Nagaoka University of Technology
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A Mechanism to Create a Delighted Student with Enhancing the Effectiveness of the Virtual Learning and Investigate the Behavior of Non-verbal Communication

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Dedication

I would like to dedicate this thesis to my beloved parents and teachers who have supported me all the way since the beginning of my studies.

Finally, this thesis is dedicated to all those who believe in the richness of learning.

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This thesis arose in part out of years of research that has been done since I came to Fukumura laboratory and Ashu laboratory. By that time, I have worked with a great number of people whose contribution in assorted ways to the research and the making of the thesis deserved special mention. It is a pleasure to convey my gratitude to them all in my humble acknowledgment.

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Abstract

The growth of the e-Learning is facilitated the solutions to the barriers in the conventional education system such as neap quality, giant cost and limited access. Although there are different approaches are available to furnish the knowledge using electronic equipment to online users, three dimensional virtual learning environment which provides the active learning become powerful way of delivering knowledge.

Student satisfaction plays an important role in determining the success of e-Learning courses mainly the intrinsic motivation of the e-Learner such as self efficacy, self determination since the dropout rate is very high comparing to the conventional learning. Enhancement of the satisfactory level and identification of the way of raising the motivation of the e-Learner are great contribution for the success of the future e-Learning. Thus, creating delighted e-Leaner with establishing effective and efficient learning atmosphere for the education while enhancing the usefulness of the virtual learning by using ICT (Information and Communications Technology) is the objective of this research.

Building a balanced and meaningful interactivity among the learning elements (student, teacher, content and environment) is the way of enhancing the learning efficiency with generating a delighted e-Learner and such interactions are proposed to achieve under the following directions in this study.

- Implement the effective communication to establish the proper interaction among the student and the teacher as well as them-selves
- Recognize the feedback of the e-Learners regarding the content to establish the proper interaction among the student and content with involving the teacher
- Identify the effective factors for each student category to establish the proper interaction among the student and environment with the support of the teacher

Three approaches including the multi-model system are considered in this research to establish a wealthy interaction among the elements of the virtual learning.

The first approach is to establish an effective communication among the participants of the virtual class to establish a proper interaction among the student and the teacher as well as them-selves since communication is the key ingredient in any relationship. Non-verbal communication owns a highest portion of the communication process and facial expression, eye blink, head pose are vital for the education. Thus the facial expression, eye blink and head pose of the student are visualized in the virtual learning environment through an avatar who represent the student in the virtual environment to establish the non-verbal communication in the virtual learning environment.

The facial expression, eye blinking and head motion of the user were detected using threshold and geometric based approach by using a web-camera video. A head model including the eye components were constructed and exported to the virtual world to

modify the avatar to represent the behavior of the non-verbal features. Then the detected information about the non-verbal behavior of the real user were transferred to the virtual learning environment. When the real user moves his/her head and/or makes the eye blink, it is appeared in the virtual class through the avatar with the facial expression of the real user. The behavior of non-verbal features and the affection of the non-verbal communication during the virtual class activities are also investigated through several experiments.

The second approach is the establishment of proper interaction between the student and the content with the support of teacher. The precise reactions of the student regarding the learning content are essential to modify the learning elements. Thus, the student tracking system including their status was constructed to obtain the feedback of the students. A web interface was constructed including almost all the behavioral information of the student such as student locations, movements, non-verbal behavior, chat, voice and especially their status to identify the student behavior during the virtual learning session. Student requirement and preferences can be identified with that behavioral information and that information can be utilized to adjust the elements of the learning based on the feedback of the student to conduct the learning activities in the virtual classroom effectively and efficiently.

The third approach is to establish a proper interaction between the student and the environment with involving the teacher. The proper interaction can be employed when the teacher gives a preferred environment for the student. Hence, teacher needs to know about the effective factors in the learning environment. Thus, the identification of the effective factors and the development a matrix including the effective factors based on the student characteristics were carried into effect in this study to establish a rich interaction among the student and the environment.

Having completed the three processes in the multi-model system, there were three experiments that conducted. The first experiment was conducted with the facial expression visualization system and the eye blink visualization system was used for the second experiment. Both eye blink and head pose were utilized to conduct the third experiment. The experiment results indicate that the students prefer to engage with the virtual learning activities with the visualization of their non-verbal behaviors and the visualization of the non-verbal behaviors are highly affected to the discussion than the other activities. In addition, the student performances were enhanced with the non-verbal communication by 12.5%. The analysis of the eye blink rate was indicated that it was depended on the internal state of the persons and it was based on the activity that he/she performed with the environmental factors. In addition, there is a mirror eye blink relation in some extent between the teacher and the student. Further the behavior of the eye blink indicated that the most of the eye blink happens at the breakpoint of speaking.

In addition to the experiments, the evaluation the affection of these three approaches

were done with the web-based Likert-scale questionnaires to identify whether the effectiveness of the virtual learning and the student satisfactory level can be enhanced or not. There were 78 subjects including 33 teachers and 45 students that evaluated for these three approaches.

The analysis of the responses of subjects was indicated that the teachers and the students preferred to engage in the virtual learning environment with visualization their non-verbal features. In addition, the teachers emphasized that the interaction between the teacher and the student was raised through the non-verbal visualization system. Thus, the enhancement of the preference of the learning parties to engage with the virtual learning environment and establishment of a rich interaction between the teacher and the students are major contribution of the non-verbal visualization system to enhance the satisfactory level of the students.

The responses of the teachers and students are stated that the tracking system is vital component of the virtual learning since it raises the link between the teacher and the students with obtaining and modifying the course content based on the precise feedback of the student while enhancing the effectiveness of the virtual learning. One way to enhance the satisfactory level of the students is establishment of a proper interaction between the student and the content through the teacher. Thus the development of the tracking system is cause to enhance the satisfactory level of the students with enhancing the effectiveness of the virtual learning.

The identification of the effective factors and development of the matrix including the effective factors is also evaluated using the same subjects. The effectiveness of the virtual learning can be enhanced and raised the satisfactory level of the student with the identification of the effective factors through providing a preferred environment of the students is the corollary of the responses of the participants. Thus the identification of the effective factors contributes to enhance the satisfactory level of the students.

The overall results of the responses indicate that the multi-model system including the three approaches were contributed to enhance the effectiveness of the virtual class while enhancing the satisfactory level of the students through a proper interaction among the learning elements.

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Chapter 1

Introduction

1.1 Methods of Education

The knowledge acquired by an individual after studying subject matters or experiencing life lessons with providing an understanding of something is the process of education. Education can take place in formal, non-formal and informal settings. Informal learning has no fixed objective in terms of education outcomes and it is referred as learning by experience. Learning which usually occurs outside the educational system with the objectives named as non-formal learning. Formal learning occurs in a structured environment and most common forms of education result from years of schooling that incorporates studies of a variety of subjects. Normally formal education is happened with multiple students together with a trained teacher in a school environment[1].
Although the education system of teacher-centered classroom already spreads throughout the world, administrators and academics of higher education have discussed the

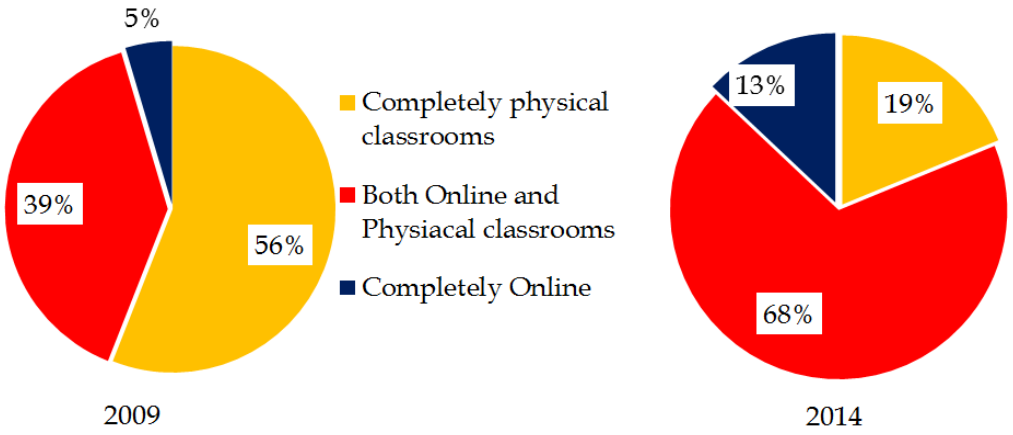


FIGURE 1.1: The Growth of the Online Education

key issues of the education such as neap quality, excessive cost and limited access [2]. The solutions are discovered for the issues in the education system with involving the advancement of the technology. As a result of that, the electronic media is utilized to deliver the knowledge.

Number of education programs which are delivered using electronic media is raised dramatically with the proportional to the increment of online users from around 400 million to more than 2000 million during the period of 2000 to 2010 [3]. The Figure 1.1 illustrates the growth of the online education comparatively to traditional classroom education. The Internet has started to reshape the education. The education will not be the same in the next decade. The current pedagogical system didactic continuously with the advancement of the technology. With the improvement of the sophistication of information technology contributes to the development of the learning with electronic media in various ways including better understanding of how to make content and delivery of online courses more effectively. With the increment of web technology and the increment of the electronic information, the Internet has become the preferred medium for learning in the field of education. Then e-Learning is originated to the world as a modern way of knowledge delivering with the following benefits over the traditional educational system.

- Class work can be scheduled around work and family
- Reduces travel time and travel costs for off-campus students
- Students may have the option to select learning materials that meets their level of knowledge and interest
- Students can study anywhere they have access to a computer and Internet connection
- Self-paced learning modules allow students to work at their own pace
- Flexibility to join discussions in the bulletin board threaded discussion areas at any hour, or visit with classmates and instructors remotely in chat rooms
- Instructors and students both report e-Learning fosters more interaction among students and instructors than in large lecture courses
- E-Learning can accommodate different learning styles and facilitate learning through a variety of activities
- Develops knowledge of the Internet and computer skills that will help learners throughout their lives and careers
- Successfully completing online or computer-based courses build and encourage students to take responsibility for their learning
- Learners can test out of or skim over materials already mastered and concentrate efforts in mastering areas containing new information and/or skills

Thus the e-Learning becomes the educational paradigm for the next decade and the platform of this study.

1.2 e-Learning

E-Learning defines as the deployment of Internet technologies to distribute a broad array of solutions that improve knowledge and performance. E-Learning is generally denoted to the intentional use of networked information and communications technology in teaching and learning [4]. A number of other labels are also utilized to explain this manner of teaching and learning such as online learning, virtual learning, distributed learning, network and web based learning.

Interactive technologies and communication systems are exploited by e-Learning to improve the learning experience. It has the ability to learn across the board and transform the way we teach. e-Learning can raise value of learning, and broaden participation in lifelong learning. Although e-Learning cannot substitute teachers, it can be reduced the time spent on administration procedures with enhancing the standards and reach of their teaching. E-Learning can contribute to construct an educational workforce empowered to change and enable every learner to attain his or her potential. It makes attainable a truly determined education system for a future learning.

E-Learning is already spread around us in schools, colleges, universities, workplace, and at the home. E-Learning is important by reason of people are finding that it can make a significant difference: to how quickly they master a skill; how easy it is to study; and, of course, how much they enjoy learning. Further e-Learning is important in another aspect since it can raise the effectiveness of the education for raising standards, improving quality, removing barriers to learning and participation in learning, preparing for employment, up skilling in the workplace, and ultimately, ensuring that every learner achieves their full potential.

E-Learning is about improving the quality of learning through using information systems, interactive computers and online communications in ways that other teaching procedures cannot achieve. It is related to learners and to all subjects at each stage of learning or training. E-learning can even reach out and re-engage people who are currently not involved in education as it is interactive and can adapt to their needs.

The importance of e-learning has been recognized since e-learning can contribute to some of the most challenging objectives with fulfilling following factors.

- Raising standards and improving attainment
- Broadening choice
- Increasing access to learning for disadvantaged communities
- Removing barriers to achievement
- Ensuring wider participation and fairer access to higher education

The following benefits are empowering learners and teachers through the nature of e-Learning.

- Individualized learning

- Collaborative learning
- Tools for teachers and learners to innovate
- Flexible study
- Online communities of practice

According to this explanation, the e-Learning has potential to provide the learning effectively and e-Learning is a perfect method to substitute the traditional classroom education with overcoming the issues of the traditional class room education such as low quality, high cost and limited access [2]. E-Learning can be divided into different types based on its characteristics [5] and those categories are explained as follows.

- Types of e-Learning

The knowledge can be delivered synchronously or asynchronously using the electronic devices and individuals or group of students become the beneficiaries in the e-Learning. Based on the mainly two characteristics 1)knowledge delivering type, synchronous or asynchronous and 2)nature of the beneficiary party, individual or group of students, e-Learning has basically four types as shown in Figure 1.2 and each category is explained as follows,

- *"Individualized self-paced synchronous e-Learning refers to situations where an individual learner 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 learner studying alone or conducting some research on the Internet or a local network."*

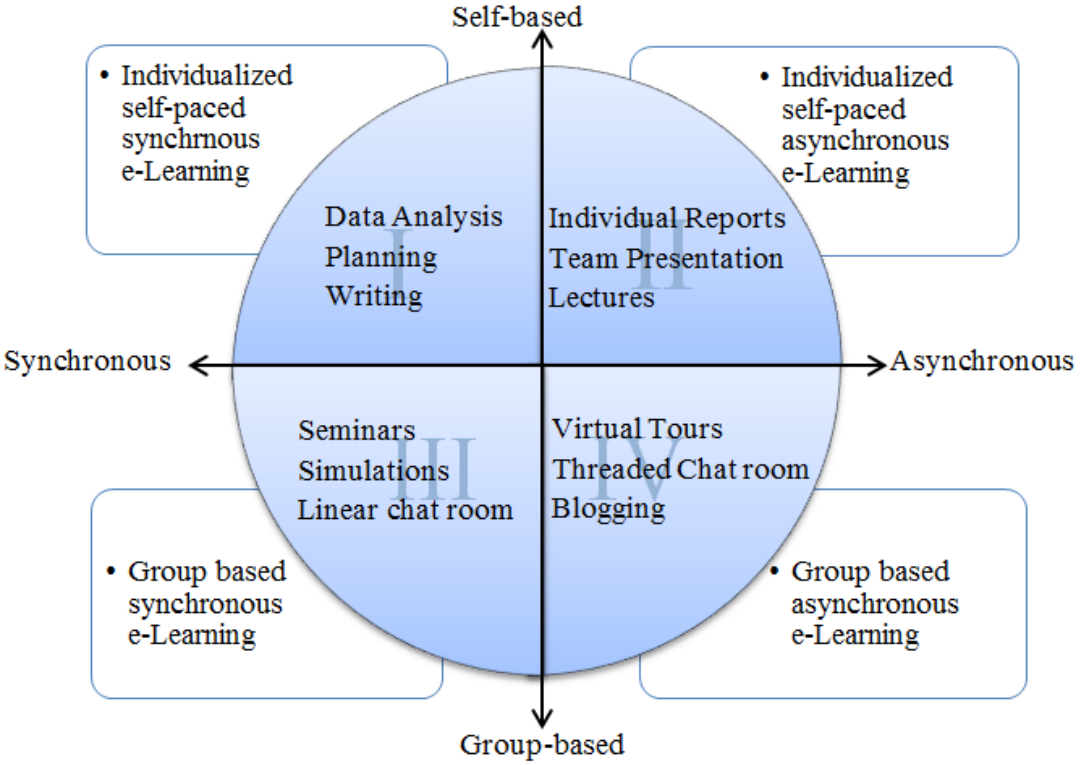


FIGURE 1.2: Types of e-Learning

- *"Individualized self-paced asynchronous e-Learning refers to situations where an individual learner is using learning resources such as a database or a computer-assisted learning package offline (i.e., while not connected to an Intranet or the Internet). An example of this is a learner working alone off a hard drive, a CD or DVD."*
- *"Group-based synchronous e-Learning refers to situations where groups of learners 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 learners engaged in a real-time chat or an audio-video conference."*
- *"Group-based asynchronous e-Learning refers to situations where groups of learners are working over an Intranet or the Internet where exchanges among participants occur with a time delay (i.e., 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[6]."*

Although e-Learning has different types, group-based synchronous e-Learning which has face to face format is imitating the most of worthy features of the traditional educational system. Group-based synchronous e-Learning is increased the student commitment and motivation to engage in education with quick responses with instant messaging or chat [7]. Virtual classroom, web meetings and webinars are the most featured ways of providing synchronous e-Learning.

