IJCSI

International Journal of Computer Science Issues

Learning Support System using Agents in E-Learning

By Abuodha Atieno Lucy

Volume 3, 2017
ISSN (Online): 1694-0784

www.IJCSI.org

IJCSI proceedings are currently indexed by:

Learning Support System using Agents in E-Learning

ISSN(online) 1694-0784

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

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LEARNING SUPPORT SYSTEM USING AGENTS IN E- LEARNING

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P58/72927/2009

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RESEARCH SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE MASTER OF SCIENCE IN COMPUTER SCIENCE AT THE UNIVERSITY OF NAIROBI

APRIL 2012

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

ABSTRACT

E-learning opportunities for students have become increasingly popular with more and more institutions of higher learning finding the need to start online programs. Much of this increase is attributed to the demands of the learners' audience who are intrigued by online education. Despite the fact that a growing number of universities in Kenya have successfully adopted E-learning, little is still known on how Agents can be used to enhance e-learning. This study aimed to show how Multi - agents can be used in e-learning.

The research adopted a cross sectional study targeting university students from St Paul University in Nairobi, Kenya. An Agent oriented methodology known as Prometheus was adopted in the analysis and design of a Multi-agent based system for E-learning. The implementation of the Multi - agents was carried out using JADE Agent development kit. This framework opens the way towards any kind of distributed Multi-agent systems, in which the Agents may be used in an E-learning environment.

Examinations were used for the purpose of evaluating the prototype with students. 70% of the students acknowledged that they would recommend the developed system to others.
The research also discovered that the most outstanding benefits Agent based e-learning have on students include improving learning based on performance assessments and learning needs. Additionally, research discovered that the use of intelligent agents to work with the tutor produces the right depth and timely content for the students.

In conclusion, the findings of the study highlight the importance of Agents in E-learning. It is therefore necessary for higher education institutions to incorporate E-learning Agent based environment due to its apparent benefits of efficiency, effectiveness and enhancing of learning.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

DECLARATION

This research project is my original work and has not been presented to any university for any award or anywhere else for academic purposes.

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This project has been submitted for examination purposes with my approval as University Supervisor.

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IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

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ACKNOWLEDGEMENT

The journey to completing this dissertation has been long, wrought with challenges and filled with experiences I could never pick from sitting in a classroom. The completion of this thesis could not have been possible without the help of others.

I would like to thank my supervisor Mr Robert Oboko, whose guidance, encouragement and support enabled me understand the subject and research skills required. His constant urging ensured that I completed the work on time.

I extend my gratitude to my colleagues who offered the moral support dully needed the E-Learning team of the School of Computing and Engineering at St Paul University who were patient with me throughout the data collection process and to all who supported me in any respect directly and indirectly. Thank you.

Lastly, I want to thank my husband and children who patiently supported me during my thesis. May the Almighty God bless you all!

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

TABLE OF CONTENTS

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

LIST OF TABLES

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

LIST OF FIGURES

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

LIST OF ABBREVIATIONS

i. JADE- Java Agent Development Framework
ii. FIPA-Foundation for Intelligent Physical Agent
iii. JADE XML- Java Agent Development Framework Extensible Markup Language
iv. TILAB- Telcom Italia Lab
v. JAVA SE- Java Platform Standard Edition
vi. SQL-Structured Query Language
vii. ACL- Agent Communication Language
viii. API- Application Programming Interface
ix. BDI- Belief Desire Intention
x. IDE – Integrated Development Environment
xi. JSP-Java Server Pages
xii. DB- Database
xiii. JAR- Java Archive File
xiv. GUI – Graphical User Interface

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
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Definition of Terms

An agent: is a small, autonomous, or semiautonomous software program that performs a set of specialized functions to meet a specific set of goals, and then provides its results to a customer (e.g., human end user, another program) in a format readily acceptable by that customer.

Methodology: is a body of methods employed by a discipline .A methodology, acts like a helps the designer to implement the solution by specifying some of the steps of the process, while leaving others to the creativity of the designer.

Multi-agent System: is a system composed of multiple interacting agents.

E-Learning: Use of technology to enable people to learn anytime and anywhere. E-Learning can include training, the delivery of just-in-time information and guidance from experts.

Ontology: An ontology a conceptualization of an application domain in a human–understandable and machine-readable form and typically comprises the classes of entities, relations between entities and axioms which apply to the entities which exist in that domain (Gibbins et al, 2003).

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Learning is the process of gaining understanding that leads to the modification of attitudes and behaviors through the acquisition of knowledge, skills and values, through study and experience. Fry (2000 p15) defines e-learning as delivery of training and education via networked interactivity and a range of other knowledge collection and distribution technologies. E-learning opportunities for students have skyrocketed in popularity. Every year, more universities are starting online programs. Much of this increase is due to the demands of the learner audience who are intrigued by online education, mostly because they face a number of obstacles that make conventional, brick-and-mortar educational options unviable which include some of the following:

Conveniently located institutions offer limited program options .Their work schedules conflict with campus-bound course schedules, this includes people who work in shifts, travel frequently on business, work long hours, and/ or are in the armed forces.

Personal and family commitments conflict with campus-bound course schedules. This includes having children at home and taking care of aging parents.

Kenyan universities are increasingly turning to e-learning as a tool to facilitate improved education. They also want to rope in more students through better access to facilities, hoping to reach a wider base in a cost effective way. This thesis aim at offering student with an agent based e-learning support system

1.2 PROBLEM STATEMENT

E-learning can only be considered successful when students gets the right content, in a timely manner according to their learning needs to satisfy their quench for knowledge. The tutors should ensure that the course materials are made available for the students according to their specific needs.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

But the most significant limitation in e-learning is lack of delivering the specific content to students because students have different cognitive and learning needs.

Thus a good e-learning system must satisfy the student need for learning. This has led to the development of an agent based support e-learning system.

1.3 RESEARCH OBJECTIVES

1.3.1 General objective

The purpose of this paper is to illustrate the advantages of using agents to facilitate the identification of appropriate e-learning resources according to the students needs in an e-learning environment.

1.3.2 Specific Objective

The following are the objectives of this research:

- To investigate how agents can be used in e-learning.
- Use e-learning agents to improve learning performance based on performance assessments and learning needs.
- Use intelligent agents to work with the instructors to produce the right depth, timely content for the students.

1.4 SIGNIFICANCE OF THE STUDY

To help user (students) to better use, manage and interact with computer applications, make decisions as well as ask for any relevant material needed without any time restrictions.

This system would help improve Quality, flexibility ease of use in terms of knowledge and depth of content because of the tutor will be able to understand what their student really need.

Integrate the methods of learning into one efficient concept_to incorporate the students' performance as students have different cognitive and learning needs.

1.5 HYPOTHESIS AND ASSUMPTION

- It is assumed that the students are technologically competent
- The students are already familiar with web based software in place**.**
- There exists a good technological infrastructure in place.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
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1.7 SUMMARY

This chapter has given an introduction of the study, the statement of the problem and the research questions that the research seeks to answer. It also gives the assumptions that will be made during the study, the aim and objectives of the research project. The chapter has concluded with an indication of the result of the research and the intended contribution that will make.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
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CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Learning is the process of gaining understanding that leads to the modification of attitudes and behaviors through the acquisition of knowledge, skills and values, through study and experience. Learning causes a change of behavior that is persistent, measurable, and specified or allows an individual to formulate a new mental construct or revise a prior mental construct (conceptual knowledge such as attitudes or values).

Learning in human beings usually takes place in the following ways:

Learning by example: Imitation of a role model is a natural mechanism for infants and children, when learning from experience.

Learning by worked examples: Worked examples in books showing exactly how the author solved problems, step by step, for example, in mathematics. Such examples may help explain methods in different ways

Learning by teaching: Teachers share new lesson content with groups of students who may prepare on their part in order to teach this content to the rest of the class.

Learning which alternative methods exist: Sometimes different methods can be applied to solve a particular problem. These methods need to be pointed out by the teacher, in which case the student should also be made aware of how to select the "best" method from among those available, and which textbooks are likely to be especially helpful.

Learning which shortcuts exist to solve specific problems: Sometimes shortcut sexist that can reduce by many hours the solution of practical problems. For example, Maxima and minima of functions can be obtained "the hard way" by a whole series of numerical calculations, while the use of calculus is often a shortcut.

The agent based e-learning system is meant to tackle the e-learning problem faced by the university students during the process of e-learning. The project will revolve around using Internet technologies in its quest to solve the problem. In this section, related literature is

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
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reviewed to help in the analysis, design and development of a prototype Agent based e-learning for St Paul University.

2.2 E-LEARNING

Fry (2000 p15) defines e-learning as delivery of training and education via networked interactivity and a range of other knowledge collection and distribution technologies. E-learning allows you to learn anywhere and usually at any time, as long as you have a properly configured computer. E-learning can be CD - Rom-based, Network-based, Intranet-based or Internet-based. It can include text, video, audio, animation and virtual environments. It can be a very rich learning experience that can even surpass the level of training you might experience in a crowded classroom. It's self-paced, hands-on learning.

2.2.1 E-Learning modalities

There are different forms of e-learning modalities which students can choose from:

- Individualized self-paced e-learning online refers to situations where an individual learning is accessing learning resources such as a database or course content online via an Intranet or the Internet. A typical example of this is a learning studying alone or conducting some research on the Internet or a local network.
- Individualized self-paced e-learning offline refers to situations where an individual learning is using learning resources such as a database or a computer-assisted learning package offline (while not connected to an Intranet or the Internet). An example of this is a learning working alone off a hard drive, a CD or DVD.
- Group-based e-learning synchronously refers to situations where groups of learning are working together in real time via an Intranet or the Internet. It may include text-based conferencing, and one or two-way audio and videoconferencing. Examples of this include learning engaged in a real-time chat or an audio-videoconference.
- Group-based e-learning asynchronously refers to situations where groups of learning are working over an Intranet or the Internet where exchanges among participants occur with a time delay (not in real time). Typical examples of this kind of activity include on-line discussions via electronic mailing lists and text-based conferencing within learning managements systems.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
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https://doi.org/10.20943/01201703.0000.1

2.3LEVELS OF E-LEARNING

There are different forms in which e-learning is offered:

2.3.1Asynchronous e-Learning

This type of e-learning allows people learn at any time. It includes the following ways:

- Self-Paced Courses

The obvious advantage of a self-paced course is convenience. People can get the training they need at any time. This can include just-in-time training where a person gets exactly the training he needs to perform a task. Self-paced courses are created with e-learning authoring tools. Self-paced courses can be delivered in many ways including: Internet, Intranet or local area networks.

Self-paced courses usually have these features:

i. Multimedia: A mix of text, graphics, animation, audio and video to enhance the learning process
ii. Interactivity: An instructional strategy that helps a learning practice what they have learned
iii. Bookmaking: Lets the learning stop the course at any time and restart it from the same point
iv. Tracking: Report the learning's performance within a course to a Learning Management System (LMS)

This mode of e-learning has challenges.

Many people need external motivation to take and complete a course of study. Since self-paced courses can be offered without a teacher and without a required completion time there may be many learners who will not enroll or complete the course work.

You must be sure that there are professional and/or personal incentives for your learners to take and complete self-paced courses. Some people need help understanding the learning material presented in a course. Since self-paced courses can be offered without teachers, those people may fail to learn.

You will need to provide experts who can answer their questions.

The learning management software is also expensive, and an expert has to manage it.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
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https://doi.org/10.20943/01201703.0000.1

- **Discussion Groups**

A discussion group is a collection of conversations that occur over time. Other names for discussion groups are message boards, bulletin boards and discussion forums. A discussion group might start out as a question from an individual. Sometime later, another individual responds to that question. Others can respond to the question (creating a thread) or they can start their own conversation (forming another thread). A threaded discussion might also start with a teacher asking an open-ended question that leads to a class discussion. Discussion groups can be used to support a group of people taking the same class or can be used to support people performing similar tasks. A discussion group is a very efficient way to provide expert answers to a large group people. A single answer to a common question can benefit many.

