

Mobile Technologies to Support Discussion Groups within in Distance Education in Developing Countries

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Problem Description

The task aims at exploring how mobile technologies can be used to improve cooperation in distance education in developing countries. In particular, the task focuses on the programme for teacher education at Makerere University. Starting from the results of a questionnaire distributed in autumn 2006, the task aims at understanding better the nature of discussion groups in distance education and current problems faced by students. The task will then propose a set of requirements for a system supporting discussion groups and its design. A simple demonstrator of the system is part of the expected results for this task.

Assignment given: 29. January 2007

Supervisor: Monica Divitini, IDI

I dedicate this thesis to my grandmother FEDERESI MISANYA

Civility costs nothing and buys everything

Abstract

During the autumn project we explored how mobile technologies could be used to improve collaboration in distance education in developing countries. During this study we identified the importance of discussion groups. In this thesis continuing from the autumn project I traveled to Uganda and administered interview on the BED students in order to understand better how discussion groups are formed and managed, hence understanding better the activities technology can support.

In this study we used different methods of data collection. Since we had already done a study in the previous semester we used some the information we had gathered before to inform us about some aspect. We also used a questionnaire as earlier mentioned and observation since we were in Uganda during a face-to-face session.

We presented the results which informed us and we characterised the discussion groups in two that is assignment discussion group and general discussion group giving the characteristics of each in detail. In the results presentation we grouped the chapter into major sub section that need support.

We then analysed the data collected were we present it in form of scenarios without technology support. In this chapter we have different possibility when Markus wants to create group, join group, leave a group, etc. In here we identify some activities that need support e.g. group management, coordination, communication and collaboration.

We then presented the services in the design chapter in use cases and described the different use cases. These use cases helped us to know the detail functionalities that we need to support. There after we developed demonstration prototype to demonstrate some of the functionalities of the design. Though we would have liked to have every thing on our demonstration prototype we just did a few services to demonstrate what we needed. We then evaluated our demonstrator against the scenarios we had earlier in the analy-

sis by trying to see how the demonstrator solve some of the problems Markus encountered.

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List of abbreviations

OS Operating System

PC Personal Computer

SE Standard Edition

JAD Java Application Descriptor

BED Bachelor of Education External

ICT Information and Communication Technology

DDE Department of Distance Education

SMS Short Message Service

ITU International Telecommunication Union

DYD Diploma in Commonwealth and Development

P2P Peer-to-peer

XML Extensible Markup Language

WAR Web Application aRchive

PHP Hypertext Preprocessor

CGI Common Getway Interface

ASP Active Server Pages

URL Uniform Resource Locator

API Application Programming Interface

PDA Personal Digital Assistants

JSP Java Server Pages

- IDE** Integrated Development Environment
- JSR** Java Specification Request
- NTNU** Norwegian University of Science and Technology
- J2ME** Java 2 Platform, Micro Edition
- CLDC** Connected Limited Device Configuration
- MIDP** Mobile Information Device Profile
- HTTP** Hypertext Transfer Protocol
- SOAP** Simple Object Access Protocol
- WSDL** Web Service Definition Language
- MCSCCL** Mobile Computer Supported Collaborative Learning
- UNISA** University of South Africa
- HTTPS** Hypertext Transfer Protocol Secure
- MOTUS** MObil Teknologi i UndervisningsSammenheng (mobile technologies for supporting communities in higher education)

CHAPTER 1

INTRODUCTION

In this chapter we give the background of the study, theoretical background, problem elaboration, the objective and methods used, highlighting our focus of this project. We also outline the structure of the document.

1.1 Background

In developing countries, distance education is critical for increasing access to education and training and it has widely been adopted for teacher education. This allows educating students who have no physical access to higher education, but most importantly, educating teachers who are already working in schools, allowing them to improve their competencies without losing their practice[1].

However, despite the advantages that accrue from computer and internet-based educational applications, developing countries still have a problem of access to the internet. In[1] we have suggested that in this type of situation mobile and ambient technologies can strengthen cooperation by providing the possibility for a contextualized and just-in-time and just-in-place access to learning resources and cooperation partners, and with limited access to internet in developing countries Mobile access to Internet might then offer a solution to make collaborative learning in teacher education sustainable.

The postal system, telephones and recently computers are some of the main means of communication in distance education in African countries. However, problems of delay and reliability of the postal system, access and costs of telephone and computers continue to present major challenges for distance education providers and students. Recently, mobile and wireless technologies have been studied and used in many regions of the world and are advocated as a promising new approach to supporting distance learning in developing countries[2].

With the enormous problems of computer and internet access by most African students, we carried out a project in the autumn 2006 semester under the MOTUS project and explored how mobile technologies could be used to improve collaboration in distance education in developing countries[3]. We focused the study on a case study of the Bachelor of Education External (BED) at Makerere University. The method of education of the BED program is of a distance nature where students only come to the University twice for a period of two weeks in a semester for what is called face-to-face session. The department has set up regional ICT centres: Lira for the northern region, Mbale for the eastern region, Fort-portal for the western region and the University main campus for the central region. During the study it was stressed that the regional ICT centres are very important in taking the services closer to the students; however, BED students are not active in using these centres.

During this project I traveled to Uganda and administered a questionnaire to BED students and a few interviews with key informants. The data collected showed that computer access by many of the BED students was limited. This concurs with the earlier information. When we found out about the services used on the mobile phones, mostly BED students used SMS other than all the other services; however, there was high access of mobile phones by students. The administrators acknowledged the importance of students forming discussion groups from the regions where they come from, though they do not follow up the implementation of the groups. We also explored in detail the cooperation patterns used, support mechanisms, ICT support and the challenges faced among different actors. We then came up with different possible solutions in scenarios, i.e. for the current situation, for the future and experimental. We then gave the possibilities of further research[3].

Being that it was stressed that discussion groups are very important during the autumn study by the respondents[3], we focus our study on understanding clearly how discussion groups foster learning. In this thesis we shall look at the collaboration among students in discussion groups. Collaborative learning is the learning of students by forming groups which is emphasised by the department administrators. Looking at the situations we have studied in MOTUS at our university, most collaboration is facilitated by students meeting regularly and with frequent access to Internet (see paragraph 2 above). It is clear that similar models of teacher education are not currently sustainable in most African countries. Students are dispersed over a long distance, often with infrastructures that make traveling difficult and costly. This implies that cooperation can take place only among collocated people. In this way, however, students are unable to share their reflection and experiences within a rich social context, getting different feedback and stimuli. We be-

lieve that this critically impacts the education of reflective teachers. Despite the advantages that are brought about by internet, regular Internet access is out of reach for many Africans. Mobile access to Internet might then offer a solution to make collaborative learning models of practice-based education sustainable in developing countries. It is therefore of paramount importance not to neglect this aspect when designing mobile infrastructure and solutions. Clearly different technological infrastructures, e.g. mobile telephony vs. wireless network, open different spaces of possibilities. It is critical to find the infrastructures that are more appropriate, also considering appropriate economic models. We believe two aspects need to be taken into account when considering the usage of mobile solutions because of their consequences on the design of new tools. First, mobile technologies bring along the possibility to get global access without losing the local dimension. Second, mobile technologies seem to promote a model of sharing rather than owning that can make them more sustainable from an economical point of view[1].

1.2 Focus

With the majority of BED students having access to mobile phones as shown in Autumn 2006 report which was mentioned earlier in section 1.1, this brings us to study and find the benefits we can get from them since they have been studied and used in many regions of the world. According to sources from The Economist[4] , "...in some African countries, subscriber growth exceeds 150% a year. Mobiles have created more entrepreneurs in Africa in the past five years than anything else." This shows not only the growing availability of mobile phones to Africans, but also the high potential for innovation that is brought along by these technologies.

During the study, most of the respondents acknowledged the importance of discussion groups in fostering learning in distance education. The importance shown by most key informants about discussion groups prevailed on us to go back to Uganda and understand better how these groups are created and managed. Even if the data shows that the majority of the students have mobile phones, but their phones have problems of being always unavailable and with limited functionality.

In this thesis we shall focus on supporting BED students in discussion groups to collaborate using mobile phones. In our focus we shall demonstrate how mobile application prototype can be used in discussion groups. This demonstration prototype will be used to demonstrate ideas that can be used to

understand better how to make mobile technologies that support collaborative learning among BED students in discussion groups.

We shall specifically look at how discussion groups help to foster collaborative learning. In collaborative learning students are responsible for one another's learning as well as their own. Proponents of collaborative learning claim that the active exchange of ideas within small groups not only increases interest among the participants, but also promotes critical thinking. The shared learning gives students an opportunity to engage in discussion which promotes knowledge sharing, take responsibility for their own learning, share practice experience and thus become critical thinkers[5].

1.3 Theoretical background

In this section we present some of the theoretical background for our study. The theoretical background is based on the fact that we are working with discussion groups. We present the theories of collaborative learning and social learning theories; however, these theories sprung from Vygotsky's socio-cultural psychology[6]. We have chosen these theoretical background because of the fact that we are in the MOTUS and considering that we argued in [1] that what is being done in the project can be sustained in developing countries.

1.3.1 Collaborative learning

In all situations where people come together in groups, it suggests a way of dealing with people which respects and highlights individual group members' abilities and contributions. There is a sharing of authority and acceptance of responsibility among group members for the groups' actions. The underlying premise of collaborative learning is based upon consensus building through cooperation by group members, in contrast to competition in which individuals base other group members. Collaborative learning practitioners apply this philosophy in the classroom, at committee meetings, with community groups, within their families and generally as a way of living with and dealing with other people.

Psychologists and educationalists influenced by Vygotsky[6] claim that students working in small groups can share and evaluate ideas and develop their

critical thinking[7, 8, 9, 10]. In this regard, students in discussion groups can be developed into great critical thinkers. The seminal work of [11] highlights the learning potential of peer group discussions which are reflective and hypothetical and where speech is tentative and exploratory.

Educator [12] noted that including collaborative activities is essential to creating an atmosphere of inviting information sharing, knowledge acquisition, and skill development. This is essential in BED group discussions hence making them important to use. Several studies have also shown that collaborative learning strategies result in more student involvement with the course[?], and more engagement in the learning process[13].

Active approaches to learning present learning as a social process which takes place through communication with others[14]. Specifically, collaborative or group learning refers to instructional methods that encourage students to work together on academic tasks. Instruction in Collaborative learning is learner-centred rather than teacher-centred and knowledge is viewed as a social construct, facilitated by peer interaction, evaluation and cooperation, meaning that learning is not only active but interactive[14]. Hartley[15] identified making use of diverse expertise, improving quality through criticism, allowing differing viewpoints, and developing communication skills, all as artifacts of collaborative learning.

Though not traditionally linked with collaborative learning, another theory that is particularly relevant for consideration of collaboration using mobile technologies is conversation theory[16], which describes learning in terms of conversations between different systems of knowledge. Mobile devices can support mobile computer supported collaborative learning (MCSCCL) by providing another means of coordination without attempting to replace any human-human interactions, as compared to say, online discussion boards which substitute for face-to-face discussions[17].

Researcher[18] believes that the understanding of teacher training in collaborative environments at a distance could be highly interesting in order to solve some of the (currently widely debated) training problems, to implement their establishment in a large scale and, finally, to try to overcome a few space and time contingencies, which can seriously limit teacher training throughout life and most importantly students in developing countries.

1.3.2 Learning by Practice

Learning is looked upon as a social, interactive process, and teacher education is intended to aid learning at several levels [19] and knowledge is acquired through social participation[6]. A Learning Community has been used to describe a cohesive community as one which embodies a culture of learning in which everyone is involved in a collective effort of understanding[20]. No one individual is burdened with the task of knowing it all, rather, knowledge is distributed amongst the group members, each of whom uses their knowledge and skills to contribute to the group endeavor. Not only are groups able to accomplish more, but it has been argued that this type of learning leads to deeper understanding of content and processes for the group members[21].

Korthagen in [19] describes a teacher education model where theory and teaching practice form a coherent entity as "realistic teacher education" and believes this will be characterised by taking as its starting point the student's own practical experience as a teacher in school, which will further systematic reflection. According to Etienne Wenger[22], we learn as we participate in social communities and our identity forms in these communities.

In [23] they say that mobility facilitates different experiences and the interaction among different people. They believe that learning technologies have a good potential of supporting mobile learners in the field.

However, to fulfill the expectations, they have to be designed so as to take into account the complexity of the learners' context and their need to access not only official informational resources, such as lecture notes, but also more informal resources and other people that can support them in the learning process. Technology can support students only if it can support these interactions in a flexible and contextualised way, e.g. by making possible the sharing of experiences while they are taking place and with whoever the learner feels is most appropriate to provide feedback in the given situation, independently by the physical location of the people involved

1.4 Problem

1.4.1 Project context

MOTUS

This thesis is within the project MOTUS which is jointly run by three different departments at NTNU, i.e. the Department of Information and Computer Science at the Faculty of Information Technology, Mathematics and Electrical Engineering, the Program for Teacher Education at the Faculty of Social Sciences and Technology Management, and the Department of Modern Languages at the Faculty of Arts. The project is aimed at investigating, through prototyping and empirical studies of overall usage, the potential and impact of mobile applications for supporting new forms of cooperation in the educational settings, independent of the participants' location[24].

The university has developed a partnership cooperation where the university are in partnership with other public school system. Students are assigned to specific partnership classes, determining where they will have their practice periods, but also to small groups called response groups, that have as main aim to establish units in which it is possible to promote social belonging and discussions on subject matters reported in [1]. Collaboration is also promoted by way of physical collocation and a number of meetings and seminars where different actors involved in the learning process can meet and share experiences. In order to understand how collaboration unfolds in practice, and consequently how it can be promoted with ICT, they observed students during one of their practice periods[25]. This paper outlines the complex and rich collaboration patterns that characterize the everyday life of teacher students. Learners participate to a number of groups and communities characterized by different degrees of coupling. Some of these groups are created on an ad-hoc basis by the teaching staff to enforce knowledge sharing, reflection and social cohesion among students taking the course; others are formed spontaneously based on, e.g. geographical proximity or common interests. Physical location and mobility continuously open new spaces of participation in some social structures, while hindering participation to others. Within this complex social context, students and their educators are involved in a number of interactions that include different partners and are characterized by different degrees of formality. These interactions might be direct, or mediated by artifacts that are introduced to coordinate activities or created by students to make their learning visible, for example notes and logs of their practice. These artifacts play a key role in learning because they are central to reflection and knowledge sharing.

Autumn2006 Project

This thesis is the continuation of a project that I carried out in Autumn 2006 under the MOTUS project[3]. In the project we were required to explore how mobile technologies can be used to improve collaboration in distance education in developing countries. We focused our study on a case study of the teacher education at Makerere University. We presented the different methods we used during the data collection and developed case study. We presented the results from a questionnaire distributed to the BED students and interviews with administrators, lecturers and DDE broadcast system developer. We then carried out the analysis of the results. We then presented some of the different possible solutions in scenarios, i.e. for the current situation, for the future and experimental.

Makerere University runs the teacher education course using the distance mode of education (see chapter 3 for detail). We identified different collaboration partterns among the key stakeholder. In this time that is when we identified the need to look into indepth about the collaboration that goes on among students in discussion groups (see chapter 4 for detail)[3].

1.5 Problem statement

In developing countries, distance education is critical for increasing access to education and training and it has widely been adopted for teacher education. Because the teacher education students are teaching in schools there fore increasingly, students need to balance work and family commitments with the demands of learning new skills[26]. As a consequence educational institutions must respond rapidly and flexibly to meet students' needs. However, the use of internet by these students in developing countries is still a night-mare and yet mobile phone subscription is growing at a very high rate.

Group discussions play a major role in fostering learning in this type of setting. Collaborative learning is an umbrella term for a variety of approaches in education that involve joint intellectual effort by students or students and teachers. Collaborative learning refers to methodologies and environments in which learners engage in a common task in which each individual depends on and is accountable to each other. Groups of students work together in searching for understanding, meaning or solutions or in creating an artifact of their learning such as a product[27].

The study we did informed us about the type of end users we were dealing with in our study. In this study we established the technologies which were available to the BED students and we also found out the services used by the BED students on their mobile phone in order to understand better the functionalities that they have on their mobile phones. Some of the results conform with what is stated in the Economist that there is high increase in the usage of mobile phones in Africa. The results showed that most respondents acknowledged the importance of discussion groups in fostering collaborative learning. Because of this, we were propelled to find mobile application needs to support discussion groups to foster collaborative learning, especially looking at how discussion groups promote knowledge sharing, how they coordinate within the discussion group, how they help discussion group members to feel connected to their peers and how they share practice experience in their discussion groups.

1.6 Objectives

1.6.1 General Objective

To provide support for discussion groups within distance education in developing countries using mobile technologies.

1.6.2 Specific Objectives

1. To provide an overview of the activities in student discussion groups.
2. To identify mobile application requirements to support student discussion group.
3. To design mobile solutions that support students in discussion groups.
4. To develop mobile application demonstrator prototype to support students in discussion groups.
5. To evaluate the mobile application demonstration prototype.

1.7 Research Method

This work is as a continuation of a project that we carried out in Autumn 2006. In the project we used a questionnaire and interviews to students and administrators respectively. In which we were able to understand better the need of discussion groups in fostering learning. In this thesis we collected data by the use of interviews, documentation and observation, we then analysed the data by use of qualitative analysis, we designed the mobile application using use cases, we developed the demonstrator prototype and evaluated the demonstrator as briefly elaborated in the next sections below. However, since I was working with the department for four years and familiar with the situation there, I used also some of my experience in working with the students to inform this research.

1.7.1 Field work

Description of research instruments

Overview: Table 1.1 gives a brief overview of the research methods used and their purpose.

Documentation: The documents used were reports at the department of distance education Makerere University in order to get figures. Since we had also done a report during the autumn 2006 so we used the document to get some information about the department of distance education. These documents were very helpful since they gave us a very good overview of our study.

Interview: The interview was administered on BED students. The questions were aimed at getting a better understanding on how students discussion groups are created and managed. The student interview guide questions from 1 to 5 were asked to get an understanding of how discussion groups are created and managed. Questions 6 to 10 were asked to get to know how meetings are organised and managed. Questions 11 to 13 were asked to get to understand the collaboration patterns that go among students in discussion groups. Questions 14 and 15 were asked in order to understand the technologies used by the BED students in the discussion groups. Lastly

Research methods	Why?
Documentation	This was used to get an overview of the BED programme and to understand how the programme was started. This helped us to get an overview of distance education at Makerere University, with focus on BED. We also used the document we had written during the autumn 2006 in order to give us a better view.
Interview	These were used to understand better what goes on inside a discussion group so that to understand better the collaboration patterns and activities that goes on in the groups.
Observation	These were used to understand how the students used the artifacts outside during the face-to-face session to interact.

Table 1.1: Overview of Research instruments used

questions 16 and 17 were asked to get a general opinion of the students about the use of these technologies in their discussion groups. See appendix A for the interview guide.

Observation: The observation was done on students during a face-to-face session at the department of distance education, Makerere University. We observed the students so that we could understand how they move around the department e.g. notice board, and lecture room.

Data collection

Interview: We interview students from the western region, the eastern region, and central region. We got students from different regions because different regions have different problems and needs for support. Like students in the central may have access to internet while those in the other regions dont have. Therefore, these interviews were carried out while students were in their face-to-face session at the department of distance education. The students were randomly chosen and asked the regions they came from. And for those who were coming regions that we had already interviewed were not interviewed. The interviews were conducted for a period of 30 minutes for each students. We used voice recorder during the interview so that we concentrate on asking questions and interacting with the respondent.

1.7.2 Analysis

In the analysis we used qualitative data analysis. Qualitative research is a particular tradition in social science that fundamentally depends on watching people in their own territory and interacting with them in their own language, on their own terms[28]. During the research we visited Uganda and interacted with the respondents so that we understand better their needs and what we could support. We visited our respondents in order to understand the phenomena as it exists. Qualitative research are generally unstructured and consist of words, pictures and sounds. During this we analytically looked at the data and came up with suggested solutions depending on the patterns of the respondents. Qualitative methodology reflects understandings of social life and meaning and also suggests a specific approach to what constitutes the production of knowledge[29]. Therefore the information we got from the interviews and observation during our stay in Uganda informed us about the analysis of the case.

1.7.3 Design

We there after designed the system using use cases in order to describe the different services that might be required by the system. The different use cases represented different functionality of the demonstrator.

1.7.4 Demonstrator

In order to test our design we develop a demonstrator prototype to demonstrate our functionalities. In this demonstrator prototype we try to show how students in discussion groups can be able to use the demonstrator in their discussion groups.

1.7.5 Evaluation

We then carry out an evaluation to find how much our demonstrator is answering from our design and findings. We try to show how much has been done and is needed to be done to improve the demonstrator.

1.8 Structure of the Thesis

The structure of the document will be divided in 9 chapters as shown below. Figure 1.1 shows the thesis outline overview.

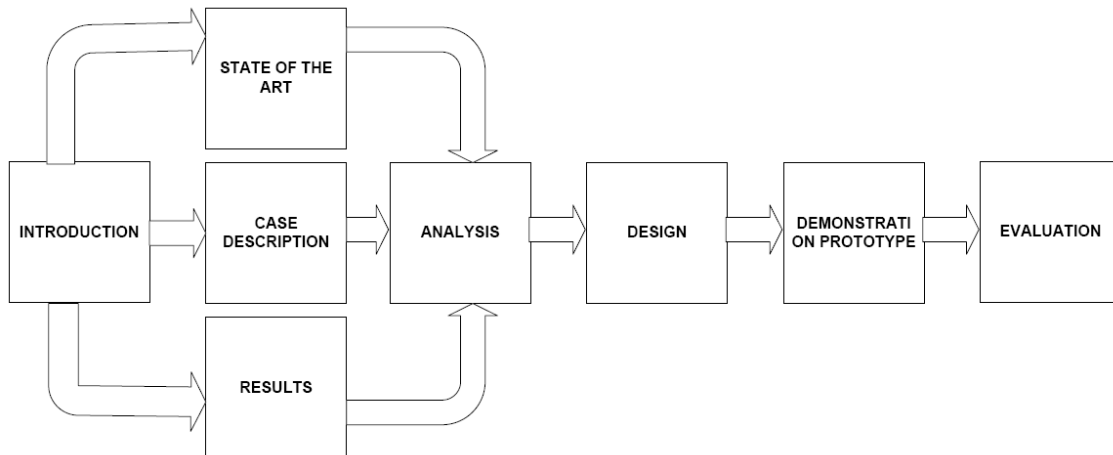


Figure 1.1: Thesis outline overview

Chapter 1 In this chapter we give a brief background of the previous project which was done in Autumn 2006, thereafter giving the motivating factors to this project, elaborating on the problem and presenting an outline of the thesis.