The virtual classroom which is located in the virtual learning environment is the most ideal for learning process among the different methods of group-based synchronous e-Learning based on the characteristics as shown in Table 1.1. In addition, the virtual classroom facilitates to the practice doing with the objects supplied by the virtual environment and it retains the 75% of knowledge according to the learning pyramid as shown in Figure 1.3. The virtual environment has become a very popular platform for

TABLE 1.1: Characteristics of the Methods in Synchronous e-Learning

	Web meetings	**Webinars**	**Virtual classrooms**
Primary purpose	To solve problems and make decisions	To share ideas and experiences	To facilitate learning
Face-to-face equivalent	A short business meeting	A session at a seminar	A classroom session
Who's in charge?	The chair of the meeting	The host and/or presenter	The teacher / trainer
Visual focus	Participant webcams; shared documents	Slides; presenter webcam; text chat; website tours	Slides; electronic whiteboard; questions; website tours; chat
Auditory focus	Participants' vocal contributions	Host / presenters' voices; possibly also participants' vocal contributions	Teacher/trainer's voice and participants' vocal contributions

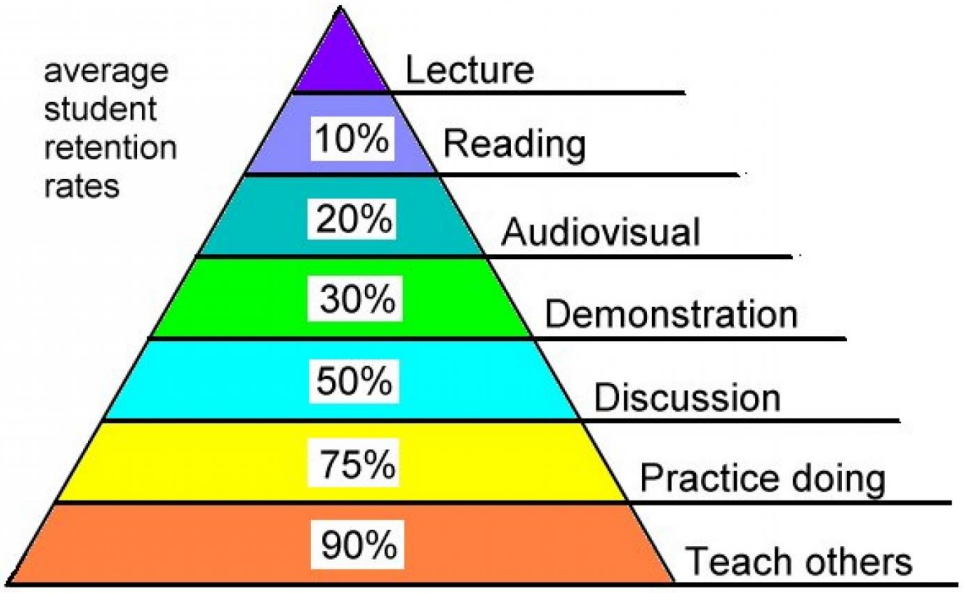


FIGURE 1.3: Learning Pyramid

conducting different kind of activities related to several fields, from education or simulation to games [8]. The virtual environment facilitates the three dimension environments and it looks like the real world environment. Today, most of the universities use virtual platform to conduct courses, assignments and tutorials etc. The virtual classroom is considered as a best way to deliver the knowledge among the other e-Learning methods and it is utilized as a platform to conduct this study.

1.2.1 Virtual Learning Environments

The software products branded virtual learning environments are developed in mid-1990s that intention to contribute learning and teaching activities through the Internet. The virtual learning environment are attractive, stimulating places where students can gather online for class events, including lectures, discussions, case studies, projects, papers, exams, and labs. The virtual learning environment facilitates educators to manage the learning resources quickly without any special technical skills. Normally the virtual learning environments deliver a combined set of Internet tools, which allow upload of materials simply and offer a regular look and feel that can be modified by the user [9]. The three dimensional graphical setting, the use of avatars to represent the class participants, and the sense of presence that puts the learner within the scene make differ

between the virtual world class and a traditional course management system [10]. The currently available software for virtual environments are indicated as follows,

- Active Worlds
- Barbie Girls
- Club Penguin
- Forterra Systems
- Gaia Online
- Habbo Hotel
- Neopets
- Second Life
- The Sims Online
- Whyville
- Zwinktopia

Although there are many virtual environments, Second Life has particular capabilities to conduct the learning activities properly as follows [11].

- Pre-existing engine makes it faster and cheaper to develop game-based learning experiences
- User-created content and 'the network effect' make for large, rich, highly diverse environment
- Global reach provides a polyglot and diverse cultural mix
- Wide range of interest groups and communities of practice represented
- Augmented capability: users can teleport, fly, see round corners, etc.
- Augmented reality: facilitators can telescope or expand time, play with scale and proportion
- Media-rich, highly social environment produces high levels of user engagement

Although there are many multi user virtual environment in existence, Second Life is the one which attracts the greatest amount of media attention. In the last five years, Second Life has grown at an exponential rate. The total number of users has grown dramatically from 1 to 2.2 and 5.5 million in respectively 2001, 2006 and 2007 [12]. The 41.1% of all residents female and 33 years is the average age of the adult in the world of Second Life while the average age of the teen is 15 [13]. Over 700 educational bodies from all over the world are in Second Life today [14]. Second Life is possibly the best-known three dimensional virtual learning environment [13]. Hence second life is better than the other virtual learning environments in the educational aspect and it is utilized as a platform to conduct the e-Learning sessions in this research.

- Second Life

Second Life is introduced in 2003 and it consists with tens of millions of square meters in the virtual lands. Currently Second Life is the largest virtual world with more than 13 million registered users (or residents), and it has a thriving economy. Developers of Second Life continue to refine the application, adding functionality and increasing the level at which aspects of the environment such as the flaccid of water, the movement of trees in the breeze, the way of changing the sunlight during the course of a day. Peoples in the real world can enter Second Life through their own avatars and can spend time in any of a vast number of locations (or islands) that have been created for purposes

including education, socializing, entertainment, and business.
Second Life has certainly special among other applications and it has some important features as follows.

- Users can interact with each other in real time through the virtual worlds
- Residents of the virtual worlds can fully customize themselves using avatars as virtual self-presentations in very flexible ways.
- Three dimensional environments have a significant advantage over virtual communities based on "2D" technology: they induce a strong presence sensation[14].

Users interact in a virtual space generated by the computer, react to actions and change their point of view on the scene with movement. The most of the users has a sensation to be part of the virtual environment [13]. Although the virtual environment has become a very popular platform for conducting different kind of activities related to several fields, from education or simulation to games [8], the strengths and weaknesses of Second Life regarding the educational activities is discussed in the next section to identify the possibility of conducting the educational activities in Second Life.

- Education in Second Life

Second Life is the most popular educational multi user virtual environment among UK tertiary educators. The platform of Second Life can facilitate innovation in pedagogy [16]. Second life depicts the most mature of the social virtual world platforms, and the high usage figures compared with other rival platforms indicates this dominance within the educational world.
Besides, Second life facilitates the platform for e-Learning models where students can engage in an active learning process which is student-centered and guided by an expert or faculty mentor/tutor that interacts with the students. Second life has an excessive capability for distance education, contributes simulations, computer based cooperative and collaborative work, and formal/informal education and training. It allows each individual to develop skills and competencies, to try new ideas and to learn from the mistakes they make. Second life has capability to create a sense of belonging, a shared space, and the sharing of experiences makes it ideal to develop pedagogical activities such as discussions, debates, presentations, simulations, role play, conferences, exhibits and virtual quests. Following indicate the current educational activities of Second Life:

- Individual lessons
- Videos and demonstrations
- Immersive displays
- Conversations and simulations
- Data visualizations and simulations
- Ancient regeneration and re-enactments
- Living and immersive archaeology
- Structure building
- Treasure hunts and quests
- Linguistic and ethnic immersion
- Creative writing

FIGURE 1.4: Appearance of the Virtual Classroom (a) outside of the classrooms (b) Inside of the classrooms

Second Life facilitates a wide range of potentials that wouldn't be possible in the real world. Real time conferences including the avatars that represent the humans from all over the world, in the same virtual room, at the same time, permit discussion to important topics. A fashion show can be arranged by fashion students. A company can be established and checked the way it works with taking real risks with real money by the management students.

At the same time, Second Life affords a possibility to reconceive how many contacts might take place. Educators are able to create and adjust learning spaces easily to test how diverse approaches for a physical space affect learning, and a similar style can be taken toward learning activities in those spaces. The results might influence the design of real-world classrooms, or it might be clear the effective environment in a virtual world as shown in Figure 1.4. Thus Second Life has much strength to use as a learning platform.

- Avatar

The concept of avatar is very valuable and important when the virtual classroom is utilized. The avatar is an object that represents a user in a multi user virtual learning environment. Unlike an icon, which is a metaphoric representation of a user such as a small picture or a username, an avatar can perform an action. The avatar could be utilized to represent human-like or cartoon-like characters. It may also represent the system or a function of the system in an application. It is a distinct unit from the content, it distributes and generally needs contribution from an infobot or chatbot application in order to engage with users [17]. Rather than offering an icon to represent a user, a virtual world allows a user to create an agent that takes action, an avatar. The avatars can be categorized and characterized in three groups: abstract, realistic or naturalistic [18].

Abstract avatars are non-humanoid avatars. They are denoted by cartoon or animated characters, and they have narrow or predefined movements giving interactivity between

FIGURE 1.5: Avatars in the Virtual Learning Environment

the user and an application. An example of abstract avatars can be found in Microsoft office suite with the animated characters. They usually give useful hints or suggestions to the user during his work process [19].
Realistic avatars provide a high level of realism in an interactive situation and they are employed in console games, multi-modal applications, or even teleconferencing occasions [20]. The expenses of the technology and the accessories that should be used are high. To form the avatar, a real time video images or a set of static images are used. The costs however of the technology and the hardware required to implement these avatars are high.

Naturalistic avatars are a low-level details approach. Humanoid-like avatars imitate some basic humans' actions or expressions, such as smiling, walking, or waving hands.
In our virtual learning environment, the avatar is most likely to realistic avatar but not naturalistic avatar as shown in Figure 1.5. The avatar can be made to run, fight, fly, chat, or change into another form when the user types in a command or clicks a button. The avatar performs as the user's agent of action in the virtual space. In addition to taking action, an avatar must take a form. The avatar's form, and the flexibility of that form, is important feature for the communication and show the expressions which are very important to educational applications. The avatar in Second Life hasn't any way to convey any behavior of the user and it has only an ordering connection with students like puppets.
The virtual classroom including the Second life and their main component, the avatar are described with their potential to identify the importance of those features to the e-Learning. Although the e-Learning including the virtual learning facilitates the great contribution to the learning field, the shortcomings are exist yet. The sustainability of

the e-Learning including the virtual learning is depending on the satisfactory level of the learners. The satisfactory level of the e-Learners is exposed to identify the shortcomings of the e-Learning including the virtual learning and the details are described in next part.

1.3 Problem Statement

Student satisfaction is an key indicator of the quality of learning procedure [21, 22]. Information system research distinctly illustrate that the user satisfaction is one of the most important factors in evaluating the success of system execution [23]. Thus inspection of the satisfactory level of the students is vital in the e-Learning process to identify the shortcomings. Besides, investigation of the student satisfaction in online settings is important due to the new technologies have altered the way that students interact with teachers and classmates [24].

The dropout rate of the students can be utilized as an indicator of the satisfactory level of the course since several researches report that the satisfaction of the student is the most important factor in making the decision whether to dropout or not. 42% of the students are dropped out the course due to the dissatisfaction with the learning environment [25]. The satisfaction with e-Learning is one of the key points for successful study according to the survey which was carried out with 200 students [26]. Since a key factor that the literature states referring to dropouts is the low satisfaction of the student with e-Learning, the student retention rate represents the satisfactory level of the e-Learning course [27, 28, 29]. Learner satisfaction is also linked to learner persistence, which in turn is related to completion of the course. Thus student satisfaction indicated the quality of the learning process and the dropout rate or persistence of the e-Learning course.

Unfortunately, the persistence of e-Learning courses is often much lower than in traditional class courses [30, 31]. Researchers have reported that the attrition from e-Learning as high as 70 - 80% [32, 33]. In addition, the dropout rate was around 25%-40% as compared to 10%-20% in on-campus course [27]. The dropout rates of the e-Learning courses were 36%, 54% and 23.9% in Turkey, US Midwestern University and Ludwig Maximilians University (LMU) of Munich, Germany in respectively [34, 35, 36]. There are many reports states relatively same statistics regarding the dropout rates of the e-Learning. Roughly concluding from the international findings, in average dropout rate were around 40% in e-Learning courses, very high compare to the traditional classroom system.

Thus, the dropout rate of the e-Learning is higher than the conventional learning and it is indirectly indicated that the student has low satisfaction regarding the e-Learning courses with low efficiency of the knowledge delivering process since the dissatisfaction is

the main cause to drop the course. If this issue is exist long time, the real benefits of the e-Learning cannot be acquired and sustainability of the e-Learning in the educational field is suspicious. Hence the attention given to enhance the satisfactory level of the student is essential to long lasting of the e-Learning and obtain the real validity. Thus, find a concrete solution to escalate the satisfactory level of the students while enhancing the effectiveness of the e-Learning is identified as the problem statement of this study.

1.4 Approach

Clearly, it is important to anticipate issues that cause low satisfactory level of the learners to quit e-Learning without completing the objectives, and to deal with those issues effectively. External and internal factors can influence to satisfactory level and learner's decision to dropout of an e-Learning course. Family pressures, time constraints, lack of organizational support from the workplace, and finances are some examples [37, 38, 39] for the external factors. Internal student factors relate primarily to motivational issues and main reason is poor contextual factors such as poorly designed courseware, problems with technology, lack of accountability, lack of interactivity, feelings of isolation, and lack of instructor presence [40, 41]. When these factors emerge, the satisfactory level goes down and consequently their decision to dropout of an e-Learning course [26]. The way to enrich the student satisfaction with overcoming those internal factors is the key to reduce the dropout rate while enhancing the effectiveness of e-Learning. The two theories "Social Cognitive Theory" and "Interaction Equivalency Theory" are utilized to identify the way to enhance the e-Leaner satisfactory level with overcoming the drawbacks of the contextual factors in this study and those theorems are described in section 2.6.

As a summary, social cognitive theory explains triadic reciprocal relationship between person, behavior, and environment and it describes how such relation helps the student to acquire knowledge to learn with enhancing motivation. The main concept behind the interaction equivalency theorem is the three forms of interaction (student, teacher, content) and it explains how such interaction helps to enrich the motivation with increasing effectiveness of the learning process. The essences of these two theorems are emphasized that the interactivity among the learning elements play a major role in online students' satisfaction and persistence. Building a balanced and meaningful interactivity among the learning elements (student, content, instructor and environment) is the root for generating delighted e-Learners according to the social cognitive theory and interaction equivalency theorem. Thus the following directions are identified to establish in the e-Learning platform to enhance the student satisfaction.

– Establishment of a proper interaction between the teacher and the student

  - Establishment of a proper interaction between the student and the learning content through the involvement of the teacher
  - Establishment of a proper interaction between the student and the environment through affiliating the teacher

The approaches to achieve above mentioned procedures are described in next sessions.

- Establishment of a proper interaction between the teacher and the student

Communication is one of the most important ingredients in any relationship and the communication play a major role to establish a proper interaction between the teacher and the student [42]. The communication of the teacher and the student is very important to deliver and obtain the knowledge exactly in the educational process. The communication is a joint activity that two or more people engage to achieve mutual goals [43]. The communication includes not only linguistic but also psychological, affective and social aspects of interaction. It can be divided in to major two parts namely verbal and non-verbal. The aim of the teacher's verbal behavior in the classroom is to give content to improve the knowledge of the student especially cognitive learning. Non-verbal behavior in the classroom helps to improve the interest in studies, subject matters and contributes to learn more about the desired subject matter. The communication or information transferring process is based on the verbal message, non-verbal message and tone. The non-verbal communication owns highest portion among the communication process. The major connection is established specially through the non-verbal communication and it is more important [44].