Challenges of a discussion group

Learners are more apt to multitask since the instructor cannot see them opening other applications, taking phone calls or balancing their checkbooks. These types of things couldn't be done in an instructor led training. The online instructor must ask for interaction from the learners often to keep them engaged in the training. This can waste valuable training time in order to just verify your trainees are paying attention.

Making certain that the technology is available for everyone attending the class online ensuring all the computers are properly equipped, have the right software and reliable power and internet source to connect to the class and participate.

2.3.2 Synchronous e-Learning

This method of e-learning allows teachers to conduct classes over the Internet. The synchronous technologies also allow people to interact with peers and experts.

- Virtual Classroom

A virtual classroom duplicates the capabilities found in a real classroom. A virtual classroom provides a place to meet and students and teachers use their computers to go to a virtual meeting place instead of a classroom.

Synchronous learning can take place in the following ways:

i. Audio and Video Conferencing

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

ii. Computers connected to the Internet. Common names for this kind of implementation are IP Audio Conferencing or Voice-over-IP.

iii. Chat: allows several people to communicate with each other. Each participant uses a computer to type their comments. The other participants can see the name of the person and their comments.

Synchronous e-learning has challenges.

Rourke and Anderson (2002) found that difficulty in conducting synchronous learning is due to different time zones .Inability to access Internet services (Kearsley & Rumble 2000).

A case study done shows that the Internet penetration rate in Malaysia is only 31.8 % (Phang, 2004). Bose (2003 p15) mentioned that, while it is feasible to access to high-speed bandwidth within the university campus, it becomes a problem outside the campus, where Internet facilities are less sophisticated. Uys (2003) stated that limited telecommunication infrastructure and facilities are hindering the e-learning process.

Chadha and Kumail (2002) found that technological barriers, such as limited bandwidth, are issues in e-learning today, even with fast DSL connections introduced to replace outdated 14.4 Kbps bandwidth. Roy (1996, p.9) provided another example of a slow connection when students in Rhode Island and Green Island could not provide answers for their instructor during an online discussion session. The limited bandwidth may hinder the learning process as the downloading of multimedia materials may take a longer time.

Several authors writing on e-learning agents have demonstrated that using agent will be very beneficial to the e-learning environment. The aim of writing this thesis is to demonstrate how agent can improve e-learning in particular to meet the student learning needs by extracting the right content for particular student using agents.

Agents are active, persistent software components that perceive, reason, act, and communicate with people and act on their behalf. Papazoglou,(2001) states that Agent characteristics like autonomy, abilities to perceive, reason and act in specialized domains, as well as their capability to cooperate with other agents makes them ideal for e-learning applications. Agents can hide the complexity of difficult tasks, perform tasks on the user's behalf, train or teach the user, help users collaborate, or monitor events and procedures (Maes,1994).

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ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

The Multi Agent Systems adapt well to the design of our learning environment because:

i. The distance learning systems are open, dynamic and complex;
ii. Agents are a natural metaphor of human acts;
iii. The distribution of the data, control and the expertise is self-imposed;
iv. Agent has a high-level representation of behavior

2.4 LEARNING NEEDS

Learning needs is additional support to assist students who might otherwise be unable to access a program of study or who, by reason of their learning difficulty or may require extra support beyond that normally provided by the College. This support will assist students to realize their full academic and personal potential. There are various ways of offering Learner support:

2.4.1 TYPES OF SUPPORT NEEDED IN E-LEARNING

E-Learning has some restrictions on how learning performance is assessed. Online testing is usually in the form of multiple-choice questions assessment. Major reasons for employing multiple-choice tasks in e-learning include ease of implementation and ease of managing learner's responses. (GMorgan,2003) argues that three types of communication in particular are important for supporting e-learning communities: content-related communication, planning of tasks, and social support.

I. Communication related to the course content is essential for learning. Just as in traditional education, e-learners need to be able to ask questions and share information and ideas.
II. Support for planning tasks is essential, especially when learners produce some kind of product, such as an assignment, in collaboration with peers.
III. Finally, social support relations are desirable for creating an atmosphere that fosters collaborative learning
IV. It also uses feedback as learning performance assessment. Feedback about student achievement can help the tutor reflect on instructional methods used and help plan the next educational steps to take. In fact, without the information gained from valid

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
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https://doi.org/10.20943/01201703.0000.1

and reliable assessments, an instructional program cannot be responsive to the needs of the students. Assessment information allows the teacher to find out whether their instruction is helping students meet criteria of mastery or make acceptable progress along academic continuums.

V. As for any large investment in technology, there needs to be a robust infrastructure so that the system is available whenever it is needed which will not only be from 9 am to 5 pm on weekdays. A VLE will become an MLE if it is integrated with existing information technology systems that is, the main campus network, email, library, student records and other online resources and if a single username and password will sign the user

VI. Curriculum design and development : Each course includes an outline at the beginning, presenting all chapters, and a conclusion summarizing the highlights of the course. Similarly, each chapter has an outline and conclusion. To provide learners with a better orientation, outlines can be presented additionally after each chapter or after each learning unit.

VII. Content objects represent the content of the course in small pieces, including also outlines and conclusions. Content objects can include text as well as all kinds of images to support learners. Additionally, the objects can contain content links, for example to additional information about the current concept or to related topics. By providing these links, learners have the possibility to relate the learned material to other topics and to get additional information.

2.5 PROJECT USING AGENT-BASED DESIGN FOR E-LEARNING ENVIRONMENT

Harbouche, K, A & Hamdi_chief (2002) states that the aim of this approach was to allow many users to interact collectively and intelligently with the environment. In this cooperation model, human users and artificial agents carry out tasks in the learnings service. They define the internal structure of our kernel supposed to work within Internet/Intranet settings. Design in this e-learning approach was structured in three parts: Individual learning space, collaborative space, and cooperative space.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
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The employment of an agent-based approach is advocated for two main reasons: agents were a natural metaphor of human acts, and the learning systems are generally complex.

This environment has to take into account problems underlined by different forms of distance learning, such as: the sociological isolation of the learning, the loss of motivation and the learning independence. Create necessary means to make of a distance situation, a reasonable equivalent of a face-to-face situation while allowing more suppleness in comparison with the constraints of time and space Propose means to attend and accompany learning and to replace the teacher during a working session Re-aim groups of learning in a productive direction pay attention to the members left out of the Correlation.

Augment and favor correlation between different agents human and artificial Coordinate cooperative tasks between learners. An environment is a space representing the world in which the agents evolve. Two types of agents were involved agents who are active entities, and passive objects, which are located in the environment.

The system was developed to:

- Interact with pedagogic users learners and teachers, display appropriate screens, - Output results, questions.
- Manage access and updating of the persistent information
- Assist and orient the learning during an assisted exercise resolution session following upon the request of the learning or the thinking time or a learning erroneous answer.
- Explain the course to the learning.

Manage whole project topic realization through proposing a calendar of the tasks, animating the dialogue and take care and motivate the learning who has left apart from the interaction by dividing pursuit and synthesizing the project. Ensure synchronous and asynchronous communication between members that manages the meeting time taking account of the availability of the various actors and to form the Working groups and elect the group. The following agents can be used:

- **Artificial agents:** These agents have to communicate with the users “actors”, make decisions, assist learnings, help teachers, consider and modify the users Database “DB”, access to the Knowledge Base

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- **User Interface:** This agent will get, announce and return available information relating to the user needs "Percepts: request, choice, time out; actions: response and sending information".
- **Assistant Companion**: It will assist the learning, to orientate him in the resolution of the assisted exercises, to answer his questions directly and dialogue with him "subcontracting of the teacher".
- **The collaborator:** It notices and diagnoses correlations between learnings of the same group. To re-aim the group in a productive direction and pay attention to the members left except correlation and save the group session work "delegated by the teacher".
- **Communication:** Manage synchronous/asynchronous, confidential/public communications, between the different dealers.
- **Evaluator:** It evaluates MCQs, returns result instantly and updates the learning valuation file substitute of the teacher.
- **Cooperation:** It facilitates co-operative work between working groups, and updates the project file delegated by the teacher.
- **Scheduler:** It finds suitable meeting time according to the groups chief disponibility, schedules meetings according to a preset or improvised planning "programs, cancels or defers", inform the chiefs, and warns the absents.
- **Updater:** It updates the pedagogic contents exercises and lectures.
- **Election:** It forms the Working groups, updates the election box and returns the result of the election.
- **Supplier:** It performs access to the Database.
- **Assisted exercise resolution**: The learning can choose the exercise to be solved. A time of thinking is allotted to him. This time is variable according to the exercise and its degree of complexity. Four spaces are placed at the disposal of the learning.

The first space allows displaying the body of the exercise.

The second space is intended for the question/response between the companion and the learning.

The third space makes it possible progressively to display the dialogue, which proceeded during the exercise resolution session.

The fourth space is intended to the progressive helps shown to the learning.

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Relationships: One of the thorniest points in any agent based application is to depict the relationships between various agents human or artificial and the knowledge. These relationships allow determining when and how different agents have to pass the relay to each other's.

- A methodology is proposed for the development of multi-agent systems using the JADE platform. The proposed methodology focuses on the key issues in the analysis and design of multi-agent systems. The analysis phase is generic in nature, while the design phase specifically focuses on the constructs provided by the popular FIPA-compliant JADE platform. The methodology essentially serves as a guide, providing a direction for the multi-agent system designer, while also giving them the opportunity to add or remove components as desired, based on the specific problem domain. In contrast to current methodologies, support is also provided for existing systems and people to be included and accounted for in the multi-agent system.

- The methodology is illustrated by applying it to a hypothetical but illustrative scenario. Moreover, it is presented in such a way that designers new to the field of agent-based computing and the JADE platform can quickly grasp the most important concepts in the development of a multi-agent system. Similarly, people currently familiar with the JADE platform can also benefit from the methodology, which, when applied, should lead to a significant reduction in system development time.

- There are four fundamental phases to the software development lifecycle: planning, analysis, design, and implementation. When implementing the software development lifecycle, it is often useful to have some formal guidelines (i.e. a list of steps and deliverables) on how to progress through these phases. This is the task of a methodology.

- A methodology saves time and effort by crystallizing the important steps that the designer should follow, and as a result, providing them with the right "direction". A methodology, thus, essentially acts like a "recipe," which helps the designer to implement the solution by specifying some of the steps of the process, while leaving others to the creativity of the designer .The importance of a methodology in the software development cycle can, therefore, not be overstated.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
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The design phase specifically focuses on the JADE platform, and the concepts provided by it. JADE is the abbreviation for the Java Agent Development Framework and has been developed by the Telecom Italia Lab (TILAB) in Italy, in compliance with the FIPA (Foundation for Intelligent Physical Agents) specifications. FIPA is a non-profit organization geared at producing standards for the interoperation of heterogeneous agents. Essentially, JADE is a middle-ware (written entirely in the Java language, using several Java technologies), which simplifies the implementation of multi-agent systems by providing a set of graphical tools that support the debugging and deployment phases.

Agent has the following properties:

- Autonomy: agents operate without the direct intervention of humans or others, and have some kind of control over their actions and internal state.
- Social ability: agents interact with other agents (and possibly humans) via some kind of agent communication language.
- Reactivity: agents perceive their environment and respond in a timely fashion to changes occurring therein.
- Pro-activeness: in addition to acting in response to their environment, agents are able to exhibit goal-directed behavior by taking the initiative.

System Implementation is the phase during which:

- The hardware and software system components are installed;
- The selected software is configured and tested;
- The software may be customized to meet local functional requirements;
- Data mapping, cleansing and migration take place;
- Reporting requirements are specified and reports produced;
- The whole system is tested before being approved, signed off and becoming a fully operational production system.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
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2.6 WHY LEARNING SUPPORT SYSTEM USING AGENTS FOR THIS STUDY?

The learning support system is based on synchronous group-based e-learning. The learning support system consisted of:

Learning Agent: This is an intelligent agent that makes exams available for the students at the end of the chapter, submits the answered questions to the tutor agent and monitors the learning progress of each individual student throughout the learning process.

Course management Agent: This agent will act as an interface between the teacher, student and the e-learning environment. The agent will manage the learning process for example determines the next available learning material, and then retrieves the required learning resources for individual students and also sends the log in progress to the tutor agent.

