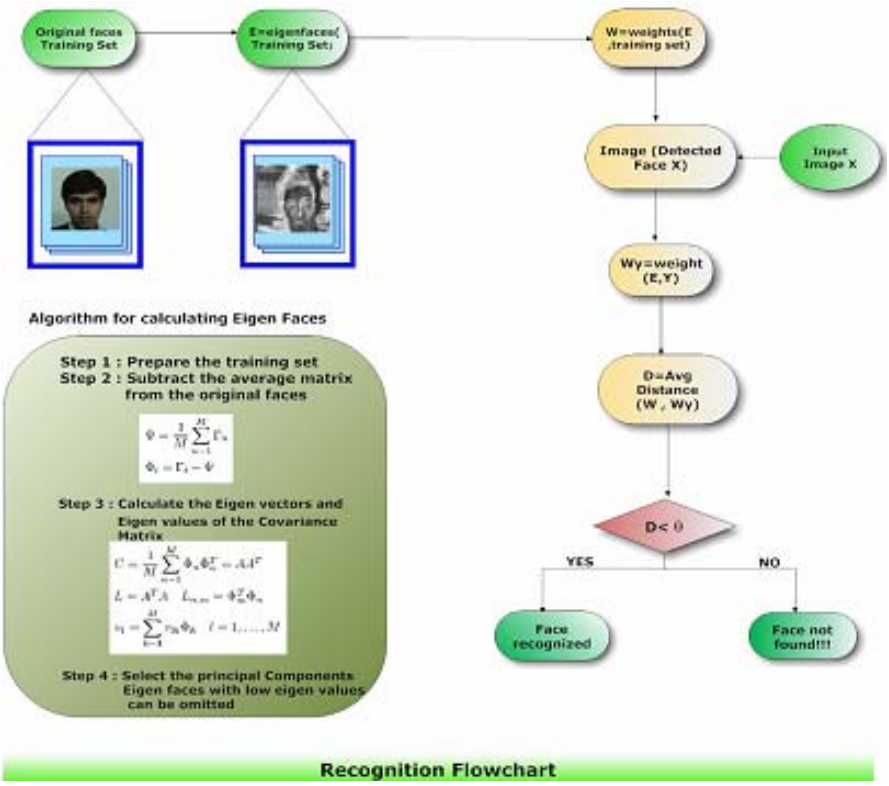
In mathematical terms out the principal components of the distribution or the eigenvectors of the covariance matrix of the set of face images were founded treating each image as a point in a very high dimensional space i.e. if we assume a face image I(x, y) to be a two dimensional N by N array, so that a typical image of size 256 by 256 becomes a vector of dimension 65,536 or equivalently, a point in 65,536-dimensional space.

In our experimentation we founded that recognition rates with PCA were good but not robust.

PCA actually yields projection directions that maximize the total scatter across all classes, i.e., across all images of all faces which retained unwanted variations due to lighting and facial expression. One of the solutions to this is LDA approach, which is a derivative of Fischer's Linear Discriminant that maximizes the ratio of between class scatter to that of within class scatter.

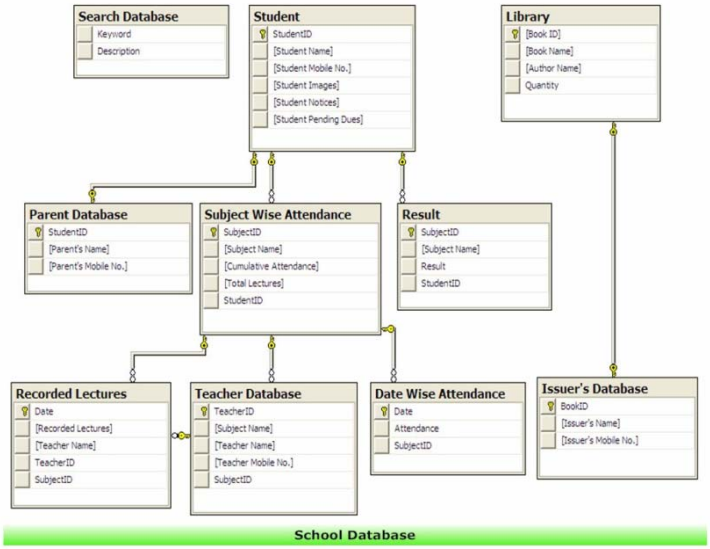
Therefore we implemented PCA followed by the LDA approach for making our facial recognition system more efficient and accurate.