There are some findings related to the non-verbal communication and the real world education. In the real world, non-verbal communication is very essential since the 82% of all teachers' communication attempts are non-verbal [45] and 2/3 of human communication is ruled by non-verbal behavior [46]. We have to consider not only the real world education but also the future trend of education with the virtual learning. It is better to investigate the affection of non-verbal communication in the virtual world education. Although the non-verbal communication is essential component of the education process, it is lack in the virtual learning environment. Hence, the establishment of the non–verbal communication in the virtual environment is one of the activities of this study.

The non-verbal communication is expect to implement in the virtual learning environment to establish a proper connection between the teacher and the student to enhance the satisfactory level of the students with enhancing the effectiveness of the virtual learning.

- Establishment of a proper interaction between the student and the learning content through the involvement of the teacher

The learning content is modified by the teacher according to the feedback of the students is the way to establish the interaction between student and content with the involvement of the teacher. In addition, a high demand on the quality assurance of course ingredients in e-Learning is emphasized with the increment of number of e-Learners day by day [47]. The quality of the course elements can be raised with the precise feedback of the e-Learners. Thus feedback is an essential part of effective learning and it helps the students to understand the subject being studied. Teachers can refine their courses and teaching practices to provide better learning experiences [48]. Effective feedback is a prominent way for teachers to use collected data in order to improve student learning and it is a vital thing in any field for improvement as well as for long lasting. But, the feedback opportunities are scarce in most classrooms [49]. The face to face manner in the conventional class at a school facilitates the teachers to keep close watch on the verbal and/or non-verbal reaction of the students to obtain the feedback and materials are possible to adjust to be more understandable or obtain the decisions to conduct the class effectively. In the e-Learning system, by its asset, the reachable information of the students is very limited to the behavioral ones such as access log, progress log, test record, chatting log, etc [50]. The student feedback through the questionnaire, interview or profiles are utilized in most e-Learning environment and output is very often in inadequate answers, deliberate confusing input. Still there is a massive gap between them in the manner of collection and evaluation of e-Learners' information.

Though, the virtual learning environment has face to face layout, the real validity of the face to face layout including the student feedback is difficult to obtain due to the low connection between the student and the avatar. Although the avatar represents the real user in the virtual environment, it doesn't reflect any characteristics of the real user and it activates according to the user commands given by input mode of the computer. Therefore, the virtual learning environment is also lack with obtaining a precise feedback of the students.

The feedback from the behavioral information including behavior of non-verbal features are genuine than the written or verbal response of the student. Humans keep the confidence for the non-verbal cues due to the following causes [51].

- Nonverbal cues have no limitations: words has limitations.
- Nonverbal signal are powerful: Nonverbal cues are primarily express inner feelings.
- Nonverbal message are likely to be more genuine: nonverbal behaviors cannot be controlled as easily as words.
- Nonverbal signals can express feelings inappropriate to state: Social etiquette limits what can be said, but nonverbal cues can communicate thoughts.

In this study, a novel approach towards the acquiring feedback of the e-Learners in the virtual class is considered through the behavioral information of the non-verbal features of the e-Learner. Such mechanism is essential to adjust the elements of the e-Learning

based on the feedback of the student to establish an interaction of the student and the content to enhance the student satisfactory and effectiveness of the virtual learning.

- Establishment of a proper interaction between the student and the environment through affiliate the teacher

The learning environment should be adjusted to provide the ideal condition for the students' needs. Many students leave because the institution has failed to create an environment [52]. Therefore, the mechanism is essential to identify the highly effective factors for the each student category.

The Perfect learning environment can be implemented with clear methodology and utilizing a set of well-defined principles. Such an environment is complex and must be continued through the use of assessment procedures and methodologies designed to enhance learning. Learners obtain the knowledge courageously when they perceive the classroom environment more positively, thus the knowledge about the classroom environment is a major part to give the attention of educators, researchers, administrators of school system and parents. Many studies on classroom setting or climates have been conducted since several years ago and have provided a lot of vital information for educators and researchers on students' perceptions of classroom environment [53, 54].

Quality of the classroom environment in schools is afforded to be an important factor of student learning [53]. Previous studies have shown that student perceptions of the classroom environment affect for the learning outcomes [55]. The classroom environment is the "culture" that determines students' learning development [56]. Students' level of learning would be improved with the friendly guidance and teacher support in classrooms. In other words, the classroom environment, which is the "culture" that teaches students how to think and to acquire knowledge through the classroom environment. It is vital to understand the features that affect to the student engagement to design better courses and improve student retention [57].

Most educators are aware that a quality learning environment with collaborative, stimulating and challenging features can significantly enhance performance and growth for every student in the classroom. It has always been significant to structure temporal location, improve collaborative processes, and employ proper utensils in order to help learners to achieve anticipated learning outcomes.

It is obvious that the real world learning environment is highly significant to the student learning based on the previous researchers. The studies related to the virtual learning environment is rare due to the virtual learning is in the early stage. Hence there is a shortage of the information regarding the preferred environment of the virtual class learners. But the virtual world provides a common learning environment for all student categories even they are in different educational levels. Thus, the identification of the effective factors based on the student characteristics in the virtual classroom are timely

important to establish a proper interaction among the student and the environment with involving the teacher contribution.

1.5 Objectives of the Research

Although the virtual learning spreads throughout the world to deliver the knowledge in e-Learning platform, it is also suffered from the common problems in e-Learning, mainly the low student retention rate compare to the traditional learning system. The low satisfactory level of the students is the main cause to drop the course. We have identified that building a balanced and meaningful interaction among the learning elements (student, teacher, content and environment) is the key to enhance the satisfactory level of the students based on the two theorems, "Social Cognitive Theory" and "The Interaction Equivalency Theorem", and considering the factors for the low satisfactory level especially the contextual factors.
Based on that foundation, the objective of this study is defined to construct a mechanism to enhance the satisfactory level of the students through creating delighted students with enhancing the effectiveness of the virtual class using ICT (Information and Communication Technology). To achieve this objective, there is a multi-model system that have been defined with three main procedures as follows,

- Establishment of a effective communication and evaluate its impact to the education with the intention of establishing a proper interaction among the student and the teacher

The proper interaction between the student and the teacher can be implemented with the establishment of a better communication. Although the verbal and the chat communication are already available in the virtual learning environment, the non-verbal communication which owns highest portion of the communication process is lack in the virtual learning environment [58]. Thus our target is to implement the non-verbal communication in the virtual learning environment to establish a effective communication. The establishment of the non-verbal communication in the virtual learning environment is a process of visualizing the behavior of non-verbal features of the real user in the virtual learning space.

- Construction of an e-Learner tracking system including their status

The feedback through the behavior of the student is essential to obtain during the learning activities for establishing a proper interaction between the student and the learning content through the teacher. Then the teacher is able to adjust the content according to the behavior of the students. A student tracking system is expected to construct and identify the student behavior to adjust the learning content.

- Development of a matrix including the effective factors based on the student characteristics

The interaction between the student and the learning environment will be able to establish through the teacher, after identifying the effective factors in the virtual classroom for the each student category. The virtual learning is still in the early stage of the education field and the student requirements are difficult to recognize in the form of distant leaning are emphasis the requirements of inventory consists of student effective factors based on their measurable characteristics. Thus, the effective factors based on the student characteristics will be vital to establish a proper connection among the student and the learning environment.

The balanced and meaningful interaction among the learning elements will be established with these three practices and it will be contributed to enhance the satisfactory level of the students. Ultimately, these three processes may attend to our main objective to enhance the satisfactory level of the students through generating delighted students with increasing the effectiveness of the virtual learning.

1.6 Structure of the Thesis

The rest of the thesis is organized as follows. The next chapter discusses the background of this study and the previous work related to this research work. The third chapter, methodology explains the procedure to achieve the objective of this research. Mainly the three targets are discussed, visualizing the non-verbal behavior in the virtual learning environment, construction of a student tracking system with their status and identification of the effective factors based on the student characteristics. The details of the assessment procedure for whole the study and the experiments which were conducted with the non-verbal visualization system is discussed under the forth chapter named as Process of the Evaluation. The fifth chapter presents the result that has been obtained through the assessment procedure and the experiments. The sixth chapter, Discussion provides a summary of the valuable results and discusses the pros and cons of this research. Final chapter, Conclusion presents the brief of the study with recommendations and concludes remarks for a better virtual classroom for future e-Learning.

1.7 Summary

To overcome the drawbacks of the conventional learning system, e-Learning is originated with massive benefits. The virtual learning is a kind of knowledge delivering form in the e-Learning and it genesis as a result of the affection of advancement of technology

to e-Learning. Even though there are various methods to deliver the knowledge in the e-Learning and the enrollments are raised dramatically, the retention rate become low compare to the conventional learning due to the low satisfaction of the e-Learners. The key suggestion to enhance the satisfaction of the students is to establish a balanced and meaningful interaction among the learning elements. Thus, the enhancement of the satisfactory level of the students with establishing a balanced and meaningful interaction among the learning elements while escalating the effectiveness of the virtual learning is the objective of this study and it is fulfilled under three approaches as follows.

- Establishment of a proper communication method to enrich the interaction among the teacher and the students
- Creating a mechanism to obtain the feedback of the student to establish a proper interaction among the student and the content
- Construction a guidance for the effective factors to provide a preferred environment to establish a proper interaction among the student and the environment

The intention of this study is to follow these three approaches to enhance the satisfactory level of the students.

Chapter 2

Literature Survey

2.1 Development of the e-Learning and the Virtual Learning

E-Learning is being speedily employed by most educational institutions across the world as such media of teaching are cost-effective, easy to use and distributable to a larger audience. There has been significant attention in the potential for the improvement of e-Learning in universities, schools and further education [59]. Although the online enrollments have continued to rise at slower rates than the previous years, the rate of the online admission is far in excess compared to the total student population according to the survey that consists more than 2,500 colleges and universities of United States. The 3.5 million students was taken at least one online course during the fall 2006 term; a nearly 10% escalation over the number informed the previous year. The 1.5% progress rate for the overall student population of higher education is far lower the 9.7% growth rate of online admissions [60]. It is predicted that advances in Internet technology are likely to increase the use of multimedia and interactive simulations or games in online learning during the next 5 to 10 years [61]. Not only for education but also it is spread to several fields with supplying training to workers [62]. The training session for the workers can be better served by e-Learning environments rather than conventional training [63]. With the advancement of the sophistication of information technology contributes to the development of the e-Learning in various ways including better understanding of how to make content and delivery of online courses more effectively. Thus, higher education institutions have introduced numerous types of e-Learning support system. As a result of that, virtual learning is emerged. With the implementation of virtual environment, new chapter of e-Learning is released with the specific major benefits.
The virtual learning environments are defined as computer-based environments that are

relatively open systems, letting interactions and knowledge distribution with other members and teachers' and providing access to a wide range of assets [64]. Virtual learning environment is provided more genuine and realistic models of virtual classes within a fully-immersive, collaborative and three-dimensional virtual world. Active participation of students in learning process is the educational value of this platform. Students can perceive or conduct virtual exercise and training, which are either difficult to be performed in a traditional classes [65]. Therefore it is important to develop the virtual education with the advancement of technology.

Some of the authors have already investigated the possibility of carrying out problem based learning in the virtual environment [66]. They were successful and already established a problem based learning model in a virtual space. Many universities conduct their various educational projects and courses using virtual environment. Exercises, assignments and some activities are conducted based on this platform. Educators use virtual world to develop the creativity, improve the programming skills, etc. It is not always true that every virtual learning environment provides a high-quality learning. There are several opportunities that exist to develop the virtual learning platform to deliver the knowledge effectively since the virtual platform is still in the initial stages. Thus the problem of the e-Learning sector is important to investigate and those problems can be overcome with fulfilling the opportunities of the virtual learning platform.

2.2 Literature Regarding the Quality of the Knowledge Delivering Process in e-Learning

The previous researchers indicate that the e-Learning, including the development form of enormous open online courses, from the institutional viewpoint, not from the student's. They have identified that the one of the barriers to widespread acceptance of online education was low retention rates [67]. As discussed in the introduction, dropout rate of the e-Learning is relatively high which is indicated the low retention. Student satisfaction with their online experience is mainly linked to the student retention in online programs [25]. If students were satisfied with their online learning process, they would be more likely to retain in the program [68]. The key cause for the low retention is the neap satisfaction and the satisfaction is a vital element in creating a successful online program [69].

The satisfaction of the students is complex phenomena and affected by numerous factors. Numerous studies are available regarding the student satisfaction with e-Learning [70] fully online as well as with blended learning simulations [71]. There have also been a numerous studies on the judges of student satisfaction with online learning [72]. Few of them are explained as follows.

Many research discoveries specify that higher levels of interaction between teachers and learners are associated to raise learner satisfaction in the online learning setting [73]. Learner-content interaction and learner-instructor interaction were discovered to be the most important variables for a satisfying online experience according to another finding. Further, they stated that development a rich interactive content and instructor presence in learning session cause to satisfy the online learner. Although interaction between the teacher and the student are related to enhance the student satisfaction, the interaction among the students was not found to be significantly correlated with satisfaction [74]. Another research illustrates that the three constructs to be important in measuring student satisfaction with online courses: interactivity, instructor variables and issues with technology [75]. Further, building an interaction with the online community raises the student satisfaction [68].

In addition, the ways to enhance the satisfactory level of the students are listed as follows from the previous findings [76, 77, 78],

- Student's comfort level with technology
- Clarity of expectations and the student's self-assessment
- Positive perceptions of technology
- Autonomous and innovative learning styles
- Students' perceptions of social presence
- Personal relevance (linkage of course content with personal experience)
- Instructor support
- Active learning
- Authentic learning (real-life problem-solving)

According to the literature, satisfactory level of the students is vital in e-Learning process and almost all the researchers' emphasis the requirement of interactivity among the learning components to enhance the satisfaction. Although they emphasized the interactivity, the lists of components that establish the interactivity, have different arguments. Thus the two theorems which are related to the education and satisfactory level, "Social Cognitive Theory" and "Interaction Equivalency Theory" are utilized in this study to identify the components that should be established the interaction. The details of the two theorems are explained in section 2.6.

According to that, the balanced and meaningful interaction among the learning components (student, teacher, content and environment) is the root to enhance the satisfactory level of the students and that is the aim of this study.

Thus, the expectation of this study is to enhance the satisfactory of the students with utilizing the opportunities of the virtual learning platform with a proposed multi-model system (Visualizing the behavior of non-verbal features, developing a student tracking system and intruding a matrix with effective factors based on the student characteristics) with establishing a balanced and meaningful interaction among the learning components

(student, teacher, content and environment). It is difficult to find the related work concerning the multi-model system which consists several activities in one study that is discussed in this research. Hence, previous works are discussed related to the each process from next section onward.

2.3 Literature Regarding the Visualization of the Behavior of Non-Verbal Features

The related work concerning the implementation of non-verbal communication which is the first section of the proposed multi-model process in this study is going to be discussed. Effective communication contributes to establish a proper connection between the teacher and the student [79]. According to the Mehrabhian's model as shown in Figure 2.1, the non-verbal communication obtains the highest portion in the communication process. Researchers have found that the non-verbal behavior is more effective communicative method for improving student-teacher connection than the verbal communication through surveys of more than 10,000 teachers. Students prefer to teachers who have more non-verbal expressiveness than less expressive teachers [80]. There was an investigational study to recognize the non-verbal connection among the teacher and the students at kindergarten level [81]. Teacher non-verbal features help to increase the students' keenness to discuss things and the non-verbal features of the teachers help them to improve their performance and understanding [82]. There are some evidences in

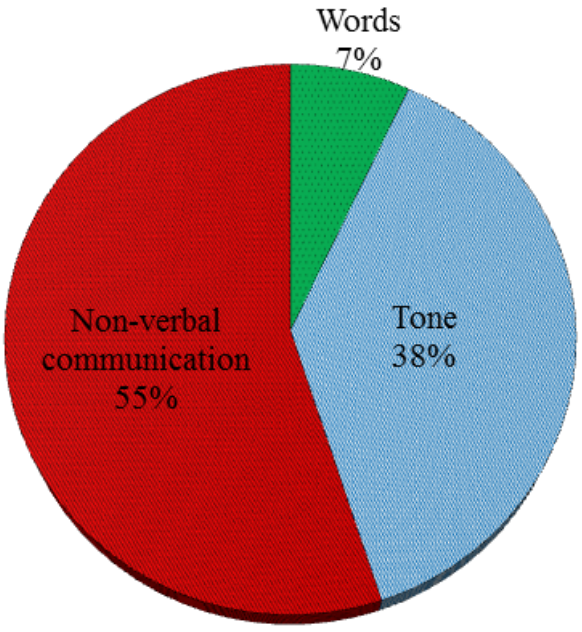


FIGURE 2.1: Mehrabian's Communication Model

the real world that the student performance increases through the non-verbal features. When the virtual lectures employ facial expression, the students achieved better by 86% in the lectures compared to the performance of the lectures that did not use facial expressions. The proper utilization of smiling increased the awareness of the students and consequently their performance [83]. The literature states that the non-verbal communication has possibility to affect positively in the education process and it is essential component to enhance the effectiveness of the learning process.