Tutor Agent: Evaluates the learning performance of the students by reviewing the exam marks, if performance is lower than the minimum threshold the students will need to retake the assessment.

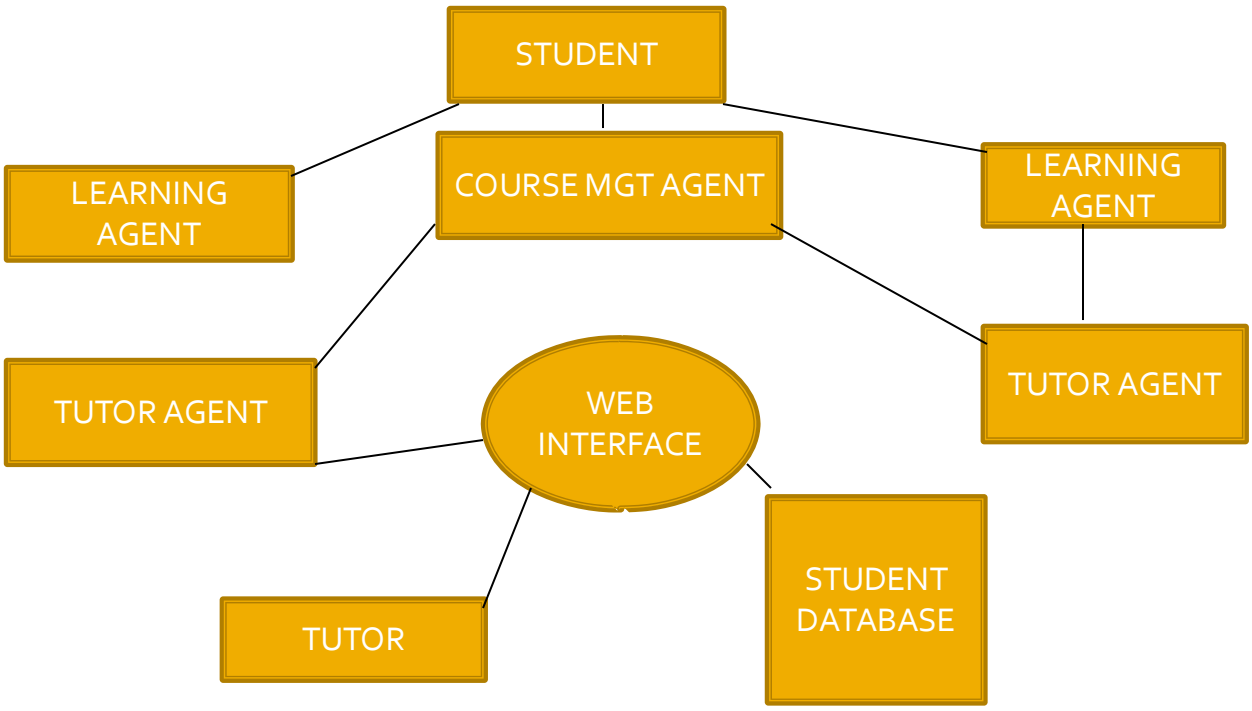

Figure 1: The Developed System

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

2.7AGENT ARCHITECTURE

Agent Architecture proposes a particular methodology for building an autonomous agent. How the construction of the agent decomposed into the construction component modules, how the modules should interact.

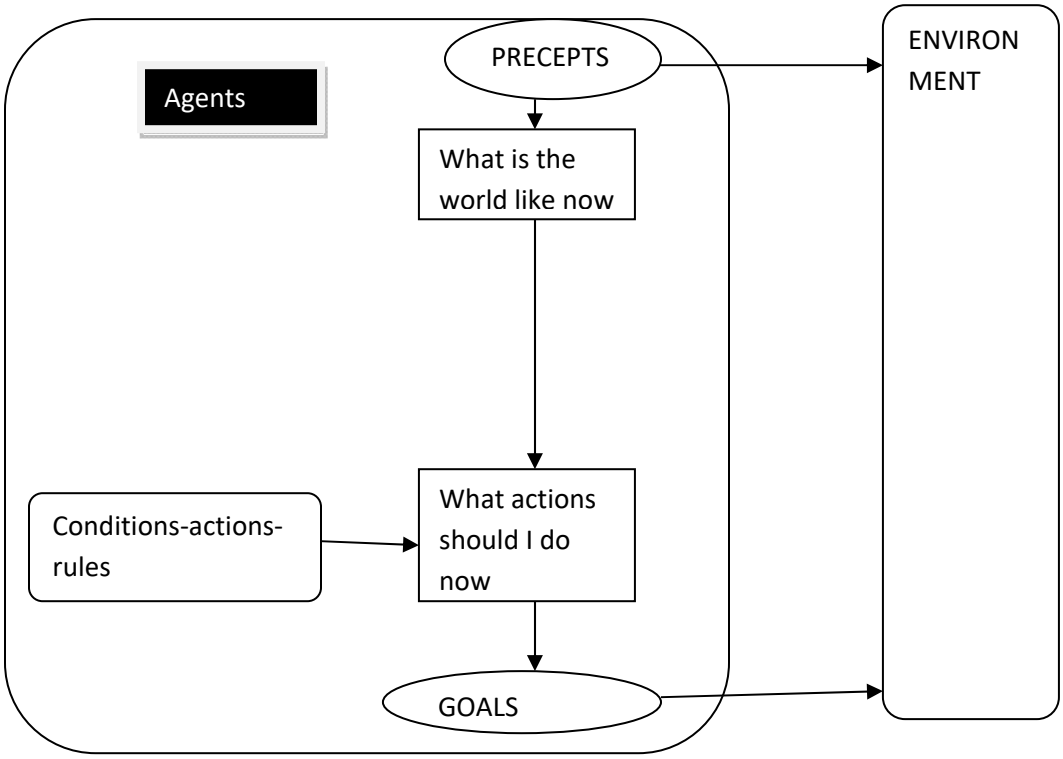

Figure 2: Agent architecture

- **Precepts**

  The multiagent system should be able to observe all the rules accordingly e.g, Is the student eligible to do exams?

- **Goals**

The multi agent system seeks to address various goals. Some of the goals defined in the agent architecture are:

I. The students are able to access notes

II. The students are able to log in

III. The students are able to do exams

- **Environment:** The Agents are operating in an e-learning environment.
- **Actions**
  - **I.** The students should read
  - **II.** Exams should be marked
  - **III.** Students are able to submit comments
  - **IV.** Tutor is able to see comments and act accordingly

2.8 SUMMARY

This chapter has looked at the e-learning guidebook as part of the literature review .Limitation of e-learning and the e-learning consulting. A lot of emphasis was placed on the different types of e-learning forms (methods). The next chapter will look at the methodologies that will be adopted to realize the agent based e- learning support system.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This agent based e-learning support system is based on a study of the St.Paul University fourth year students taking Bachelor in Business Information Technology. The students taking the e-learning courses particular in a course unit known as Database management system exam marks are analyzed and evaluated. An exam is done by the students in class, after the end of the session; the results are an instant feedback that the students receive after the session.

The students will be evaluated through the following ways:

Formal feedback on test from the tutor: Depending on what grade the students attains, a criteria will be used to determine whether the student needs more course material or not. In this method the following criteria is used:

Table 1: Students Marks Criteria

Marks OUT OF 50	Remarks
40	PASS
30-25	FAIR
24 AND BELOW	REPEAT THE UNIT

The marks will also be attached with condition on the no of log in the student have attained when accessing the notes.

The population of the agent based e learning project for the St Paul University students comprised of:

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ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

Table 2: Students Population

Category	Population
Students	60

3.2 RESEARCH DESIGN

This is concerned with turning the research question into a testing project. In this research experimental design was used. In experimental design the researcher actively tries to change the situation, circumstances or experience of participants (manipulation), which leads to a change in behavior of the participants of the study. The participants are assigned to different conditions, and variables of interest are measured. All other variables are controlled Experiments are normally highly fixed before the data collection starts.

3.3 DATA COLLECTION

3.3.1 Questionnaire

The questionnaires were also distributed to the students. In executing the questionnaires, a time frame was provided and agreed with the respondents.

An answer to questions was cross checked and analyzed using descriptive statically method.

This method was adopted because it is cheap, respondents can be reached conveniently and it also enabled reach a larger sample thus making results more dependable. The data collected was then subjected together with questionnaire of the current learning support system analyzed and comparison made with data received from the agent based e-learning support system. The analyzing of the questionnaire was done using descriptive statistics method, compute predictions for binomial response from the data collected. Testing of Agent based e-learning system is done by comparing the previous e-learning system functionality and the Agent based e-learning support system, this took place by:

Students were assigned username and passwords to help them access the agent based system

The students accessed the uploaded notes online, after which they were expected to undertake a test after each chapter. Student have filled the questionnaires, these questionnaires were analyzed. The feedback of the students will determine part of the project success.

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ISSN (Online): 1694-0784
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3.4 SYSTEM DEVELOPMENT METHODOLOGY

This is a framework that is used to structure, plan, and control the process of developing an information system. E-learning agent based system was be implemented using Prometheus methodology, inference rules and JADE platform. The agent platform can be distributed across multiple machines, regardless of the underlying operating system, and the configuration controlled via a remote graphical user interface. More information on JADE can be found later in the methodology. By specifically focusing on the JADE platform in the design phase, the designer can move straight to implementation afterwards, without having to tediously adapt the results of the design phase to an agent platform of their choice. This will obviously result in significant time gains for the designer, in addition to providing them with a much clearer picture on how to progress in implementation.

3.4.1 The following are stages taken from Analysis to Implementation

Planning is the early stages of the software development cycle, where it is decided which tool (e.g. which programming paradigm) to use, and an assessment is made on whether an agent-based option (among other options) is the most appropriate solution tool. The proposed methodology is presented as follows: This section gives an overview of the methodology, while also outlining the assumed definition of an agent and the hypothetical example used to illustrate the methodology (Section 2.2). Section 3 outlines the steps in the analysis, while Section 4 outlines the steps in the design. Section 5 gives some brief indicators on the post design stage. Section 6 gives details on how the methodology could be adapted to other agent development platforms. Finally, in Section7 some conclusions are presented, and further work discussed.

The analysis phase is general in nature and independent of the adopted platform One or more tools that and, where relevant, some heuristic rules and design patterns are presented. The described process covers the analysis phase and the design phase and is shown. Conversely, the design phase specifically assumes JADE as the implementation platform and focuses directly on the classes and concepts provided by JADE (for other platforms, see Section 6). Observing Figure 1, it can be seen that there is no strict boundary between the analysis and design phases. Moreover, the methodology is of an iterative nature, thus allowing the designer to move back and forth between the analysis and design phases and the steps therein.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
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At the end of the design phase, the developer should be able to progress straight to the implementation, which is where the actual coding occurs. In addition, most of this phase can probably be carried out by means of a Information proper tool which automates the implementation process. The planning stage, like implementation and testing, is not formally addressed in the proposed methodology. However, for the sake of the methodology, a question is included (see Figure 1), which initially asks if the designer has made a rational decision on whether to use an agent-based solution. If the answer is yes, the designer moves on the analysis, while if the answer is no, the designer should seek an alternative solution4. Obviously planning, which is the first phase in the software development life cycle, will entail many other considerations. For the sake of analysis and design though, the only assumption required in the proposed methodology is that an agent-based solution has been chosen as the best alternative.