Chapter 2 In this chapter we give the state of the art which we shall build on the previous autumn project in order to position our project.

Chapter 3 In this chapter we describe our case study which will direct us in solutions we shall get thereafter.

Chapter 4 In this chapter we present the results we collected from the interviews we administered on the BED students.

Chapter 5 In this chapter we analyse the results that we have presented in the previous chapter so that we can come up with what we need to support.

Chapter 6 In this chapter we come up with the design of the demonstration prototype which we use to develop the demonstration prototype to support the needs.

Chapter 7 In this chapter we present the demonstration prototype by illustrating the technologies used.

Chapter 8 In this chapter we present the revised scenarios with technology support and a discussion on how the demonstration prototype intends to solve it.

Chapter 9 In this chapter we give a summary of results, discussion and suggest further studies.

CHAPTER 2

STATE OF THE ART

In this chapter we describe the related literature to the study of mobile technologies in supporting collaboration. Since our project is focused on the usage of mobile phones in discussion groups in Africa, we have organised this chapter in sub-titles of the usage of mobiles in Africa, which is aimed at understanding better how the technology is being used in Africa, Mobile technology and pedagogy which is aimed at understanding how mobile and pedagogical issues fit together, collaborative learning using mobile technology which is aimed at understanding how mobile phones are used to foster collaborative learning; micro-learning which is aimed at understanding how learning objects are packaged and communication among students which is aimed at understanding what communication happens among students.

2.1 Usage of mobiles in Africa

The African continent has many developing nations that are technologically far behind the developed world, and this lack of technological development has a detrimental effect on the education sector. As a result, young people in developing countries face immense challenges, which make it difficult for the next generation to catch up with the developed world[30]. Brown[31] points out that due to the lack of infrastructure for ICT (cabling for telecommunications and the Internet) in certain areas in Africa, the growth of wireless infrastructure is more rapid than in many first world countries. Jensen[32] holds similar views to that of Brown[31], and states that most of the existing telecommunications infrastructure in Africa cannot reach the bulk of the population, with 50 percent of the available lines concentrated in the capital cities, where only about 10 percent of the population lives. In more than 15 countries in Africa, over 70 percent of the lines are still located in the largest city. However, according to Jensen[32], the situation is not quite as bad as it would appear because of the penetration of mobile networks, where these subscribers have now surpassed fixed line users in most countries, underlining

the demand for basic voice services. Due to the low cost and long range of the cellular base stations, many rural areas have also been covered. This is in line with our findings in the autumn project which was described earlier in section 1.1 with respect to high mobile access to the BED students in Uganda.

SMS services in Africa are the most widely used service now due to the increasing costs of calling[2]. As pointed out by one of the respondents during the interview, there is high increase in the usage of SMS by students because of high costs of calling[3].

With the increase of mobile phones in Africa, as stated by the International Telecommunication Union (ITU), Africa has seen an increase of more than 1000% in cellular phone subscribers between 1998 and 2003[2]. This increase in subscriber rate, given the advantages that come with mobile phones, can prompt the use mobile phones to support collaborative learning. The use of wireless technologies in education impacts learner motivation, collaboration and mobility, which results in benefits for learners, parents and teachers[2]. The results of the Zurita et al[17] research show that wireless technologies solve the weaknesses of coordination, communication, organisation, negotiation, interactivity and mobility encountered in collaborative learning (without technology) in education. According to Brown[31], mobile learning in Africa is a reality that will continue to grow in form, stature and importance, and it will become the learning environment of choice.

The University of South Africa (UNISA) has implemented a project to explore the effectiveness of SMS communication between the University and the students. They made their study with students of Diploma in commonwealth and development (DYD), and all the DYD students had mobile phones. When students were asked the location they were in when they received SMS from University the majority of the respondents were either at work (46.7%) or at home (44.4%). When the students were asked how they felt when they received SMS, the majority of the students felt very good and advocated the continuation of sending SMS to them. However, the report also indicates that though communication through SMS is a very good tool, there would be a huge cost on the side of the Institution[2].

Makerere University, Department of Distance Education has carried out a study on the usage of the SMS system by students at their department. This study was done on selected few Bachelor of Commerce External students with regard to the effectiveness of the SMS communication among the students. This study showed high usage of mobile phones as the majority of the students had mobile phones. The study showed that the usage of SMS

was more effective in conveying information about upcoming programs and development at the main campus[33].

2.2 Mobile technology and Pedagogy

There is an increasing and unprecedented adoption of wireless technologies in developed and developing countries alike[34]. Wireless technologies are revolutionising education, transforming the traditional ways of learning and teaching into 'anytime' and particularly, 'anyplace' education. Empirical studies have reported the advantages of using wireless technologies in learning environments, including supporting group work on projects, engaging learners in learning-related activities in diverse physical locations, and enhancing communication and collaborative learning in the classroom[35]. This can further be elaborated in Vygotsky's social-cultural psychology, activity theory conversational theory which describes learning in terms of conversations between different systems of knowledge[36]. Another important pedagogical aspect concerning hand-held devices is that they extend the learning environment beyond the classroom, as they are portable, support the paperless classroom, and provide additional methods of communication[37] and this aspect fits well in developing countries since the students in the course are distance learners.

Simply having a set of hand-held devices does not imply that they will be integrated into a teacher's curriculum with ease, and difficulties may be encountered[2]. Keegan[34] states that the main pedagogical issue to consider is the suitability of a course to the m-learning environment, as not all courses are suited to the m-learning environment. For example, short courses and mainly theory and information type courses are better suited to the m-learning environment.

The traditional classroom-based pedagogies alone are inadequate to address the current educational challenges of under-prepared students, large class sizes, diversity, renewed demands for graduate throughput, to mention but a few, which are the common trend of developing countries of today, with even limited infrastructure and tutors [2]. Since BED programme is a distance learning course with most of the students separated from their lecturers, this means that the number of students is large and this calls for a better way of handling them other than the traditional classroom-based teaching.

Research was done where BSCW was introduced as a shared resource tool

for a module entitled "Innovative Trends in Information Systems"[38]. This module, which is normally taken by final year undergraduates on computing courses, was designed to provide students with the opportunity both to demonstrate their research skills and to follow up areas of specific personal interest in the areas of computer science and information systems. The paper concluded that Innovative Trends in Information Systems module was probably an inappropriate choice and that choosing a more focused module would have probably encouraged the setting up of a much less anarchic resource which could have been more easily moderated for quality. They felt that while BSCW might work very well with more mature, post graduate students, using it with undergraduate students required a great deal more focus and control on the part of the supervisor in order to optimise its value. They felt as Beaudin reports "that this exploratory study reinforced many of the principles and practices used in face-to-face classrooms to keep discussion on topic and should serve as a reminder that good instructional design is essential whether it is on line or face-to-face", [39]. Also, that the "structural design in the on line environment requires even greater sensitivity and attention than in the traditional classroom" [39]. However, the use of BSCW did stimulate and facilitate a greater degree of collaborative working than may otherwise have been feasible and students reportedly got a good deal of personal satisfaction from the experience of using it[38].

2.3 Collaborative Learning

Collaborative learning is a term associated with a teaching style that recognizes the social character of learning and emphasizes cooperative efforts among students[40, 41]. Given that BED students work in groups, this shows that they practice collaborative learning. Its purpose is the nurturing of active learning, a term that seems to lack a clear definition but implies that students are not viewed as simply "receptacles of knowledge" but are doing something besides listening [42]. A large body of research findings support the positive effects of collaboration on student achievement[43, 44].

Research on 6 and 7 year old children described how weaknesses in coordination, communication, organization of materials, negotiation, interactivity and lack of mobility can be solved with a mobile computer supported collaborative learning environment with hand-helds interconnected by a wireless network. The results of work identified that the use of wireless networks in collaborative learning activities opens a new world of possibilities, with the interface

design as a central element. They acknowledged that MCSCL activities support transparently the collaborative work by strengthening the following: (a) organization of the managed material; (b) social negotiation space of group members; (c) communication among the group members, through the wireless network that supports the social face-to-face network; (d) coordination between the activity states; (e) possibility to mediate the interactivity; (f) encouraging of the members' mobility[5].

Collaborative learning has been frequently seen as a stimulus for cognitive development, through its capacity to stimulate social interaction and learning among the members of a group. The goal of collaborative learning is to assist teaching in a specific educational objective through a coordinated and shared activity, by means of social interactions among the group members[45]. However, given that BED students are distance students who don't spend most of the time with the tutors, social interactions play a very big role in learning. These social interactions are essential to achieve the desired learning, as a result of a continuous attempt to construct and sustain a shared and open point of view of the problem[46].

Since face-to-face collaborative learning provides a richer social and learning experience, computer systems are often designed to support it[5]. There fore in this case our role is to explore how mobile phones can enhance and improve users' face-to-face collaborative learning interactions among student groups.

Vygotsky stressed that collaborative learning, either among students or between students and a teacher, is essential for assisting each student in advancing through his or her own zone of proximal development, that is, the gap between what the learner could accomplish in cooperation with others who are more skilled or experienced. This shows that the learner gets to learn a lot when working with peers who are more skilled in a group discussion.

Scholars describe learning as a semiotic apprenticeship based on the creation of collaborative community of practice in which learners develop their thinking through talk rather than through modeling. Since BED students are distance learners and are usually assigned problems which they work together in groups when they are in their region, this helps in developing them into being problem solvers. This also helps them to develop self-assessment skills.

For students to achieve more of the benefits of collaborative learning, it should be students not the technologies to solve problems, make planning, and set goals. Therefore the role of technology should promote and facilitate learners to maximize the use of their intelligence and knowledge. In other

words, the tools design should focus on Salomon's[] suggestion to provide quality interfaces that facilitate students learn in group discussion (the "effect of" technology), rather than off-loading and task dividing that try to ease students' cognitive burden (the "effect with" technology).

2.4 Micro-learning

The developments of computers, Internet and mobile phones in the last ten years have transformed our living, working and learning environments to such an extent that we are actually continuously engaged in micro learning. "Micro learning" has become the most common everyday practice in the information society. It's the way we breathe in information and exhale communication. We do it when reading and writing e-mails or mobile texts, blogs and wikis, or when we google and podcast, set up aggregations & feeds. The new Information and Communication technologies move us rapidly in this new environment and we are learning willingly and intuitively as well as sometimes quite unwillingly and exhausted to use the technologies and integrate them into our practices. "Micro-contents" are the text bits which we produce and circulate in new, loosely coupled formats and structures. They make up the new bases of eLearning, knowledge management, and information acquisition in corporate and educational environments. We no longer write long papers but design multimedia presentations; we do not exchange essays but excel sheets; we coordinate our activities and dates, not with letters but SMSs[47].

Micro learning is not something that has still to be invented. At an informal level, it is already being practiced by knowledge workers and 'life long learners' that have no choice but to try and get the information they need out of the World Wide Web. In such a situation, traditional macro-sized e-learning has often proved to be too expensive, too static and too ineffective. It is also a matter of the 'media experience': It just does not feel right to people used to the information snippets of Google and the e-mail in box. Learning objects[47] are any entities, digital or non-digital, that can be used, re-used or referenced during technology-supported learning.

2.5 Communication among students

Many European projects have investigated wireless technologies in education, naming a few of them among the many are M-learning, DfES/Becta PDA

Project, MOTUS2 and MOBIlearn. The M-learning project addressed the social and educational problems in young adults using hand held devices, and its aim was not to replace traditional education, but rather to reengage those who have left educational institutions [48]. The DfSE/Becta PDA project evaluated the use of small, hand held computing devices for both teachers and learners in schools[49]. MOTUS[24] investigated, through prototyping and empirical studies the overall usage, the potential and impact of mobile applications for supporting new forms of cooperation in the educational settings, independent of the participants' location. MOBIlearn[?] explored new ways to use mobile environments to meet the needs of learners working by themselves, and with others, using the latest wireless technologies. A further project conducted in Japan, investigated the extent to which mobile phones were utilised for educational purposes among university learners, and measured learners' reactions to educational materials developed specifically for mobile phones[50]. This shows a lot of research has been done in the area of supporting communication among students, and the increase in mobile access in developing countries calls for investigating better and developing suitable solutions for learners.

Perry (2003), as reported in[2], states that wireless technologies, notably PDAs, are proving to benefit 'family learning' as learners are able to use them for various literacy tasks, note-taking, reading e-books, and then take them home to continue working on them with their parents. In the same book[2] Perry reports that, Becta project schools are unanimous that their learners were excited and highly motivated when they began using the hand held devices. Belt[51] states that after implementing wireless technologies in the classroom, learner participation increases and they appear "more engaged in the process". In the work previous mentioned[2], giving learners wireless technologies "lights up" their enthusiasm, although whether this will always be the case remains to be seen. Belt[51] agrees with Perry (2003) as reported in[2], suggesting that the increase in learner participation and enthusiasm can be partially explained by the novelty of using a hand-held in the classroom. However, after the novelty of the new devices has worn off, learners come to view the devices as working tools[51].

CHAPTER 3

TEACHER EDUCATION AT MAKERERE UNIVERSITY

In this chapter we describe teacher education at Makerere University. We describe distance education programme of Makerere university and thereafter describe the BED programme in detail.

3.1 Distance education at Makerere University

3.1.1 Background

Distance education spread in Uganda starting in the 60s when many Ugandans enrolled in the British correspondence colleges and obtained qualifications of General Certificate of Education (GCE), Cambridge School Certificate and, advanced certificates and accountancy qualifications. Since then it has grown tremendously, though with disturbances during the years of civil wars[52].

In the Kironde Report[53], which focused on the need to provide continuing education to various expectant groups in Uganda, it was recommended that correspondence education be expanded and Makerere University to start offering courses in that field which was supposed to lead later to the establishment of an Open University in Uganda. However, up to now the Open University has never been established, though the distance education has taken off at Makerere University.

The external degree programs of Makerere University were launched after the recommendation of the University Council in 1984. The proposal to launch

the external degree programs recommended that the Institute of Adult and Continuing Education, through the department of Distance Education, be responsible for the day-to-day running of the programs. Though the council recommended that external degree start in 1984, the programs started in 1992.

The external degree program was launched in 1991 with two degree courses, that is, the Bachelor of Commerce External and Bachelor of Education External, but started in 1992, under the Department of distance education with the mandate to handle the administrative requirements. Then there was the introduction of the Bachelor of Science External and commonwealth Diploma in youth and development.

In distance education students come to Makerere University twice every semester for a face-to-face session. During this time students are given course descriptions and a short orientation for the courses giving them year planners(Appendix B). They are also given assignments to help them learn since they are almost all the time not with their lecturers. The face-to-face sessions are organised in holidays when the students are free to take the courses. Distance education program is run using print and audio study materials, integration of face-to-face sessions and organized study groups through study centers and self-directed learning.

In Uganda and in Makerere University in particular, a number of programmes including teacher education have been offered using distance education. However, many of these programmes have not fully utilised a variety of technologies and have largely depended on first generation¹ (print) and on second generation² (face-to-face sessions). There have been some efforts to integrate computers in education[54].

The distance education department runs the distance programme courses in collaboration with the Faculty of Economics and Management, the School of Education and Faculty of Science. The collaborating faculties are responsible for the academic component of the programmes while the department of distance education is responsible for the administrative component. Figure 3.1 shows the patterns of collaboration with the different actors as shown in the autumn report[3].

¹First generation is where distance learning institutes entirely depend on print

²Second generation is where distance learning institutes entirely depend on face-to-face sessions

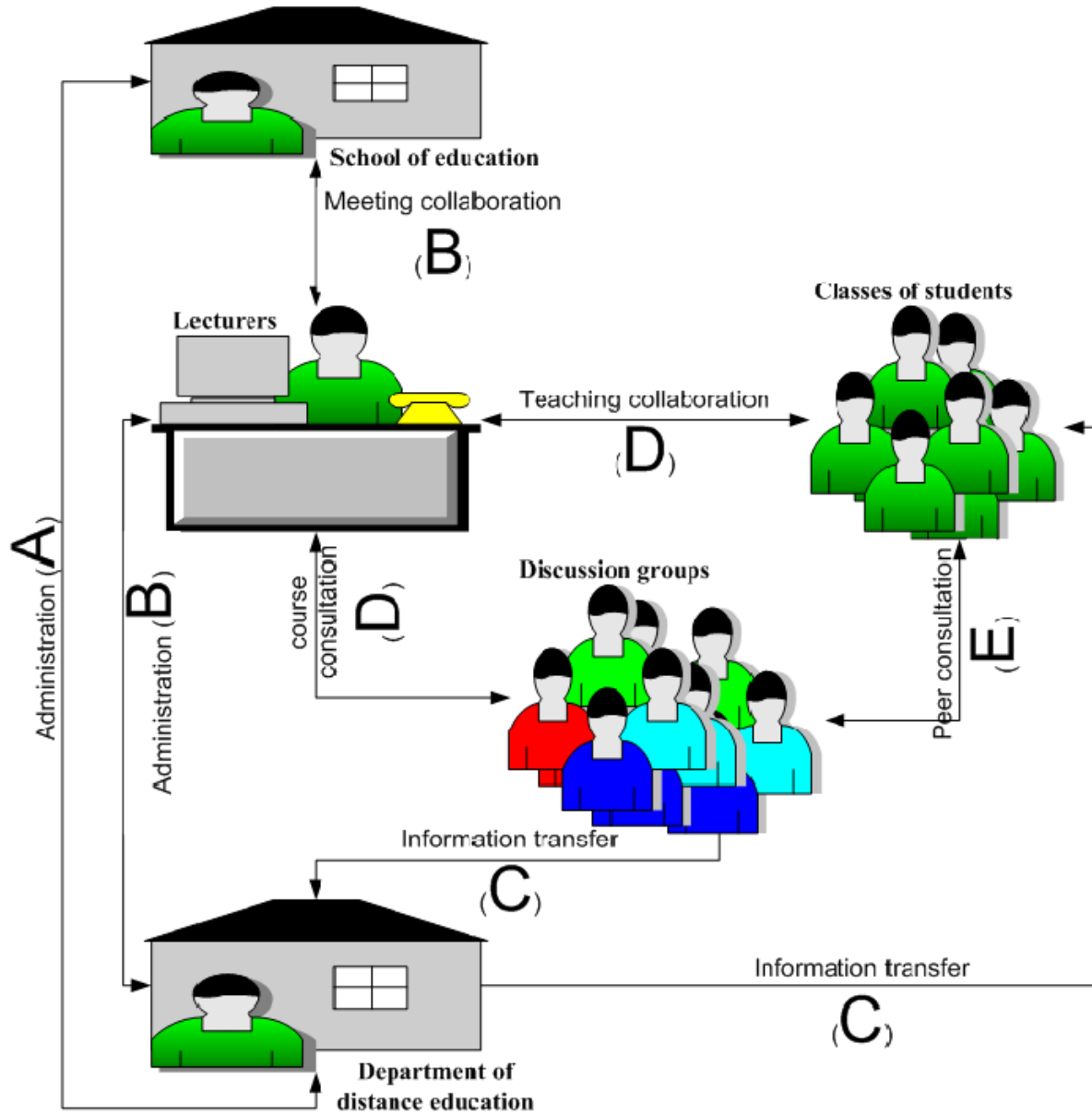


Figure 3.1: Patterns of collaboration with different actors[3]

3.1.2 ICT centres

Figure 3.3 shows an overview of different regional ICT centres and Makerere University main campus. The department has regional centres intended to support the students where they are located. Since most of the students spend less time at the university and more time in the location where they teach, these centres were established to facilitate communication with the main campus and decentralise distance learning services. So instead of the student traveling to the main campus, he can, through the ICT centres, communicate to the department or get services because the department has placed a member of staff at the centre who helps in the communication. The communication between the department and the centre is done by use of telephone contacts usually landlines, email, fax and physical movement by the centre staff. The centres currently have 6 networked computers, a fax machine, a printer, telephone hand set and a dial-up internet link. Students use these centres to practice, access internet, and hand in assignments. The

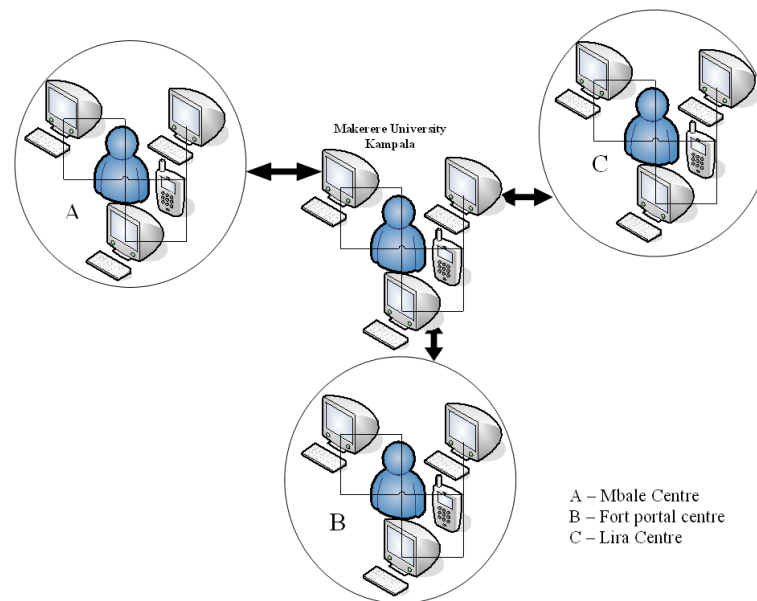


Figure 3.2: Overview of Makerere University and Regional ICT centres

ICT centres are distributed across the country with Mbale centre serving the eastern region, Lira centre serving the northern region, Fort portal centre serving the western region and Makerere University main campus serving the central region. However, the ICT centres in the country are very few and much less equipped, making students still not have access to the services at

the centres as expected.



Figure 3.3: Students using computers at Makerere University ICT centre

3.2 BED Programme

3.2.1 Overview

Makerere University's B.Ed. (External) programme is specifically developed for upgrading teachers to the bachelor's level. The programme admits grade V³ teachers who are to be upgraded to the bachelor's level and runs for three academic years. The programme is the largest distance education programme for the teachers in the country with a total enrollment of nearly 705 students per year since 1998.