Unfortunately, the non-verbal communication is lack in the virtual environment, which is very essential part of the education process [84]. According to the literature, there is a system to visualize the basic activities of the real user in the virtual environment using mobile phone [85]. But there are no any studies to be found with concerning the visualization of the behavior of non-verbal features of the real user.

The behavior of the non-verbal features of a person consists a broad area including facial expression, head motion, eye behavior, gesture and pose and it is difficult to implement all these non-verbal behaviors in the virtual class. Among those non-verbal characteristics, the facial expression is vital since it is one of the most potent, natural and instant means for human beings to communicate their expressions and intentions [86]. In addition, the eye blink is important since it is an indicator of cognitive load [87] and it is origin from the eyes, which is most expressive component of the face [88]. Further, the focus of attention can be derived with the head pose estimation [89]. Hence the facial expression, the eye blink and the head pose are designated to introduce to the virtual class, as they are main characteristics of the non-verbal environment. The previous studies are examined and briefly described in the next paragraphs to recognize the proper methods to detect the facial expression, eye blink and head pose estimation.

In general, the geometric feature-based methods and appearance-based methods are two methods to denote the face and consequently the facial features to execute the facial expression analysis [90]. The shape, texture and/or position detail of important face features such as the mouth, eyes, nose, eyebrow, and chin, which can cover the deviation in the outlook of the facial expression, is utilized for the geometric facial feature-based methods. Normally the appearance-based methods are using image filters such as Gabor wavelets to produce the facial feature for either the whole-face or particular areas in a face image. Recently researchers have verified that geometric feature-based approaches offer similar or better performance than appearance-based methods in Action Unit recognition [91]. However, the geometric feature-based method generally needs precise and reliable detection of facial feature and tracking, which is tough task to accommodate in many occasions. Recognize the facial expression is still a challenging task even though it has been investigated in the past ten years [92].

The eye blink is a physiological action of quick closing and opening of the eyelid, which

are the vital activities of the eye that supports to spread tears across and eliminate irritants from the surface of the cornea and conjunctiva. Although the eye blink speed differ due to causes such as tiredness, emotional tension, behavior category, amount of sleep, eye injury, medication, and disease, the normal spontaneous eye blink rate of human being is vary from 15 to 30 per minute [93]. In the last few years, much research has focused on eye blink detection and one of the most commonly used techniques based on Electromyography (EMG) readings, which are obtained by using three small electrodes that attached to the skin with micro-pore tape around the orbicularis oculi muscle [94]. Although EMG-based system is effective in detecting the eye blinks through muscle signals, EMG signal quality and electrical noise are affected negatively. Several advantages can be obtained from the web-camera based system compared to EMG such as ease of the setup, placement of the web-camera and nothing needs to be attached to the person. In addition, web-camera is a cheap and commercially available piece of hardware [95]. The eye blink roughly occurs once each 2 to 4 seconds, and the normal blink continues about 250 milliseconds. Not less than 15 frames per second can be captured by a normal camera comfortably. Therefore eye blinks is possible to detect using a camera including a web-camera [96]. The eye blinking is better to detect using geometric methods with the help of a real time web-camera video.

The head pose estimation is interpreted as the capability to infer the positioning the person's head relative to the view of camera. The head motion of an adult male can cover averagely (forward to backward movement of the neck) from -60.4^0 to 69.6^0, a frontal lateral bending (right to left bending of the neck) from -40.9^0 to 36.3^0, and a horizontal axial rotation (right to left rotation of the head) from -79.8^0 to 75.3^0 [97]. The head motion of a human is limited to 3^0 of freedom in pose, which can be characterized by pitch, roll, and yaw angles as shown in Figure 2.2. There are several approaches that have been used to estimate the head pose and those are listed as follows [98].

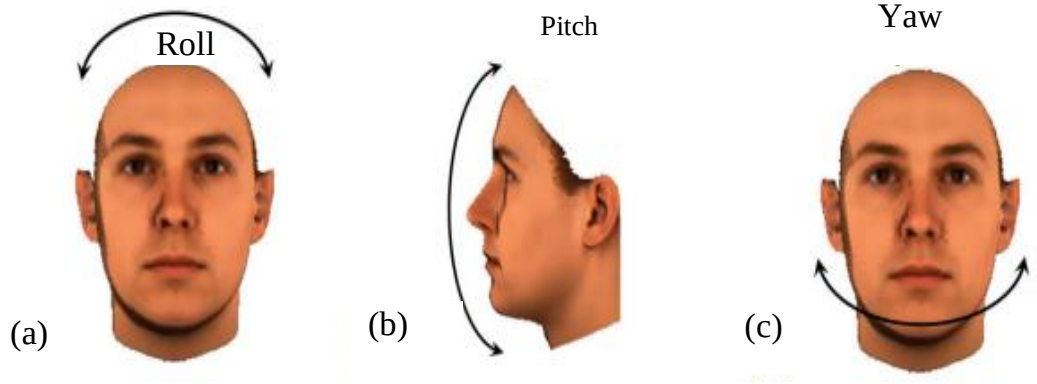


FIGURE 2.2: Human Head Rotation Around Three Axes (a) Roll (b) Pitch (c) Yaw

- *Appearance template methods compare a new image of a head to a set of exemplars (each labeled with a discrete pose) in order to find the most similar view.*
- *Detect or array methods train a series of head detectors each attuned to a specific pose and assign a discrete pose to the detector with the greatest support.*
- *Nonlinear regression methods use nonlinear regression tools to develop a functional mapping from the image or feature data to a head pose measurement.*
- *Manifold embedding methods seek low-dimensional manifolds that model the continuous variation in head pose. New images can be embedded into these manifolds and then used for embedded template matching or regression.*
- *Flexible models fit a non-rigid model to the facial structure of each individual in the image plane. Head pose is estimated from feature-level comparisons or from the instantiation of the model parameters.*
- *Geometric methods use the location of characteristics such as the eyes, mouth, and nose tip to determine pose from their relative configuration.*
- *Tracking methods recover the global pose change of the head from the observed movement between video frames.*
- *Hybrid methods combine one or more of these aforementioned methods to overcome the limitations inherent in any single approach.*

Geometric approaches are flexible methods, yet modern approaches can automatically and reliably recognize facial feature positions, and these approaches should carry [98]. The head pose is better to detect using geometric methods with the help of a real time web-camera video.

As a byproduct of our activity namely the implementation of the non-verbal communication in the virtual classroom, there is an opportunity to analyze the behavior of non-verbal features especially the eye blink behavior. The previous studies are examined and briefly described in next paragraphs to identify the factors that are affecting to the variation of the eye blink rate to analyze the eye blink rate.

The manner of the eye blinking is discussed since it is one of the main components of the non-verbal communication and several studies have conveyed that the behavior of the eye is one of the powerful non-verbal signs that have capability to create impressions on people [99]. The eye blinking strongly reflects the psychological states of the person [100]. Previous researchers have investigated the effect of eye contact, gaze and gaze avoidance on impressions. The eye contact and the eye gaze are frequently related with a positive impression and the opposite way reflects the negative impression [101]. Thus the analysis of the eye blink behavior is vital in the education process and some findings related to the rate of eye blink are discussed as follows.

Although the average rate of the eye blink was 17 blinks per minute, it is increased to 26 during a conversation, and it was reduced to 4.5 while reading, according to the previous researches. As compared with rest, the blink rate decreased by 55.08% while reading

and increased by 99.70% during the conversation. The most common blink rate pattern was conversation >rest >reading [87]. When the eye blink frequency increased, students become nervous and careless [102]. Another researcher reported a significant increase in eye blink frequency when subjects were required to solve anagrams. The increment of eye blink reflects the stress, tension, nervous and relaxation cause to reduce the blink rate in generally [103]. Frequencies of person's blinks are also influence to the impression of the viewer [104]. Tasks involving conversation or memory escalate the blink rate, while those demanding visual fixation diminish the blink rate [87, 105]. The low blink rate is related with the daydreaming, which creates visual fixation [106]. In addition, other factors cognitive, visual and memory tasks are also effected to blink rate. Besides, when the peoples are conversing or involving in an interview also showed an increases in blink frequency. Generally negative situations such as nervousness, stress and fatigue are reflected by the increased blink frequency. The blink rate depends upon cognitive and emotional states [107]. The literature states that the eye blink rate depends on the activity that he/she engages and it can be utilized as a measurement of the behavior of student based on the historical evidences. Thus the analysis of the eye blink behavior is important in the education process especially in the process of e-Learning to identify the behavior of the student.

According the literature, the non-verbal communication has been done tremendous affect in the real world application in the education process under several aspects. Thus the establishment of the non-verbal communication in the virtual learning environment is vital with the facial expression, the eye blink and the head pose. The literature states that the basically geometric methods are ideal to detect the non-verbal behavior. In addition, the idea about the behavior of the eye blink is obtained according to the previous researches and it will be helped to analyze the eye blink behavior in this study.

2.4 Literature about the Methods to obtain the Precise Feedback through the Student Behavior

The related work regarding the methods to obtain the feedback through the student behavior, which is the second part of the proposed multi-model process in this study, is going to be discussed. There are much researches have focused on the learning behavior in web based learning. Analyzing the learning portfolio which includes learning path, preferred learning course, grade of course, and learning time, etc., is a one way of obtaining the feedback through identification of the learning behaviors of learners. The learning portfolio is useful to analyze the learning behaviors of the learners and to realize the learning rules for understanding the reason why a variety of learning performance of the learners [108, 109, 110]. These kinds of statistical analysis in learning portfolio

are used to analyze the behavior of students such as students' grades and performance. However, all the teachers don't have the knowledge of statistics to analyze the student behavior and teacher has to spend time to analysis as well as it is not possible for large group of students.

With the development of technology, teachers are able to obtain the analysis of the student response immediately without a prior knowledge about the statistic or analysis tools. The Student Response System (SRS) allows teachers to submit the questions and students to enter their answers using a variety of handheld devices, varying from graphing calculators to palmtop or laptop computers, which they share in small groups of three or four. The teacher is received the response of the student on the computer screen and it can be projected to the students also. The result of the students is possible to analyze immediately and teacher can give attention for the each student in the large class also [111, 112, 113].

The ways to obtain the student response or feedback that previously discussed, have some limitations. Even though, they obtained the student behavioral information such as response time, learning path, preferred learning course, grade of course, and learning time, the problem is raised about the reliability of the feedback or status of the student whether the real response acquired or not. The actual inner feeling and the feeling that are trying to show for others may be different and the verbal or writing response can be easily differed from the actual feeling is the reason for doubtfulness of the reliability of the student feedback in tools like portfolio and SRS system. In addition, the purpose of obtaining student response in those methods (portfolio and SRS system) are limited to evaluate the student and not for developing the learning elements such as learning content, characteristics of the teacher, environmental conditions etc.

Sometimes the nonverbal communications deny the verbal; frequently nonverbal express exacts emotional state more precisely than the verbal or written language. Tracking the behavioral sequence of the non-verbal characteristics of the student is helpful to identify the precise response of the student. Humans trust non-verbal cues than the verbal signs due to the following causes [114].

- Nonverbal cues have no limitations: words has limitations
- Nonverbal signal are powerful: Nonverbal cues primary express inner feelings
- Nonverbal message are likely to be more genuine: nonverbal behaviors cannot be controlled as easily as words.
- Nonverbal signals can express feelings inappropriate to state: Social etiquette limits what can be said, but nonverbal cues can communicate thoughts.

Thus, analyzing the behavior of non-verbal features of the student is important way to obtain the feedback during the learning session and opportunities are emerged to improve the learning elements through those feedback of the student.

2.5 Importance of the Identification of the Preferred Classroom Environment

The related work and the importance of the identification of the preferred classroom environment, which is the third as well as the last part of the proposed multi-model process in this study, are discussed in this session.

Researchers have interested in the relationship between the classroom environment and way it influences to the academic engagement [115]. Many factors consist in the environment affect to the learning experience. Some of those factors are infrastructure, standard of content and evaluation method, quality of learner contribution systems, assumptions made by learners and educators about the learning experience itself and peer support networks for learners and educators [116].

There is a rich link between classroom environments and student outcomes [117]. A proper learning environment is achieved the desired learning outcomes [118]. Students' outcomes better when they obtain their preferred learning environment [119]. In addition, a well-arranged classroom contributes to enhance student academic and behavioral performance [120]. However, facilitating a well-arranged classroom setting to students is one way to accomplish the classroom more successfully with less instruction because it causes fewer behavior difficulties and establishes a favorable climate to learning. Based on these findings, it is obvious that the learning environment has dramatic impact to the behavior of the learner. Thus the facilitation of the student preferred environment through identification their effective factors are vital in the education process.

In the conventional learning, the environment of the class can see, feel, listen and even touch. Not like real world classrooms, students cannot reach to all the environmental facts bombarding since the recognizable ways of the environment information is inadequate in the virtual classrooms. They can only see and feel it psychologically. Students try to obtain the information about the environment for their consideration via automatic and controlled processes. Student try to realize what they are sensing by piecing bits of information together from the bottom up and by applying existing judgments and predetermination from the top down. Sometimes the students may focus their awareness to particular object in the learning environment that they find more interesting, important, or unfamiliar than others. In any education setting, the students maintain their limited cognitive assets by actively selecting environmental facts for further consideration and by using existing awareness structures to understand this information in ways that have worked previously. Thus, the environment condition is affect to the behavior of student even they are interact with the virtual learning.

The current emerging nature of e-Learning, the virtual learning emphasis the necessity of research regarding the effective factors to identify the student preferred environment

in the virtual classroom. Although the environment may effect to the learner behavior in the virtual world, research activities related to the virtual environment are few due to the novelty of the virtual learning platform. Since the virtual learning environment is still new to the learners as well as teachers, the preference items in the virtual environment of the students need to be identified to engage with the learning activities properly in that environment. Generally, elements of the learning environment such as classroom design, way of instruction are varying with the basic student characteristics. As an example, the instruction way is differ from the student educational level when comparing the students in school and university. However, the common environment is utilized in the virtual learning environment currently to deliver the knowledge. The common environment is not the preferred environment for each and every student engaging with the virtual classroom. It is obvious that the inventory including the effective factors of the virtual learning environment for each student category is essential requirement in timely. The information including the effective educational condition for each student category will be helpful to conduct the learning sessions productively especially for the e-Learning due to the students and the teachers are not known. The identification of the effective factors in the virtual learning environment may be helpful to establish the interaction between the student and the environment and it is indirectly affect to the enhancement of the satisfactory level of the students.
Related works regarding the three processes (Visualizing the behavior of non-verbal features, developing the student tracking system and introducing the matrix with effective factors with student characteristics), which are proposed in this study, are discussed and identified the importance of those three processes in the virtual learning.

2.6 Theories behind This Study

The two theories, social cognitive theory and interaction equivalency theory are deployed mainly in this study to identify the way to enhance the satisfactory level of the students and explained as follows.