The algorithm is described in figure below.



Recognition Flowchart

- First, the original images of the training set are transformed into a set of eigenfaces E. Procedure for calculating eigenfaces described in the fig. involves complex mathematics. Afterwards, weights are calculated for each image of the training set and stored in set W.
- Upon observing an unknown image X, face is detected out first using the face detection algorithm. Weights are calculated for that particular image and stored in the vector WX
- WX is compared with weights of images by regarding each weight vector as a point in space and calculating average distance D between weight vectors from WX and weight vector of the unknown image WX. If average distance exceeds some threshold value θ, the weight vector of the unknown image WX is too far from the weights of the faces.



School Database

Data Repository

A server acts like a Data repository for the School Database. The School Database is implemented using Microsoft SQL Server 2005. We have created a friendly user interface for managing the data, which reduces the learning curve of the end user. The Database Structure of the School is shown in the figure.

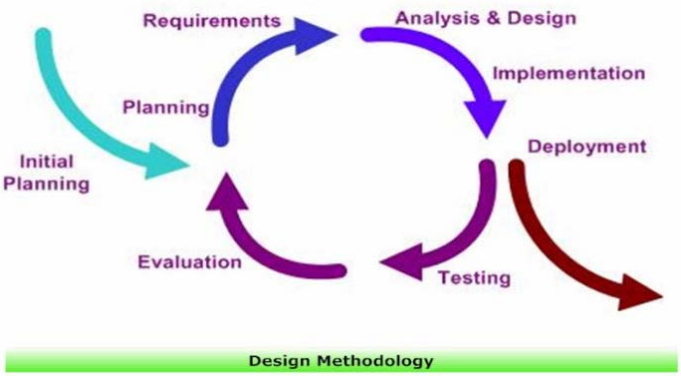
NSIT.AES.com Website

It's an accessible front-end to the system. NSIT.AES.com web site provide an interface for students and teachers to get access to a range of facilities, from which some of the unique facilities are listed below:

- Teacher can upload various notices, forthcoming events etc after logging in to the web site. They can enter appointment time for setting up appointment with the concerned applicant.
- Uploading various dues, attendance, marks records on entering name and roll number of the student.
- Students can download lectures, which were recorded in class, by just entering the date of lecture, subject and then choosing a lecture from the conducted lectures by various teachers on the particular day.
- This site can be modified according to the school/college name as NAME.AES.COM. This has been uploaded on the Local Area Network of NSIT, but not yet uploaded on the web.

Design Methodology and Team Organization

We chalked out a black box approach in the beginning of the project. Output and Input for each component was clearly defined. The team worked closely together on all parts of the solution, often pairing up to focus on specific components, then re-pairing upon completion to focus on other areas. Thorough testing was performed to validate that the requirements were met and to verify that the implementation matched the design. An incremental approach [16] was applied for the system integration, which allowed us to smoothly link all the software and hardware parts of our system together. Furthermore, as we concentrated on reliability and robustness, we benefited a lot from test driven development (test-first coding) and pair programming.



The team members have specific roles to maximize the use of their skills and interests:

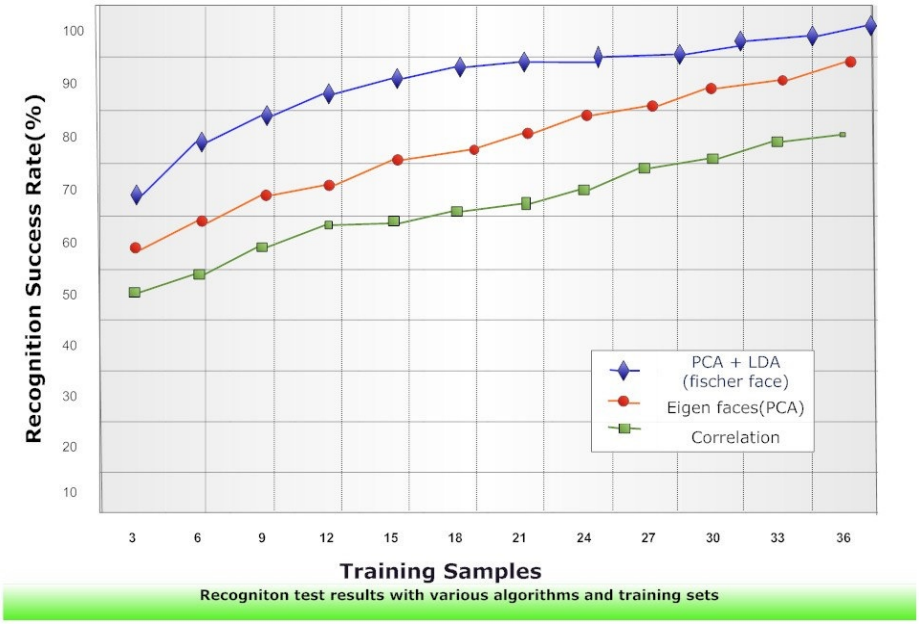
- Ankur Verma - He is the team leader and is responsible for project design, task assign and process control.
- Vishal Gupta – He is in charge of Facial detection and recognition part of the project.
- Ankur Arora - He is responsible for hardware aspects of the project (website interfacing part and the message sending and receiving module, eBox2300 aspects)
- Mandeep Singh – He is responsible for software programming (C#, Database Storage Module), and worked upon mobile searching part.