The majority of the teachers who come for this programme are teaching in schools. The programme is run without teaching practice which is typical of teacher education program, this is because of the category of students that

³Grade V teachers are teachers who have acquired Grade V certificate in teacher education as per Ugandan system of education(see Table 3.1 for an overview)

the department admits. The programme admits grade V teachers who not only teach in schools, but also have done teaching practice in their earlier diploma training.

The lecturers/tutors on this programme also teach in the regular teacher education programme. However, the tutors are oriented on how to teach teacher education students who are not usually available like the regular students. The department of distance education organises workshops for the lecturers/tutors to learn how to write distance learning oriented study materials.

The students on this programme come to the university for face-to-face sessions twice every semester and each session runs for two weeks. During the face-to-face session students are given the course overview and what is expected from the course. They are also given assignments which guide them in the reading for the course since most of the time they are separated from their lecturers/tutors. These assignments encourage them to form discussion groups to discuss the assignments while they are in their schools. Since most of the students are teachers, all the face to face sessions are organized during the holidays of the school calendar.

3.2.2 Collaborating Faculty

A collaborating faculty is a one of the faculties in the university which, in collaboration with department of distance education, runs the distance learning course. The department of distance education runs its programme in collaboration with the collaborating faculty. The BED programme is run in collaboration with the School of Education. The collaborating faculty is responsible for the academic component and the department of distance education takes the distance education expertise.

3.2.3 BED Organisational Structure

The organisation structure is sketched in figure 3.4 and 3.5 for administrators and students, respectively. This structure omits the top university adminis-

Category	Age levels	Number of years	Description
Primary	6 - 12	7	Primary education lasts for seven years, leading to the Primary School Leaving Certificate.
Lower Secondary	13 - 16	4	Lower secondary education lasts for four years, leading to the Uganda Certificate of Education.
Upper secondary	17 - 18	2	Upper secondary education lasts for two years, leading to the Uganda Advanced Certificate of Education.
Grade III teachers	17 - 18	2	Grade III teacher education lasts two years of study after completing four years of lower secondary education. Students are trained to teach lower primary schools and their course leads to the Grade III Teachers Certificate.
Grade V teachers		3	From Grade III teachers you upgrade directly to Grade V teachers by studying three years and qualify for a Grade V teachers certificate. Grade IV teacher education was removed after some time. Holders, of the Uganda certificate of Education can also be trained as Grade V teachers and their training lasts for two years.

Table 3.1: Summary of Ugandan education system [55]

trators like Vice chancellor, Director and presents the people who are directly all the time collaborating with the BED students. We will begin by elaborating on the roles of each category by levels starting from the top, i.e. year I coordinator, year II coordinator and year III coordinator will be taken as year coordinators since they do similar roles. The roles of each are elaborated in Table 3.3 below.

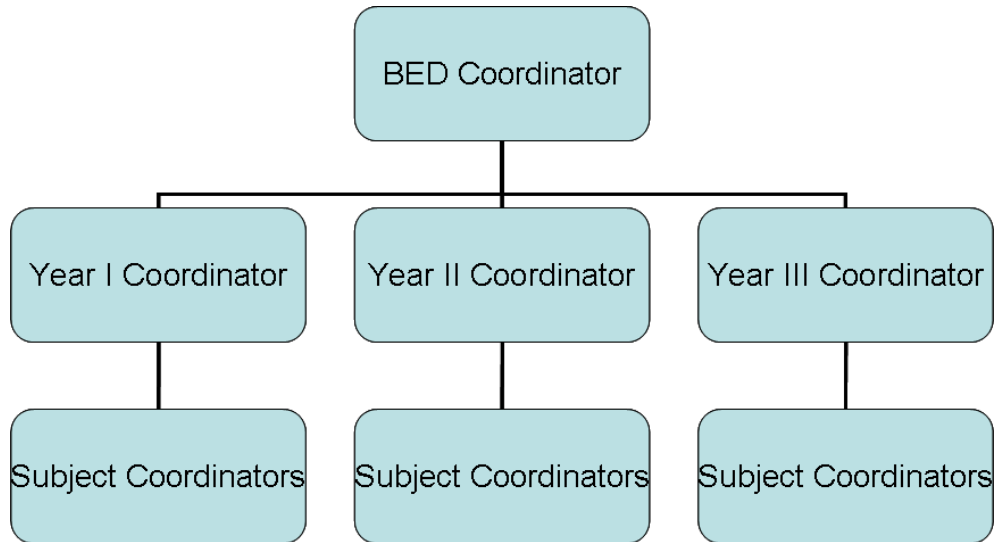


Figure 3.4: Administration structure for BED

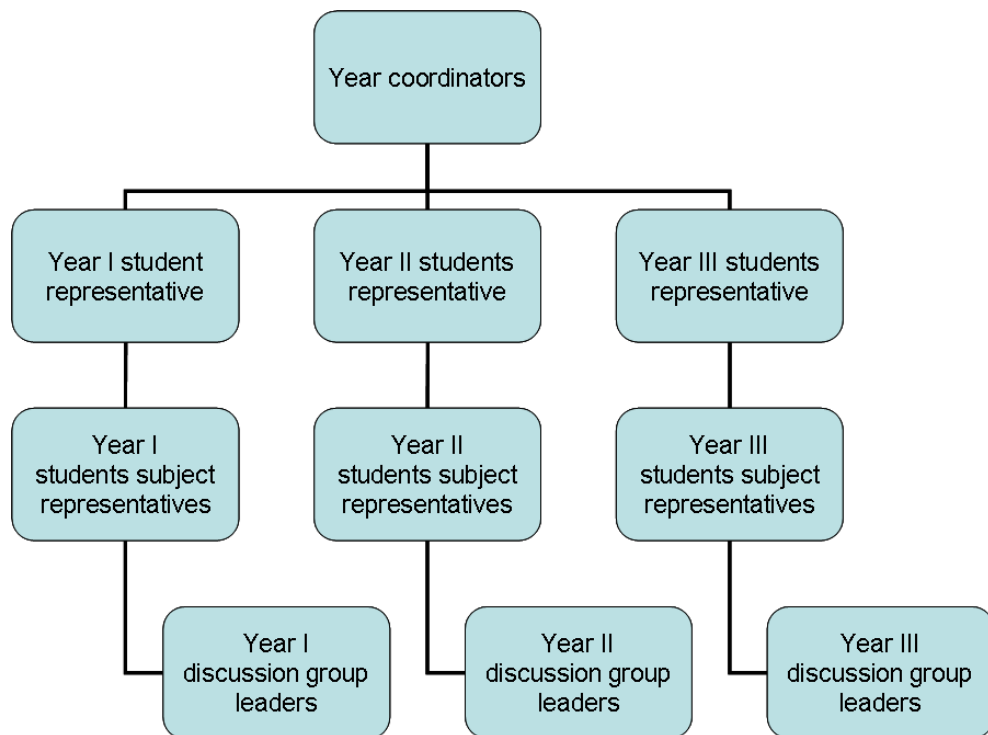


Figure 3.5: BED student representatives structure

Category	Role description
BED coordinator	He/she oversees the running of the BED programme. He/she draws the year planner for the programme showing the dates when students will be coming for face-to-face session, exams and upcountry face-to-face sessions.
Year coordinators	They are always in charge of particular academic years. They take charge of organising face-to-face sessions for their particular years, by looking for venues for the lectures or exams. They organise exam results for the students of the year they coordinate. Year coordinators always coordinate students from first year to third year, i.e. if year coordinator X gets students in the first year, he continues with them until they finish.
Subject coordinators	They are always from the collaborating faculty, see section 3.2.2. A subject coordinator looks for the lecturers who will teach in particular subject. Together with the year coordinator, he/she makes timetables for a particular semester and assigns lecturers with the right expertise in the subject. Acts as a link between the department and the collaborating faculty.
Lecturers/tutors	Lecturers participate in teaching students or guiding them and marking both exams and assignments.

Table 3.2: Roles of BED administrators

Category	Role description
Year students representatives	Since there are three academic years running at the same time, i.e. first year, second year and third year, each year has a year student representative. They represent students of particular years in the departmental planning meeting and voice the students' needs to the department of distance education administration.
Year student subject representatives	These represent the students in class since the year student representative may not be taking all the subjects. They report to the year student representatives during student meetings and help the department get feedback on how lectures are going.
Year student discussion group leaders	They are elected from the regions where they come from to help their peers to communicate with the department on their behalf and organise discussion meetings with their peers. The students select their leaders to coordinate their meetings upcountry where they come from. Since each region has many students taking different subjects, year student discussion group leaders can be very many in one region.

Table 3.3: Roles of BED Student representatives

CHAPTER 4

RESULTS

In this chapter we present the results obtained from the interview and observation with BED students. We look specifically on the discussion groups, their characteristics, the way they are formed and sustained.

4.1 Discussion Groups

From the information we gathered, we shall define a discussion group in our case as:

”group of BED students who work together collaboratively to solve a common task basically through the use of assignments or preparation for exams”

The general role of the discussion groups is to foster learning since students are not always at the University. Therefore discussion groups help them to discuss the different areas of the course.

BED students are not always at the University but only come to the university twice in a semester for two weeks. Therefore, because of the need for the students to continue working on their course material even when they are not at the university, the lecturers give them assignments which help to guide the students to form discussion groups to solve the problems, hence learning.

Currently the size of the discussion groups differs from region to region and course to course. If the course is, say, a core course which is mandatory in that it is done by everyone, the numbers can range from 15 to 60 students depending on the region. However, for courses which are elective, the numbers range from 1 to 60 students. In the central region which has very many students for core courses students still have small discussion groups with numbers ranging from 4 to 15.

4.2 Characteristics of discussion groups

From the interviews we have been able to identify two main types of discussion groups. These types were arrived at depending on their size and what happens in the discussion groups e.g. assignment and general discussion groups. Assignment discussion groups are created in order to solve the assignment task and the group members range from 5 to 10 students. While general discussion groups are created with the aim of solving the problems of syllabus tasks or going through the past exam questions and the group members range from 1 to 60 students depending on the regions. The two different cases are elaborated in section 4.3 and 4.4.

4.3 Assignment discussion groups

These groups are generally small groups organised to do an assignment. Because assignments are worked out in a group of 5 to 10 students, these groups are therefore formed to get solution of the assignment. The assignment itself has many tasks which are divided up among group members who work in collaboration with each other. After each student in the group has worked on her/his assignment task, the students meet and each student goes through their tasks, which helps them to get feedback to improve on what they have done. Thereafter one of the students is given the responsibility to write or type the assignment solution depending on whether the lecturer needs a hand-written or typed assignment solution. Since the students hand in one assignment, one student is given the responsibility to hand in the assignment. At hand in the department tells all students to make copies of their assignments which are stamped with a date on them so that the student stays with one copy of the assignment. This helps students in cases of problems of lost assignments, they can bring their stamped assignment for marking. Besides, it also helps the other students to be confident that the group member sent to hand in the assignment did so. After the assignment is marked, students get feedback of the assignment as shown in the sections 4.3.2. This helps them to understand better the subject area and write well the exam.

4.3.1 Assignment discussion group workflow

Figure 4.1 shows the work flow of assignment from the time the lecturer gives out the assignment questions to the time the students write the exams. This shows one case of assignment; however, the students have many courses and sometimes each subject course might have many assignments. In this model the formation process only happens in first years of study, but when the students know each other later in the course, there is no need of the formation of these groups. Unlike in general discussion groups, group formation in assignment groups is simple since students can just talk to each other in class given that the numbers are small. Since in this project we are looking at discussion groups, the dotted triangle shows the assignment discussion group, from the formation to when the assignment is delivered.

4.3.2 Assignments

Assignments are used as both assessment and learning tools. Most assignments are given to students and required to be done in groups of between 5 and 10 students. Because the assignments are intended to encourage students to form discussion groups, each group hands in one assignment.

The assignments and the feedback got from the students act as correspondence tutoring where comments are written in the students' assignments which the student uses to improve on his/her knowledge about the subject area. The lecturers write comments in the assignments which help the students to learn from them or motivate them to work hard. Figure 4.2 shows a general comment from the lecturer on one of the assignments of the student discussion group, that is to say:

Good essay. However, the discussion tends to ignore non school content.

This general comment encourages the students but also informs them about the need to look at non-school content.

Figure 4.3 shows a specific comment which says:

bright point but required you to show how.

This comment was put against a particular paragraph in the assignment, which both encourages and educates the students lacking parts of the point.

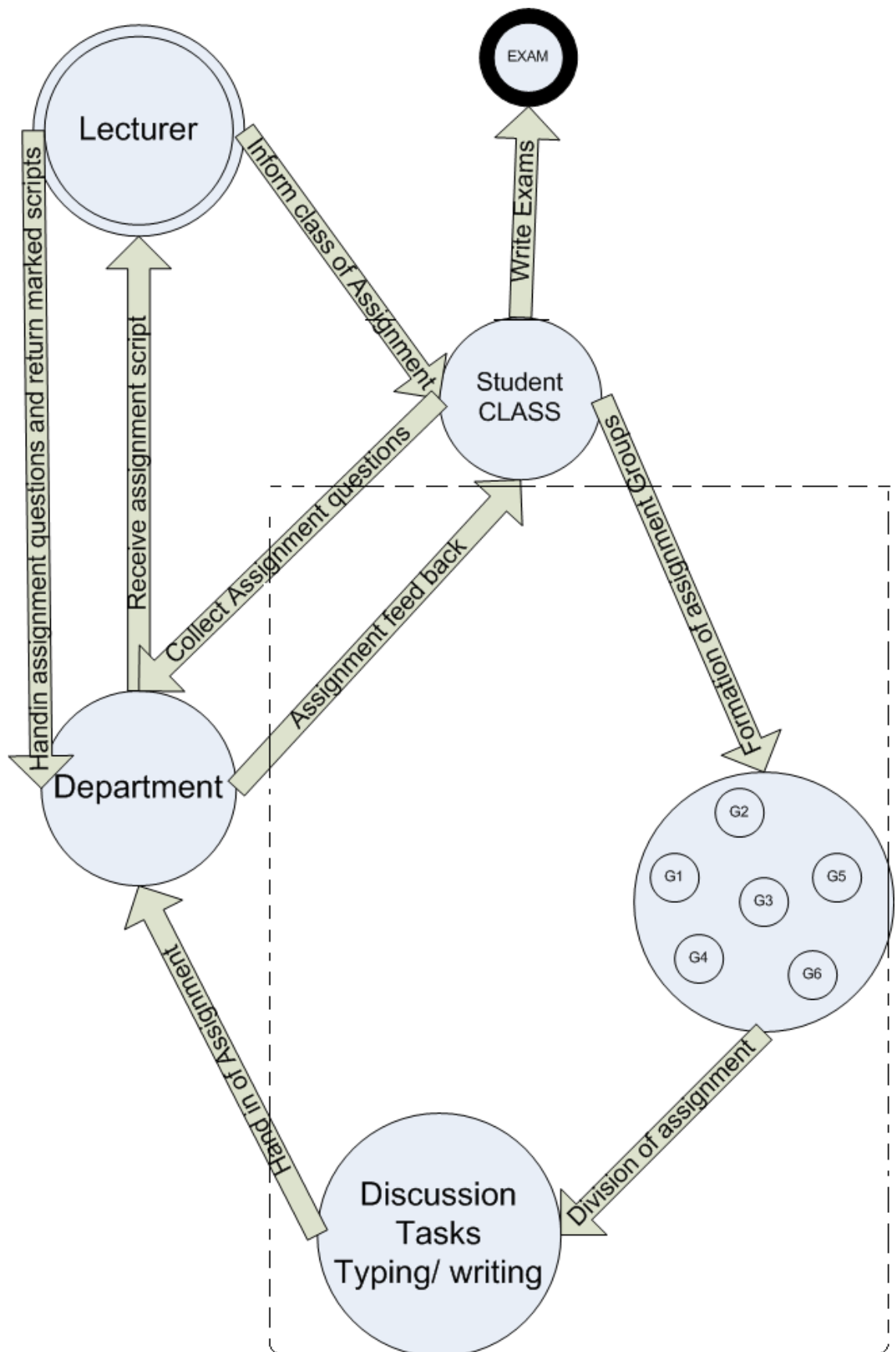


Figure 4.1: Assignment discussion group Workflow

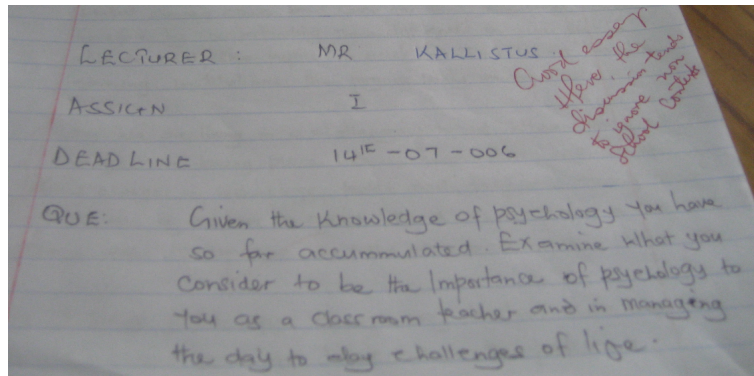


Figure 4.2: General comment on student discussion group assignment

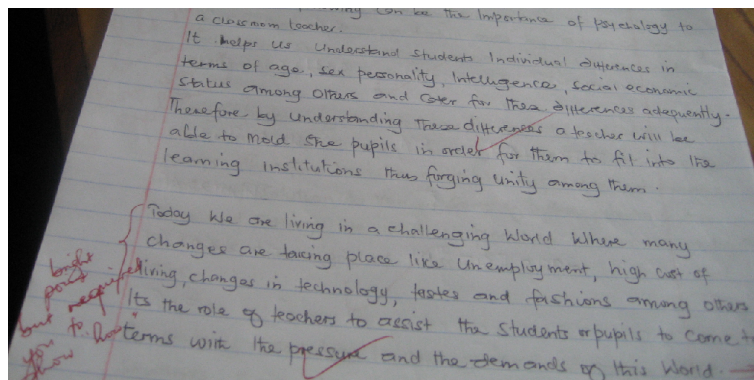


Figure 4.3: Specific comment on student discussion group assignment

4.4 General discussion groups

These groups are generally large groups organised to prepare for exams by using the course outline to go through past exam questions and sometimes going through different topics in the syllabus.

... we normally consider a number of approaches. We look at the course outline which guides us when going through related questions. But sometimes we also go through the syllabus.

In these two particular cases, when the students are dealing with past exams or going through the syllabus, the collaboration differs. For the case when dealing with past exams, though the students don't get feedback about their answers, they have some concrete outcome they expect at the end of solving these questions, like getting answers for the past exam questions. Though this case is similar to assignment discussion group in that they are working out solutions for questions, because of the sizes the collaboration patterns that go in both differ and assignments have deadlines which the exam question solving case does not have. (In assignments you have a deliverable which is not the case of exam question solving). Each student is assigned a question from a question paper before so that he/she prepares to discuss it with the other group members. However, during the discussion the students in attendance can ask the student presenting and even refuse what he discusses in case they think otherwise. For the case when dealing with topics in the syllabus one student who has more knowledge and has understood well that topic goes through the topic while others listen and ask him questions which prompt discussions.

4.4.1 General discussion group work flow

Figure 4.4 shows the work flow of the activity of the general discussion group from the time the lecturer starts the lectures to the time the students write the exams. This shows one course; however, the students have many courses and for each course they have general discussion groups. In this work flow given that the numbers are large, the formation process is dynamic. However, it only happens with first year students. But still given that the students are many in general discussion groups, the joining and leaving by the students in the groups is dynamic.

4.4.2 Creation of Discussion groups

During the interview with the administrators, they acknowledged that the department only encourages the formation of discussion groups by telling them to know their neighbors during the face-to-face session [3]. The administrators give the benefits of discussion groups in the course they are going to

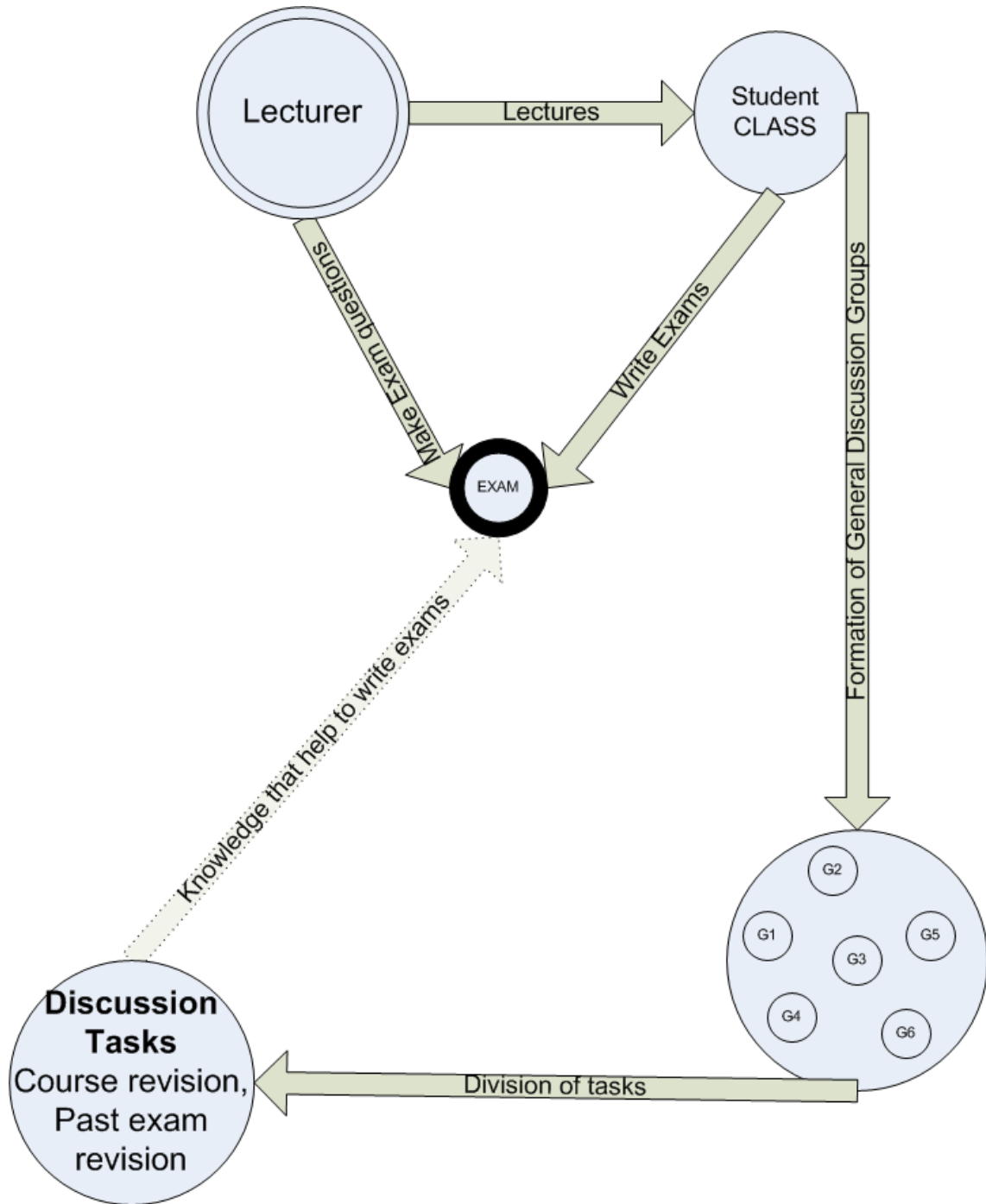


Figure 4.4: General discussion group Work flow

take given that it is a distance learning course. Also, the lecturers, when giving assignments, recommend students to hand in the assignments in groups, which encourages the students to form groups to work on the assignments together. These assignments are out of class assignments and usually long term assignments with the objective to prompt the students to read more about the course since these students are only at the university twice for two weeks in a semester, not all the course content is covered in that time, hence the need to give prompting assignments.