2.6.1 Social Cognitive Theory

Social cognitive theory stemmed from the social learning theory, written by Albert Bandura in the early 1960's. In 1986, Bandura officially launched the social cognitive theory. Social cognitive theory explains human behavior in terms of a three-way, dynamic, reciprocal model in which personal factors, environmental influences, and behavior continually interact as shown in Figure 2.3. Social cognitive theory purports that an individual's learning is directly related to what an individual observes and subsequently learns by

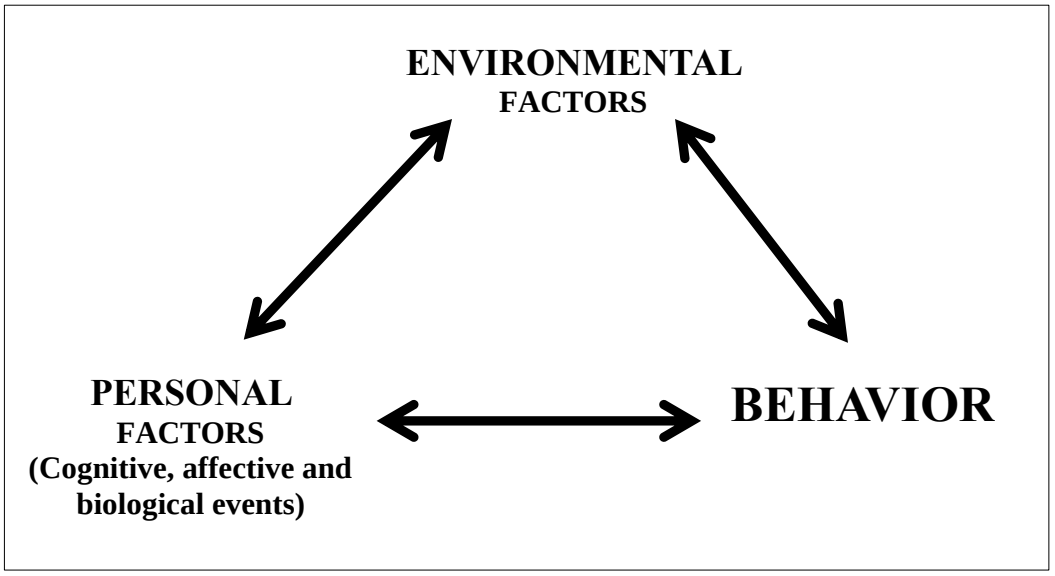


FIGURE 2.3: Framework of the Social Cognitive Learning Theory

imitating the actions of another while being influenced by their own thoughts and the environment in which they are learning. This theory focuses on the cognitive, behavioral, individuals and environmental factors that affect how people behave and how people are motivated. There is no single reason that can determine our thoughts or behaviors. A basic premise of social cognitive theory is that people learn not only through their own experiences, but also by observing the actions of others and the results of those actions. According to this theory, an individual's behavior is uniquely determined by each of these three factors [121]:

- Personal Factors: A person's expectations, beliefs, self-perceptions, goals and intentions shape and direct behavior. However, the behavior that is carried out will then affect one's thoughts and emotions.
- Environmental Factors: Human expectations, beliefs, and cognitive competencies are developed and modified by social influences and physical structures within the environment. These social influences can convey information and activate emotional reactions through such factors as modeling, instruction and social persuasion.
- Behavioral Factors: A person's behavior will determine the aspects of their environment to which they are exposed, behavior is, in turn, modified by that environment.

This theory purports that people acquire knowledge and skills through a triadic reciprocal relationship between person, behavior and environment. High levels of interactivity

lead to higher levels of student motivation, improved learning outcomes and satisfaction over less interactive learning environments [122]. The satisfaction, motivation and achievements can be improved through the interactivity among the student-student and student-instructor in online course design. The rich interactivity between students and their environment (peers, instructors, and content) in active learning can be improved overall learning achievement and satisfaction with motivating students.

2.6.2 The Interaction Equivalency Theory

Anderson developed an interaction equivalency theory which was designed to help educators to select the most effective and efficient type of interaction. It states:

- Thesis 1: Deep and meaningful formal learning is supported as long as one of the three forms of interaction (student-teacher, student-student, teacher-content) is at a high level. The other two may be offered at minimal levels, or even eliminated, without degrading the educational experience.
- Thesis 2: High levels of more than one of these three modes will likely provide a more satisfying educational experience, though these experiences may not be as cost or time effective as less interactive learning sequences.

Figure 2.4 is a tentative visualization of the theorem conceptualization. The first thesis refers to the equivalency of value, (the quality of the interaction) as shown in Figure 2.5 (b). In the most extreme case, it proposes that only one of the interaction elements is necessary to ensure high-quality learning. Even though the teacher is not present and

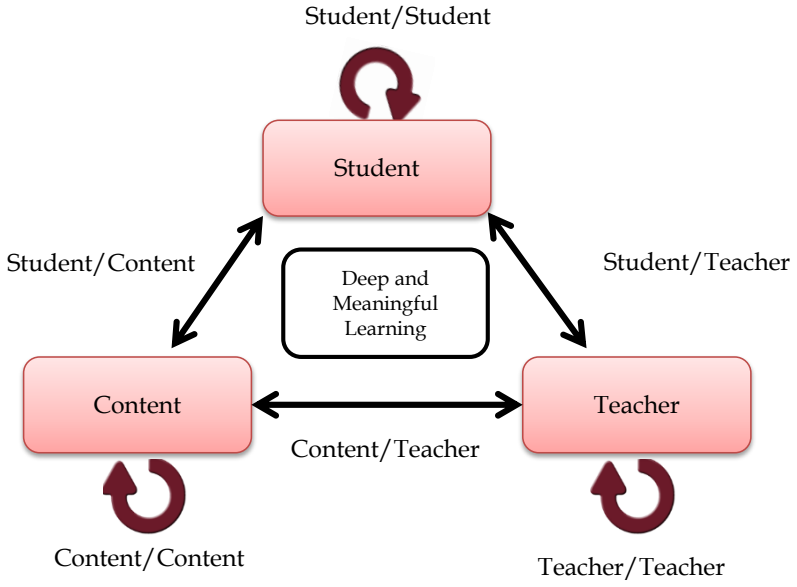


FIGURE 2.4: Framework of the Interaction Equivalency Theorem

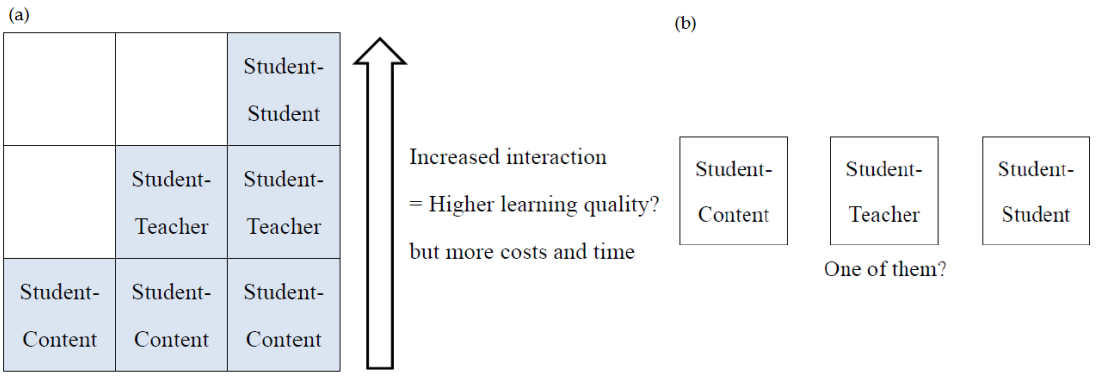


FIGURE 2.5: Framework of the Interaction Equivalency Theorem

the course content is unsuitable, student can accomplish a superior learning experience through strong relation with other course members (e.g. collaborative or cooperative learning).

In contrast, the second thesis refers to the quantity of the interaction (i.e., there might be an educational situation in which a student engages in intense interactions with the course teacher, the course content, and/or other students) as shown in Figure 2.5 (a). Although the course related to the second thesis would likely offer a high superior learning, the expenses for creating the content and the time durations for that are very high.

The three forms of interaction (student-teacher; student-student; student-content) are introduced as follows,

Student Interaction

- Quality educational program requires high levels of interaction by students in at least one area, and can substitute for minimal to no interaction in the other two.
- Student-teacher interaction currently has the highest perceived value among students
- Student-student interaction is critical for learning designs based upon constructive learning theories, but less critical to cognitive and behaviorist learning theory based approaches.
- Student-student interaction is critical for skill proficiency needed for collaborative or cooperative tasks. Thus, most effective learning to reach these goals maximizes student-student interaction.
- Student-content interaction is most accessible and most readily adapted, via individualized "student portfolios," that can influence design, assessment or delivery customization (mass customization).

Teacher Interaction

- Teacher-student interaction is generally the least scalable type of interaction, and thus is usually substituted by student-content interaction in mass education systems.

- Some teacher interaction can be transformed into learning objects (videos, animations, assessment programs etc.), thus migrating student-teacher interaction to student-content interaction.
- Teacher-teacher collaboration is critical to the current model of university based research production and evaluation.

Content Interaction

- The importance of the content is dependent on the interaction of the students or the teachers. Such interaction leads to relevant knowledge creation. There is a direct relationship between this interaction and commitment, interest, and motivation.
- The cost and limits on value of content interaction is dropping much faster than interaction involving the other two forms of interaction and thus human based interaction: student-student, student-teacher, and teacher-teacher are vital.

Interactivity can occur between student-student, student-instructor and student-content. The interaction equivalency theorem suggests that meaningful learning can happen when at least one of the three forms of interaction is exist at a high level. When high levels of more than one type of interactivity are exist, a more satisfying educational experience will be occur. Although meaningful learning occurs with at least one interaction, more than one interaction contributes to enhance the satisfactory level of the students. If it is possible to establish the interaction between each learning elements, the learning will occur and student satisfactory will be enhanced. According to the interaction equivalency theory, the establishment of a proper interaction among the learning content (student, teacher and content) is the way to occur learning process successfully and raise the satisfactory level of the students [123, 124, 125].

Based on these two theorems, social cognitive theory and interaction equivalency theory, the establishment of a balanced and meaningful interaction between the learning elements (student, teacher, content and environment) is the way to conduct the learning process successfully and enhance the satisfactory level of the students.

2.7 Summary

The literature states that the enhancement of the satisfactory level of the e-Learners is the key for the success of an e-Learning programs and it can be accomplished with establishing a proper interaction among the learning elements according to the "Social Cognitive Theory" and "Interaction Equivalent Theory". To establish the interaction among the student and the teacher, the communication is vital especially the non-verbal communication. Facial expression, eye blink and head pose are the major non-verbal

behaviors and the geometric methods are still potential to detect those non-verbal features since geometric methods are not reached their full potential yet. In addition, the precise way to obtain the feedback of the e-Learners is vital in the e-Learning process due to the distance barrier and the drawbacks of the current evaluation methods. Further, the environment and the behavior of the student have strong relationship based on the literature and providing their preferred environment is caused to enhance the effectiveness of the learning process in many aspects. Thus the literature states that, establish the non-verbal communication, creating mechanism to obtain the feedback of the students precisely and providing their preferred environment caused to enhance the student satisfactory level and it may indirectly raise the persistence rate of the e-Learning.

Chapter 3

Methodology

Aggrandizing the satisfactory level of the students in the virtual classroom with establishing a balanced and meaningful interaction between the learning elements is the purpose to achieve in this research. Students, teacher, content and the environment are the elements of the learning process and the proper interaction between these elements may lead to enhance the satisfactory level. The proposed plan for the establishment of the interaction between learning elements is appeared in Figure 3.1. There are major three activities towards the win flag of this research.

- Establishment of the non-verbal communication in the virtual classroom to enhance the interaction among the student-teacher and them-selves
- Construction of a student tracking system to obtain the feedback of the students for establishing an interaction among the student and the content through the involvement of the teacher
- Identification of the effective factors for the each student category to establish an interaction among the student and the environment by the teacher.

The aim of the establishment of the non-verbal communication in the virtual classroom is to launch the proper interaction between the student and the teacher and them-selves. The ambition of the construction of a student tracking system is to obtain the feedback of the students to implement an interaction between the student and the content through the involvement of the teacher. The purpose of the identification of effective factors based on the student category is to build a proper interaction between the student and the environment by the teacher.

The conceptual framework has been designed to deliver the theoretical structure of the proposed plan including the detailed description with organizing major activities for comprising a broad concept as depicted in Figure 3.2.

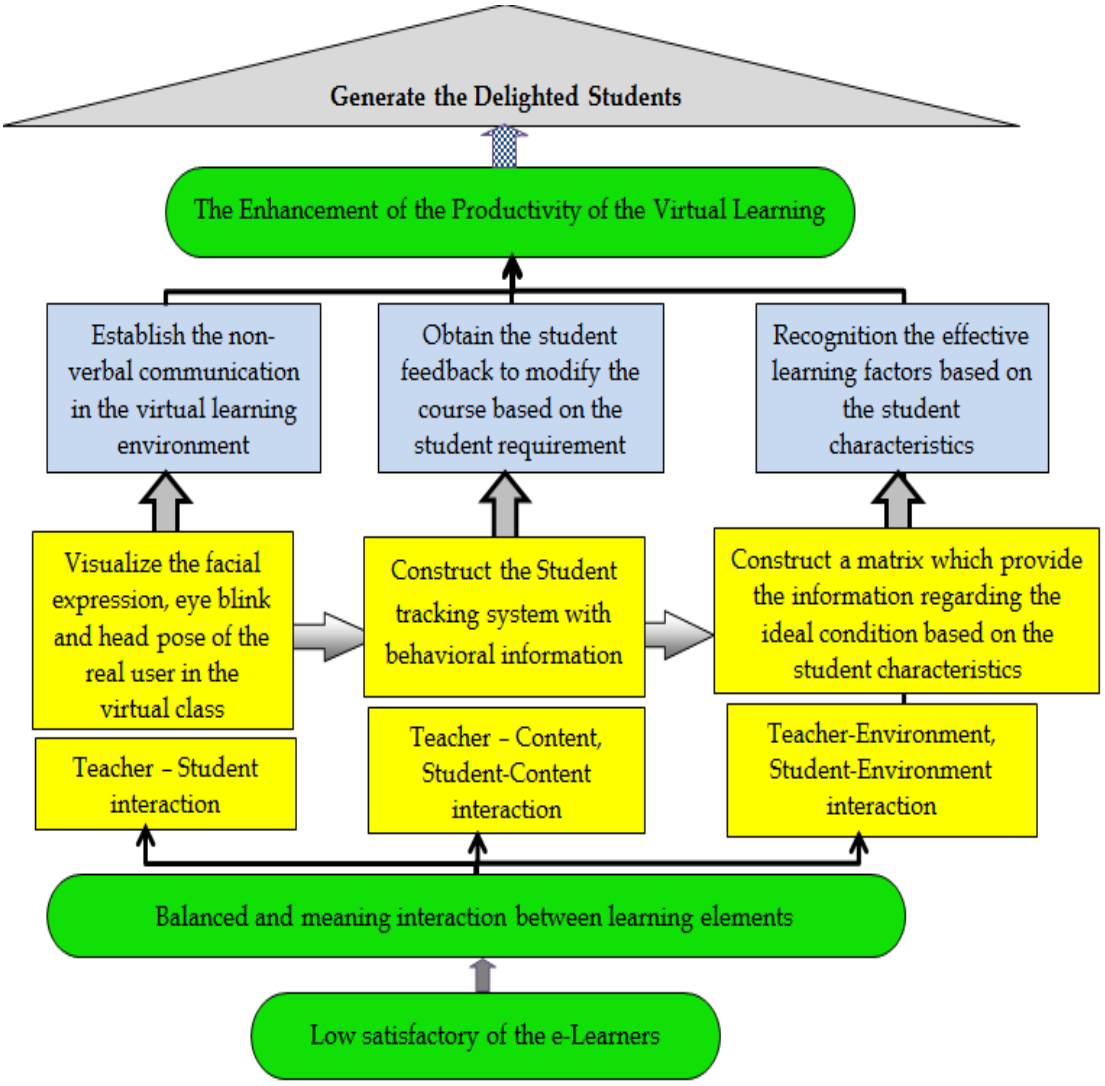


FIGURE 3.1: Framework of the Entire System

3.1 Architecture of the Whole Process

The architecture of the whole processes is indicated in Figure 3.3. The first part of the figure is indicated that the visualization of the behavior of non-verbal features of the real user. Though the students and the teachers are in different locations in the real world, virtual classroom can be accessed by the students and teachers through the electronic equipment ranging from palmtop to laptop or desktop computers. When they are engaging with the learning activities, the behavior of non-verbal features are captured by a web-camera. The non-verbal visualization system is identified the real students' non-verbal characteristics by using a real time web-camera images. The server is worked as an intermediary to transfer the obtained behavior of non-verbal information from the real world to the virtual world. When the transferring process is completed, the non-verbal characteristics of the real user are reflected in the virtual environment through