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ISSN (Online): 1694-0784
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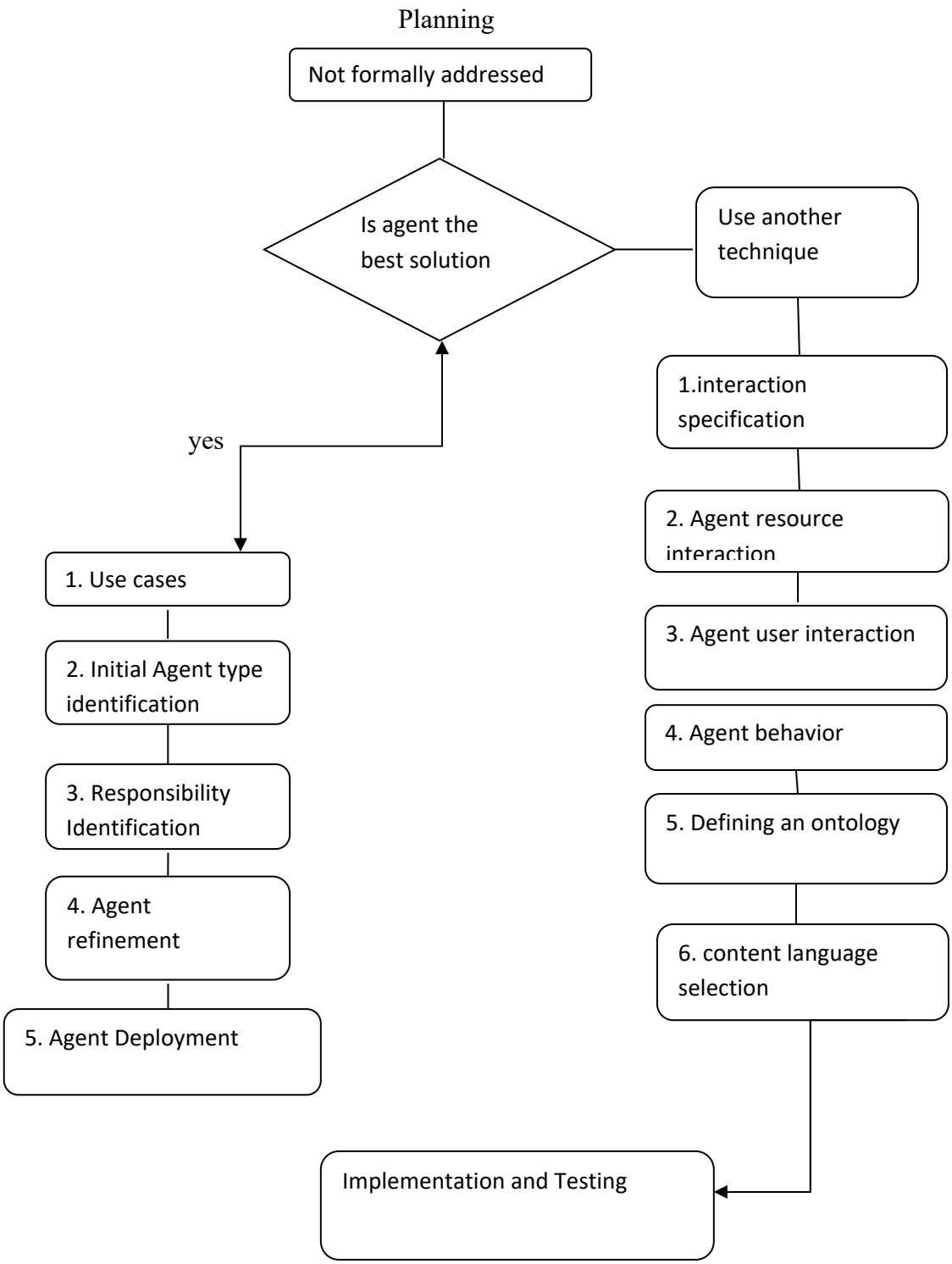
Figure 3: Steps for designing an agent-based system



IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
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The Multi Agent Systems adapt well to the design of our learning environment because:

- The distance learning systems are open, dynamic and complex;
- Agents are a natural metaphor of human acts;
- The distribution of the data, control and the expertise is self-imposed;
- Agent has a high-level representation of behavior
- Agents reside on a platform that, consistent with the presented vision, provides the agents with a proper mechanism to communicate by names, regardless of the complexity and nature of the underlying environment (i.e. operating systems, networks, etc).

Thus, the assumed view is exactly the same as that presented in,but in addition, the agents have unique names as a means of identification. This particular view of agents is the only assumption for analysis, while the design is specific to the JADE platform, which is a FIPA-compliant realization of the above vision, i.e. in the design phase, the constructs provided by the JADE platform are assumed.

3.4.2 The Prometheus Methodology

Prometheus is a Goal-Oriented approach, is an example of system development methodology used to design this agent based system, where roles are identified from the analysis of system goals. It supports the design of BDI systems, although it is not limited to such; all but the lowest level of design, leading into code, can be used equally well for non-BDI systems. The use of Prometheus was beneficial thanks to its usability, refinability, the Multi Agents System environment modeling and the agents' environment. The Prometheus methodology consists of three phases which will be used for design and development of the system:

- System Specification: the system will be specified using goals and use case scenarios; the system's interface to its environment is described in terms of actions, percepts, and external data; and functionalities are defined.
- Architectural design: The agent types are identified; the system's overall structure is captured in a system overview diagram; and use case scenarios are developed into interaction protocols.
- Detailed design: where the details of each agent's internals are developed and defined in terms of capabilities, data, events, and plans; process diagrams are used as a stepping stone between interaction protocols and plans.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
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3.5 ANALYSIS

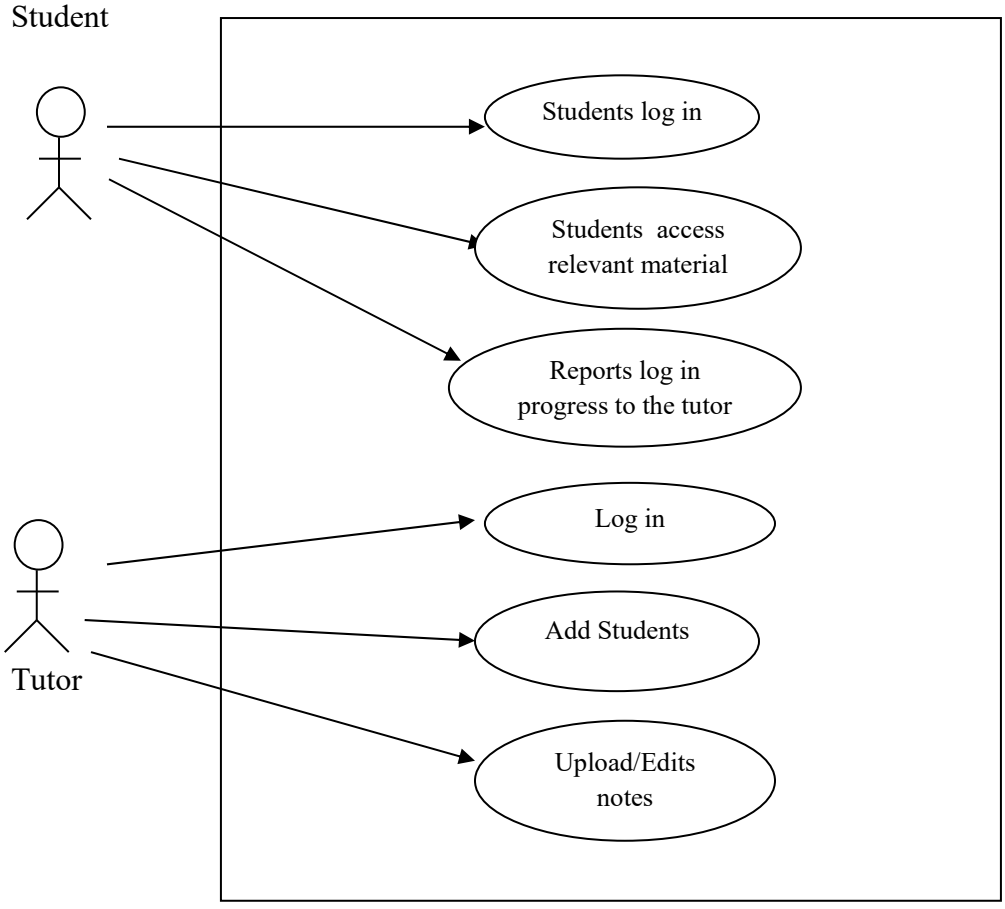
The analysis phase aims to clarify the problem without any concerns about the solution. In the , the analysis phase is carried out through a number of steps.

STEP 1: Use Cases

Use cases are an effective way to capture the potential functional requirements of a new system. Each use case presents one or more scenarios that demonstrate how the system should interact with the end user or another system to achieve a specific goal. There are a number of standards for representing use cases. The most popular is the Unified Modeling Language specification, which defines a graphical notation (as an alternative, it is also possible to produce written use cases). Though use cases are used extensively by object-oriented practitioners, their applicability is not restricted to object oriented systems, because they are not object orientated in nature Hence, it is also possible to apply use cases (without modification) to capture the functional requirements of multi-agent systems.

Accordingly, the use cases can be defined, and a use case diagram produced as shown in Figure below;

Figure 4: Learning Based Support Use Case



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ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

STEP 2: Initial Agent Types Identification

This step involves identification of the main agent types and subsequent formation of a first draft of the agent diagram. The following rules should be applied in this step:

Add one type of agent per user/device.

Add one type of agent per resource (which includes legacy software).

STEP 3: Responsibilities Identification

In this step, for each identified agent type, an initial list is made of its main responsibilities in an informal and intuitive way. The artifact resulting from this process is the responsibility table. Derive the initial set of responsibilities from the use cases identified in Step 1.

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ISSN (Online): 1694-0784
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Table 3: Agent Responsibilities

Agent Type	Responsibilities
Course management Agent	acts as an interface between teacher, student and the e-learning environment manages the learning process eg determines the next available learning material, and then retrieves the required learning resources for individual students Report the student log in progress the to the tutor agent
Learning Agent	make test available for the students Submit the answered questions to the tutor agent monitors the learning progress of each individual student throughout learning process
Tutor Agent	Evaluates the learning performance of the students by reviewing the exam marks and the login hours, if performance is lower than the minimum threshold the students will need to retake the assessment.

STEP 4: Acquaintances Identification

In this step, the focus is on who needs to interact with whom and the agent diagram is updated by adding proper acquaintance relations connecting agents that need to have one or more interactions. This phase is the architectural design in the Prometheus methodology.

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ISSN (Online): 1694-0784
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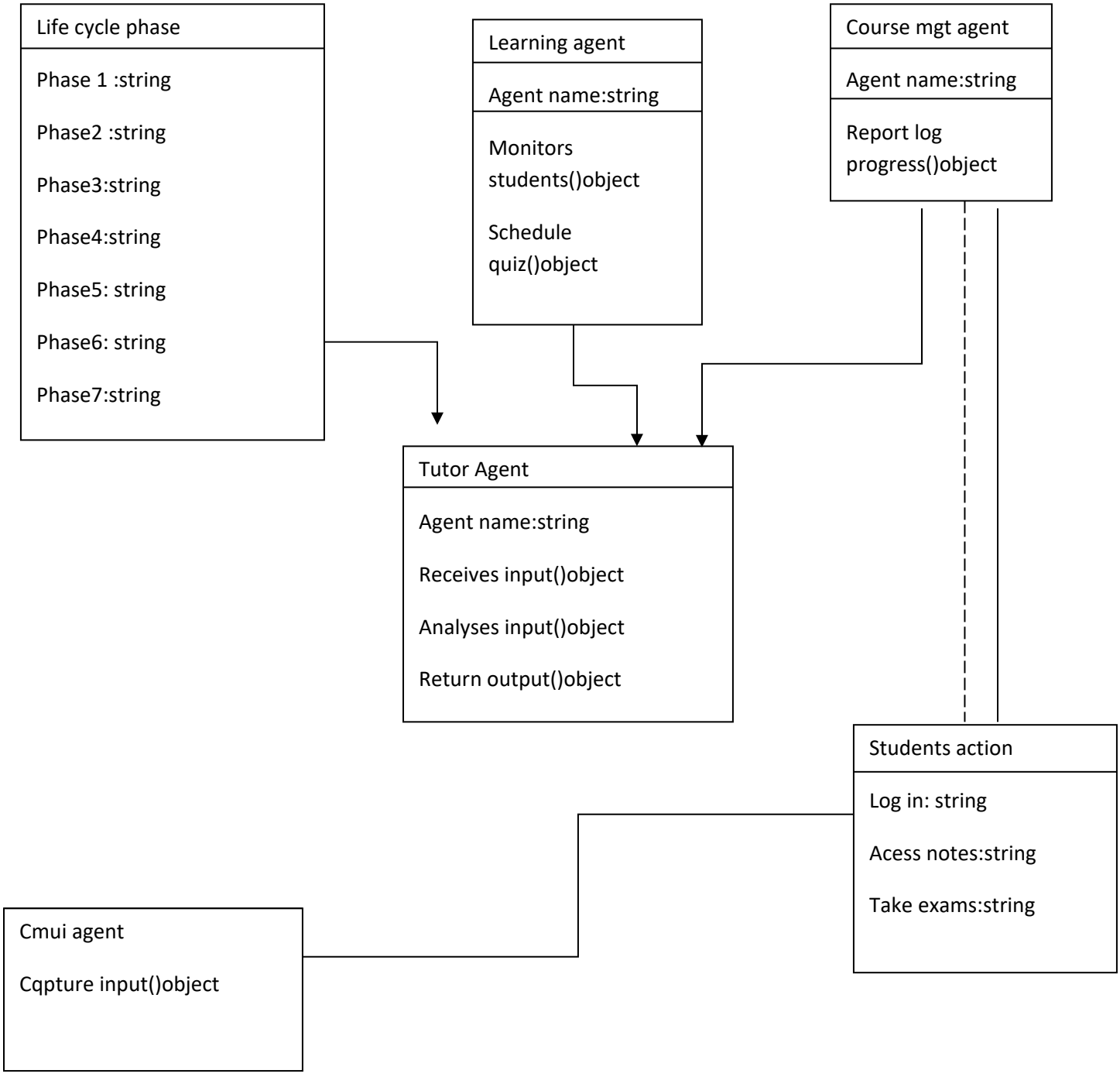
Figure 5: Learning Support System Class Diagram