The BED students, during the interview, said that they had many discussion groups depending on the subjects you are taking in a particular semester

... in fact we have a number of discussion groups depending on the courses you are taking in a given semester say Literature, History, CRE etc form their discussion groups. There are also general discussion groups for courses that are done by every student

This means one student can belong to several discussion groups, which sometimes becomes a challenge when at some time a student takes an elective course no other students are taking and in this course he/she is alone. The students also find problems in cases where they have retakes¹ in some subjects and they have to be in groups with other classmates.

The interviewees also said that the students were from different schools in their regions. However, because of being far from each other, meeting regularly is expensive for them.

4.5 Discussion meetings

The organisation of discussion groups differs depending on whether it is an assignment discussion group or general discussion group as early elaborated. For the assignment discussion groups, students meet as long as they have an assignment to hand in. However, students upcountry, because of the cost of traveling (especially if the students in that group come from different schools), meet once or twice. But if the students are from the same schools or schools that are so close to each other, then they meet more times.

¹Attending lectures and preparing for an examination with another group of students who are below you by class level.

... the small discussion that we have we some times do it dairy because we are close to each other or from the same school. Now after face to face we call each other once in a while over the weekend and meet for a major regional discussion. Most especially students from Tororo, Kumi, Soroti, Pallisa, Busia and Mbale meet in Mbale for the discussion

During the meeting each student goes through her/his task which they then combine and form one assignment for handing in. As for general discussion groups, meetings don't happen very often because of the cost of traveling to the centre. The students usually come from different schools since they are always many. Fred when asked about the how regularly they meet he said

Not so often because it has some financial constraints of transporting ourselves to where the discussion will be

During the interview we asked students how regularly they meet for the discussion in the discussion groups. A student in the central region responded that they meet three times in a week while that in the western region responded that they don't meet regularly because of the costs. This difference might be caused by the sparse distribution of the schools in which these students teach in the western region, compared to schools in the central region.

When we asked the students what they do when they can not attend a meeting, they responded that they communicate to the group members through members who come close to them. Though it is sometimes supposed to be communicated through the discussion group leader, some students communicate through their closest friends in the group most especially those who come nearest to them. For the students who come after they have missed the previous meeting, the group avoids wasting time to go through all that they did previously, by requesting one of the group members to help them at any other time, but not during the discussion group.

Discussion group leader is elected by the group to help in organising meetings, venues and dates. However, because students only meeting during face then they also decide on the dates when they are in groups and leave the leader with only venues but he can still inform them in cases of change in date or venue.

... before we leave after the face to face we have to talk and find the dates when we should meet. Then the discussion group leader arranges the venue and the time.

... as we conclude our discussion we normally give ourselves a program for when we shall meet next but however, if there are any changes we call each other.

4.6 Technologies used

As was reported in autumn 2006 project[3], there is less usage of ICT and internet by the BED students. Even if there is a big usage of the mobile phone, but still there is low usage of the services of the mobile phone. However, during the interview students acknowledged the importance of email, the reason being that they can express their questions well.

... ideally the email would be the best to use for collaboration because it takes large text unlike SMS but students don't use or have these services on their phones.

Though they use the phone for calling and SMS each other about the on going activities in the discussion group, there is still a problem of the cost. Since they acknowledge the importance of email, we asked them about the possibility of sending email using their mobile phones and most of them said that they were not aware if the mobile phones can be used to send email.

... that functionality may be there but it is still new and most of us don't know about it. We also buy phones that are less costly meaning that they don't support email functions

However, still they also have some problem of limited content which has already been expressed by the students.

Though there is acknowledged benefit of emails by the students we interviewed, internet access is still a problem to many BED students as shown in the autumn 2006 report[3]. Students also outlined a few ways in which mobile phones help them among them was locating thier colleagues, reminding each other and appointments.

... the way mobile phones are helping us now that we have come for face to face like this is to locate our colleagues by calling or "beeping"² or sending SMS. Maybe

²This is a common means by most students to initiate a call and when the phone goes through on the receivers end before the other person picks the calling student terminates the call. The reason is to remind the other person about a meeting or that they are waiting

we are all at Makerere and we can not see each other then you send an SMS saying "am at the Department where are you?" It also helps us when you have made a programme with some one and in case he/she delays you just beep him to remind him to come fast. At times when you come to the university for say a face to face or exams and one of your colleagues is not available may be because he for got or he did not get a communication from the department then we call him asking him "I have not seen you at the face-to-face session and yet we are starting exams tomorrow" Then he/she will come over

However, we think that since many students have access to mobile phones, we can suggest solutions that can facilitate discussion groups.

4.7 Mobility of students

The students are distributed all over the country. However, they are located near the school in which they teach. During face-to-face session and group discussion they have to travel from their homes to Makerere University and discussion meeting places respectively. Figure 4.5 shows an overview of the different places where BED students might be located.

We come from different parts of the region

The students are distributed and mobile since they come from different regions of the country.

During a face-to-face session, we observed that students were highly mobile as they moved from notice boards, lectures, discussion group meetings and where they slept. Figure 4.6 shows students at the departmental notice board during face-to-face session and Figure 4.7 shows students in the class attending a lecture.

The students are also highly mobile at their schools where they teach as they have to move from the staff room, notice board and different lessons throughout the working day.

for him/her. Some times they use it to make other people call them back in cases where they dont have enough credit on their mobile phones.

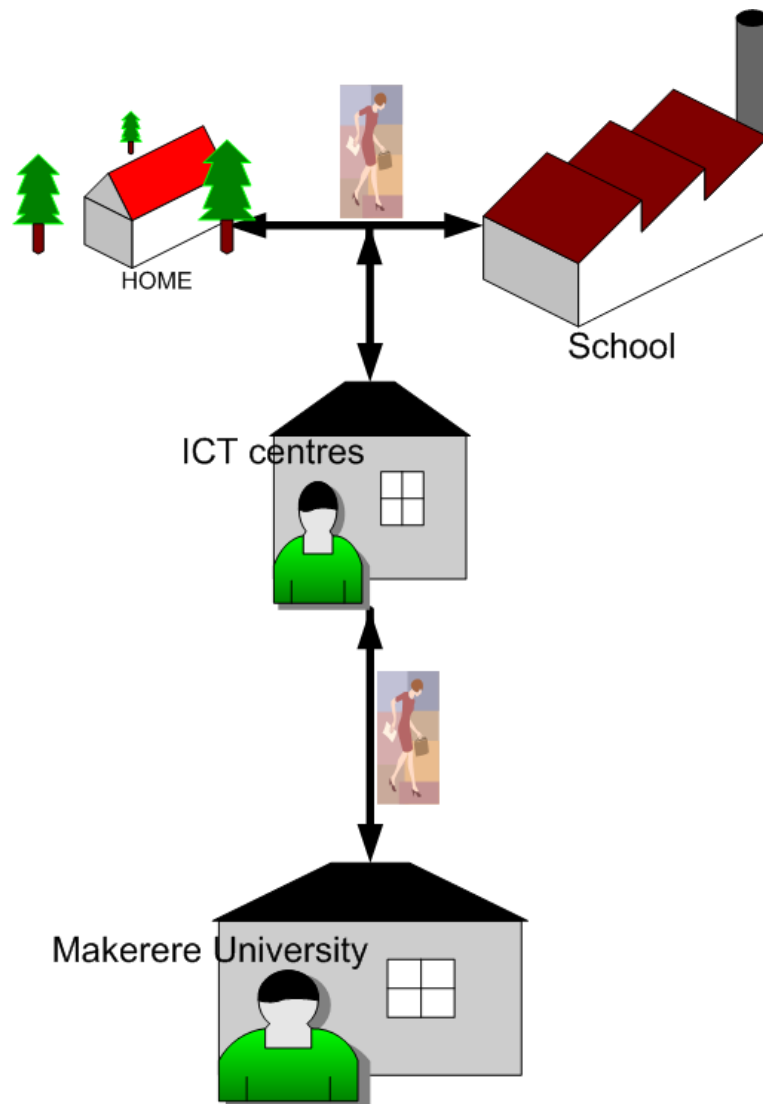


Figure 4.5: The different places where the BED students belong



Figure 4.6: BED students at the notice board reading examination time tables



Figure 4.7: Students attending lectures

CHAPTER 5

ANALYSIS

In this chapter we present the analysis in form of scenarios in order to understand better how discussion groups are created and sustained. From the interviews we characterised the discussion groups in two types as presented in the previous chapter. In this chapter we are going to focus on the general discussion group type. The scenario is based on the large groups alone. The reason why we opted for the large groups is that, as research has shown, large groups can easily be supported with technology, compared to small groups.

5.1 Scenarios

In this scenario we opted for the general discussion group type, since when dealing with large groups, the procedures and mechanisms are very complex hence need to use technology to support them and also students in general groups are more sparse from each other hence need to support them while they are mobile. These are scenarios without technology support based on the results collected.

5.1.1 Scenario 1: Markus decides to start a new discussion group

Markus knows that the best time to get all students he needs to form a discussion group is during a face-to-face session at Makerere University. However, he knows still that it is hard to get all students from the region where he comes from. He then waits until the students meet in the class for that particular course he wants to start a new discussion group. Before the lecture starts, he requests the lecturer or through the class leaders to help him announce that he needs to talk to the class when the lecture ends. At the end of the lecture he is allowed to announce, where he calls upon all the students who come

from the eastern region where he lives to meet with an aim of forming a discussion group, reminding them about the advantages as already talked about in orientation weeks. The eastern region where he comes from encompasses students from the districts of Mbale, Tororo, Pallisa, Kumi, Kapchorwa and Soroti. Then 56 students meet after the lecture under a tree since they can not get a free lecture room as the one they were having is going to be used by another class. During the meeting they elect the leaders, discuss how to meet and the venues of the discussion group. They also take the details of each group member so that in case they need to communicate with them, they can do so through the information given. Among the information collected is their telephone number, email, schools where they teach and districts. The lists are kept into a file folder by the discussion group leader who always adds new members and removes members that leave from the list. The file folders are available for students at the department of distance education.

Challenges

Markus faces a lot of challenges during the creation of the group because of the level of complexity which is caused by the number of students, which is typical of distance learning programmes in developing countries and the world over. The scenario looks at when the students are at Makerere University for a face-to-face session but it can be extremely a big challenge when Markus wants to form a discussion group when students are in their upcountry homes, given that the students are sparsely located and mobile in the regions where they come from. Another challenge is the way to manage the complexity of the lists in the files. Since updates of adding and deleting discussion group members are supposed to be done by the discussion group leader, it is a challenge because of its complexity. Sometimes he can forget or fail to update or delete, joining or leaving discussion group members respectively.

5.1.2 Scenario 2: Markus decides to join an existing discussion group during face-to-face session at Makerere University

For this scenario, Markus wants to join the discussion group and it's during the face-to-face session at Makerere university. Given that during face-to-face session there are many students who are mobile and very much sparsely located, since the University is large, he waits until during the lecture of a

particular course. In the lecture he will either talk to the students he already knows from his region or ask the lecturer to announce so that Markus gets to know the discussion group leader of the eastern region where he comes from, so that he can talk to him/her after the lecture about joining the discussion group. So at the end of the lecture the lecturer announces for him. He then meets the eastern region discussion group leader after the lecture. The discussion group leader briefly informs him about the discussion group meetings, venues and dates when they will meet next. Markus writes all the details in his note book just to know the details if there is need to call or contact any one. But however, during their meeting the discussion group leader informally tells him the discussion group members who come from close to him. This causes him to be more inquisitive on knowing these members. He realises that one of the members the discussion group leader has mentioned teaches in the school next to his. The leader then informs him the importance of knowing the closest discussion group members since they can help give him more information about the discussion group. The discussion group leader writes down the details about Markus in his/her note book so that he/she can include Markus on the list and put it in the file folder. Then he attends his first discussion with the other discussion group members.

Challenges

From the scenario above you realise that Markus goes through a lot of complex procedures of knowing the discussion group leader, as earlier mentioned about the problems caused due to the complexity of the management of the student list. Since the discussion group leader was not able to update his list on the spot but wrote the details in his/her note book, hoping to transfer the information later when he gets to the file which contains the list, there is a problem that he can forget to update the lists or even misplace his note book hence having wrong information in the lists. This manual procedures also create a lot of work on the side of the discussion student leader and yet he also needs time to prepare for the course.

5.1.3 Scenario 3: Markus decides to join an existing discussion group during the time he is upcountry in Mbale

At this time Markus is at his upcountry place in Mbale and he would like to join an existing discussion group. However, all discussion group leaders are

encouraged to register with the department of distance education, specifically with student support section. If he comes from a school where he is the only one who takes the course and since the department has information about the discussion group leader, then he calls the department of distance education to give him the details of the discussion group leader in his region. This enables him to call the group leader to give him information on the next group meeting and the venue. Because of the cost of calling, he takes little time talking to the group leader. He then attends his first group discussion with the group. In the meeting he gets to know the people who are closest to him in the place where he works.

Challenges

From scenario 3 above you realise that Markus goes through a lot of complex procedures of knowing the discussion group leader since he has to call the Department of Distance Education. Markus might like joining a discussion group any day or time, but he cannot communicate to the department on any day or time since the department does not open over the weekend, besides he cannot call after working time. This creates a hindrance or limitation of the time and day when to communicate with department. Given that the students are teaching during the day, they may also get time in the evenings or during the weekends when the department is not functional making it difficult for distance learning students. At the same time, this problem does not only occur with respect to calling the department, but also it might be difficult to call your discussion group leader very late.

5.1.4 Scenario 4: Markus cannot attend a meeting

Because of some reason, Markus cannot attend the next discussion meeting. He calls the discussion group leader and informs him that he will not be able to attend the next discussion. However, because at the previous meeting Markus was given a section to discuss. The discussion group leader feels bad because they will lack the input from Markus. He still keeps the section he is supposed to discuss for another meeting. Before the start of the presentation the discussion group leader informs the other group members that Markus will not be able to attend because of some reasons and he will discuss his work the next time he turns up. But after the discussion group leader has informed the group about Markus and because of the high interest in the section Markus was supposed to discuss, they request the discussion group

leader to allow someone else who knows the section to discuss that part. The discussion group members agree and they allow someone else to discuss Markus's section.

Challenges

There is the challenge of the complexity of meeting management. There is need to help in the coordination of discussion group activities before, during and after discussion. As we have seen that when Markus does not come to attend the meeting the other members get to know about his absence during the meeting. This alone can demotivate the other group members most especially when they came with a lot of interest in the section Markus was to discuss. The problem can even become worse when two members supposed to discuss key sections don't turn up or even made much worse if every member does not come, which might call for canceling the meeting, yet the students spend money to come for the meeting. Even if they select another person to go through the part Markus was supposed to present, this person needs time, so informing them earlier would be fine.

5.1.5 Scenario 5: Markus attends meeting after missing the previous one

When Markus turns up for a meeting when he missed the previous meeting even before the meeting starts he tries to ask the other group members what they discussed, so that he gets an overview of what went on. Because usually different group members are assigned sections to discuss, he asks the specific members just before the discussion starts to get to know most of the section he wanted most. When the discussion starts, depending on whether his section was discussed while he was away or not, he discusses the part that he was supposed to discuss. And thereafter the discussion continues with what they agreed on in the previous discussion meeting which he missed.

Challenges

There is need to understand better the way meetings are organised, taking into consideration members missing certain meetings and the way they can learn what the others discussed in their absence. Since what is discussed is not written as a group, every member is left to summarize what they discuss

in the way they understand. It creates a problem for a member who misses a meeting and comes in the next one since there is no organised way of keeping the proceedings of the meeting as every one tries to note in his own way, the way he understands what the person presenting is saying. In fact it makes it worse when some students don't make written presentation but just come with summarised notes to present to the other members.

5.1.6 Scenario 6: Markus is part of a discussion group participating as a member

Markus is in a group of 53 students participating in a General discussion group. When he arrives for the discussion, he sits and pulls out his note book. In his note book he has the names of the topics of the members going to discuss. Today he is not going to discuss any particular topic but he will participate in asking questions during the discussion. However, before the discussion starts he does a lot of informal communication with the peers. Shortly the discussion group leader calls for order for the discussion to start and Markus takes his seat. In front of Markus is a notebook and a pen which he will use to write the key points as one of the members talks. The person discussing a given topic uses the black board and a piece of chalk to illustrate what he is talking about, and he always carries what he discusses on a piece of paper which he reads through during the discussion. During the discussion a neighbor asks Markus to help him clarify on some point the member discussing said. But because Markus needs more concentration on what the person discussing is saying and also knows once he answers his/her neighbor he misses what the presenter will say next, he interrupts the discussion and requests the person discussing to listen to the question from a member and answer it. Markus's neighbor then asks the presenter, who promptly answers him. The answer given makes Markus understand better the concept the presenter has explained. After the answer, the presentation continues; however, he encounters something he does not understand, asks for clarification which develops into a collaborative argument between the members until the discussion group leader intervenes and says, "we take note of that and we shall ask the tutor so that we can continue". However, Markus continues to take notes while the discussion continues. After all the other members of the discussion have finished their presentations, the discussion group members decide when and where the next meeting will take place. When they finalise with the venues and dates, he takes notes in his note book. However, when all this is finished there is a lot of informal communication

where the members try to ask the particular students who discussed to get more clarity, and they also share experience about their schools.

Challenges

As we have realised above, there is a lot of both formal and informal communication which goes on before, during and after the discussion. Here we learn that there is a lot of unplanned collaboration among the students. This shows that the groups here are loosely coupled discussion groups which don't have tight coupled collaboration. However, this in its own making is very challenging, most especially before and after the meeting since sometimes students are mobile.

5.1.7 Scenario 7: Markus is appointed leader for the discussion group

Markus is elected as the discussion group leader. He leads the discussion in suggesting the dates when the next discussion will take place. Meanwhile because he is busy leading the meeting he requests one of the group members to write down what is being discussed and agreed upon. Because they can not know the venue of the next meeting, he informs the group that he will inform them of the venue. Meanwhile, as the meeting is going on, he informs the members that he is passing a piece of paper around to get the details of everybody and on this sheet they are supposed to register their names, schools where they teach and telephone numbers, as shown in the figure 5.1 below.

Challenges

The biggest challenge in this scenario is to manage the complexity of the user lists in the file and coordination of the discussion meeting by the discussion group leader. Since the discussion group leader is responsible for arranging meetings, venues and then communicate to the other members in case of the cancellation of the meeting, this in itself is a challenge to the leader mostly given that the members are mobile.

SS / SST	Ms. BIRUNGI Zoom	03/0/2868/Ext	077561773	KAMPALA
LE / ELS	Mr. NSUBUGA Charles	03/0/3192/Ext	071-833375	KAMPALA
GC / GEOGRAPHY	Ms. AZAIKWE Luwence	03/0/2859/Ext	-	WAKISO
HISTORY	Ms. ASHABANEWA T. Africa	03/0/2842/Ext	-	NTUNGGAMO
MATH	Mr. NALUWAYIRO David	03/0/3145/Ext	077631487	KAMPALA
KISWAHILI	Mr. TUMUSIME Christoph	03/0/3112/Ext	077598165	BUSHEBYI
LUBANDA	Ms. KUBONAKU Evelyn	03/0/1/Ext	071982916	MUKONO
LITERATURE	Mr. AGUME Robert	03/0/2821/Ext	077398693	KABALE
F/ART	Mr. KUSOLO Charles	03/0/3030/Ext	071833336	KAMPALA
REL. STUDIES	Ms. KYAZIKE Aida Chirike	03/0/3034/Ext	077397601	WAKISO
FED.	Ms. BAKUBANANA Jane	03/0/1/Ext	077361707	KAMPALA
BUS. (SEC STUDIES)	Ms. NANSASI Oliver	03/0/3170/Ext	075892371	MUSENDE

Figure 5.1: Students registration list

5.2 Scenario review

Based on the scenarios, we elaborate on four different components which we identified from the scenarios, i.e. group management, coordination, communication, and collaboration.

5.3 Groups involved in the process

Based on the scenarios above, we identify three groups involved in the process. In a discussion group are discussion group leader, discussion group member and department of distance education administrator. However, there are only two major groups involved in the process since the department of distance education administrators use the application in a very small way.

However, the major users are the discussion group members and leaders since they will use the system more frequently. The focus here is on discussion groups which are majorly managed by the students themselves. The other user also would be very important in the usage of the system. The department of distance education administrators will use it in searching information about the students and discussion groups.

5.4 Group Management

From scenario 1 we identified group creation as being very important since it involves complex procedures. Given that these students are mobile and not always together, this calls for the need to support group creation for sparsely located students. Scenario 1 also identifies complex student lists which are created and managed by the discussion group leader. The student lists are made the first time the students meet during the creation of the discussion group. The way in which the complex lists are managed by the discussion group leader drives us get solutions to give support to sparsely located and mobile students. And given that most students don't have access to internet as shown in the Autumn report[3], the increased access and usage of mobile phones by the students can call for usage of these tools to support the students. Scenario 2 also shows how the discussion group leader can have complex procedures to update the student lists when new group members join or leave the discussion group. Having mobile solutions to support the mobile students can help students to join or leave discussion groups with ease and hence automatic update of lists which can be easily queried by the students.