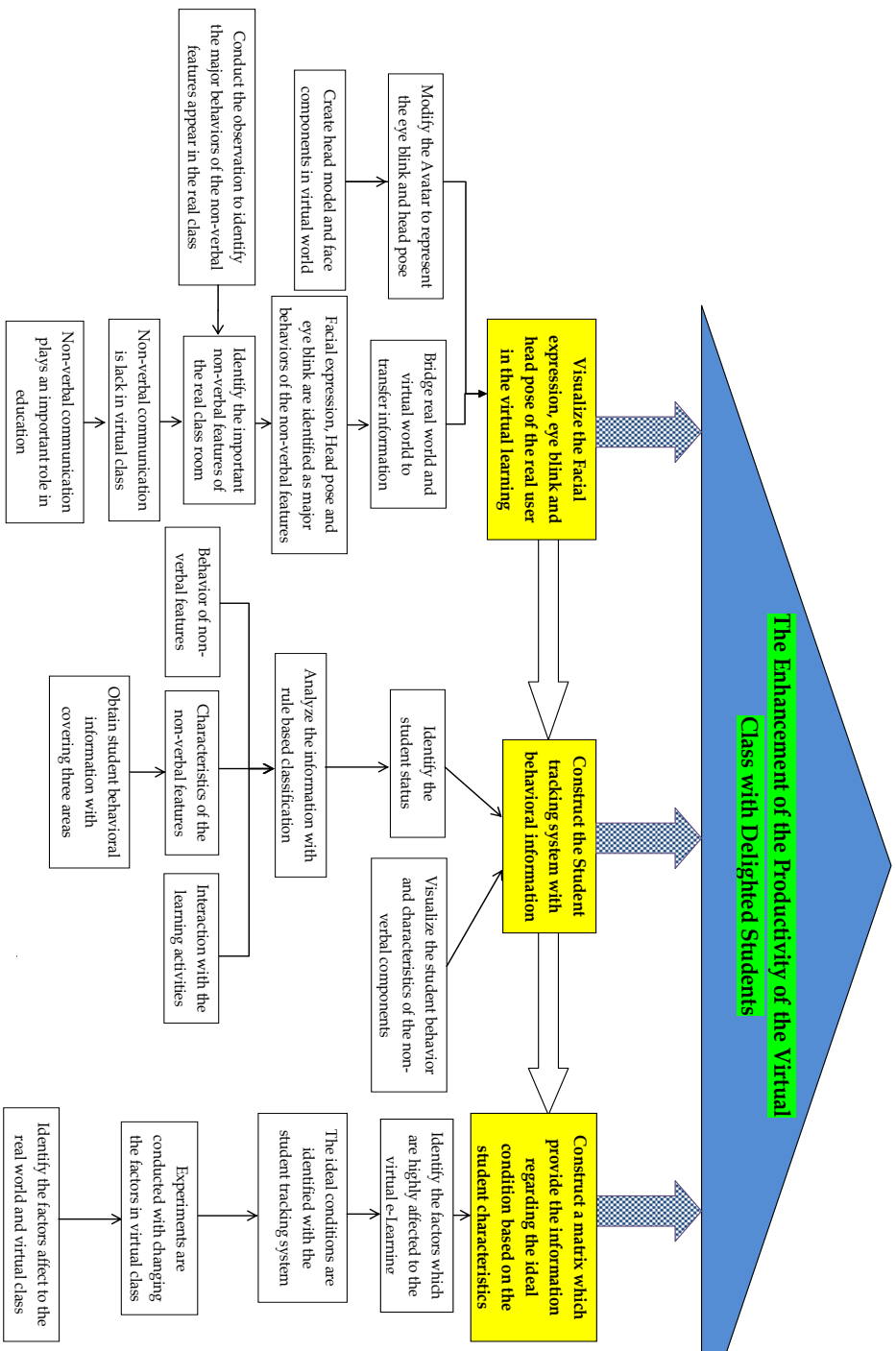


FIGURE 3.2: Conceptual Framework of the Entire System

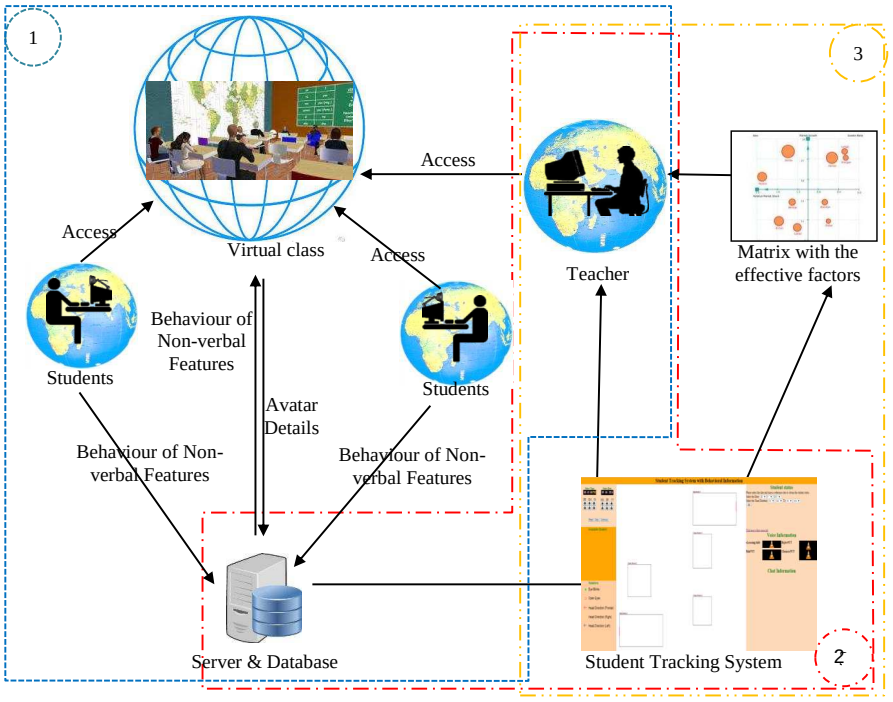


FIGURE 3.3: Architecture of the Whole Process

the avatar during a learning activity. The teacher or the third party can observe the behavior of non-verbal characteristics of the student by directly logging to the virtual world.

The second part of the Figure 3.3 indicates the student tracking system and that is interacts with the other two processes. During the transferring process of the behavior of the non-verbal features from the real world to the virtual world in the first part, the server and the database are contributed as a repository of the student information. In addition, some behavioral information such as chat information, position and posture of the avatar which is reflects the student's engagement in the virtual class, are obtained from the virtual world and stored in the server. The repository information is utilized to derive the status of the student to construct the student tracking system with verbal and non-verbal behavioral information. The tracking system provides the feedback about the learning elements to the teacher indicating status of the students during the activities in the virtual class. The teacher can monitor the verbal and non-verbal characteristics of the students even though they are in distinct places and then the teacher has opportunity to obtain the precise decisions to maintain the class effectively based on the student behavior through the tracking system which is indicated in the second part of Figure 3.3.

The layout to identify the effective factors for the learning environment is indicated in the third part of Figure 3.3. The tracking system provides the reaction about the

learning elements to the teacher indicating status of the students during the activities in the virtual class. The learning sessions can be conducted in the virtual world with different conditions and the effective factors for the each student category can be identified through the tracking system. A matrix can be developed based on the effective factors for each student category and it will be utilized by the teacher to conduct the leaning session productively. The teacher can designed the tailor made environment for the students based on the matrix, which consists with effective factors.
The proposed solution has major three sectors to fulfill as follows and the description about each segment is discussed in the next session.

- Visualization of the real user non-verbal behavior in the virtual class
- Student tracking system including the behavioral information
- Identification of the effective factors based on the student characteristics

3.2 Visualization of the Real User Non-Verbal Behavior in the Virtual Class

Visualizing the behavior of non-verbal features of the real user in the virtual world through the avatar is the initial activity of this multi-model process. The framework for the establishment of the behavior of non-verbal features of the real user in the virtual

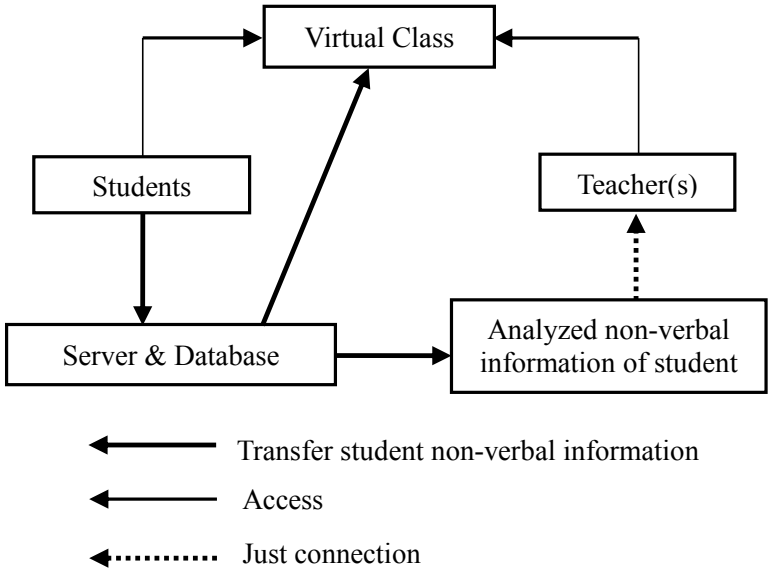


FIGURE 3.4: Architecture of the Non-verbal Visualization System

environment is illustrated in Figure 3.4 and it is consisted with mainly three steps as follows.

- Identification of the behavior of non-verbal features of the real user
  - ✓Facial Expression
  - ✓Eye blinking
  - ✓Head pose
- Transfer the behavior of non-verbal features to the virtual world
- Modifying the avatar in the virtual world to represent the behavior of non-verbal features of the real user

Detecting the behavior of non-verbal features of the real student is the initial step of the visualization process of non-verbal features in the virtual world. The obtained information is required to transfer to the virtual world to visualize the information of the real user through the avatar is a second step. The adjustment or modification of the avatar has to be done as the third step to reflect the behavior of non-verbal features since the artificial avatar in the virtual world cannot make any non-verbal representation relating to the real user. The non-verbal characteristics are appeared in the virtual world to introduce the non-verbal communication in the virtual classroom through the avatar when the non-verbal cues are being transpired by the real user in the real world after completing the above three steps. The way to fulfill those three activities are discussed in next part.

3.2.1 Identify the Behavior of Non-Verbal Features of the Real User

The non-verbal is a broad area and it consists many characteristics such as posture, facial expression, eye blink, gestures with hands and arms, speech and tone of voice and so on. The most important behaviors of non-verbal features in the learning process is essential to clarify since the behavior of all non-verbal information is impossible to implement

FIGURE 3.5: Environment of the Real World Classroom During the Experiment

in the virtual environment practically. The observation is conducted in the real world class as shown in Figure 3.5 to identify the most important non-verbal behavior(s) in the learning process based on the real world classroom education and the result is indicated that the eye blink of the students has good relationship with their activities [102] since it is an indicator of cognitive load [87]. And also the facial expression is vital since it is one of the most potent, natural and instant means for human beings to communicate their expressions and intentions [86]. In addition, the head pose is an important indicator to

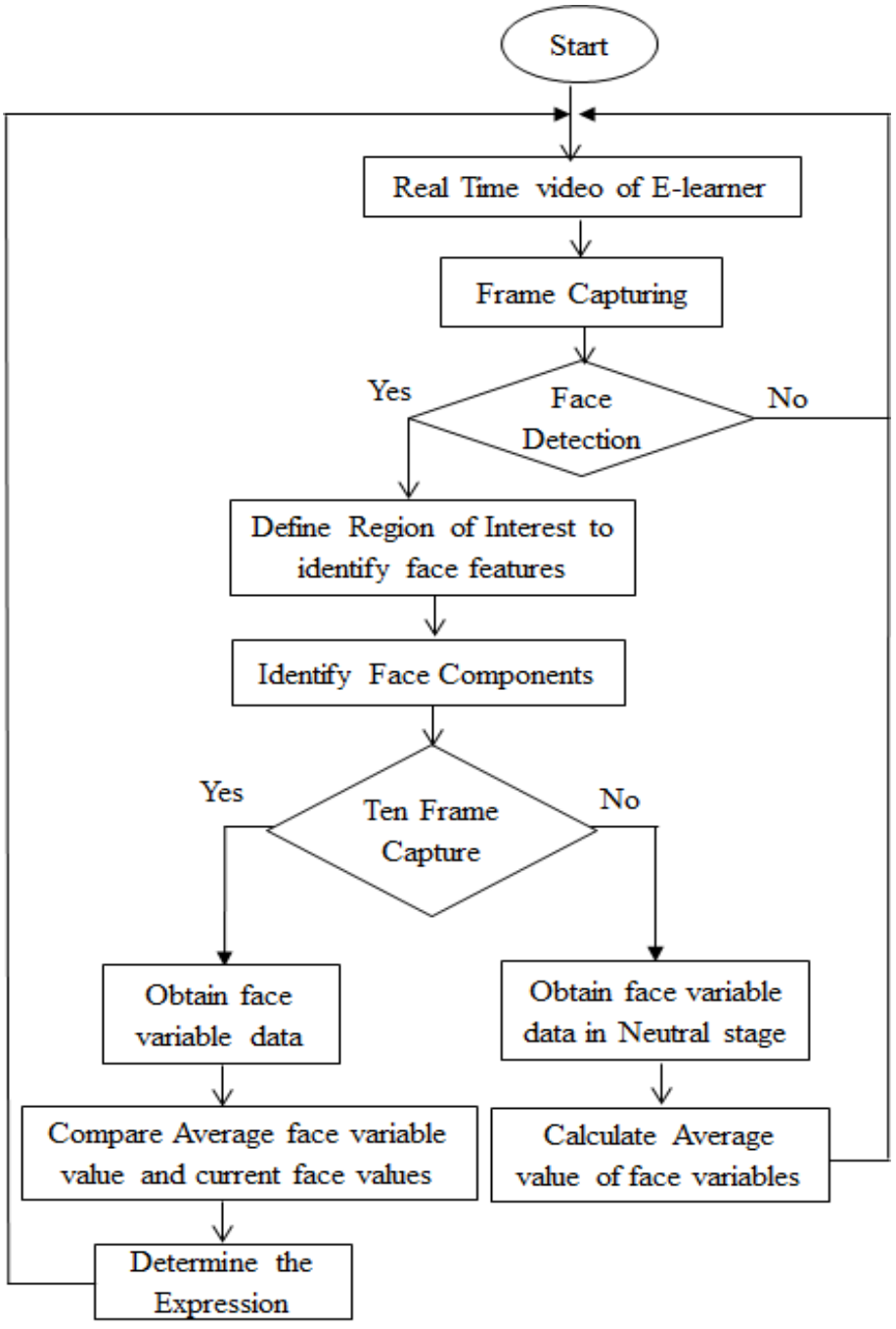


FIGURE 3.6: Major Steps to Identify the Facial expression

focus of attention [89] that allows teacher to figure out who gives attention to the learning session. Thus, the facial expression, the eye blink and the head pose are identified as the most valuable for the educational process and way of detection the facial expression, the eye blink and the head pose will be discussed in the next session.

- Facial Expression Identification System

Geometric based method is applied to identify the expression of the student since literature states that the better performance can be achieved through geometric based method than appearance-based approaches [127]. The procedure to identify the facial expression is illustrated in Figure 3.6. The video with an expressive face of a student is obtained during the learning session with the help of a web-camera. The video is a set of images which has sequence from start to end. Then image analysis is carried to identify the facial expression. After obtaining the real time image, the face of the user is detected with Haar-feature based cascade classification [128]. Then the image classification is done to identify whether the face is included or not. If there is no face in the image, then the procedure re-starts from the beginning. If the face is identified, the components of the face such as eyes, nose and mouth are required to detect. The detection of the face components becomes ease due to the area of examine becomes reduced in face image with the regions of interest for face components are known as shown in Figure 3.7. Haar-feature based classification is applied again to detect the face components. Having detected the face and the face components, the behavior of the facial components is analyzed with obtaining the following variables.