LEARNING SUPPORT SYTEM CLASS DIAGRAM



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ISSN (Online): 1694-0784
www.IJCSI.org
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STEP 5 Detailed designs:

This is where the details of each agent's internals are developed and defined in terms of capabilities, data, events, and plans.

PHASE_ONE - The students logs in

PHASE_TWO - The course management agent gives relevant materials to the students

PHASE_THREE- The course management reports the log in progress to the teacher

PHASE_FOUR - The learning agent monitors the learning progress of the student

Check if the day quiz are scheduled

PHASE_FIVE - The learning Agents makes quiz available to the students and notify the tutor agent the student has finished exams

PHASE_SIX - The tutor agent analyses the performance of the student

PHASE_SEVEN- The tutor Agent determines whether the student needs extra notes or not.

STEP 6 Design Phase

Once the problem was clarified to a sufficient level of detail, a move was made from the analysis to the design phase, which aims to specify the solution. There is not a strong boundary between these two phases, and while iterating on the analysis or design, one can move between the two.

Carrying out the design phase allowed me to reach a level of detail that is sufficient enough to have a relatively straightforward transition to the implementation, with the possibility of a significant amount of code being generated by an automatic tool.

Similar to the analysis, the design phase was carried out by following a number of logical steps, with a certain degree of overlap. The steps in the design phase are discussed in details below:

- **Agent Splitting/Merging/Renaming**

This step involves observing the artifacts produced in the design phase and determining Whether the agent types produced in the agent diagram should be split or merged. This step is considered important, since it has a direct effect on overall system efficiency and complexity. Based on this, the following rules should be applied in this step:

Data duplication should be avoided. If there are two or more agents that share a

Large majority of the information required to carry out their tasks, these agents can possibly be merged into a single one.

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ISSN (Online): 1694-0784
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Duplication of code to access resources should be avoided. If there are two or more agents that need to access the same resource, these agents can possibly be merged.

Avoid splitting agents unless there are good reasons for doing this, Dealing with too many agents increases the overall system complexity and decreases system efficiency since unnecessary communication between agents will possibly take place.

Each agent is situated on a single machine. A major factor which leads the splitting of an agent is deployment issues. If two pieces of functionality must be provided on different machines, these pieces of functionality must be provided by different agents.

Avoid having agents that are too big and complex. This makes them difficult to design and to maintain.

In the case of the learning support system case study, there are a relatively small number of agent types identified in the analysis phase. Hence, splitting or merging of agent types is not considered to be a major issue.

- **Interactions Specification**

In this step, for each agent type, all responsibilities that are related to an acquaintance relation with another agent (based on the responsibility table produced in analysis) are taken into account and an interaction table is produced for each agent type. Each row in the table will represent an interaction and will include:

A descriptive name for the interaction The responsibility (identified in the responsibly table produced in the analysis phase) that originates this interaction. This links design artifacts to analysis artifacts and can be used later to check consistency.

A suitable interaction protocol is chosen to implement the interaction. The standard FIPA interaction protocols should be considered as a candidate first. If none of these protocols are deemed suitable, an ad-hoc interaction protocol should be defined, as described in Step 3 of the design phase.

The agent type and name (if relevant) of the complementary role. The trigger condition, i.e. when this interaction takes place. This condition should be expressed in an informal but descriptive way.

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ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

- **Message Templates**

All the interaction protocol roles identified in the previous step are implemented as JADE behaviors. In this step, suitable Message Template objects are specified to be used in these behaviors' to receive incoming messages, and these templates are added to the rows of the interaction table. The following rules should be applied in this step:

• Message Templates are used based on the conversation ID in behaviors implementing initiator roles .

• Merge in a single behavior responder roles dealing with the same combination of initiation message performative, ontology, and language.

• Message Templates are used based on the above combinations of performative, ontology, and language, in all always-active behaviors implementing responder roles.

• Analyze conflicts and modify Message Template used in responder behaviors'.

It should be noted that at this stage some assumptions are made about the ontology and language used in the system when specifying the templates.

- **Agent-Resource Interactions**

It is often the case that one or more agents in the system must interact with external resources such as databases, files storing information, or legacy software. In some cases some hardware appliances must be controlled or monitored, but this always happens through some dedicated software that actually hides the hardware behind it. Agents interacting with external resources have been identified in the analysis phase and are expressed in the agent diagram by an acquaintance relation with a resource element. Such resources can be classified into two main categories:

• Passive resources: resources that change their status only as a consequence of some stimulus issued by the agent controlling the resource itself.

• Active resources: resources that may change their status independently from the controlling agent.

- **Passive Resources**

Examples of passive resources are a database fully controlled by the interacting agent, a data file in the local file system or a C library providing computational functions. Interacting with passive resources is out of the scope of this methodology. Moreover, a JADE agent is, in effect, a piece

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ISSN (Online): 1694-0784
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of Java code and standard Java techniques can be used to handle these cases. For example, in the case of a database, MYSQL is used for database connectivity purposes, this also depends on the database management system used, in the case of a data file java.

- **Active Resources**

Examples of active resources are a database where a human operator (or an external program) can insert or modify data, a log file continuously filled (updated) by an external program, an appliance that can raise alarms and software controlling a sensor detecting changes in the local environment. Active resources may provide a listener-based interface so that the controlling agent can immediately detect changes inside the resource. In other cases, the resource may provide an interface with methods that block until a change is detected, e.g. a network socket where some data is expected to be received. Finally, in certain cases the only way to detect relevant changes in an active resource is to periodically poll the resource itself. Though several approaches are possible to deal with active resources, a single approach is proposed, which attempts to homogenize all the possible combinations of cases described above. This approach is based on the following rules:

• If no listener-based interface is available, use a dedicated Java thread, or pool of threads, to emulate it, i.e. to detect relevant changes inside the resource and act as listener notifier.

• Provide the notifier with a listener implemented so that each call from the notifier results in adding a proper Behaviour to the agent according to the Listener adding behaviours pattern

• Use a jade.util.Event object and its waitUntilProcessed() and notifyProcessed() methods to synchronize the listener and the added Behaviour when a result (produced by the behaviour) must be passed back to the notifier as the return value of a method of the listener interface.

The proposed approach is quite flexible and avoids synchronization problems between the notifier threads and the agent thread since all relevant operations are carried out by the agent thread within the added behaviours. Moreover, using different behaviours to serve the events generated by the notifier transparently deals with the case where the notifier holds several threads that may notify events concurrently.

- **Querying a Relational Database**

A particular case that deserves some more consideration is that of a relational database.

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ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

Since querying a database is typically performed using a very flexible language such as SQL, MySQL, This case study uses SQL for its database implementation. An agent wishing to retrieve information from the database should send a query expressed in that, on its turn, should translate it them back to the initiator. However, expressing SQL queries in SL is definitely not a trivial task and typically one ends up with mapping all possible queries that other agents may wish to perform on the database to dedicated actions, thus making the domain ontology much more complex than it should be.

The proposed solution preserves the full power of SQL/JDBC without the need for embedding JDBC code (and the related complexity) inside all agents that need to perform queries on the database.

STEP 7: Agent-User Interactions

In many cases, an agent needs to interact with a user. Agents interacting with users have been identified in Step 2 of the analysis phase and are expressed in the agent diagram by an acquaintance relation with an actor element.

There are several ways a human user can interact with a piece of software such as a JADE agent. Here, the focus is on the graphical user interface (GUI), which is by far the most commonly used type of user interface.

A web GUI implemented using JSP technology was used in the development of an agent based system.

- **Web GUI based on JSP**

This section provides guidance about the development of a web interface to a JADE multi-agent system implemented using (JSP) technology .The proposed approach is based on the creation of a dedicated agent inside the JSP, acting as gateway between the JSP and the JADE world (i.e. the other agents in the system). A web interface was provided for to help students acess notes as well as exams.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
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STEP 8: Internal Agent Behaviors

The actual job an agent has to do is typically carried out within the agent's "behavior(s)". Hence, in this step, the system designer should look at the agent responsibilities (via the responsibility table) identified in the analysis phase and map them to agent behaviors.

For a responsibility related to an interaction in the interaction table described in Step 2 of the design phase obtain the JADE class implementing the interaction protocol and role selected for that interaction and provide a suitable extension. Therefore the behaviour implementing that responsibility should be a proper subclass of the jade.course management class. Other responsibilities must be implemented using completely application-specific behaviours and therefore it is quite difficult to provide a formal guidance for this process.

The suggestion, in any case, is not to extend the jade.core.Behaviour class directly, but to start from the JADE classes that implement the skeletons for commonly required types of task. These classes include:

• OneShotBehaviour: implementing an atomic task that runs once and terminates immediately. In this learning support when students log in

• CyclicBehaviour: implementing a task that is always active, and performs the same operations each time it is scheduled.

STEP 9: Defining an Ontology

When agents in the system interact, they exchange information that refers to entities, abstract or concrete, that exist in the environment agents reside in. These entities may be primitive, such as a String or a number, or may have complex structures defined by templates specified in terms of a name and a set of slots whose values must be of a given type.

These complex entity templates are referred to as Concepts. These relation templates are referred to as Predicates. Finally, a particular kind of complex entity is represented by descriptors of actions that agents can perform. The templates of these action descriptors are referred to as Agent Actions. Actions, when executed, may produce an effect and/or generate a result to be sent back to the requester.

An ontology is a set of concepts, predicates and agent actions referring to a given domain. Some more details on expressing ontology's are provided in the following section.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

- **Formalisms for Expressing Ontology's**

Different formalisms can be adopted for expressing ontology. In the developed methodology, a graphical formalism is advocated, based on UML class diagrams Each ontological template is expressed as a class. The stereotype is used to differentiate between concepts, predicates and agent actions.

A slot of an ontological template whose type is primitive is expressed as an attribute of the corresponding class.

A slot of an ontological template whose type is itself a concept in the ontology is expressed as a role of an association linking the ontological element that owns the slot with the concept representing the type of the slot. Effects and results produced by the execution of an action are documented as comments attached to the agent action. The inheritance relation is used as usual to indicate that an ontological template is a specialization of another ontological template.

- **Heuristic rules**

Defining an ontology is typically not an easy task since the same domain can typically be described by means of several different sets of concepts, predicates, and agent actions,

by means of several different ontology's. The details that motivate the outcome of each choice become clearer as the development process progresses. For this reason, the ontology is typically refined while iterating through the steps in the design phase.