As we have already seen, discussion group creation is almost entirely done by the students themselves. The administrators only play a role in encouraging the students on the importance of discussion groups in their course. This is done in the first day of the face-to-face session and it is referred to as orientation. However, in the orientation the administrators don't only talk about the importance of discussion group, but also they talk about the different administrative issues that are relevant to the students during the face-to-face session and after. The encouragements are also given by the lecturers during the lectures, who give them group assignments. This makes them form discussion group assignments, though this is not our emphasis. But it helps them to learn how to work in groups.

You realise that in Scenario 3 when the students are in their upcountry places and yet they need to join an existing group, there is need to get this information from the department of distance education. The discussion student leaders register with the department which puts this information readily available for the BED students. This helps the students to have this information whenever they want it.

There is also need to support the mobility of new members who are joining and leaving a discussion group. As we have seen in scenario 3, students who have to call the department for information about the discussion group leaders are restricted on calling on working hours and yet BED students are

also busy during that time, hence the need to support "any time any place". Also, because of the complexity of the student lists, mobility can help to reduce the work load on the discussion student leader as he is not supposed to mind about the updates of the lists. But since we already know from the results that students can be members of more than one discussion group, this should be supported.

5.5 Coordination

We are already aware that coordination is the act of managing interdependencies between activities. Therefore in the discussion group, there are several activities that go on from the time of its creation to the time it terminates. Most of the coordination activities are done by the discussion group leader who is elected at the start of the discussion group as shown in scenario 1. Based on scenario 7, we find many activities that are coordinated by the discussion group leader, i.e. arranging discussion venues and time, calling for meetings, cancellation of meetings, re-scheduling meetings, sending reminders for meetings and also liaising with the department on behalf of the students. However, the coordination is not only done by the discussion leaders, but also the students send SMS messages to each other, e.g. asking when the next discussion will be held, reminding each other about the next discussion, etc.

There is need to support coordination among the discussion group members since there is a lot of activities that go on between the discussion group members. The procedures of calling for meetings, canceling meetings and re-scheduling meetings can be complex. This needs to be supported. Meeting management is a complex process, as we have seen in scenario 7, as it requires a lot of coordination among students and the discussion group leader.

Also, there is need to support easy passing of information about the group members who will not attend the next meeting. This helps the other members to prepare how to discuss sections for the members who will not come. It also helps the discussion group members to know early about how many people are missing, which can give a general opinion to the discussion group leader to schedule the meeting well in advance.

5.6 Communication

There is a lot of communication among discussion group members that fosters easy coordination and collaboration, as we have seen in the scenarios. The discussion groups support both formal and informal communication, plus the advantages that come with each of them. As we have seen in scenario 6, before the discussion starts and at the end there is a lot of informal communication among the discussion group members. Even those students who take the same bus on their way back have a lot of informal communication. At that time they share experiences of where they work so that they get to understand better how other places operate and how they can improve on theirs. As we have noticed in the scenarios, there are also a lot of formal activities like calling for meetings, cancellation of meetings, etc which require formal communication among the discussion group members. During face-to-face sessions there are also mechanisms that support chance encounters like notice boards and the compound at the department of distance education as shown in figures 5.2 & 5.3.



Figure 5.2: Students at the compound of the department of distance education where they can have chance encounters - one

As we have seen in the preceding chapters, there is a lot of communication among discussion group members. However, because of limited access to internet and the high costs of calling, the discussion group members seldom



Figure 5.3: Students at the compound of the department of distance education where they can have chance encounters - two

use their mobile phones or internet. Though the students are most times distributed, there is limited communication among the students. However, much of the communication is done when the students are together discussing or face-to-face. Communication is a key element in group discussion and helps in collaborative learning. Most of the communication happens for collocated discussion members just because of the high costs of calling. However, distributed discussion members also communicate through the use of SMS but rarely.

Since communication is important in everyday life, especially with respect to discussion groups, there is need for it to be supported. After knowing the importance of communication in both collaboration and coordination in a discussion group and yet effective communication occurs only if the receiver understands the exact information or idea that the sender intended to transmit, then we need to support information to be transmitted without being changed. Knowing that most of the students are distributed, as we have seen in scenarios, there is need to support both asynchronous and synchronous communication, most especially asynchronous communication since the BED students mobile phones are not always available.

5.7 Collaboration

Collaboration patterns define sequences of interaction among members of a group that satisfy established criteria for collaborative behavior. The BED student discussion group satisfies these collaborative patterns because the discussion is made around certain tasks. As we have seen in scenario 6, there is a lot of collaboration that goes on during the discussion among discussion group members and the leader. This collaboration is triggered around what the presenter mentions during the presentation. In scenario 6 when one of the presenter was presenting some concepts that were not clear one of the discussion group members requested clarification of some points which sometimes trigger collaborative argument. As we are already aware, these students are distributed and only meet once in a while and yet as we see in the scenarios there are no sufficient mechanisms that support collaboration for distributed students.

For the students to collaborate well in a discussion group, there is need to support both asynchronous and synchronous collaboration among them. There is also need to have the presentations that are discussed by each presenter to be made available for each of the discussion group members to access at any place and any time. This will help to foster collaboration around the solutions for the section presented and if further it's made available to the lecturer who can give a comment of what they have presented once in a while because it can make a big motivation for students.

CHAPTER 6

DESIGN

In this chapter we present the design of the requirements of our case study. We start by giving the system overview, then we elaborate on the system services in the use cases and then compare the design approaches of loosely coupled groups.

6.1 System services

Here we describe the different services of the demonstrator prototype in form of use cases. We describe the discussion group management, meeting management, presentation management, comment management and search management. Though we don't say much about the discussion via the mobile phone but it is very important. However, we only support students to discuss by sending comments as you can see in comment management. During discussion there is need to have voice over mobile phones though the cost of calling these students is very high.

6.1.1 Discussion group management

Figure 6.1 shows the use case to show the different functionalities in the discussion group management. In this service we identify three use cases, i.e. *group creation*, *join group* and *leave group*. As shown in the scenario, the management of the student lists is very complex and having it automated would solve the problem of the students leader having to worry about updating the students lists.

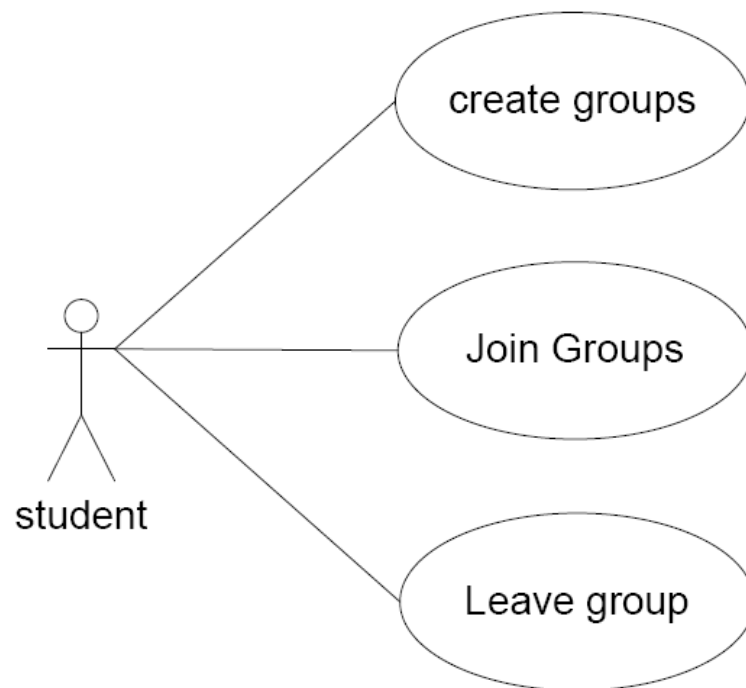


Figure 6.1: Discussion group management

Group creation

Figure 6.2 describes the use case for group creation which gives in detail the process the actor goes through to create a discussion group.

Join group

Figure 6.3 describes the use case for join group which gives in detail the process the actor undergoes through to join a dicussion group.

Leave group

Figure 6.4 describes the use case for leave group which gives in detail the process the actor undergoes to leave a discussion group.

Create Group
Brief description: The actor creates a new discussion group
Actors: Participant
Preconditions: The actor is a registered student
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to create a new group 4. The system guides the actor to fill in required information to create a discussion group 5. The actor selects students to invite to join the discussion group 6. The system acknowledges that a new discussion group is created 7. The actor leaves the system.
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to create a new group <ul style="list-style-type: none"> • The system informs the actor 5a. The system fails to find students from the actor's region <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: There is a new group, Actor is listed as group leader
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.2: Use case description for *create group*

Join Group
Brief description: The actor joins an existing discussion group
Actors: Participant
Preconditions: The actor is a registered student and there is at least one existing discussion group
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to join an existing discussion group 4. The actor is guided by the system to fill in required information to join a group 5. The actor selects a discussion group to join 6. The system acknowledges that the actor joined the discussion group 7. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to the actor to join an existing discussion group <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: The actor is a participant in an existing discussion group
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.3: Use case description for *join group*

Leave Group
Brief description: The actor leave a discussion group
Actors: Participant
Preconditions: The actor is a registered student and member of the discussion group
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to leave a discussion group 4. The actor is guided by the system to specify the discussion group he wants to leave 5. The system acknowledges that the actor left the discussion group 6. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails the actor to leave a discussion group <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: Actor is not member of that discussion group
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.4: Use case description for *leave group*

6.1.2 Meeting management

Figure 6.5 shows the use case to show the different functionalities in the meeting management. In this service we identify three use cases, i.e. *call for meeting*, *reschedule meeting* and *cancel meeting*. We have already identified coordination as an important mechanism to support in discussion groups, since students need to know when and where the meeting will take place, when the meeting is canceled or rescheduled. Below we briefly explain the three use cases identified in meeting management, i.e. *call for meeting*, *reschedule meeting* and *cancel meeting*.

Call for meeting

Figure 6.6 describes the use case for *call for meeting* which gives in detail the process the actor undergoes to call for a meeting.

Reschedule meeting

Figure 6.7 describes the use case for *reschedule meeting* which gives in detail the process the actor undergoes to reschedule a meeting.

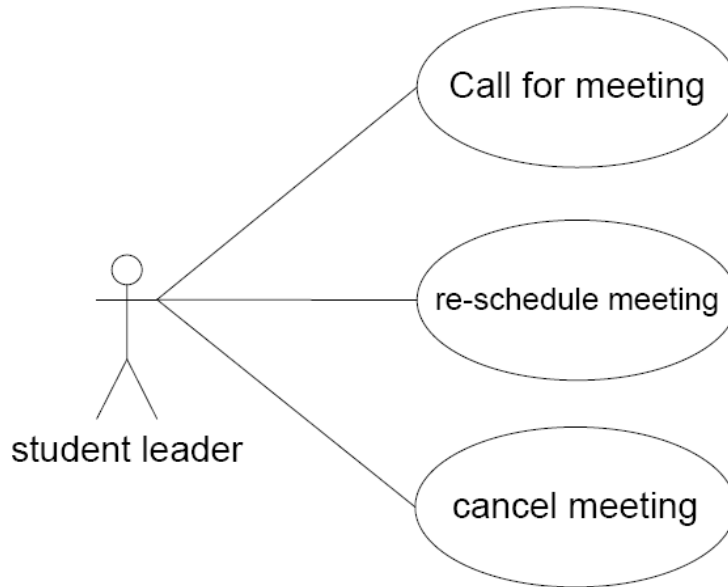


Figure 6.5: Meeting management

Call for Meeting
Brief description: The actor calls for a meeting
Actors: Group leader
Preconditions: The actor is a registered student and leader of a discussion group in which he/she wants to call for a meeting
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to call for a meeting 4. The actor is prompted by the system to fill in the relevant information 5. The actor selects a discussion group to call for the meeting 6. The system sends the message to all discussion group members 7. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to call for a meeting <ul style="list-style-type: none"> • The system informs the actor 6a. The system fails to send messages to the discussion group members <ul style="list-style-type: none"> • The systems informs the actor to try again
Post-conditions: Discussion group members are called for a meeting
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.6: Use case description for *call for meeting*

Re-schedule Meeting
Brief description: The actor re-schedules meeting
Actors: Group leader
Preconditions: The actor is a registered student and leader of a discussion group in which he/she wants to re-schedule meeting
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to re-schedule meeting 4. The actor is guided by the system to fill in required information to re-schedule meeting 5. The system sends a message to all the discussion group members and acknowledges that meeting is re-scheduled 6. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 2a. The system fails to re-schedule meeting <ul style="list-style-type: none"> • The system informs the actor 5a. The system fails to send a message <ul style="list-style-type: none"> • The system informs the actor that message is not sent to try again
Post-conditions: The meeting is re-scheduled
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.7: Use case description for *reschedule meeting*

Cancel meeting

Figure 6.8 describes the use case for *cancel meeting* which gives in detail the process the actor undergoes to cancel a meeting.

6.1.3 Presentation Management

Figure 6.9 shows the use case of the different functionalities in the presentation management. In this service we identify three use cases, i.e. *add presentation*, *edit presentation* and *delete presentation*. As we have seen in chapter 5, the need to store information about the presentation undertaken can help students collaborate on the presentation by sending comments (see section 6.1.4). Presentation management helps in storing information about the presentation and being able to change it where necessary.

Cancel Meeting
Brief description: The actor cancels meeting
Actors: Group leader
Preconditions: The actor is a registered student and leader of a discussion group in which he/she wants to cancel a meeting
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to cancel a meeting 4. The actor is guided by the system to fill in required information to cancel a meeting 5. The system sends a message to the discussion members telling them that the meeting has been cancelled 6. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to cancel meeting <ul style="list-style-type: none"> • The system informs the actor 5a. The system fails to send a message <ul style="list-style-type: none"> • The system informs the actor to try again
Post-conditions: The meeting is cancelled
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

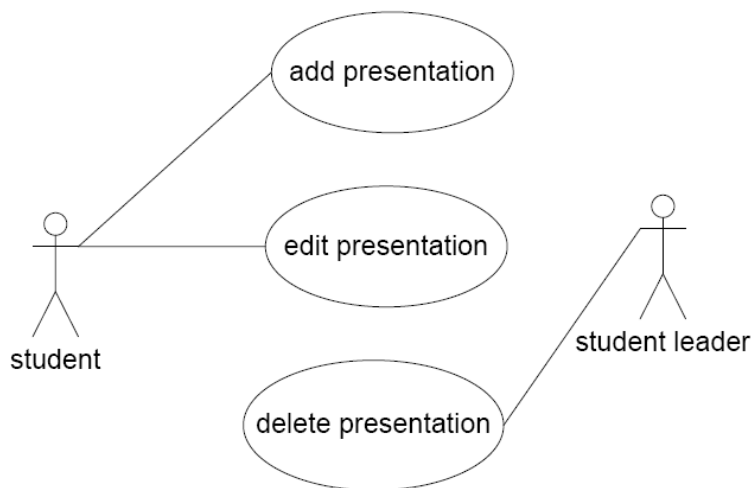
Figure 6.8: Use case description for *cancel meeting*

Figure 6.9: Presentation management

Add presentation

Figure 6.10 describes the use case for *add presentation* which gives in detail the process the actor undergoes to add a presentation.

Add Presentation
Brief description: The actor adds a new presentation
Actors: Participant
Preconditions: The actor is a registered student and member of the discussion group
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to add a presentation 4. The actor is guided by the system to fill in required information to add a presentation 5. The system acknowledges that presentation added 6. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to add presentation <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: There is a new group, Actor is listed as group leader
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.10: Use case description for *add presentation*

Edit presentation

Figure 6.11 describes the use case for *edit presentation* which gives in detail the process the actor undergoes to edit a presentation.

Delete presentation

Figure 6.12 shows the use case for *delete presentation* which describes in detail the actors interaction with the system to delete a presentation.

6.1.4 Comments Management

Figure 6.13 shows the use case for the different functionalities in the comments management. In this service we identify three use cases, i.e. *add*

Edit Presentation
Brief description: The actor edits an existing presentation
Actors: Participant
Preconditions: The actor is a registered student and member of a discussion group
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to edit a presentation 4. The system returns the filled in form with the previous text 5. The actor edits the text 6. The system acknowledges that presentation is edited 7. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to return the filled form with previous text <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: The presentation is edited
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.11: Use case description for *edit presentation*

Delete Presentation
Brief description: The actor deletes a presentation
Actors: Group leader
Preconditions: The actor is a registered student and a discussion group leader
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to delete a presentation 4. The actor is guided by the system to fill in required information to delete a presentation 5. The system acknowledges that presentation deleted 6. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to delete a presentation <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: The presentation is deleted
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.12: Use case description for *delete presentation*

comment, *edit comment* and *delete comment*. Collaboration can be achieved around presentation which prompts students to send comments, hence collaboration around the artifact of the presentation. Comment management helps the students to store comments which can be visited or retrieved through searching for particular comments. However, comments can also be sent about for failure to attend a meeting, when you are in the field and you find something to share with other members and also getting feedback on the experience with teaching practice. The comment section can be used for many aspects like commenting about who presents what, the agenda and finding out about many other issues as they come by in the field.

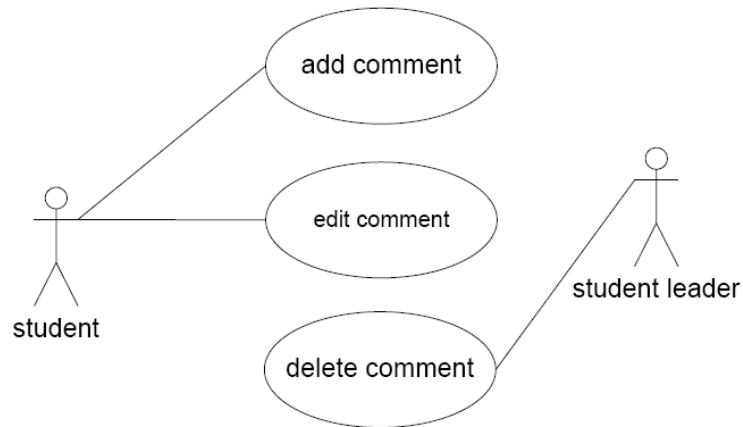


Figure 6.13: Comment management

Add comment

Figure 6.14 describes the use case for *add comment* which describes in detail the actor's interaction with the system to add a comment.

Edit comment

Figure 6.15 describes the use case for *edit comment* which describes in detail the actor's interaction with the system to edit a comment.

Add Comment
Brief description: The actor adds a comment
Actors: Participant
Preconditions: The actor is a registered student
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to add a comment 4. The actor is guided by the system to fill in required information to add a comment 5. The system acknowledges that comment added 6. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to add a comment <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: The new comment is added
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.14: Use case description for *add comment*

Edit Comment
Brief description: The actor edits a comment
Actors: Participant
Preconditions: The actor is a registered student
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to edit a comment 4. The system returns the filled in form with the previous text 5. The actor edits the text 6. The system acknowledges that comment is edited 7. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to return the filled form with previous text <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: The comment is edited
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.15: Use case description for *edit comment*

Delete comment

Figure 6.16 describes the use case for *delete comment* which describes in detail the actors interaction with the system to delete a comment.

Delete Comment
Brief description: The actor deletes a comment
Actors: Group Leader
Preconditions: The actor is a registered student
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to delete a comment 4. The actor is guided by the system to fill in required information to delete a comment 5. The system acknowledges that comment deleted 6. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to delete comment <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: The comment is deleted
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.16: Use case description for *delete comment*

6.1.5 Search Management

Figure 6.17 shows the use case for the different functionalities in the search management. In this service we identify seven use cases, i.e. search student leaders, search students, search group, search close students, search meeting, search comment and search presentation. As we saw in chapter 5, there is for information to be buffered/ stored for access by the students in discussion groups. In scenario 3, when Markus wanted to join an existing group while he was at home, he called the department of distance education to seek information about the discussion group leader in his region. Search management can help discussion group students to access information any time, at any place in order to take right decision.

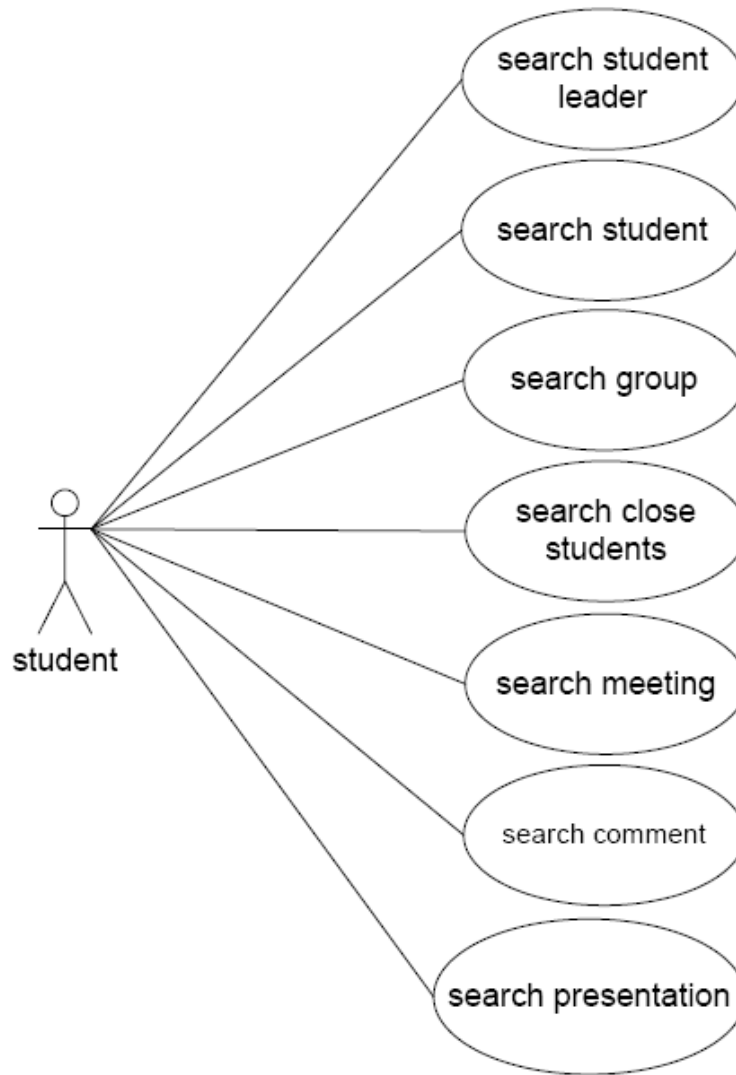


Figure 6.17: Search management

Search student leader

Figure 6.18 describes the use case for *search student leader* which describes in detail the actor's interaction with the system to search for student leader.