- Left eye height
- Left eye width
- Right eye height
- Right eye width
- Nose height
- Nose width
- Mouth height
- Mouth width
- Face height
- Face width

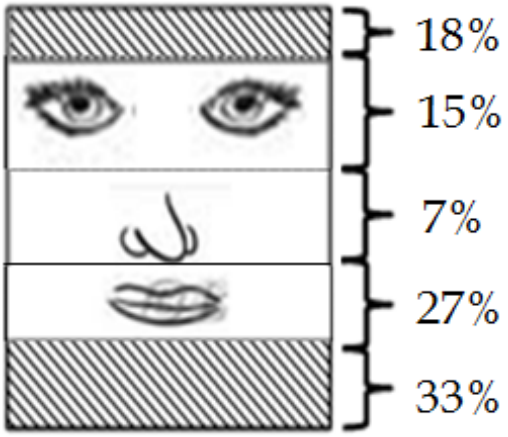


FIGURE 3.7: Roughly Identify the Areas of the Face Components

During the first ten frames capturing, the behavior of the facial components is obtained and calculated the average value of each facial variable in neutral state. After ten frames capturing with face components, the facial expression can be determined.
Although there are ten face variables obtained, the affection way of each face variables is different for each facial expression. By utilizing the Principle Component Analysis with MINITAB software, the highly related face variables for each facial expression are identified. Thus the highly affected face variables are identified for each facial expression

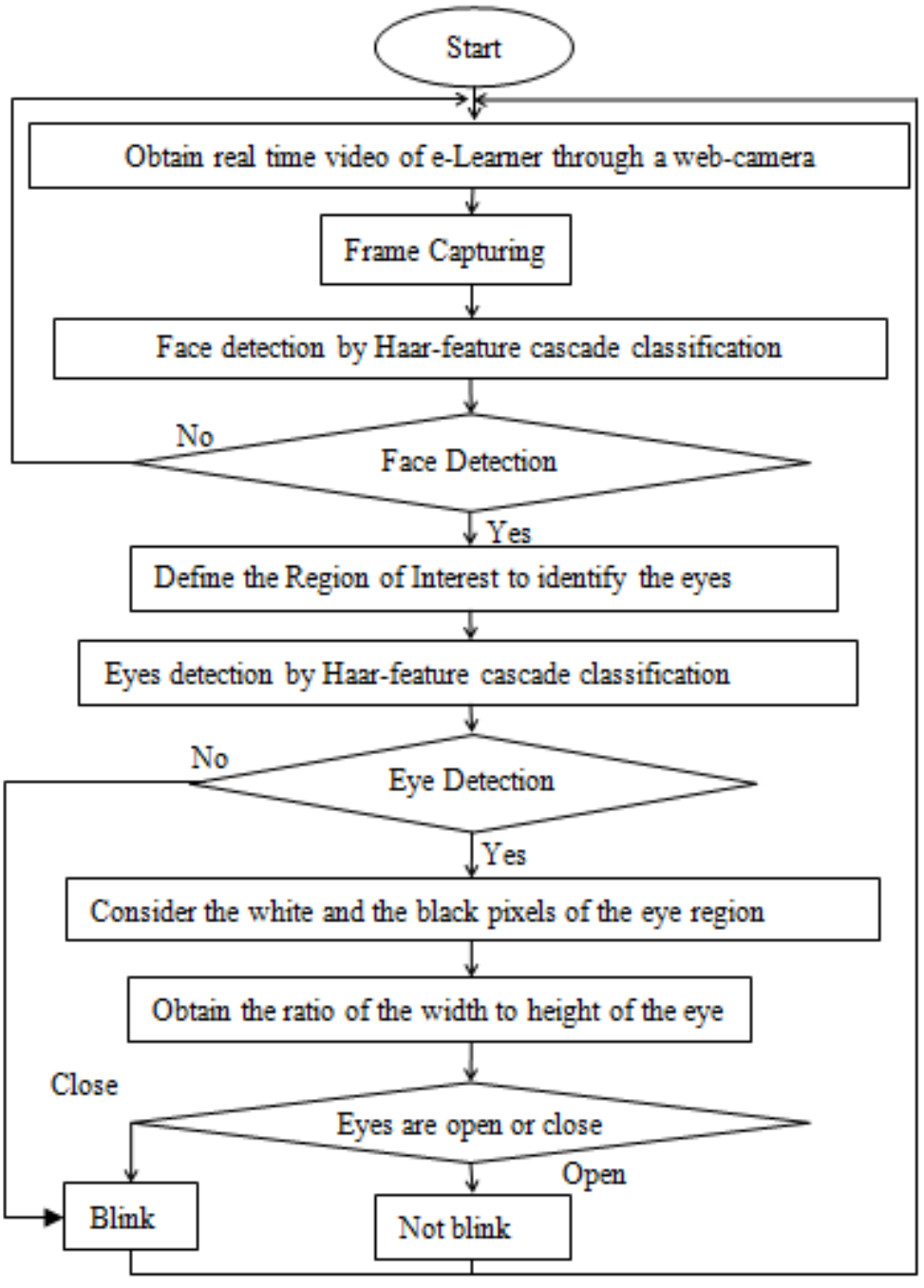


FIGURE 3.8: Procedure to Detect the Eye Blink

and defined new axes for each facial expression based on the ten face variables. Through the comparison of face variable data in neutral state and current face variable data, the appropriate facial expression can be obtained. The system checks average natural length and the current length of each component for each occurrence. According to the changes of the lengths of the face components, the system is identified basic facial features such as "Neutral", "Happy", "Surprise", and "Sad".

- Eye Blink Detection

The procedure to detect the eye blink of the student is shown in Figure 3.8. The real time video of the student is obtained by using a web-camera. The video consists of frames and it is captured frame by frame to analyze the each frame. Haar-feature cascade classification [128] is utilized to detect the face of the frame. When the face is detected, the process is being continued to the next step. Otherwise the process has to be started from the beginning. The next step is the detection of eyes by the similar method, Haar-feature based cascade classification. The detection of the eyes becomes ease because of the region of interest for the eye is known when the face is detected as shown in Figure 3.7 and as well as the area that want to be examined, is reduced. Then the eye may or may not be identified. If the eyes are not identified, but the face is detected, it can be classified as a blink since the Haar-features are trained for the positive images, which are consist with open eyes. Although the face is detected, the eyes may not be detected due to the close status of the eyes and it can be classified as an eye blink. When the eyes are detected, it is needed to identify further that the eyes open or close. Two measurements are utilized to clarify it. The ratio of the width to height of the eyes and the number of black and white pixels of the eye regions are the two measurements. The decision can be obtained whether eyes open or close by using the declared measurements. When the eyes close, it can be identified as an 'eye blink' and 'not blink' is recognized through the open eyes. The eye blink can be detected using this procedure and the steps of the procedure are indicated as follows.

Step 1: Start
Step 2: Obtain a real time video of the e-Learner through a web-camera
Step 3: Frame Capturing
Step 4: Face detection by Haar-feature cascade classification
Step 5: If the face detection is true
Define the Region of Interest to identify the eyes
Eyes detection by Haar-feature cascade classification
Else
Stop
Step 6: If Eye Detection is true
Consider the white and the black pixels of the eye region
Obtain the ratio of the width to height of the eye

TABLE 3.1: Accuracy of the Eye Blink Detection System

	Detection accuracy for subjects		
	Japanese Students	Other Students	Total performance
Face Detection	94	95	95
Eye Detection	84	89	86
Eye blink Detection	79	83	81

Else

Blink

Step 7: If the eyes open, is true

Not blink

Else

Blink

Step 8: Stop

The accuracy of the eye blink detection is evaluated for six Japanese and for eleven other students who are in different nations as shown in Table 3.1 and Figure 3.9. The eye blink detection is identified after detecting the face and the eyes. Therefore, the accuracy checking is expanded into three parts, face, eyes and eye blink detection respectively. It is evident that the detection accuracy is slowly reduced from the face detection to eye blink detection as the preceding order since the eye blink detection is done after detect the face and the eyes respectively. The overall performance of the face, the eyes and

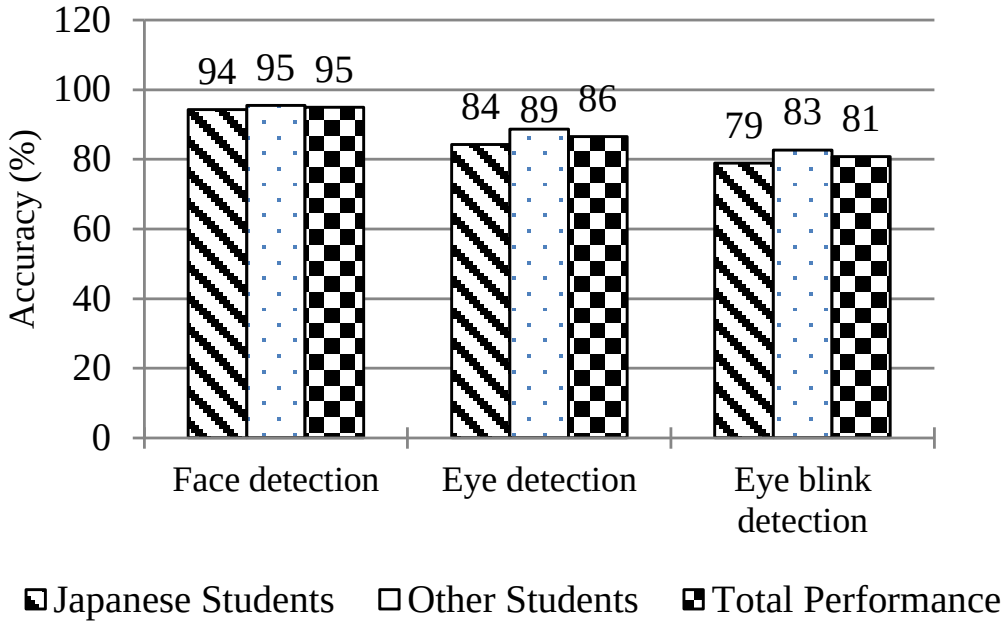


FIGURE 3.9: Accuracy of the Eye Blink Detection

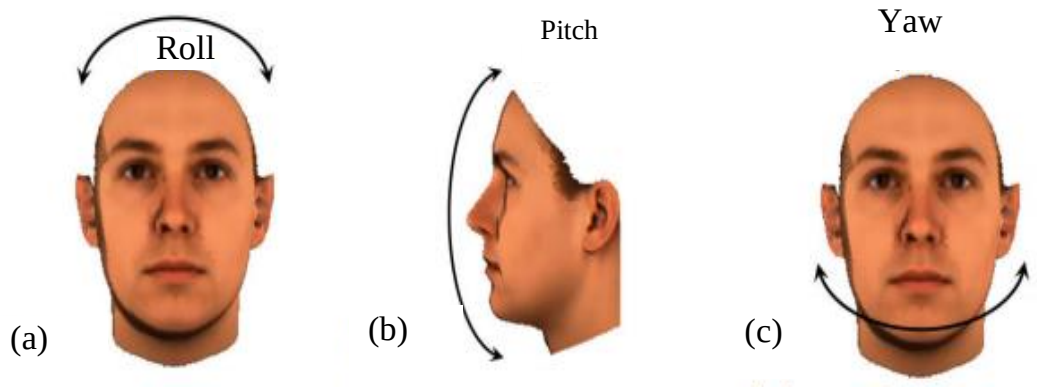


FIGURE 3.10: Human Head Rotation Around Three Axes (a) Roll (b) Pitch (c) Yaw

the eye blink detection systems are 95%, 86% and 81% respectively. The accuracy is reduced for the Japanese students than the other students since the size of the eyes of Japanese students is small comparing to the other students and it may be the reason for difficulty of detecting eyes. However, the overall accuracy for the eye blink detection is 81%.

There are much research related to the eye blink detection and one of the methods was obtained 97.28% of average accuracy using Electrooculogram [129]. Another researcher use the Hough transforms in combination with the deformable templates to extract eye-feature points, but this approach is time consuming [130]. Although most of these researchers have obtained the good performance, their eye blink detection procedure is based on expensive equipment and wearing such equipment are barriers to engage with education. In addition, some of those methods are based on manual interaction and not a real time process. There is an approach for real-time remote detection of eye blink and the mean blink detection rate is 70% [131]. Comparing to those results, our approach with the 81% of accuracy is better since it is detected the real time eye blink instantly with the inexpensive web-camera.

- Head Pose Estimation

Human beings can move their head around three axes and those are called roll, pitch and yaw as shown in Figure 3.10. The full movement of the head is not needed to identify in the virtual learning since they are engaging with the computer and teacher wants to know whether students are engaging with the learning activity or not. If students are engaging with learning activity, the head direction should be directed towards the computer screen and those movements are essentially captured. When the student looks at outside the computer screen, the degree of the movement is not needed preciously and a rough determination is enough. The head pose estimation in this study is developed based on those requirements.

The system covers the head movements of the user around the pitch and the yaw axes

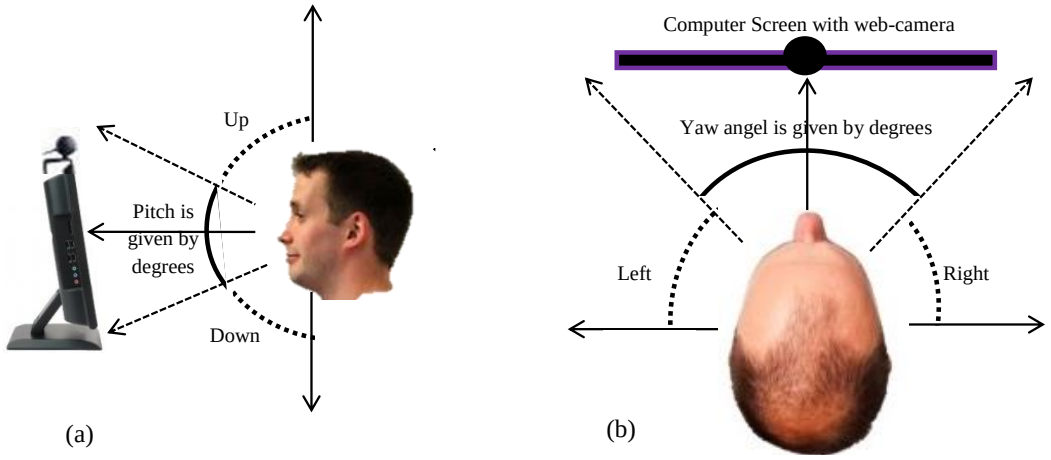


FIGURE 3.11: Basic Head Direction and Head Pose Estimation by Degree in (a) Pitch and (b) Yaw

in two sections as shown in Figure 3.11. The head movement is considered under the pitch and the yaw axes by degrees when the user is looking at or nearly looking at the computer screen. When the student is looking outside the computer screen, only the basic direction is obtained such as up or down for the pitch axis and left or right direction for the yaw axis. The full coverage is facilitated for the roll axis with degree by degree. The procedure to identify the head pose is consisted with several steps as follows.