- **Ontology Boundaries**

Ontology is essentially a model of the application domain addressed by the system. Moreover, it is not always trivial to decide which types of entities and relations to model inside the ontology. On the one hand, it is desirable to keep the ontology as simple as possible, while on the other hand, it must be ensured that the ontology is complete enough to allow agents to perform their jobs. The guideline provided to drive this choice is the following:

Include in the ontology only concepts and predicates that agents need to talk about, i.e. whose instances must be encoded inside the content of ACL messages exchanged by two or more agents in the system.

- **Information Retrieval**

It is often the case that an agent in the system must retrieve some information from another agent. Using the ACL language, as JADE agents do, this may be achieved through either a

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ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

QUERY_REF message including a proper Identifying Referential Expression as content, or a REQUEST message specifying an action whose result is the information that must be retrieved. This choice is clearly related to the ontology. Referential expression is more complex. As a heuristic rule, the following is provided:

• If the agent providing the information to be retrieved includes a knowledge base that is able to handle Identifying Referential Expression directly, define predicates in the ontology. Otherwise, define actions.

- **Tools for Defining an Ontology**

JADE provides a sophisticated mechanism, described in, to handle ontological elements as instances of Java classes that are basically beans with proper get and set methods for all the slots in the template and to automatically convert them back and forth strings to be used as message contents. When moving from the design to the implementation, the creation of these ontological Java classes is very straightforward, but, especially when dealing with large ontologies with a lot of templates, it may be quite time consuming.

Use of this approach is particularly convenient when:

• There are several templates in the ontology.

• The ontological classes do not require any other method than the get and set methods corresponding to the ontological template slots. Furthermore, if other methods or fields are added manually after the automatic generation, and if the ontology must subsequently be modified and therefore regenerated, all manual modifications are not preserved by the bean generator.

- **Content Language Selection**

JADE provides codecs for two content languages: the SL language and the LEAP language (through the jade. content package). Furthermore, a codec can be defined by a programmer if they desire for the agents to “speak” a different content language. The SL language is a human-readable string-encoded content language, while LEAP is a non-human readable byte-encoded content language. Based on this, some heuristics on choosing the appropriate content language are as follows:

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

3.8 SUMMARY

The JADE platform is a popular, FIPA-compliant platform for the development of multiagent systems. The developed methodology serves to fill this gap in conjuction with the tutorials and other resources provided by the JADE team and contributors, allows the system designers to fully build a multi-agent systems, from requirements to implementation.

This assumes that an agent-based solution has been chosen as the best alternative, from a range of options. The proposed methodology does not explicitly provide pointers on when an agent-based solution should be used, but provides references, which can be consulted when a designer is contemplating an agent-based solution. Furthermore, the literature has many examples of multi-agents systems being developed for a wide range of applications. Paying attention to such cases will thus help to determine if an agent-based solution is the best choice. There has been presented as a series of steps, therein containing (where appropriate) guidelines for creating artifacts, heuristic rules, notations and design Patterns for the designer to use and adapt (when necessary) to their own situation. It is not essential that the proposed methodology be strictly followed, and it should only serve as a means of guidance in the development process. In addition, the designer is encouraged to use their own imagination (in a rational manner), and add or remove steps as they desire, in order to adapt the proposed methodology to their own needs. Following the steps in the methodology should be an active process and the designer should continuously iterate the steps and move back and forth between analysis and design whenever necessary.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

CHAPTER FOUR

IMPLEMENTATION

4.1 IMPLEMENTATION ENVIRONMENT

Multi-agent systems programming languages, platforms and development tools are important components that can affect the diffusion and use of agent technologies across different application domains. In fact, the success of multi-agent systems is largely dependent on the availability of appropriate technology (i.e. programming languages, software libraries and development tools) that allows relatively straightforward implementation of the concepts and techniques that form the basis of multi-agent systems.

Today, several agent-oriented languages are available (Bordini, et al., 2006). Agent-oriented programming languages are a new class of programming languages that focus on taking into account the main characteristics of multi-agent systems. Minimally, an agent-oriented programming language must include some structure corresponding to an agent, but many also provide mechanisms for supporting additional attributes of agency such as beliefs, goals, plans, roles and norms.

4.1.1 Development environment

i. Agent based platform – Java Agent Development Framework (JADE) was used in the developed methodology.
ii. Integrated development environment (IDE)- NetBeans7.1 is a complete open source IDE with many plug-in and has support for many popular languages like Java, PHP, Jruby and Ruby on rails. Since JADE and JDBC are written entirely in Java, it is easy to import them to the IDE. NetBeans7.1 comes with a built-in Tomcat server (web server) for development of JSPs and Servlets. It also has templates for Web Applications, JSP pages and Servlet classes.
iii. Java Development Kit (JDK) version 1.4 or later and Java Standard Edition Runtime Environment (JRE) version 6 should be installed to provide complete runtime support for

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

Java applications. The runtime environment includes the Java Plug-in product which supports the Java environment inside web browsers.

iv. Java Server page (JSP) is a platform technology for developing generating dynamic content for the web. JSP enable the developers to directly insert Java code into jsp file, has the capability to generate dynamic HTML and is able to use available Java APIs to handle various work such as database connection, authentication, etc, this makes the development process very simple and its maintenance also becomes very easy.

v. Java Database Connectivity (JDBC) is a Java API that provides excellent database connectivity in heterogeneous database environment.

- **Operational steps of the system**

The main users of this e-learning agent based system are the students of the various Higher learning institutions. The operational step for students to view their results is as follows:

PHASE_ONE - The students logs in

PHASE_TWO - The course management agent gives relevant materials to the students

PHASE_THREE- The course management reports the log in progress to the teacher

PHASE_FOUR - The learning agent monitors the learning progress of the student

Check if the day quiz are scheduled

PHASE_FIVE - The learning Agents makes quiz available to the students and then notify the tutor agent the student has finished exams

PHASE_SIX - The tutor agent analyses the performance of the student

PHASE_SEVEN- The tutor Agent determines whether the student needs extra notes or not.

The students are able to view their results.

4.2 TESTING METHODS

4.2.1 Integration Testing

Integration testing involves the designing of test cases that validate that the different modules of the system interact in a desired manner. Software integration testing is an incremental test that is performed every time a module is added to the system. This test mainly focused on ensuring that the agents were passing messages in a standard format that was understood by each component.

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ISSN (Online): 1694-0784
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4.2.2 System Testing

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results.

The system test was based in the following aspects;

i. The ability of the student to log into the system.
ii. The right content of notes uploaded in the system and how the students were able to access them.
iii. The ability of the students to view their results.

4.3 TRAINING

This is the process of familiarizing the user with the system. The students were trained on how to use the e-learning agent based system

4.4 SYSTEM CHANGE OVER

There are different type of system change over but in agent based e-learning system parallel changeover was used.

- **Parallel Change over**

It refers to the running of an old and new system at the same time. Once the new system is proved reliable, the old system is drop. The e-learning software based system was used together with agent based e-learning system. The advantage of this method is more security when the new system fails then you can revert to the old system; there is adequate way to compare new and old system. This method is expensive to run both two systems at the same time, Very difficult to compare the out together. The students also filled questionnaires as part of the testing process to give their views on the case study; the questionnaires are analyzed as following to get result and conclude. The accuracy of the entire system was measured against the test (real-world) data collected from e-learning running on a software platform. The bench mark being having students successful use the agent based e-learning system and the ability to demonstrate how agents can be used in an e-learning environment. Failure: having the students not satisfied with the agent based e-learning system.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

CHAPTER FIVE

RESULTS AND DISCUSSION

5.0 INTRODUCTION

The system was tested using information of 60 students who were undertaking the course Data Base Management Systems. Student and course details were captured. The students who participated in the study were from St Paul University in Nairobi.

5.1 RESULTS

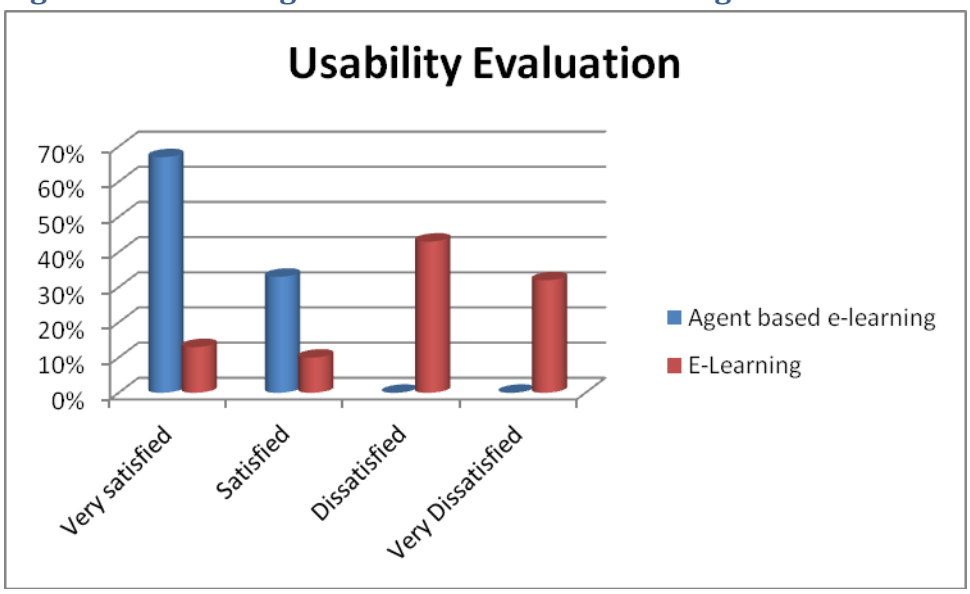
The results are organized according to the research objectives.

Objective 1: Agents can be used in e-learning.

Result 1: Overall Evaluation of effectiveness of Agent based E-learning system

This objective focused to show that agents can be used in e-learning environment; the students were able to read and do their exams successfully. Questions (1,7,18,20) from the questionnaire found in Appendix 1 was used to determine the same, and a graph in figure1below was generated.

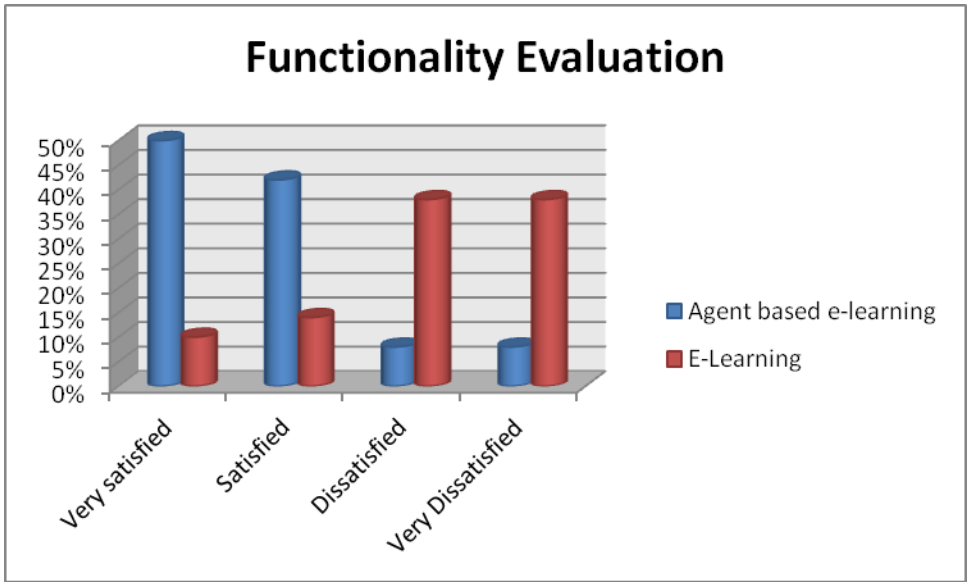
Figure 6: Evaluating Results on effectiveness of agent based e-learning system



IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

70% of respondents accepted that the build prototype is excellent in terms of ease of use and user friendliness while less than 10% of the respondent were not satisfied with the system.

Calculating mean score of the percentages we found that 80% of the interviewed respondents accepted that the system usability was satisfying. 19% of respondents interviewed accepted that usability was not good enough.



Calculating mean score of the percentages we found that 90% of the interviewed respondents accepted that functionality was excellent, this was in terms of interactivity of the system by the user and meeting the students' needs.10% of the students preferred the software based e-learning system.