Search Student Leader
Brief description: The actor receives results on discussion student leader
Actors: Participant
Preconditions: The actor is a registered student
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to search for student leader 4. The actor is guided by the system to fill the required criteria's to search for student leader 5. The actor receives results for student leader 6. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to search <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: The system outputs results for the search of student leader
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.18: Use case description for *search student leader*

Search student

Figure 6.19 describes the use case for *search student* which describes in detail the actor's interaction with the system to search for student.

Search group

Figure 6.20 describes the use case for *search group* which describes in detail the actor's interaction with the system to search for a discussion group.

Search close student

Figure 6.21 describes the use case for *search close student* which describes in detail the actor's interaction with the system to search for close students.

Search student
Brief description: The actor receives results of students
Actors: Participant
Preconditions: The actor is a registered student
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to search for student 4. The actor is guided by the system to fill the required criteria's to search for student 5. The actor receives results for student 6. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to search <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: The system outputs results for the search of student
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.19: Use case description for *search student*

Search Group
Brief description: The actor receives results on discussion groups
Actors: Participant
Preconditions: The actor is a registered student
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to search for a discussion group 4. The system guides the actor to fill in required criteria's to search for a discussion group 5. The actor receives results of a discussion group 6. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to search <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: The system outputs results for the search of discussion group
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.20: Use case description for *search group*

Search Close Students
Brief description: The actor receives results on close students
Actors: Participant
Preconditions: The actor is a registered student
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to search for close student 4. The actor is guided by the system to fill the required criteria's to search for close student 5. The actor receives results for close student 6. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to search <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: The system outputs results for the search of close student
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.21: Use case description for *search close student*

Search meeting

Figure 6.22 describes the use case for *search meeting* which describes in detail the actor's interaction with the system to search for meetings.

Search comment

Figure 6.23 describes the use case for *search comment* which describes in detail the actor's interaction with the system to search for comments.

Search presentation

Figure 6.24 describes the use case for *search presentation* which describes in detail the actor's interaction with the system to search for presentation.

6.2 Data structures

Figure 6.25 shows the data structures in the entity relationship, as used by the use cases above for the development of the demonstrator prototype. In here we present the different tables that are created in the database. We

Search Meeting
Brief description: The actor receives results on meetings
Actors: Participant
Preconditions: The actor is a registered student
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to search for meeting 4. The actor is guided by the system to fill the required criteria's to search for meeting 5. The actor receives results for meeting 6. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to search <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: The system outputs results for the search of meeting
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.22: Use case description for *search meeting*

Search Comment
Brief description: The actor receives results on comments
Actors: Participant
Preconditions: The actor is a registered student
Basic flow of events: <ol style="list-style-type: none"> 1. The actor logs into the system 2. The system authenticates the actor and starts a session 3. The actor chooses to search for comment 4. The actor is guided by the system to fill the required criteria's to search for comment 5. The actor receives results for the comment 6. The actor leaves the system
Extensions: <ol style="list-style-type: none"> 1a. The system fails to authenticate the actor. <ul style="list-style-type: none"> • The system informs the actor and doesn't allow the actor to proceed 3a. The system fails to search <ul style="list-style-type: none"> • The system informs the actor
Post-conditions: The system outputs results for the search of comment
Special requirements: Actor is connected to Internet and uses a Java enabled Mobile phone

Figure 6.23: Use case description for *search comment*

Search Presentation
Brief description: The actor receives results about presentation
Actors: Participant
Preconditions: The actor is a registered student
Basic flow of events: <ol style="list-style-type: none">1. The actor logs into the system2. The system authenticates the actor and starts a session3. The actor chooses to search for presentation4. The actor is guided by the system to fill the required criteria's to search for a presentation5. The actor receives results of the presentation6. The actor leaves the system
Extensions: <ol style="list-style-type: none">1a. The system fails to authenticate the actor.<ul style="list-style-type: none">• The system informs the actor and doesn't allow the actor to proceed3a. The system fails to search<ul style="list-style-type: none">• The system informs the actor
Post-conditions: The system outputs results for the search of presentation
Special requirements: Actor is connected to Internet and uses a java enabled mobile phone.

Figure 6.24: Use case description for *search presentation*

also show how the different fields are related to each other through different fields.

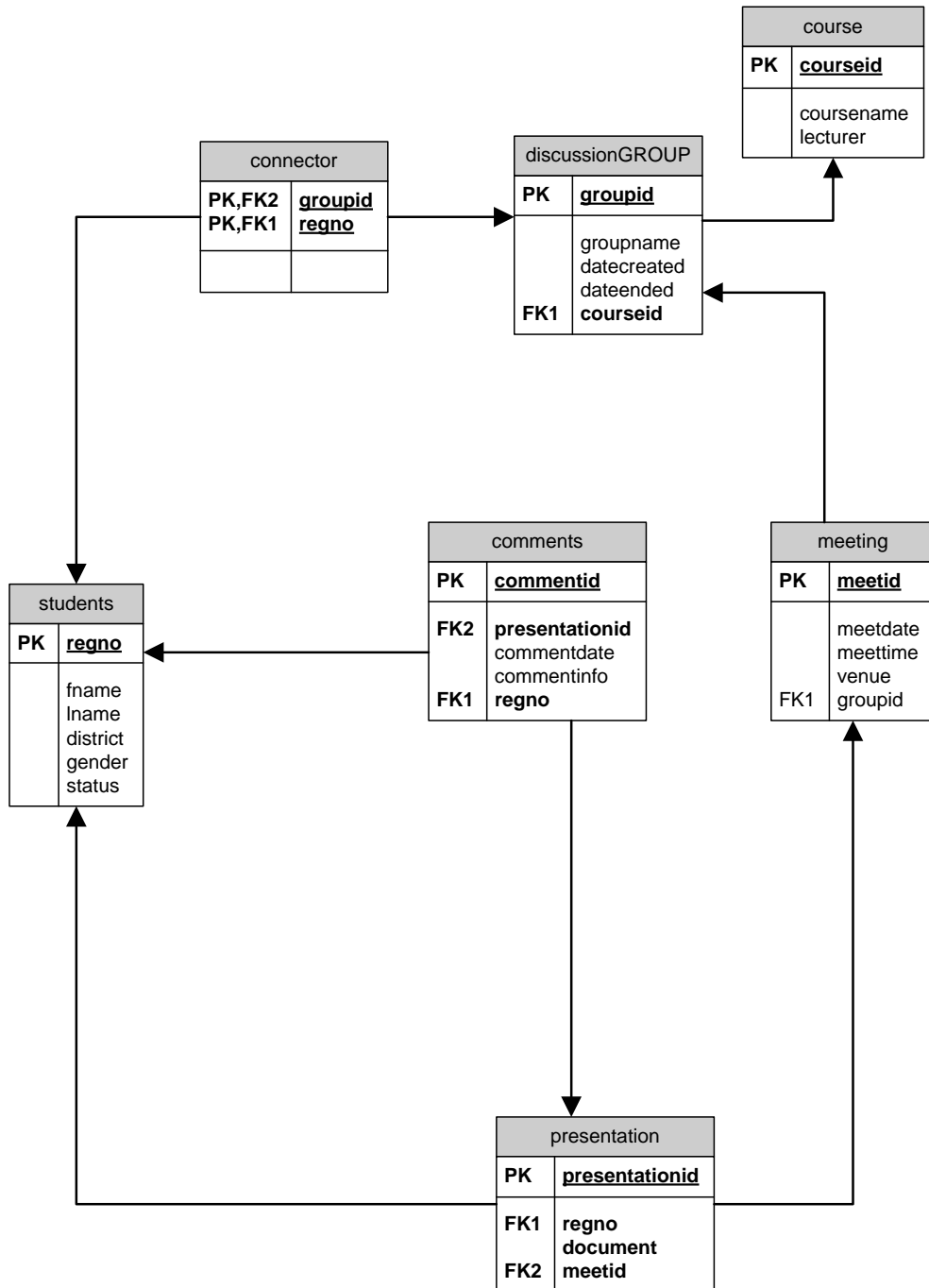


Figure 6.25: Entity relations

7

CHAPTER
DEMONSTRATOR

In this chapter we illustrate the demonstrator prototype, giving the technologies we used to support some of the functionalities of our case study. We start by first describing what our demonstrator is met to do, we then give a system overview, the technology used and the demonstrator.

7.1 Overview

In this demonstration prototype we aim at demonstrating how mobile technologies can be used by students in discussion groups to support collaboration. Looking at the design we try to demonstrate some of the functionalities. Given that students of our case are distributed and don't have access to internet, and yet telephone subscription by the students is high, then we try to demonstrate how students can use the mobile telephones to collaborate. We show how information can be buffered up and referred to at a later date when it is needed. In the demonstration we have the mobile client with limited processor power and memory, web server, and database. Given the low memory and processor power and yet students would like to access information from wherever they are, then we were prompted to store the information in the database which can be accessed through HTTP. Students can collaborate through the system sending comments to each other and searching information from the system. The client will have input and output forms which the user will use to access the system or read out data.

7.2 System overview

Figure 7.1 shows a general system overview. As we have seen in the analysis, the need to refer to information from mobile students requires us to have a repository for this data which is the database server. The web server

communicates with the database server to query information and the mobile student who is at the client side. We opted for a client server architecture other than peer-to-peer (P2P) because of the need to buffer up some data to be accessed by the clients. Given that the clients in our case are the resource constrained devices, it would be hard for information to be moved from these devices. A peer-to-peer ("P2P") computer network relies primarily on the computing power and bandwidth of the participants in the network rather than concentrating it on a relatively low number of servers. This brings a problem since the given participants have low computing power, hence the need to go client-server. Client-server is computing architecture which separates a client from a server, and is almost always implemented over a computer network. Each client or server connected to a network can also be referred to as a node. In our case, since we have low processor power at the client, we need to use the processing powers at the server. Below we briefly explain the different levels, i.e. client, web server and database server.

7.2.1 Client

The client is not only a physical computer since the majority of the students cannot have computers with access to internet but also mobile technologies. Because many students have access to mobile phones, therefore having mobile applications that can access a web server so that information can be stored and processed at the web server would be very important to support the mobility of the students. The mobile client will communicate with the web server using http/https. Because of the limitation of resources at the client, the processing will be done at the web server and information just passed to the client for display and it will be used to pass information to the database server.

7.2.2 Web Server

The web server will help in the quering of information from the database server since information is required to be stored on the database server. It will also help in transferring of results back to the database server. The web server will use the Java Servlet pages which help in adding dynamic content

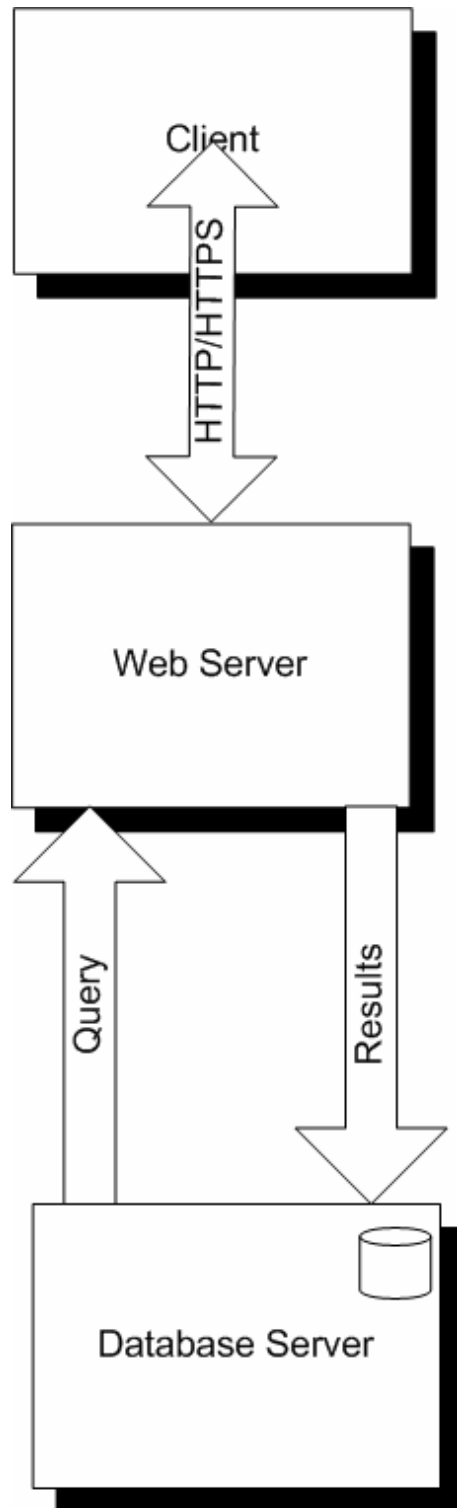


Figure 7.1: System overview

to a Web server using the Java platform. The generated content is commonly HTML, but it may also be XML. Servlets are the Java counterpart to non-Java dynamic Web content technologies such as PHP, CGI and ASP.NET. Servlets can maintain state across many server transactions by using HTTP cookies, session variables or URL rewriting.

The Servlet API, contained in the Java package hierarchy `javax.servlet`, defines the expected interactions of a Web container and a servlet. A Web container is essentially the component of a Web server that interacts with the servlets. The Web container is responsible for managing the life cycle of servlets, mapping a URL to a particular servlet and ensuring that the URL requester has the correct access rights.

A Servlet is an object that receives a request and generates a response based on that request. The basic servlet package defines Java objects to represent servlet requests and responses, as well as objects to reflect the servlet's configuration parameters and execution environment. The package `javax.servlet.http` defines HTTP-specific subclasses of the generic servlet elements, including session management objects that track multiple requests and responses between the Web server and a client. Servlets may be packaged in a WAR file as a Web application.

7.2.3 Database Server

This will keep the data structures which will be accessed through the web server to the mobile client. Because the activities that go on in the discussion groups among students need to be stored and with the limited resource on the mobile phones, then there is need for data to be stored in the data base which can be accessed anywhere by the discussion group members. Any choice of data base that can allow concurrent access through the web would be good enough.

7.3 Technology Selection

Here we give an overview of the different technologies and then suggest one that we use in our case. Tables 7.1 and 7.2 show the advantages and disadvantages of the different technologies that can be used in developing mobile application to support our case.

7.3.1 Java 2 Platform, Micro Edition

Java Platform, Micro Edition is a collection of Java Application Programming Interfaces (API) targeted for development on resource constrained devices, e.g. mobile cell phones, and PDAs. The Java platform edition defines a set of technologies that can be used with a particular product, i.e. Java Virtual Machines that fit inside a wide range of computing devices, libraries and APIs specialized for each kind of computing device, and tools for deployment and device configuration. The J2ME specifically addresses the large, rapidly growing consumer space, which covers a range of devices from tiny commodities, such as pagers, mobile phone, all way up to TV set-top box and electronic appliance. Like the large java editions, J2ME aims to maintain the qualities that Java technology has become known for, including built-in consistency across products, portability of code, safe network delivery, and upward scalability. The J2ME environment supports minimal configurations of the Java Virtual Machine and Java libraries that embody just the essential capabilities of each kind of device. As device manufacturers develop new features in their devices or service providers develop new and exciting applications, these minimal configurations can be expanded with additional libraries that address the needs of particular market segment. To support this kind of customizability and extensibility, three essential concepts are defined by the J2ME architecture, i.e. configuration, profile and optional package.

Configuration

A J2ME configuration defines a minimum platform for a category or grouping of devices, each with similar requirements on total memory budget and processing power. A configuration defines the Java language and virtual machine features and minimum class libraries that device manufacturer or a content provider can expect to be available on all devices of the same category[56].

Profile

A J2ME profile is layered on top of a configuration. A profile addresses the specific demands of a certain device family. The main goal of a profile is to guarantee interoperability within a certain vertical device family or domain by defining a standard java platform. Profiles include class libraries which are domain specific[56].

Optional package

A J2ME optional package is a set of APIs that is layered on top of a profile. An optional package typically contains functionality that is independent of any particular vertical market segment or device family. The main goal of an optional package is to allow the definition of APIs that can be added flexibly on top of a number of different profiles. One device can support multiple optional packages[56].

This helps application written within the same device family to run on all devices within the family. Mobile applications use a configuration called the Connected, Limited Device Configuration and uses the Mobile Information Device Profile (MIDP) as its only profile. MIDlets are the names given to application written in these profiles.

7.4 Client

The client application will be built with Java 2 Platform, Micro Edition (J2ME) which allows the application to run and access the java code through the mobile phone. J2ME is a collection of Java APIs for the development of software for resource-constrained devices such as PDAs, cell phones and other consumer appliances. Java ME is formally a specification, although the term is frequently used to also refer to the runtime implementations of the specification. Java ME was developed under the Java Community Process as JSR 68. The evolution of the platform has abandoned the umbrella Java Specification Request in favor of separate JSRs for the different flavors of Java ME.

7.5 CLDC

Connected, Limited Device Configuration (CLDC) is one of the core building blocks of J2ME. The goal of CLDC is to provide a standardised, highly portable, minimum-footprint Java application development platform for resource-constrained, connected devices[56]. Below are the general characteristics of CLDC target devices

- at least 192 kilobytes of total memory budget available for the Java platform

Category	Technology	strength	weakness
Platform support	.NET Framework	Windows Mobile is based on Windows CE and .NET Compact Framework.	Windows Mobile extends the familiarity of the Windows desktop to Windows Mobile-based Pocket PC and Smartphone devices. It only support windows based mobile phones.
	J2ME	J2ME supports Portability of programs since it compiles it byte codes	It only runs on Java enabled phones
Supported devices	.NET Framework	It is supported on Pocket PC and smart phones running windows OS	High costs of these type of devices make it difficult for students in developing countries to access them.
	J2ME	Supported on Java enabled mobile technologies, i.e. PDAs, Mobile phones and electronic appliances. There is a large number of the mobile devices supported.	Not all mobile phones used by most developing countries are java enabled.
Security	.NET Framework		
	J2ME	Class file verification, well defined application programming interfaces, and security features ensure that the third-party behave reliably and cannot harm the devices and networks.	

Table 7.1: Technology selection - one

Category	Technology	strength	weakness
Cross-platform compatibility	.NET Framework		The .NET Framework dont have cross platform support.
	J2ME	Standardized language features and libraries mean that applications and content can be transferred flexibly between different devices, within constraints of the supported J2ME configuration and profiles.	
Developer community	.NET Framework		
	J2ME	The Java programming language is rapidly becoming the most popular programming language taught in schools and Universities. The developer talent needed for Java software development already exists and is readily available making it the language of choice.	

Table 7.2: Technology selection - two

- a 16 bit or 32 bit processor
- low power consumption, often operating with battery power
- connectivity to some kind of network, often with a wireless, intermittent connection and with limited (often 9600 bps or less) bandwidth.

CLDC is core technology that can be used as the basis for one or more J2ME profiles, i.e. cell phones, two-way pagers, personal digital assistants (PDAs), organisers, home appliances, low-end TV set-top boxes, point of sale terminals, etc

7.6 MIDP

Mobile Information Device Profile (MIDP) for J2ME is an architecture and a set of Java libraries that create an open application environment for small, resource-constrained mobile information devices. The MIDP target devices include the cell phone, two way pagers and wireless personal organisers[56]. Below are the minimum requirements for a MIDP devices.

- Memory:
 - 256 kilobytes of non-volatile memory for the MIDP components
 - 8 kilobytes of non-volatile memory for application-created persistent data
 - 128 kilobytes of volatile memory for the virtual machine runtime (for example, the object heap)
- Display:
 - Screen-size: 96x54
 - Display depth: 1 bit
 - Pixel shape (aspect ratio): approximately 1:1
- Input: One or more of the following user-input mechanisms:
 - "one-handed keypad"
 - "two-handed keyboard"
 - touch screen
- Networking:

- Two-way, wireless, possibly intermittent, with limited bandwidth
- Sound:
 - The ability to play tones, either via dedicated hardware or via software algorithm

Since MIDP runs on top of the J2ME CLDC, the memory requirements of CLDC must be added to the minimum numbers for MIDP.

7.7 Netbeans

The NetBeans IDE is a free, open-source Integrated Development Environment for software developers. The IDE runs on many platforms including Windows, Linux, Solaris, and the MacOS. It is easy to install and use straight out of the box. The NetBeans IDE provides developers with all the tools they need to create professional cross-platform desktop, enterprise, web and mobile applications. It has several add-ons, i.e. Mobility Pack, Visual Web Pack, Enterprise Pack, Profiler, C/C++ Pack, and UML Modeling. In our project we only used the mobility pack and the visual web pack since they were directly connected with our project. Mobility park which helped in building of mobile client so that we can emulate the client using the default mobile emulator. The visual web pack was used to build the web servers. Figure 7.2 shows the visual look of netbeans working area.

Netbeans has mobile pack that supports mobile client to web application. With the Mobile Client to Web Application Generator, you create a MIDP client, a servlet and supporting files to enable a MIDlet to communicate with a Web service. This type of connection utilizes three "tiers": client, web application containing servlet, and server. The client communicates with the generated middleware servlet using a proprietary communication protocol. The servlet and server communicate using standard Simple Object Access Protocol (SOAP) messages. The code generated by the Mobile Client to Web Application Generator has a footprint that can be as small as 3 kilobytes, so it can be deployed on low-end Java ME MIDP devices. The network bandwidth used in calls from the client to the server is also efficient, typically using only slightly more than the minimum needed to transfer the raw data. The Mobile Client to Web Application Generator creates: a Java ME client class, a servlet and supporting classes and a mapping file in xml format that can be used to regenerate the server and Java ME client classes.