Testing and Verification

The testing phase for software and hardware were performed both concurrently during implementation so as to ensure that the individual components were robust and performed as per the expectations.

Recognition application testing

This was an important and critical testing, as we wanted the results to be highly accurate. We performed the tests with various algorithms and with various training sets, the results of which are shown in the following graph. Clearly the Fischer face approach gave us the most accurate results. Other major issues affecting the test results were varying lighting conditions, face alignment, effect of hair styles and beard, occlusion etc. We have made certain changes in the algorithm to account for the above problems. Further we can see that the success rate increases greatly if the number of training samples per student is increased. Thus we tested our system with different samples of students under varying conditions and had a visible increase in result accuracy.



Recogniton test results with various algorithms and training sets

GSM module testing

When query results were searched from the database, the time taken from sending the SMS to receiving the result was around 20 seconds with a database of 100 students. A '*Keyword*' search using our designed algorithm took around 30 seconds with an internet connection speed of 64Kbps. Sometimes during testing of search we received *Forbidden Error*, but it was resolved in IE because Wikipedia was passing it to their code generation engine and posting a response to the URL. Using webclient, the steps were not the same as in IE. To make our search more robust, we didn't rely only on Wiki but used other encyclopedias whenever an exception from wiki was cached. This made our search algorithm more robust. These are the results when tested with a GSM AT compliant mobile phone. Time is decreased with a GSM Modem. An SMS provider connection would be fast enough to handle large SMS requests from the Control Center.

Conclusions and Future Work

AES solves many problems that our current education system is facing. Before the development of AES, we thought of many alternative solutions and finally came to a to develop a system that would cater to the need of students as well as teachers, thus making the present education system more effective. We looked for real life problems and found their practical solutions. We thoroughly discussed the problem and did an extensive research before finally reaching to a perfect design that would eliminate the drawbacks of the education system keeping in mind, the effectiveness and cost of the system. AES incorporates various technologies to fulfill the requirement of the innovative system. The whole project was accomplished with close teamwork. But, still there is always a scope for improvement like:

- Take attendance of whole class by moving the camera in a predefined manner (embedded with artificial intelligence to account for special situations such as facial-detection controlled rotation of motor) using a stepper motor. This would further reduce the time taken for attendance and make it more efficient.
- Improve accuracy of facial recognition system under various constraints such as varying lighting condition, posture, facial hair, etc.
- Filter search results so undesired terms for students are prevented from being searched.

Acknowledgements

Our Team is very grateful to following persons for their help:

1. Mr. Khushil Saini, Computer Science Department, NSIT Delhi.
2. K.R.Srivathsan Director ,Indian Institute of Information Technology and Management Kerala.
3. Jivesh Govil, Phd Student, University of Michigan.
4. Prof. Subhashish Banerjee, Head of Computer Science and Engineering Department, IIT Delhi.
5. Dr Parul Garg, Electronics and Communication Department, NSIT Delhi.
6. Arun Verma, Telecom Officer, Bharat Sanchar Nigam Limited.