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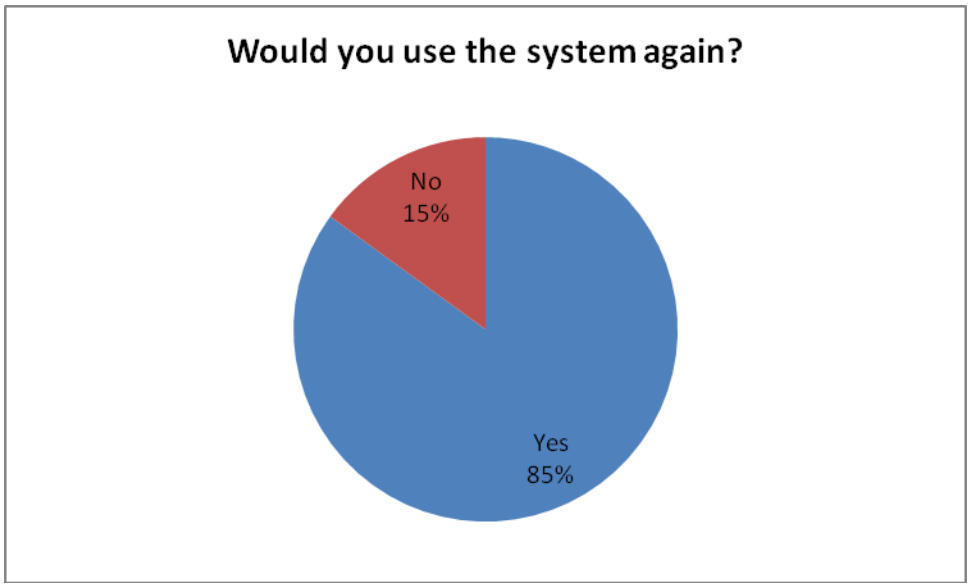
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1



85% of the students were motivated to use the system repeatedly beause the program is much flexible and intuitive. Only 15% of the students said No,this can be as a result of students skills and ability limitation in learning the new system .

5.1.1DISCUSSION

The students' response was an indicator that agents can be used successfully in e-learning environment. The number of students who were satisfied with Agent used in e-learning as per the graphs above was **80%**in number as compared to the number of students who were dissatisfied who were **10%** in number.

Objective2: Use intelligent agents to work with instructor to produce content of the right depth and that is timely?

There were two key aspects of focus about the course, under objective 2: Depth of the course and timeliness of the availability of the course.

Result1: Was the Depth of the course content right?

The items in the questionnaire which corresponded to depth of content were: Q2, Q4, Q11 and Q13. The complete questionnaire may be found in Appendix 1. A summary of these results are shown in Table 4 below.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

Table 4: Summary of the questionnaire items corresponding to the depth of the content

Questions	Very satisfied	Satisfied	Dissatisfied	Very dissatisfied
1. How satisfied or dissatisfied were you with the content of the course?	4	5	2	0
2. Were you satisfied with the availability of course content?	7	3	1	0
3. How satisfied or dissatisfied were you with the amount of online interaction you had with the course content availability?	6	2	1	2
4. Was the presentation of course topics clear?	3	7	1	0
TOTALS	20	17	5	2
MEAN	5	3	2	1

The questions were compiled and the above results were drawn. From the table it shows that most of the students were satisfied with the depth of the course content

Result 2: Was the content timely?

The items in the questionnaire which corresponded to timeliness of the availability of the course content were: Q3, Q5, Q8, Q9 and Q10. The complete questionnaire may be found in Appendix 1. A summary of these results are shown in Table below.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
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Table 5: Summary of the Questionnaire items corresponding to timeliness of the availability of the course content

Questions	Very satisfied	Satisfied	Dissatisfied	Very dissatisfied
1. Were the content presented in a timely manner?.	6	2	2	1
2. How satisfied or dissatisfied were you with the ability to navigate through the course content?	7	4	0	0
3. How satisfied or dissatisfied were you with the access time for the course pages?.	2	8	0	1
4.) How satisfied or dissatisfied were you with the online interaction you had with the agents	4	7	0	0
5) How satisfied or dissatisfied were you with the access time for the course pages?	8	2	0	1
TOTALS	27	23	2	2
MEAN	5	4	1	1

The above table shows the respondent of the students according to the timeliness of the course content. The table shows that most of the students were satisfied with the availability of timely course content.

5.1.3 DISCUSSION

The students' response can be used as an indicator that they were satisfied with the depth of course content and provided in a timely manner. As from the above Table 8, the no of students

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

who were very satisfied and satisfied were **9** in total as compared to the students who were very dissatisfied and dissatisfied which were **4** in total .

Objective 3: Use e-learning agents to improve learning performance based on performance assessments and learning needs.

Result 1: Improvement of Performance after Performance Assessment

The performance of the students was assessed. If it was less than 50 %, the student was given a chance to make a second attempt. Table 6 below shows the performance of students after the first and second attempts for those who scored less than 50 % in their first attempt.

Table 6: The Sample results measure learning performance of students after the first and second topic attempts

STUDENTS REG NO	TOPIC CONTENT	FIRST ATTEMPT	SECOND ATTEMPT
1	TOPIC 1	42	90
2	TOPIC1	22	88
3	TOPIC1	42	84
4	TOPIC1	40	76
5	TOPIC1	40	84

From Table 6 above, those students who were given a second chance posted improved scores. They were given a second chance if they performance in the 1st attempt was not up to average.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

Result 2: Improvement of Performance after adjustment to meet learning needs

The learning needs were identified from analysis of the students' comments about the course. Some of the learning needs identified include: need for more content on the chapters and also need for diagrams to support the content. There was also an indication of differences in learner preferences. A summary of the learning needs is shown in Table 7 below.

Table7: Students comments/feedback

TYPES OF SUGGESTIONS	NO. OF SUGGESTIONS
please add more diagram in chapter2 please add more diagram in chapter3	4
The course is very well articulated	5
Please add more content in chapter 3	8
More figures and tables	7
Like the course keep it up	8

The above sample shows summary of comments that were used to improve the course content. More diagrams, tables and notes were added to improve the presentation of the content.

At the ends of the course, students were asked to complete a questionnaire about their experience of the aspects of the course that were then improved based on the feedback.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

5.1.1 DISCUSSION

The students' performance can be used as an indicator of need for more learning support to be provided. It is clear that when this support is provided in terms of more chances to study the course content, the student performance improved. Therefore identifying learning needs and adjusting the course accordingly improves learners' achievement.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

CHAPTER 6

CONCLUSION AND RECOMMEDATIONS

6.1 CONCLUSION

E-learning is the delivery of individualized, comprehensive, dynamic learning content in real time, aiding the development of communities of knowledge, linking learners and practitioners with experts. E-learning is undoubtedly, a more flexible way of learning. It can make a significant difference about how learners learn to master a skill quickly through the flexibility of studies while enjoying their learning (Richard & Diana, 2000). Therefore, this validates the growing need by many universities to adopt e-learning stemming from its attributes of technical efficiency and effectiveness..

This research has identified the components needed for designing an agent based e-learning system, the data requirements for each component and the means of acquiring this data. The research also demonstrated how multi-agent system (MAS) paradigm can be used in e-learning system. Based on the study results, one concludes that students' responses indicate that the Agents used in e-learning offer efficient and effective services to the students. It is clear that when Agents are used in e-learning the students can confidently undertake their course work without any interruptions and down time. It is therefore very clear that Agents can be used as a backbone for e-learning.

The results also showed that the students were satisfied with the depth of course content and to help determine whether the course was provided in a timely manner. Further, from the study results, it is clear that when this support is provided in timely, availability of content as well as the right content for the course, the students' ability to study effectively is enhanced.

It is evident from the study that when students were given more support in terms of more chances to study the course content, the student performance improved. Therefore identifying learning needs and adjusting the course accordingly improves learners' achievement.

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
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Agent based e-learning system is efficient given that it has automated the process of course content extraction, marking exams and using Agents in e-learning environment.

6.2 Achievements

This research study was able to achieve the following;

• It demonstrated that Agents can be used in an e-learning environment

• It showed that Agents can provide timely, depth and right content for the student and

• That E – learning Agents can be used to improve learning based on performance assessments and learning needs

6.3. Challenges

The study was done when the students were closing the semester; it was quite hard putting them together.

6. 4 Limitations

Latency time: There is a speed constraint especially when many students submit their exams for marking

6.5 Suggestions For Further Work

Like most agent systems, there is the possibility for future expansion. The system can be enhanced to accommodate cooperation and collaborative work among the agents, as well as take care of students' emotional needs to increase learning support during their e-learning study.

The second area of improvement is the user interface; the current system was meant for students from a certain university only. The interface can be improved to make it accommodate any Higher learning institution.

The third area of improvement is to decrease the latency time; this is the time difference between when many students submit their questions for marking and when they get the results. This can be achieved by enhancing the algorithm of the Tutor Agent.

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APPENDIX 1

SAMPLE OF QUESTIONAIRE FILLED BY THE STUDENTS

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
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1) Is it simple to use?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

2) How satisfied or dissatisfied were you with the content of the course?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

3) Were the content presented in a timely manner?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

4) Were you satisfied with the availability of course content?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

5) How satisfied or dissatisfied were you with the ability to navigate through the course content?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

6) How satisfied or dissatisfied were you with the log in hours tied to the marks of the course?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

7) Is the system user friendly?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

8) How satisfied or dissatisfied were you with the access time for the course pages?

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

9) ☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

10) How satisfied or dissatisfied were you with the online interaction you had with the agents?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

How satisfied or dissatisfied were you with the amount of online interaction you had with the course content availability?

11) ☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

12) Was the course instructor was accessible to answer questions or give feedback.

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

13) Was the presentation of course topics clear?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

14) Did the participation in this e-learning agent based system enhanced your motivation to learn ?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

15) Are you satisfied with the functions of Agents in e-learning course ?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

16) Did the participation in this e-learning agent based system help you to reach your learning objectives?

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
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☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

17) Did the system allow you to study enough?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

18) Did you manage to easily interact with the interface, how satisfied were you with the interface?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

19) Was the interface flexible enough to allow navigation according to the user satisfaction?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

20) Are you motivated to use this system again?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

21) Did the use of this e-learning agent based system contribute to exam success?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

22) Overall, how satisfied or dissatisfied were you with the course?

☐ Satisfied ☐ Very Satisfied ☐ Dissatisfied ☐ Very Dissatisfied

APPENDIX 2

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
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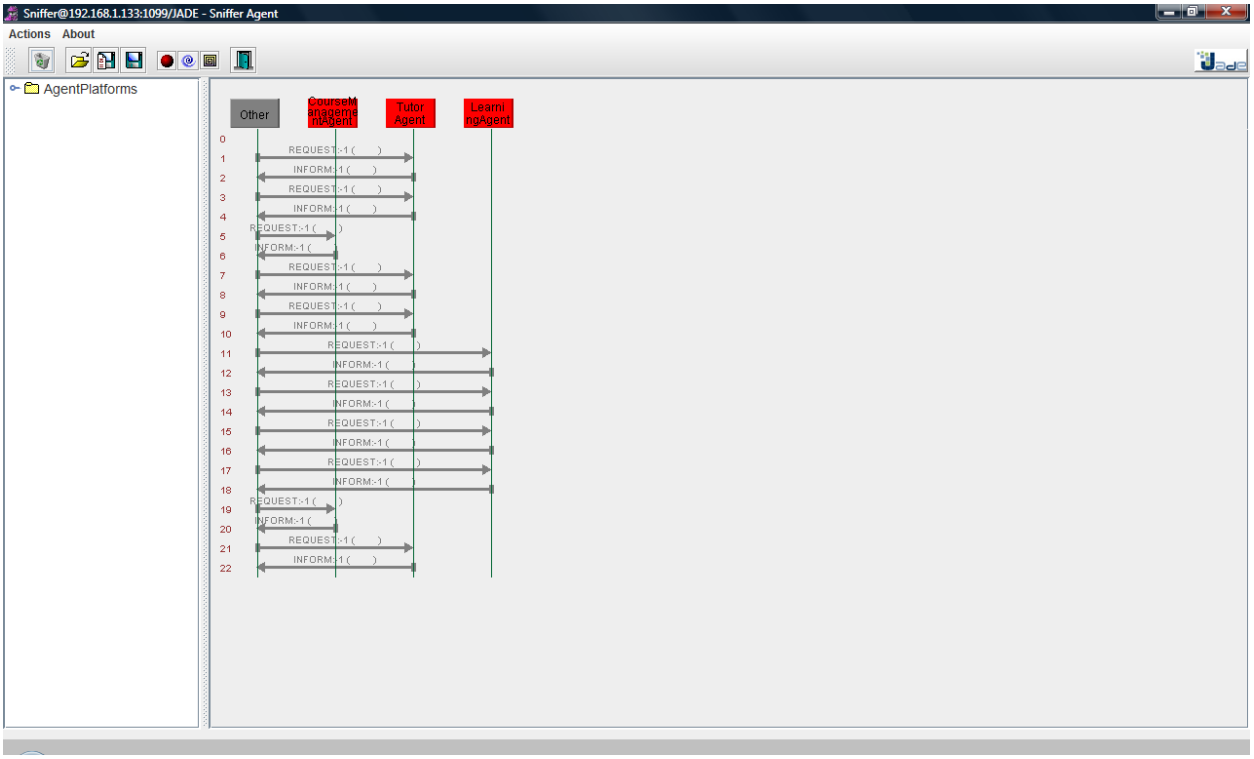
SCREEN SHOTS