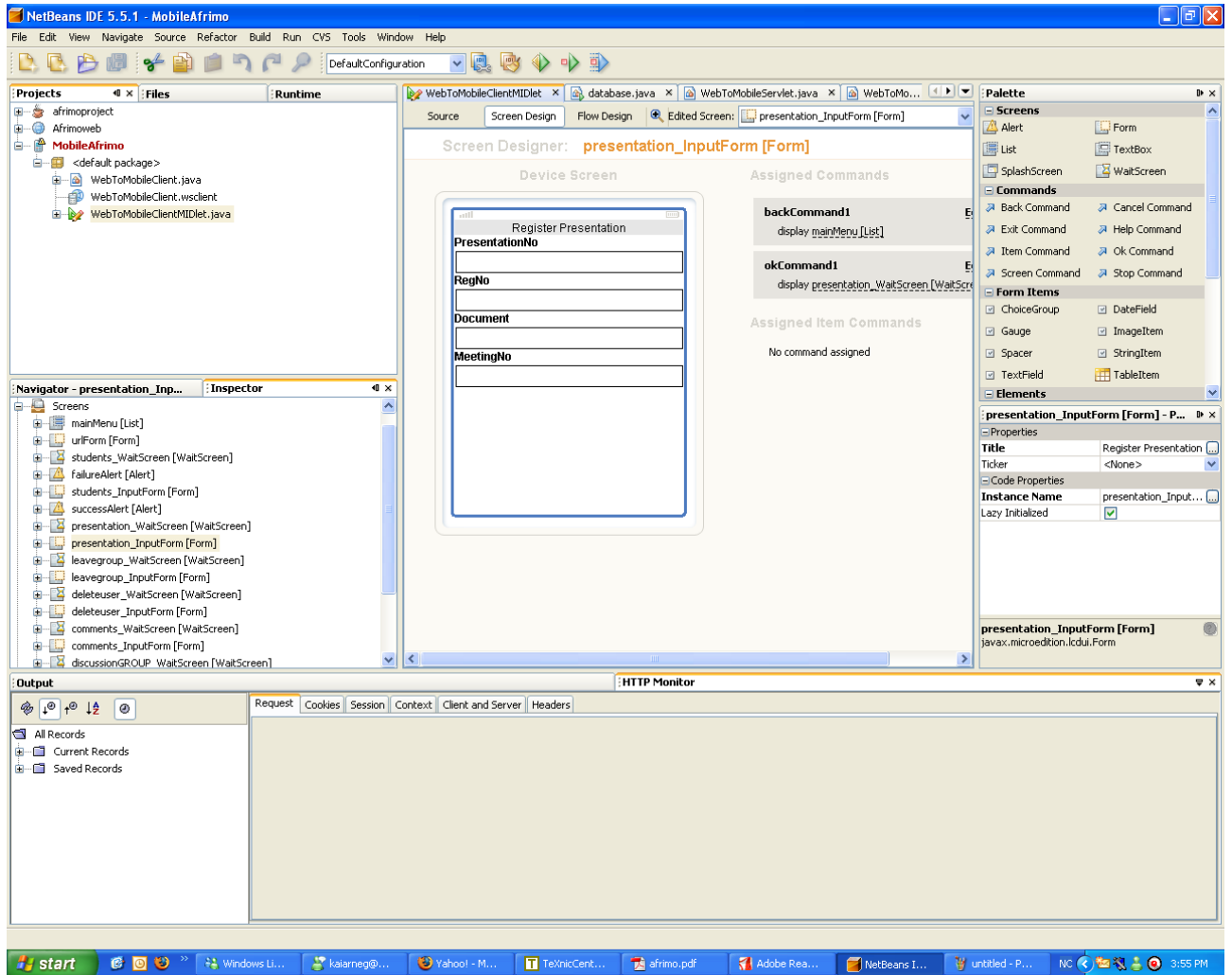


Figure 7.2: Netbeans working area

Web services extend the availability of server-based applications and services to remote clients. Mobile client applications use the same Web services architecture as do larger Java SE applications: SOAP (Simple Object Access Protocol) & WSDL (Web Service Definition Language). The IDE enables you to create client MIDlets that can connect to Web services either through a direct "two-tier" architecture, or a "three-tier" architecture that connects to Web services through a middleware Web application. The IDE provides two wizards for creating the connecting classes: The J2ME Web Service Client wizard. Use this wizard if you want to use the Web Services specification to create a "two-tier" connection to Web services. This wizard creates stub (client-side proxy) files and, optionally, a sample client MIDlet that calls a web service. You must have a device or emulator platform that supports the JSR-172 specification to use this wizard. The Mobile Client to Web Application Generator. Use this wizard to create a "three-tier" connection to Web services if your devices do not support the JSR-172 Web Services specification. The wizard generates a servlet that connects to a web application that includes a web service client. Before you use the Mobile Client to Web Application Generator, you must have a Web project that includes a Web service client.

7.8 Web server

The web server is used to access information in the database. We use the Tomcat which is a web server that supports servlets and JSPs. The accompanying Tomcat Jasper compiler compiles JSPs into servlets. The Tomcat servlet engine is often used in combination with an Apache HTTP Server or other web servers. Tomcat can also function as an independent web server. Tomcat is cross-platform, running on any operating system that has a Java Runtime Environment.

Java Servlet technology provides Web developers with a simple, consistent mechanism for extending the functionality of a Web server and for accessing existing business systems. Servlets are server-side Java EE components that generate responses (typically HTML pages) to requests (typically HTTP requests) from clients. A servlet can almost be thought of as an applet that runs on the server side without a face.

7.9 Database Server

The database server keeps the data structures and the data stored. We used MySQL database which is at mysql.stud.ntnu.no. MySQL is the most popular Open Source SQL database management system; it is developed, distributed, and supported by MySQL AB. MySQL AB is a commercial company, founded by the MySQL developers. It is a second generation Open Source company that unites Open Source values and methodology with a successful business model. It can support a lot of functionalities ranging from large to very small. MySQL database is secure in that it provides for privileged and system. It's scalable in that it can handle from small to very large databases. It also supports different connections to MySQL server ranging from TCP/IP sockets to any platform and also supports many languages whose APIs and libraries have been built, e.g. C, C++, Eiffel, Java, Perl, PHP, Python, Ruby, and Tcl allowing MySQL client to be written in any language.

We used the JDBC API which is an industry standard for database-independent connectivity between the Java programming language and a wide range of databases. The JDBC API provides a call-level API for SQL-based database access. JDBC technology allows you to use the Java programming language to exploit "Write Once, Run Anywhere" capabilities for applications that require access to enterprise data. The JDBC API allows you to establish a connection with MySQL database or access to data sources, Send SQL statements and Process the results. For all this to work, we used *org.gjt.mm.mysql.Driver* driver which helps to accomplish all this.

7.10 Demonstrator overview

To start using the demonstrator you must first run the server which is a web server as mentioned in section ... and it will be waiting for connections from the mobile client. The midlet is the entry point on the client side which will have reference to client-object, e.g. *afrimo_group_man*, *afrimo_meeting_man* etc. These classes represent the bridge between the J2ME client and the server. The client has associated different commands, e.g. send, exit etc. The midlet will listen for any activation of these commands by implementing the interface *CommandListener* and registering itself to the appropriate commands. So, when a command is activated, the appropriate code in the *commandAction* is activated. So, when one of these commands is activated,

a HTTP connection is opened and some metadata output, e.g. a protocol number etc. These variables will be used on the serverside as input to the appropriate method, i.e. a request is sent to a server, and the servlet is activated, reading the protocolnumber specified by the client, and initiating the 'protocol' consistent with this request. This will then result in the execution of one or more methods, using the data the client output as arguments for the calls. After all the calls are made, methods called the database class then do the appropriate work it was called for and either returns some data or some status code. The communication protocol used is http, so it has streams in both directions (*datainputstream*, *dataoutputstream*), and the client will just wait till the server is done with processing. The waiting can result in some unwanted behaviour, i.e. deadlocks. Therefore netbeans solves this by keeping the midlet in one thread through abstractions of the wait screen and executable tasks.

7.11 Mobile Application

As we have already mentioned in the previous chapters, this mobile application demonstration prototype was developed using J2ME. Since this demonstration prototype was developed to demonstrate our design means that just a spoonful has been catered for. Below we shall go through the demonstration menus and forms and explain briefly what was not done but in design. Figure 7.3 shows how the used mobile emulator looks like and from now onwards we shall use only the display part of the emulator. This emulator shows data search for close students in Busia district. Figure 7.4 shows the main menus of our demonstration prototype. As you realise, in the design we mentioned that the actor logs into the system, although this functionality has not been demonstrated. But however we don't say that it is useless; it's very important that why it is part of our design.

The main menu in figure 7.4 labeled 1 (in red) shows the menu with *group management*, *meeting managemnet*, *presentation management*, *comment management* and *search management*. When you enter a given menu like group management you can access the different forms like *register*, *create discussion group*, *join discussion group*, *leave discussion group*, *enter course*. Figure 7.5 shows the mobile client forms for some of the entry forms in *group management* sub menu.

In the meeting management we have the different entry forms *Call for meeting*, *reschedule meeting* and *Cancel meeting*. Presentation management has

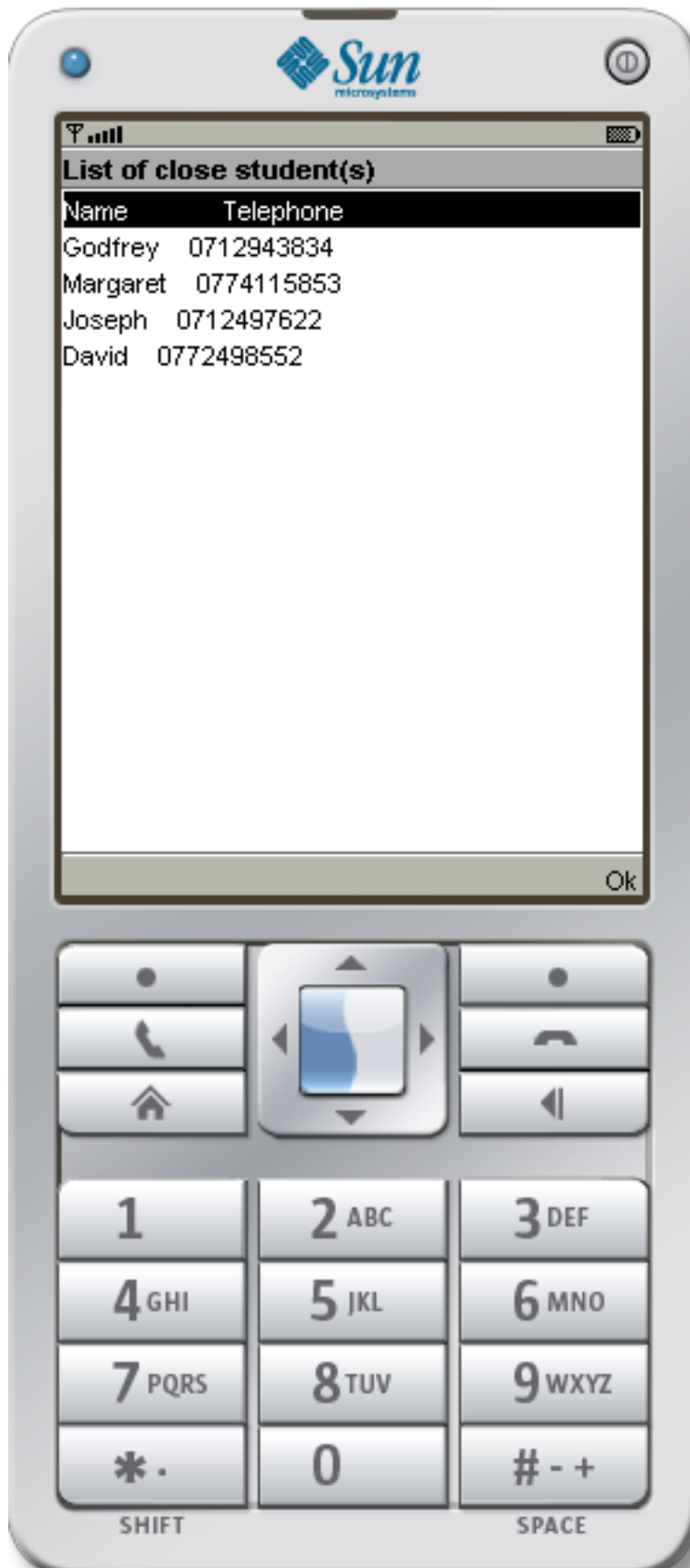


Figure 7.3: Out of close students from Busia searched from the mobile client

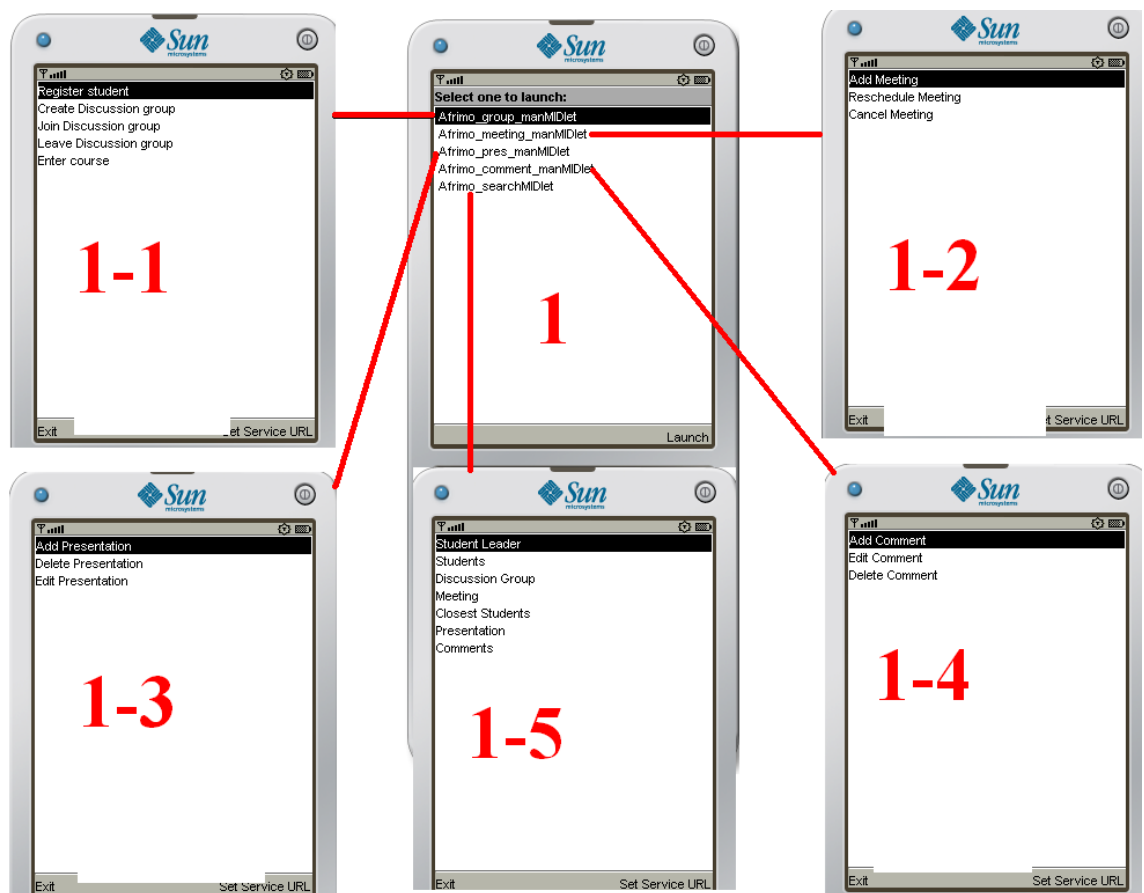


Figure 7.4: Main Menus of the application

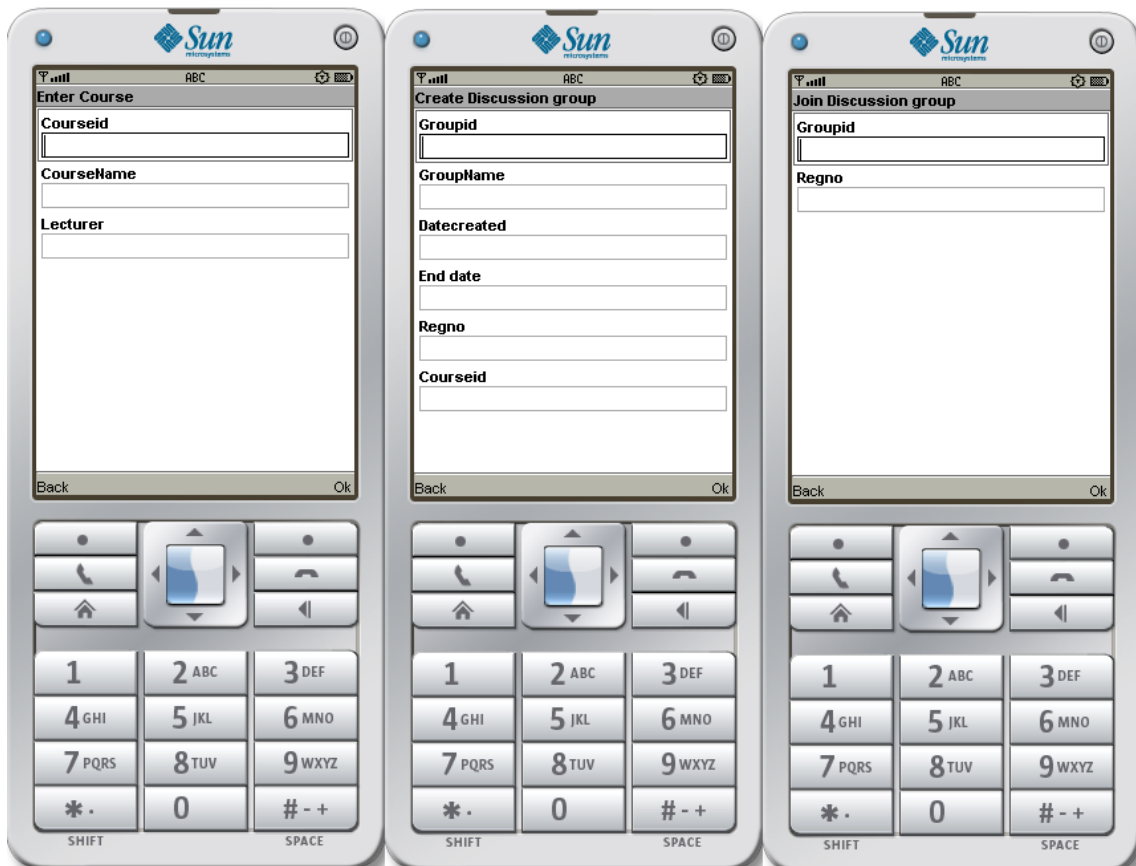


Figure 7.5: Mobile client entry forms for *enter course*, *create discussion group* and *join discussion group*

add presentation, edit presentation and delete presentation. Comments management has *add comment, edit comment and delete comment.* Search management has *search student leader, search student, search group, search close students, search meeting, search comment and search presentation.* Figure 7.6 shows the different search output forms on the mobile client. Appendix C shows the sample code for a method for searching a student leader and a method for calling a meeting.



Figure 7.6: Mobile client output forms for *students, close students, comment and meetings*

CHAPTER 8

EVALUATION

In this chapter we present the scenarios with the support of technology in order to understand better which areas have been supported better. In the scenarios we present the ideal system depending on our design. In the discussion we present what our demonstrator is able to accomplish.

8.1 Revised Scenarios

These are scenarios that are revised from the previous scenarios presented in chapter 5. In the revised scenarios we try to show how technology can be used to solve Markus's tasks that he wanted to solve without technology. We then discuss how our design tries to solve the given scenarios and the way forward. However, all scenarios require a login which is not implemented in the demonstrator mobile application prototype.

8.1.1 Scenario 1-1: Markus decides to start a new discussion group

Markus is at Makerere University for a face-to-face session in his room. He then decides to start a discussion group. He gets his mobile phone and starts the mobile application on his phone. The application requests him to enter his user name and password. He enters the entries and submits the data which starts up a main menu with different possibilities, i.e. group management, meeting management, presentation management, comment management and search management. He then chooses the *group management* since he wants to start a new discussion group and thereafter selects *create group*. This requests him to enter some required information on the form that displays on the mobile phone. The form as shown in figure 8.1. However, the system assumes that he is already a registered student. After entering

information and submitting the system requests him to select the members from that region to invite. Thereafter the new group is created and Markus is made a group leader. Markus then gets out of the system.

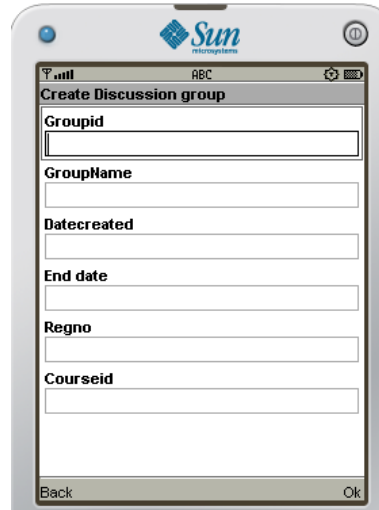
The image shows a mobile application interface for creating a discussion group. The screen is titled "Create Discussion group" and features a "Sun" logo at the top. Below the title, there are several input fields: "Groupid", "GroupName", "Datecreated", "End date", "Regno", and "Courseid". At the bottom of the screen, there are two buttons: "Back" and "Ok". The interface is designed for a mobile device, with a standard Android-style status bar at the top showing signal strength, battery level, and time.

Figure 8.1: Create discussion group mobile client entry form

Discussion

As we can see, some of the functionalities don't exist in the demonstrator prototype. When Markus starts the demonstrator mobile application he does not login into the system which is expected in the ideal system. He also does not have the opportunity to invite the students to join the group that he has created which is a very important functionality that needs not to be neglected. Since every thing that is entered through the mobile application is inserted into the data base, there is no worry of updating the lists in the files. The functionality of creating a discussion group is accomplished in this demonstrator.

8.1.2 Scenario 2-2&3: Markus decides to join an existing discussion group

Markus is on his way from Makerere University to his home up-country and he decides to join an existing discussion group. He gets his mobile phone and

starts the mobile application on his phone. The application requests him to enter his user name and password. He enters the entries and submits the data which starts up a main menu with different possibilities i.e. group management, meeting management, presentation management, comment management and search management. He then chooses the *group management* since he wants to join an existing discussion group and thereafter, selects *join group*. The figure 8.2 below shows up. This requests him to enter some required information on the form that displays on the mobile phone. However, he also has a possibility to search for a discussion group as shown in figure 7.3. He then enters the information and submits which makes him a member of the group he chose to join. He then gets out of the system.