References

1. British Broadcasting Corporation. (2004) Research on audience characteristics. http://www.bbc.co.uk/commissioning/marketresearch/audiencegroup2.shtml#5.
2. Web Camera Driver. http://www.gotdotnet.com/workspaces/workspace.aspx?id=0eb87e35-13e4-4fa3-9fde-71e9136f47de.
3. VLC Video Library. http://www.videolan.org/pub/testing/wince/wince-arm-gcc4.0.0-cvs-linux-crosscompiler-20050517.tar.bz2.
4. VLC Libraries. http://download.videolan.org/pub/testing/wince/contrib-20050220-wince-xscale-bin.tar.bz2.
5. M. Turk and A. Pentland, “Eigenfaces for recognition”, J. Cognitive Neuroscience, vol. 3, no. 1, pp. 7186, 1991.
6. Peter N. Belhumeur, Joao P. Hespanha, and David J. Kriegman . “Eigenfaces vs. Fisher faces: Recognition Using Class Specific Linear Projection”, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 19, No. 7, July 1997
7. J. Kittler, Y. P. Li and J. Matas. On matching scores for LDA-based face verification”, Centre for Vision, Speech and Signal Processing, University of Surrey, Guildford, Surrey, UK.
8. Lindsay Smith I., “A Tutorial on Principal Component Analysis”, February 2002.
9. John Kennedy, Principles of Communication Systems, Tata Mc Graw Hill.
10. Mike Hall: Technical Product Manager, Mobile and Embedded device group. mikehall@microsoft.com Mike Hall’s Blog.: http://blogs.microsoft.com/mikehall.
11. Microsoft help: helpp@microsoft.com
12. Windows Embedded Tutorials http://msdn.microsoft.com/embedded/getstart/basics/default.aspx. This site provides how-to tutorials on basic and advanced topics about using Windows CE in development of embedded devices.
13. http://www.learnvisualstudio.net. This site provides video tutorials for learning Visual studio.
14. http://opennetcf.org/ The OpenNETCF Smart Device Framework Library.
15. Dhananjay V. Gadre, Programming and Customizing the AVR RISC Microcontrollers. McGraw Hill, USA, 2000, ISBN: 007134666X.

16. 1996: Booch, G. Object Solutions. Addison-Wesley. Explains the importance of an iterative and incremental lifecycle.
17. H. Yu and J. Yang, "A direct LDA algorithm for high-dimensional data-with application to face recognition," Pattern Recognition, vol. 34, pp. 2067–2070, 2001.

About the Authors

Ankur Verma (Principal Author) is a third year student pursuing Electronics and Communication Engineering at Netaji Subhas Institute of Technology (Delhi University), New Delhi. Despite the cutthroat competition at one of India's premier universities, he sustained a position amongst the top ten students in his department (class strength 100), scoring an aggregate of more than 80%. He is actively involved in several projects. He is the Technical Operations Director and Student Advisor of the Computer Society of India (CSI)-NSIT student chapter. He has undergone Industrial training in CDOT, OCB, 5ESS and EWSD Telecommunication Landline Switches at Bharat Sanchar Nigam Limited (BSNL), Jalandhar City. He got All India 22 Rank in Combined Entrance Exam for admission to University of Delhi. He received merit certificates from Central Board of Secondary Education (CBSE) for being in top 0.1% students of India. He is also receiving CBSE merit scholarship for undergraduate studies for getting 100% in Mathematics and 98% in Chemistry in high School exam.

Email: ankur.verma@nsitonline.in , ankur_18d@yahoo.com
Website: http://ankur.nsit.googlepages.com/

Ankur Arora is a third year student pursuing Electronics and Communication Engineering at Netaji Subhas Institute of Technology (Delhi University), New Delhi. He received All India 30 Rank in Combined Entrance Exam for admission to University of Delhi. He has a deep interest in Network Technologies and Security.

Email: ankurarora.nsit@gmail.com

Vishal Gupta is a third year student pursuing Computer Engineering at Netaji Subhas Institute of Technology (Delhi University), New Delhi. He is getting CBSE Scholarship for undergraduate studies for getting All India 112 Rank in A.I.E.E.E Exam. He received 3rd Rank in P.C.E.T Exam conducted by Punjab Government. He is interested in Algorithms and Data Structures.
Email: vishal@coe.nsit.ac.in

Mandeep Singh is a third year student pursuing Computer Engineering at Netaji Subhas Institute of Technology (Delhi University), New Delhi. He received 91.6% in High School Exam and is deeply interested in Computer field. He is actively involved in various projects.
Email: mandeep@coe.nsit.ac.in