SCREEN 1: STUDENT LOGIN



SCREEN 2: AGENTS FUNCTIONALITY

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ISSN (Online): 1694-0784
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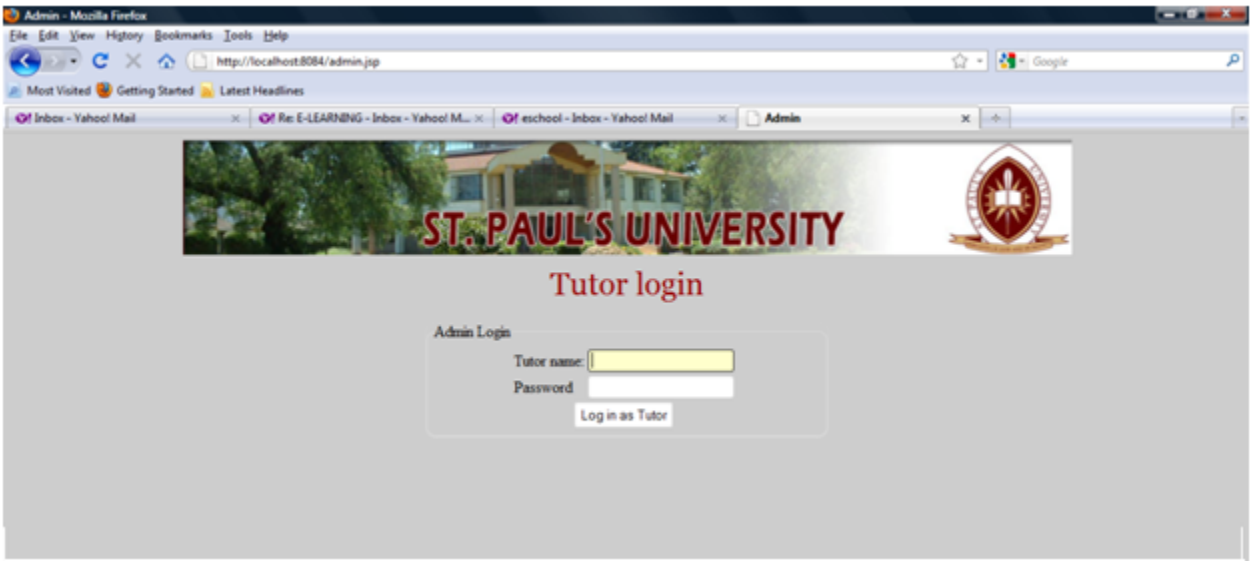
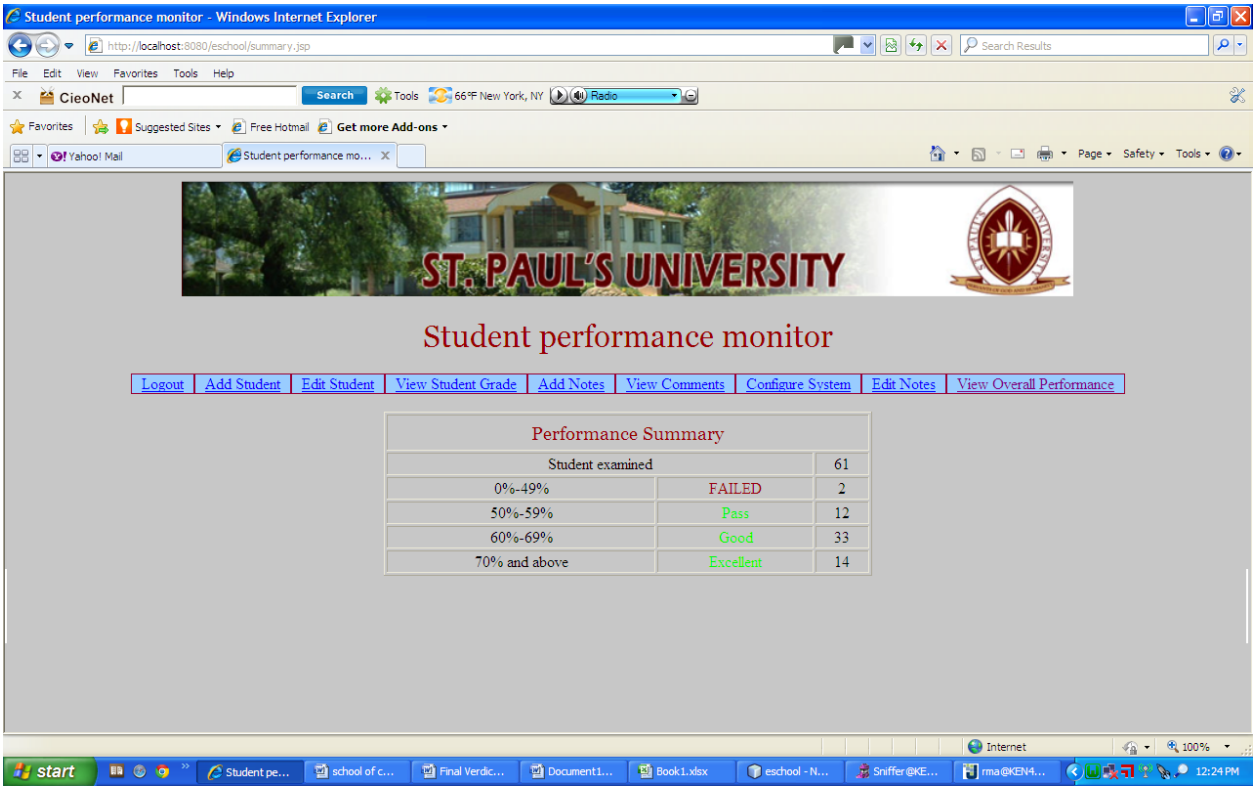


SCREEN 3: TUTOR LOGIN PAGE



SCREEN SHOT 5: OVERALL STUDENT PERFORMANCE

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

APPENDIX 3:SHOWING FETCH CONTENT

BEHAVIOUR OF THE AGENT

```
/*
 * To change this template, choose Tools | Templates
 * and open the template in the editor.
 */
package main.behaviours;

import ACL.ActionStatus;
import ACL.CourseContent;
import db.parameters;
import jade.core.Agent;
import jade.core.behaviours.OneShotBehaviour;
import jade.lang.acl.ACLMessage;
import java.sql.*;
import java.util.logging.Level;
import java.util.logging.Logger;

/**
 *
 * @author lucy
 */
public class FetchContent extends OneShotBehaviour {

    private String stage;
    private String unit;
    int i=0;
    private String regNo;
    public FetchContent(Agent a, String stage, String unit,String regno) {
```

IJCSI International Journal of Computer Science Issues, Volume 3, 2017
ISSN (Online): 1694-0784
www.IJCSI.org
https://doi.org/10.20943/01201703.0000.1

```
        super(a);
        this.stage = stage;
        this.unit = unit;
        regNo=regno;
        i=1;
    }

    public FetchContent(Agent a, String s, String unit,String regno,boolean next) {
        super(a);
        this.stage=s;
        this.regNo=regno;
        this.unit=unit;

        i=2;
    }

    @Override
    public void action() {
        if(i==1)
            fetchRestricted(unit,stage);
        else if(i==2)
            fetchAuto(stage);
    }
        private void fetchRestricted(String Unit, String Order)
    {
            try {
            String sql = "SELECT * FROM academiccontent WHERE unitName='" + Unit +
"' AND orderNo='" + Order + "';";
            System.out.println(sql);
            parameters DB = new parameters();
```

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```
        String connectionURL = "jdbc:mysql://" + DB.getServer() + "/" +
DB.getDatabase();
        Connection connection;
        ResultSet rs;
        Class.forName(DB.getDrivers());
        connection = DriverManager.getConnection(connectionURL, DB.getUsername(),
DB.getPassword());
        Statement s = connection.createStatement();
        s.executeQuery(sql);
        rs = s.getResultSet();
        int check=0;
        while(rs.next())
        {
          ++check;
          CourseContent cs = new CourseContent();
          cs.setContent(rs.getString("stageContent"));
          cs.setStage(stage);
          cs.setTopic(rs.getString("sectionTopic"));
          cs.setUnit(unit);
          cs.setRegNo(regNo);
          myAgent.addBehaviour(new SendAction(myAgent, cs, "ControlContainer-1",
ACLMessage.INFORM));
          myAgent.addBehaviour(new UpdateReadStatus(myAgent, stage, regNo, unit,
true));
        }
        if(check==0){
          ActionStatus as =  new ActionStatus();
          as.setRegNo(regNo);
          as.setStatus("No Such Content Found");
```

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```
            myAgent.addBehaviour(new SendAction(myAgent, as, "ControlContainer-1",
ACLMessage.INFORM));
        }
        rs.close();
        s.close();
        connection.close();
    } catch (SQLException ex) {
        Logger.getLogger(FetchContent.class.getName()).log(Level.SEVERE, null, ex);
    } catch (ClassNotFoundException ex) {
        Logger.getLogger(FetchContent.class.getName()).log(Level.SEVERE, null, ex);
    }
  }

  private void fetchAuto(String Order)
  {
        try {
        String sql = "SELECT * FROM academiccontent WHERE  orderNo='" + Order +
"';";
        System.out.println(sql);
        parameters DB = new parameters();
        String connectionURL = "jdbc:mysql://" + DB.getServer() + "/" +
DB.getDatabase();
        Connection connection;
        ResultSet rs;
        Class.forName(DB.getDrivers());
        connection = DriverManager.getConnection(connectionURL, DB.getUsername(),
DB.getPassword());
        Statement s = connection.createStatement();
        s.executeQuery(sql);
        rs = s.getResultSet();
```

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```
            int check=0;
            while(rs.next())
            {
               ++check;
               CourseContent cs = new CourseContent();
               cs.setContent(rs.getString("stageContent")+"<br/>");
               cs.setStage(stage);
               cs.setTopic(rs.getString("sectionTopic"));
               cs.setUnit(unit);
               cs.setRegNo(regNo);
               myAgent.addBehaviour(new SendAction(myAgent, cs, "ControlContainer-1",
ACLMessage.INFORM));
            }
            if(check==0){
               ActionStatus as =  new ActionStatus();
               as.setRegNo(regNo);
               as.setStatus("No Such Content Found");
               myAgent.addBehaviour(new SendAction(myAgent, as, "ControlContainer-1",
ACLMessage.INFORM));
            }
            rs.close();
            s.close();
            connection.close();
         } catch (SQLException ex) {
            Logger.getLogger(FetchContent.class.getName()).log(Level.SEVERE, null, ex);
         } catch (ClassNotFoundException ex) {
            Logger.getLogger(FetchContent.class.getName()).log(Level.SEVERE, null, ex);
         }
      }
   }
```