Figure 8.2: Join discussion group mobile client entry form

Discussion

There is need for Markus to be able to search for information about groups while he is still entering data in the join group, since the groupid field is required on form of join group. When someone joins the discussion group automatically the database is updated, making the new list of new members up to date. The functionality of a student being able to join a discussion group is accomplished in this demonstrator. The student is able to join the discussion group and data is entered into the database.

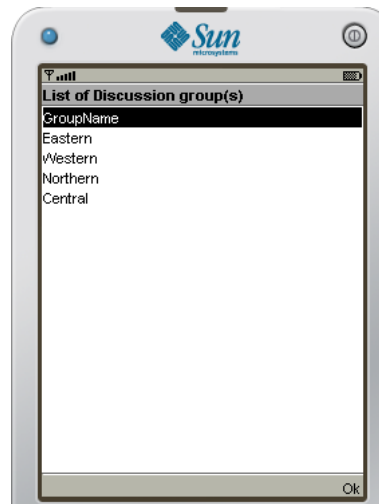


Figure 8.3: Output of a search for discussion group on a mobile client

8.1.3 Scenario 3-4: Markus cannot come for a meeting

Because of some reason, Markus realises he will not be able to attend the meeting which will take place in a week's time. He then goes out for his mobile phone and starts out the mobile application. The application requests him to enter his user name and password. He enters the entries and submits the data which starts up a main menu with different possibilities, i.e. group management, meeting management, presentation management, comment management and search management. He then chooses the *meeting management* since he wants to inform members about his absence from the meeting and thereafter selects *inform members*. This requests him to enter some required information on the form that displays on the mobile phone. He then enters the information and submits it, then the information is sent to every member of the discussion group. Given that Markus has a section that everyone is interested in, one of the discussion group members sends out a comment requesting someone else to help out discuss his part. After some collaboration using comments, they agree to have someone else to discuss that section. Figure 8.4 shows a sample comment. He then gets out of the system.

Discussion

Here you realise that all the discussion group members get to know about Markus's absence well in advance which helps them to plan for another dis-

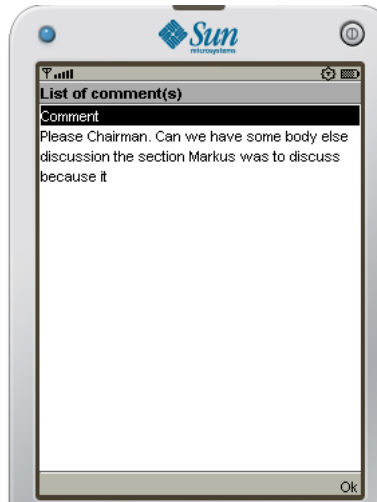


Figure 8.4: Output of a search for comment on a mobile client

cussion group member to prepare to discuss that part. This helps to increase awareness of all the other group members by the group members. In the demonstration, it was not clearly indicated were a person who will not attend a meeting enters information on the demonstrator. However, since a comment function was implemented he can add comment which can be viewed by all the other members.

8.1.4 Scenario 4-5: Markus attends meeting after missing the previous one

Some days to the meeting Markus starts mobile application. He is requested to enter his user name and password. After entering the information, he submits it and the system starts the main menu. He then selects *search management* were he then selects meetings as shown in figure 8.7. This helps him to confirm the date of the next meeting. After confirming the date, he then searches for the presentation which was made as shown in figure 8.5. He reads through and adds comments which prompt a discussion, hence making him understand better. While he searches through the presentations and comments, he is helped to know that the part he was supposed to discuss was discussed while he was away. Figure 8.6 shows a comment. This helps the discussion move on without a lot of disturbance of wanting to go through what you discussed for people who did not attend.

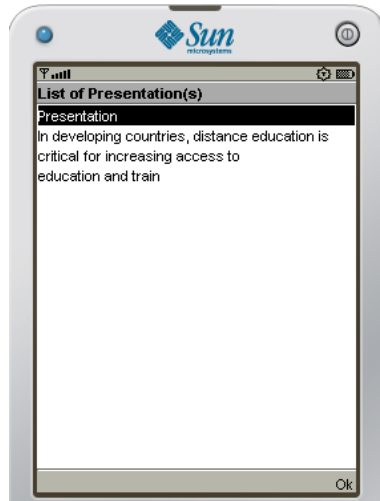


Figure 8.5: Output of a search for presentation on a mobile client



Figure 8.6: Add comment mobile client entry form

Discussion

Most of the support for mobile students via the mobile phones is done through the comments. Since students can be able to send comments to the system via the mobile phones. The comment function was implemented since students are able to send and edit comments through the mobile client.

8.1.5 Scenario 5-6: Markus is part of a discussion group participating as a member

Before Markus comes, he looks out for his mobile phone and starts a mobile application. The system prompts him to enter his user name and password. He then searches for the meeting which shows him the date and venue for the meeting as shown in figure 8.7. He then starts the conference where he can hear what the other members are discussing at the meeting venue. He can send comments both in audio and text. The audio can also be heard by the members at the discussion venue. When the discussion stops, the system application is stopped.

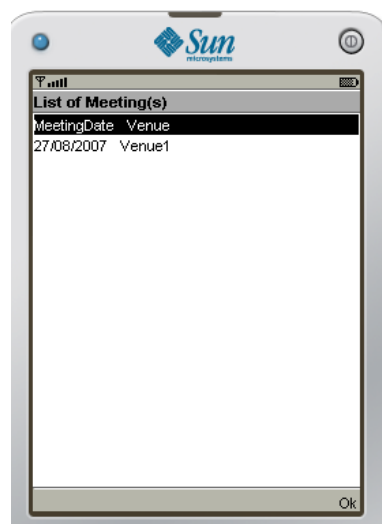


Figure 8.7: Output of a search for meeting on a mobile client

Discussion

The only way we can emulate collocated students is by use of the comment functionality. So that students can be able to collabrate through the mobile clients. However, there is need to support more collaboration among students who collocated.

8.1.6 Scenario 6-7: Markus is appointed leader for the group

Markus is elected as the discussion group leader. After they have agreed on the dates and time of the next meeting, he starts up his mobile application and logs in as required. He starts up the meeting form where he enters the dates of the meeting and time. Many members request that they will not be available for the meeting, so Markus reschedules the meeting for another day as shown in figure 8.8. Then a message is sent to all the other group members informing them about the meeting schedule, which can call for collaboration among themselves until a specific date is agreed. However, now there is need of asking Markus about the other students since the students can search for themselves as shown in figure 8.9. He then closes the system.

The image shows a mobile application interface on a device. At the top, there is a status bar with signal strength, the text 'ABC', and battery level. Below the status bar is the application header with the 'Sun' logo and 'microsystems' text. The main content area is titled 'Reschedule Meeting' and contains three input fields: 'Meetid', 'Meeting Date', and 'Meeting Time'. At the bottom of the screen, there are two buttons: 'Back' on the left and 'Ok' on the right.

Figure 8.8: Meeting reschedule mobile client entry form



Figure 8.9: Output of students from the mobile client

Discussion

Markus is now able to do coordination of calling for meeting, rescheduling meeting and canceling meeting. The call for meeting, reschedule meeting and cancel meeting has been implemented in the demonstrator prototype. However, there is need to implement the functionality of the system being able to sending message to other members whenever a meeting is called, rescheduled or canceled.

8.2 Summary

Tables 8.1 & 8.2 show the summary of the functionalities which one have been implemented and some comments to show to what extent. In the tables, UIF and FM stands for user interface forms and functional methods respectively. Since we did not implement user authentication, some functionalities which are supposed to be done with other use group are done by any body e.g. *Delete comment, delete presentation.*

Function	UIF	FM	Comment
User authentication	No	No	
Register Student	Yes	Yes	Data integrity is not implemented. We also need to allow students to edit their entries since their data might change in the due process.
Create discussion group	Yes	Yes	Data integrity is not implemented.
Join discussion group	Yes	Yes	Data integrity is not implemented.
Leave discussion group	Yes	Yes	Data integrity is not implemented.
Enter course	Yes	Yes	Data integrity is not implemented. We should allow for the editing of the courses.
Call for meeting	Yes	Yes	Data integrity is not implemented. Sending of message to the mobile phones for each student is not implemented. We only submit data into the database.
Reschedule meeting	Yes	Yes	Data integrity is not implemented. We should also store information about rescheduled meetings. In this function we just do an update of the meeting information.
Cancel meeting	Yes	Yes	Data integrity is not implemented. We should also store information about canceled meetings. We just delete the meeting.
add presentation	Yes	Yes	Data integrity is not implemented.
Edit presentation	Yes	Yes	Data integrity is not implemented. Edit form does not return data in it's text fields for editing it requires the user to know the the <i>presentationid</i> he/she needs to edit.
Delete presentation	Yes	Yes	Data integrity is not implemented.

Table 8.1: Summary of the Evaluation - 1

Function	UIF	FM	Comment
add comment	Yes	Yes	Data integrity is not implemented. We need also to send a message to the students phones when the comment is added which is not done in this demonstrator.
Edit comment	Yes	Yes	Data integrity is not implemented. Edit form does not return data in it's text fields for editing it requires the user to know the the <i>commentid</i> he/she needs to edit.
Delete comment	Yes	Yes	Data integrity is not implemented. We should also keep the comments deleted so that we are able to refer to them later.
Search student leader	Yes	No	Data integrity is not implemented.
Search student	Yes	Yes	Data integrity is not implemented.
Search group	Yes	Yes	Data integrity is not implemented.
Search close student	Yes	Yes	Data integrity is not implemented.
Search meeting	Yes	Yes	Data integrity is not implemented.
Search comment	Yes	Yes	Data integrity is not implemented.
Search presentation	Yes	Yes	Data integrity is not implemented.

Table 8.2: Summary of the Evaluation - 2

CHAPTER 9

CONCLUSION

In this chapter we present the conclusion of our research, giving a summary of results, discussion and future work.

9.1 Summary of results

We focused our study on how BED students can be supported in discussion groups using mobile technologies. From the interviews we were able to come up with a working definition of discussion groups.

”group of BED students who work together collaboratively to solve a common task basically through the use of assignments or preparation for exams”

We thereafter identified two main types of discussion groups, based on their size and what happens in the discussion groups, i.e. assignment and general discussion groups. Assignment discussion groups are created in order to solve the assignment task and the group members range from 5 to 10 students. The general discussion groups are created with the aim of solving the problems of syllabus tasks or going through the past exam questions and the group members range from 1 to 60 students depending on the regions. In order to illustrate the results, we presented scenarios to understand better what happens in the formation and management of the discussion groups without technology. However, in the scenarios we chose the general discussion group and thereafter we dealt with that group. From the interviews and scenarios we were able to answer the objective of providing an overview of the activities in student discussion groups. With that information we were further helped to identify important aspects that need much attention, e.g. group management, coordination, communication and collaboration. All these aspects are intertwined in that for students to manage groups they must coordinate, communicate and collaborate; to coordinate they must communicate

and collaborate; they cannot communicate without coordination or collaboration. However, since they were very big aspects to deal with, we further identified services that were much connected to the discussion groups, i.e. discussion group management, meeting management, presentation management, comment management and search management. This helped us answer the objective of identifying mobile application requirements to support student discussion groups. This drove us further into design where we used user requirements in form of use case diagram and thereafter we made use case descriptions. Table 9.1 shows use cases for the different services which were identified and for which use case descriptions were made. This answers the objective which required us to design mobile solutions that support students in discussion groups.

Services	Use Cases
Discussion Group Management	Register
	Create group
	join group
	leave group
	add course
Meeting Management	Call for meeting
	reschedule meeting
	Cancel meeting
Presentation Management	add presentation
	edit presentation
	delete presentation
Comments Management	add comment
	edit comment
	delete comment
Search Management	search student leader
	search student
	search group
	search close students
	search meeting
	search comment
	search presentation

Table 9.1: Use cases for each service

We then developed a demonstration prototype using J2ME. In our demonstration we chose a client-server architecture other than peer-to-peer (P2P), because of the need to buffer up some data to be accessed by the clients.

Given that the client in our case are resource constrained devices, it would be hard for information to be moved from these devices. A peer-to-peer ("P2P") computer network relies primarily on the computing power and bandwidth of the participants in the network rather than concentrating it in a relatively low number of servers. This brings a problem since the given participants have low computing power, hence the need to go client-server. Client-server is computing architecture which separates a client from a server, and is almost always implemented over a computer network. However, we did not implement all the functionalities as identified in the design. We used MySQL database to create the database and store information. We used tomcat web-server which accessed the database using MySQL drivers to connect to it. At the webserver we used the java servlet to communicate easily with the data base and return appropriate information to the mobile client. The mobile client has the input and output forms which are developed from midlets. This answers the objective that required us to develop the mobile application demonstrator prototype to support students in discussion groups, since students are able to solve some of the tasks that they are supposed to do.

Lastly, we evaluated the demonstrator, looking at the ideal system and what our demonstrator was able to accomplish. In this chapter we put some screen shoots trying to show how the demonstrator can be used by the students to accomplish what they are supposed to do. This answers the objective of evaluation of the mobile application demonstration prototype.

9.2 Discussion

From the general objective which required us to provide support for discussion groups within distance education in developing countries using mobile technologies, we can now say that generally the objective has been met only that there is need to improve the already developed prototype and try it out with a sample of discussion group students to help improve its design. Its importance is not doubtful anymore since the area is a very rich and has always been advocated by many researchers. There fore we also argue that the need to use mobile technology would offer the best solutions for distance education students given their limitation in access to the internet.

For objective one which required us to provide an overview of the activities in student discussion groups, much of the information was got, though we think that if we had observed the students during a discussion, we would have got better information. Trying out the demonstrator on the actual students and

observing how they use it would help to get more information about what kind of other activities go on in the discussion groups, hence improve design.

As for the objectives of identifying mobile application requirements to support student discussion group and design mobile solutions that support students in discussion groups, we were able to identify the requirements and designed the system using user case descriptions. However, as we said before, there is need to try out the demonstrator to discussion groups students so that we can be informed better.

The demonstrator is not a good functional system. We just tried to demonstrate the interface appearance, but we did not deal much with the data integrity. Even the relational database integrity was not enforced, but this can be done since this is just aimed at demonstrating how the students can use mobile application in their discussion groups. However, though we used the emulator, we were not able to install the application on the mobile phones to test how it works. We therefore think that you should test the tool on actual mobile phone which can bring out many changes, as we develop a fully functional system.

The evaluation was done, showing how our demonstrator tries to solve Markus problems with technology. We also try to discuss what was able to be accomplished. At the end we present a summary of the functionalities that have been worked out on the demonstrator and which one are not.

9.2.1 Limitation

The limitations are listed below with limitation due to my work and due to deployment of the solutions.

1. We lacked some information since we were not able to observe students while they were presenting in their discussion groups. However, we did some observation of the students when they were in their face-to-face session at department of distance education, Makerere University.
2. The numbers of the students we interviewed were not also very sufficient, since even students in the some region can have differences given that they are separated by big differences.
3. We were also not able to evaluate the demonstrator with users. This would have informed as on a lot of design changes.

4. We were also able to try out the demonstrator on the real mobile phones. May be it call for some issues to change.
5. There is also a limitation of low memory and capacity of mobile technologies. With this mobile phones can display just a few output on the mobile client and there processor power is very small.
6. There is a also a limitation on the side of the students in using the system since they have to pay some money whenever they use the system. On this limitation we suggest that the Makerere University talks to the mobile telephone companies to subsidize for the students in order to increase the usage of the system.

9.3 Future work

There is need to use the demonstrator with students in the discussion to inform us on better improvement of the system. There is also need to incorporate tutors in the system to get feed back on the students inputs.

With the enormous increase of mobile phones in Africa and yet internet access is still low, we think that careful understanding of its use in all aspects of education would be the best alternative. Since the learning management systems have failed to take off dispute their importance in the recent of world because of low internet access by students, there is need to understand how they can be implemented on the mobile phones. However, the reason hindering their use in developing countries is access to internet by most students, especially distance education students. We therefore think that internet mobile access can pave the way for this usage for distance students.

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APPENDIX **A**

INTERVIEW GUIDE

1. Which course are you doing?
2. Do you have a discussion group?
3. How many members are in a discussion group?
4. Explain how discussion groups are created? How do new members leave and join the discussion group?
5. Are the members of your discussion groups from the same school?
6. What is the role of the discussion group leader?
7. What is the role of the members in the organization of the group?
8. How regularly do you meet?
9. How do you make your appointments of meeting with each other?
10. Apart from the assignments what else makes you meet for discussion?
11. After the discussion is finished how do you keep in touch?
12. What do you discuss during the discussion?
13. If you are told to describe what happens from the time you arrive to the time you finish in a discussion. How would you describe it?
14. Do many of the students in your discussion groups have access to internet and use their email frequently?
15. Apart from the mobile phone which other technologies do you use for communication?
16. Is your mobile phone always available? Give reasons for your answer?
17. Do you think a mobile phone can be a very useful tool for learning and how?

18. What are your suggestions in how we can use mobile phones in discussion groups?

B

APPENDIX

BED YEAR PLANNER

**MAKERERE UNIVERSITY
INSTITUTE OF ADULT & CONTINUING EDUCATION
DEPARTMENT OF DISTANCE EDUCATION
YEAR PLANNER FOR B.ED (EXTERNAL)
ACADEMIC YEAR 2006/2007**

DATE	YEAR	ACTIVITY
21st Aug - 2nd Sept 2006	BED I (2006/2007)	1st Semester Face-to-Face / Registration
21st Aug - 2nd Sept 2006	BEDIM (2003/2004)	2nd Semester Face-to-Face / Registration
4th Sept - 16th Sept 2006	BED I (2005/2006)	2nd Semester Face-to-Face / Registration
4th Sept - 16th Sept 2006	BED II (2004/2005)	2nd Semester Face-to-Face / Registration
7th Oct - 9th Oct 2006	BED (2006/2007)	Mini Face-to-Face(Geography, History,RS,SST) & Tests in Foundations
28th Oct-29th Oct 2006	BED (2006/2007)	Mini Face-to-Face(IPS, Political, MAM, MAD)
4th Nov-5th Nov 2006	BED (2006/2007)	Mini Face-to-Face(KIS,LUG, LIT, LED, ELS, BUS)
11th Dec -21st Dec 2006	BED (2006/2007)	End of Semester 1 Exams
11th Dec -21st Dec 2006	BED (2005/2006)	End of Semester II Exams
11th Dec -21st Dec 2006	BED II (2004/2005)	End of Semester II Exams
11th Dec -21st Dec 2006	BED III (2003 / 2004)	End of Semester II Exams
8th Jan - 27th Jan 2007	BED I (2006/2007)	Orientation & Face-to-Face (SEM 1)
8th Jan - 27th Jan 2007	BED II (2005/2006)	Orientation & Face-to-Face (SEM 1)
8th Jan - 27th Jan 2007	BEDIM (2004/2005)	Orientation & Face-to-Face (SEM 1)
9th March - 11th March 2007	BED I (2006/2007)	Mini Face-to-Face
16th March -18th March 2007	BED II (2005/2006)	Mini Face-to-Face
23rd March -25th March 2007	BED III (2004/2005)	Mini Face-to-Face
7th May -17th May 2007	BED I (2006 / 2007)	End of Semester II Exams
7th May -17th May 2007	BED II (2005/2006)	End of Semester 1 Exams
7th May -17th May 2007	BEDIM (2004/2005)	End of Semester 1 Exams
18th May -24th May 2007	BED II (2006/2007)	Orientation Face-to-Face into Semester 1
18th May -24th May 2007	BED II (2005/2006)	Orientation Face-to-Face into Semester II
18th May -24th May 2007	BEDIM (2004/2005)	Orientation Face-to-Face into Semester II

YEAR CO-ORDINATORS
 BED I (2006 / 2007) Ms Nakawungu Betty (RM 17) BED I (2005 / 2006) Mrs Barbara Masaba (RM 10) BED II (2004 / 2005) Mr Arthur Mugisha (RM 10) BED III (2003 / 2004) Ms Dorothy Nakibuuka (RM 10)

Figure B.1:

APPENDIX C

SAMPLE CODE

Sample code for search for student leader, add data and connections to the database.

```
public String[] searchsl(String ssl_district){
    String query = "SELECT * FROM students WHERE district =
        '" + ssl_district + "'";
    String querysl = "SELECT * FROM connector WHERE status = 'leader'";
    Statement st;
    Statement ts;
    try {
        st = con.createStatement();
        ts = con.createStatement();
        ResultSet rs = st.executeQuery(query);
        ResultSet rsl = ts.executeQuery(querysl);
        ArrayList arr = new ArrayList();
        ArrayList tel = new ArrayList();
        ArrayList studregno = new ArrayList();
        ArrayList connregno = new ArrayList();

        while(rs.next()){
            arr.add(rs.getString("fname"));
            tel.add(rs.getString("tel"));
            studregno.add(rs.getString("regno"));
        }
        while (rsl.next()){
            connregno.add(rsl.getString("regno"));
        }
        String[] ret = new String[arr.size()+1];
        ret[0] = "Name           Telephone";
        // Looking up for the student leader in student
```

```

//table and connector table.
for(int i=1, m=0; i<ret.length; i++, m++){
    for(int c=0; c<connregno.size(); c++){
        if (studregno.get(m)==connregno.get(c)){
            ret[i] = (String)arr.get(m) + "          "
                + (String)tel.get(m);
        }
    }
}
return ret;
} catch (SQLException ex) {
    ex.printStackTrace();
}
return new String[]{};
}

```

```

public void meeting(String pm_meetid, String pm_meetdate,
String pm_meetime, String pm_venue, String pm_groupid){

String query = "INSERT INTO meeting(meetid, meetdate, meetime,
venue, groupid) VALUES ('" + pm_meetid + "', '" + pm_meetdate +
"', '" + pm_meetime + "', '" + pm_venue + "', '" + pm_groupid + "')";

Statement st;
try {
    st = con.createStatement();
    st.execute(query);
} catch (SQLException ex) {
    ex.printStackTrace();
}
}

```

```

public database() {
    try{
        Class.forName("org.gjt.mm.mysql.Driver"); //.newInstance();
        con = DriverManager.getConnection("jdbc:mysql://mysql.stud.
ntnu.no/databasename", "username", "Password");
    }
}

```

```
        con.setAutoCommit(true);
    } catch (SQLException e){
        System.out.println("err in constructor, can't connect " +
            e.getMessage());

        closeConnection();
    } catch (Exception e){
        System.out.println("Problem with context? " + e.getMessage());
        closeConnection();
    }
}
```