Step 1: Start

Step 2: Obtain real time image of an e-Learner through a web-camera

Step 3: Obtain the threshold value and select the eyes, nose and mouth of the image by e-Learner

Step 4: Obtain a real time video of the e-Learner through the web-camera

Step 5: Frame Capturing

Step 6: Face detection by Haar-feature cascade-classification

Step 7: If face Detection is true

Define regions of interest to identify the face components

Detect the eyes, nose and mouth using template matching

Define pitch, roll, and yaw angles using geometric method

Else

Smooth the image and change the color format from RGB to HSV

Threshold the HSV image and create a binary image

Find the biggest contour

Obtain the rectangle area of the white pixels

Define the head direction using shape of the biggest contour of the white pixel

Step 8: Stop

The complete procedure to identify the head pose is illustrated in Figure 3.12. The

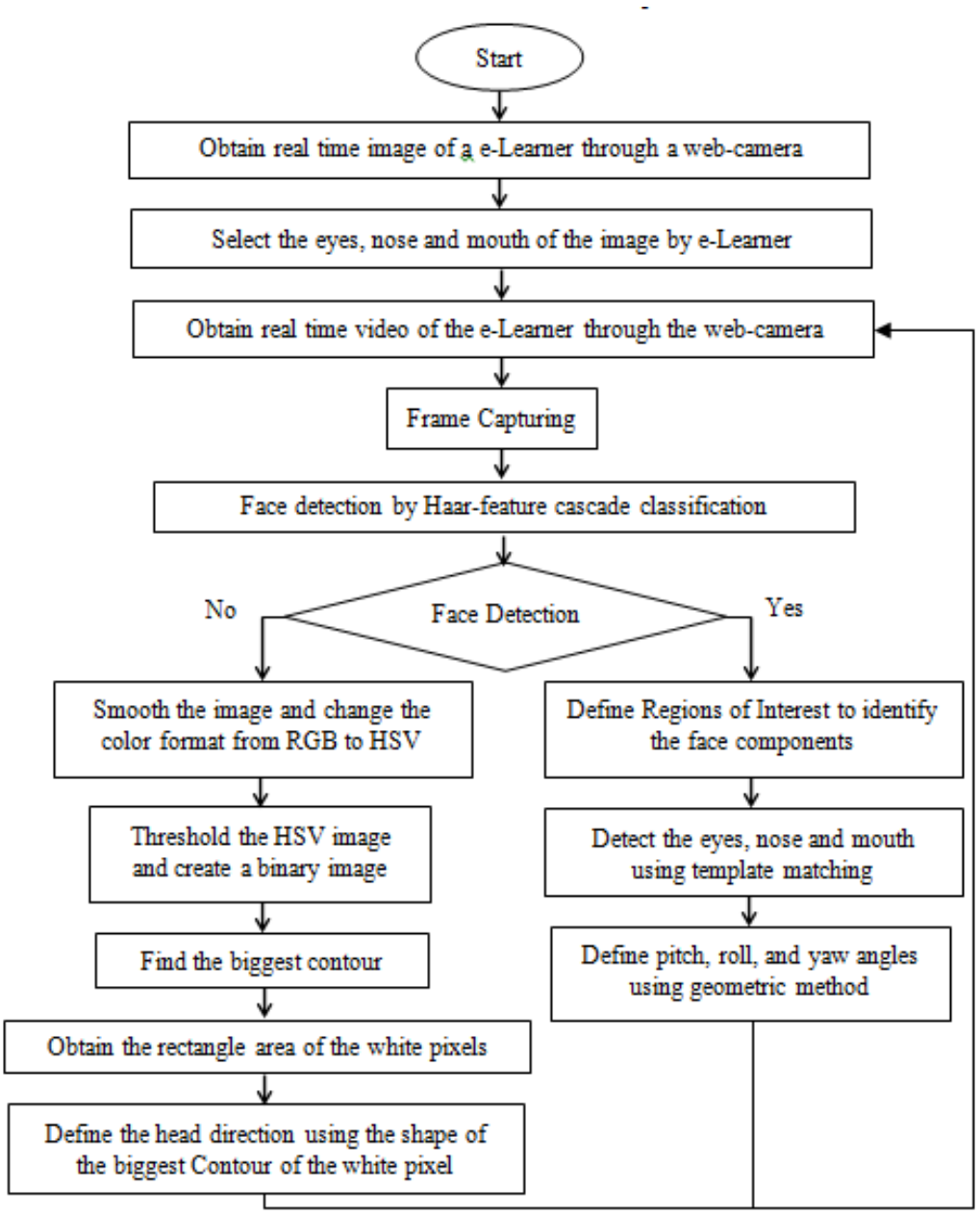


FIGURE 3.12: Procedure to Detect the Head Pose

image of the e-Learner is obtained through a web-camera. e-Learner has to mark the eyes, nose and mouth of his/her image and the system obtains the default threshold value in the frontal view which is utilized to determine the basic head direction when the user is in non-frontal view in forthcoming step. Then the system begins to identify the head pose of the e-Learner. The real time video of the e-Learner is obtained continuously through the web-camera and the frame of the video is captured since the video is being consisted a set of frames. The face in the each frame is detected using the Haar-feature based cascade classification. The detection of the face is indirectly indicated that the

user is in frontal or near frontal view compare to the computer screen since the web-camera is located on the computer. The successful face detection indirectly specifies that the user is involving with the computer and user involve with the learning activity. The degree of the head movement of each axis is required to identify when the face of the user is detected. And the basic face direction is needed to identify when the face is not detected.

Having detected the face, the degree of the head movement under three axes can be derived after completing several steps. Initially, the interest region for the each face component is roughly defined for the ease of the detection of the face components and it can be easily done since the face is already detected as shown in Figure 3.7. The face components are detected by using the method of template matching. When the template matching is utilized, the previously selected face components in the very first image by the e-Learner are considered as a source image and the most suitable locations of the face components of destination image are found with employing the source images. The eyes, the nose and the mouth can be identified using this procedure. Then the angles of the pitch, the roll and the yaw can be determined by using the behavior of the face

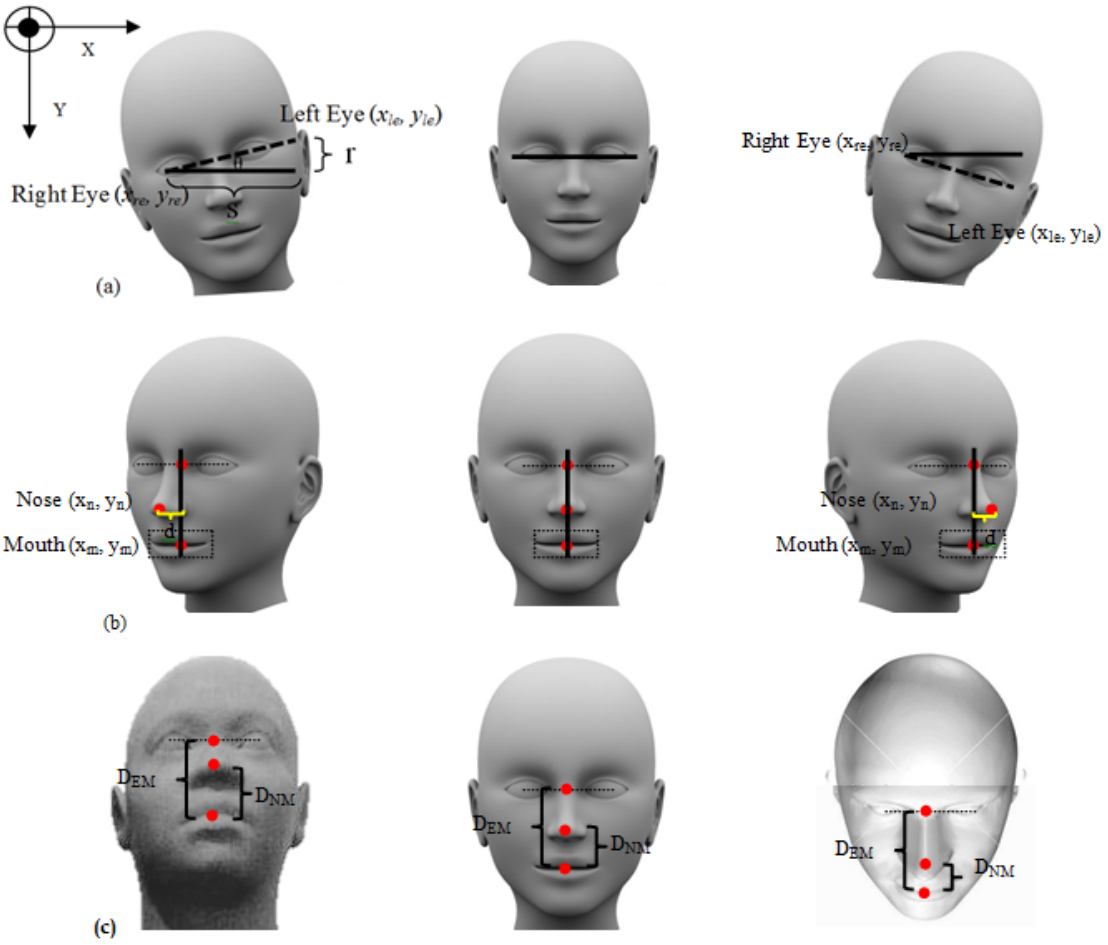


FIGURE 3.13: Procedure for Identify the (a) Roll (b) Yaw (c) Pitch Angle

components as follows.

The coordinates of the right eye, left eye, nose and mouth are considered as (x_{re}, y_{re}), (x_{le}, y_{le}), (x_n, y_n) and (x_m, y_m) respectively as shown in Figure 3.13 for the ease of explanation purpose. The roll angle and the direction can be identified using the location of the eyes as shown in Figure 3.13 (a). When the y coordinates of the eyes have nearly similar values ($y_{re} \approx y_{le}$), there is no rotation and the roll angle is zero. If the y coordinates of the right eye is greater than the left eye ($y_{re}>y_{le}$), the head roll to the right side and the vice versa. The roll angle can be identified from the following function.

$$Tan \quad \Theta \quad = \quad Opposite/Adjacent \quad = \quad r/s$$

$$Tan \quad \Theta \quad = \quad |y_{re} - y_{le}|/|x_{re} - x_{le}|$$

$$Roll \quad angle \quad = \quad \Theta \quad = \quad Tan^{-1}|y_{re} - y_{le}/x_{re} - x_{le}|$$

The eyes, nose and mouth are required to identify the yaw angle as shown in Figure 3.13 (b). A line is drawn with connecting the middle of the eyes and the center point of the mouth. When the nose point is overlapped with the line that is connecting the middle of the eyes and the mouth, the yaw angle is zero. The distance between the nose point and the eye-mouth line (d) is calculated as follows,

X coordinates of the middle of the eye fair = $(x_{re} + x_{le})/2$

X coordinates of the mouth point = x_m

The average X coordinates = $(x_{re} + x_{le})/2 + x_m/2$

X coordinate of the nose = x_n

Distance between nose and the eye-mouth line (d) = x_n - $(x_{re} + x_{le})/2 + x_m/2$

The positive or negative mark of the value is aided to identify the direction of the yaw angle whether it is right or left. The distance between the nose and the eye-mouth line (d) is proportional to the yaw angle and it is identified with training several images.

$$Yaw \quad angle \quad \alpha \quad d$$

The training was conducted once again to identify the relation between the yaw angle and the distance between the nose and the eye-mouth line (d). Yaw angel is identified with the following equation.

$$Yaw \quad angel \quad = \quad (1.7858^{*}d - 6.2361)/10;$$

The pitch angle can be obtained by using the length of eye-mouth and nose-mouth lines as shown in Figure 3.13 (c). The pitch angle is proportional to the ratio of two values; the first value is the distance among the middle of the eyes and the mouth (D_{EM}) and the second value is the distance between the nose and the mouth (D_{NM}). The relation is recognized with analyzing images.

$$Pitch \quad angle \quad \alpha \quad D_{EM}/D_{NM}$$

In addition, there was a training that used to identify the relation between the pitch angle and the ratio of distances: distance between the middle of the eyes and the mouth (D_{EM}) as well as the distance between the nose and the mouth (D_{NM}). The following equation is derived to obtain the pitch angel.

$$Pitch \quad angel \quad = \quad 2.761^{*}(D_{\mathrm{EM}}/D_{\mathrm{NM}}) - 9.8254;$$

The pitch, yaw and roll angles are identified using this procedure and it is completely based on the geometric method with the coordinate system.

The system identifies the basic head direction when the face is not detected. To identify the basic head direction, the image which is continuously obtained from the real time video, is smoothed and transferred to the HSV (Hue, Saturation and Value) color format from RGB (Red, Green and Blue) color format since the image from the web-camera has RGB color format. The image with HSV color format is helped to identify the segmentation based on the variation of colors. The threshold mechanism is utilized to segment the image based on the sharpen of the pixels in the image and transferred the pixels to white (above the threshold value) or black (below the threshold value) based on the threshold value which is identified in the very first step in the head pose estimation. Then the image consists of several contours and the biggest contour is consists with the area of the user hair as shown in Figure 3.14 (b). The system identifies the basic head direction of the user based on the biggest contour that consists the hair of the user. The rectangle can be drawn with covering the biggest contour to identify the head direction. That rectangle can be divided into two parts as right and left and the part with the highest portion of the white pixels of the biggest contour, is given the evidence of the head direction. When the left side of the rectangle consists with the highest portion of the white pixels, it is indicated that the person turns his/her head towards the left as shown in Figure 3.14 (a). When the user turns his/her head towards the right side, the right side of the rectangle has the biggest portion of the white pixels as shown in Figure 3.14 (c). The up and down of the head direction can be identified through the rectangle which is divided into two parts such as upper part and lower part. When the biggest contour is appeared at the top of the rectangle and the contour size is very large, the user turns the head to the "down" direction and "up" direction can be identified with

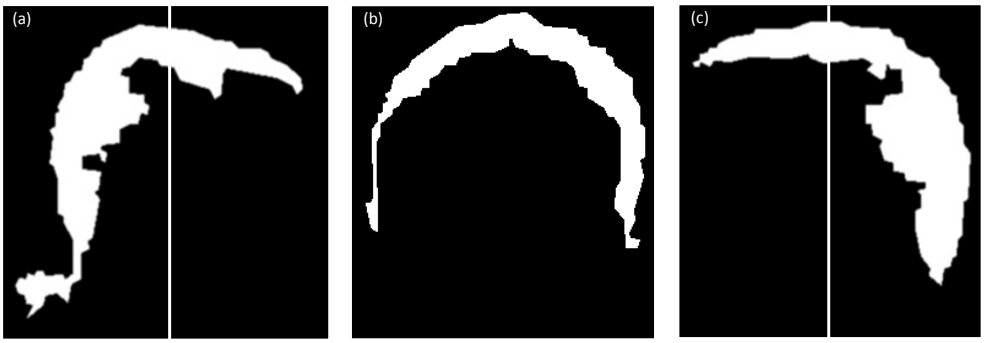


FIGURE 3.14: Biggest Contour Represent the Hair of the User (a) When the user turns to the left and the left side rectangle has highest white pixel, (b) When the user looks forward, (c) When the user turns to the right and the right half of the rectangle has higher white pixels

TABLE 3.2: Accuracy of the Head Pose Estimation

User View	Mean Absolute Error			Detection Accuracy
	Pitch Error	Yaw Error	Roll Error	
Frontal or near frontal	3.34°	5.44°	2.8°	87.21%
Non-frontal				84.03%

the biggest contour is appeared in down part of the rectangle and the size of the contour is relatively small.

When the face is detected, the system identifies the pitch, yaw and roll angles of the head. Otherwise it identifies the basic head direction such as right, left, down and up. Having completed the above steps, the web-camera obtains the real time video and identifies the head pose of the user continuously till the user commands.

The accuracy of the head pose estimation in real time is evaluated for the view of frontal/near frontal and the non-frontal view. Fifteen students were participated for the evaluation process and they were instructed to look at the pre-defined positions. Meanwhile, the estimate values from the system were recorded for corresponding user when the head was angled to the pre-defined positions. The actual angle and the head direction were compared with the estimated values of the system and mean absolute error was calculated. The mean absolute error for the pitch, yaw and roll angles were identified when the user was in the frontal or the near frontal view. Mean absolute error was 3.34, 5.44, 2.8 degrees for the pitch, yaw and roll directions respectively. In addition, the accuracy rate was calculated to identify the head pose for all views. The 87% and the 84% of performance are achieved for the frontal/near frontal and non-frontal views respectively as shown in Table 3.2.

Based on the previous researchers, there was a system to estimate the human head pose with the use of multiple camera views and they applied a neural network with Bayesian framework. That approach was classified only 73.4% of the frames correctly, when the neighboring classes were allowed [132]. The head pose models are learned and incorporated into a mixed-state particle filter framework for joint head tracking and pose estimation. Experimental results indicate the classification accuracy is 71.20% [133]. Therefore, the head pose estimation approach which is introduced in this research, has good performance comparatively previous findings.

3.2.2 Avatar modification

This is the second task in the process of visualizing the behavior of the real user non-verbal features in the virtual learning environment. In the virtual learning environment, different types of avatars are available such as furry avatar, human avatar and desired avatar can be obtained based on the preferences of the user. Although the avatars are introduced to represent the real user in the virtual learning environment, the avatar works as a puppet without facilitating the fair depiction to the user. Though the avatar is activated based on the user instructions, avatar is not denoted any features of the real user. At least, avatar in the virtual learning environment cannot make any movement related to the real user.

To represent the behavior of non-verbal features of the real user in the virtual learning environment through the avatar, the avatar should be modified with several face components. The furry avatar and the human avatar are modified in this study to represent the real user features.

Initially the head model of the furry avatar is constructed by using the prims, which are available in the virtual learning environment as shown in Figure 3.15 (a). The objects for the head model are built using prims and the developed objects are appeared in Figure 3.15 (b). The developed objects are linked to represent the face and the components of the face as shown in Figure 3.15 (c). When the face and the parts of the face are constructed, the texture and the color of the prims are adjusted to represent the head of the furry avatar as shown in Figure 3.15 (d). Finally, the developed objects are linked together to construct head model of the furry avatar as displayed in Figure 3.15 (e). The texture of the head of a furry avatar can be changed to make the eye blinks as shown in Figure 3.15 (e), (f). The head movement is also possible to appear with the rotation mechanism of the complete furry head model.

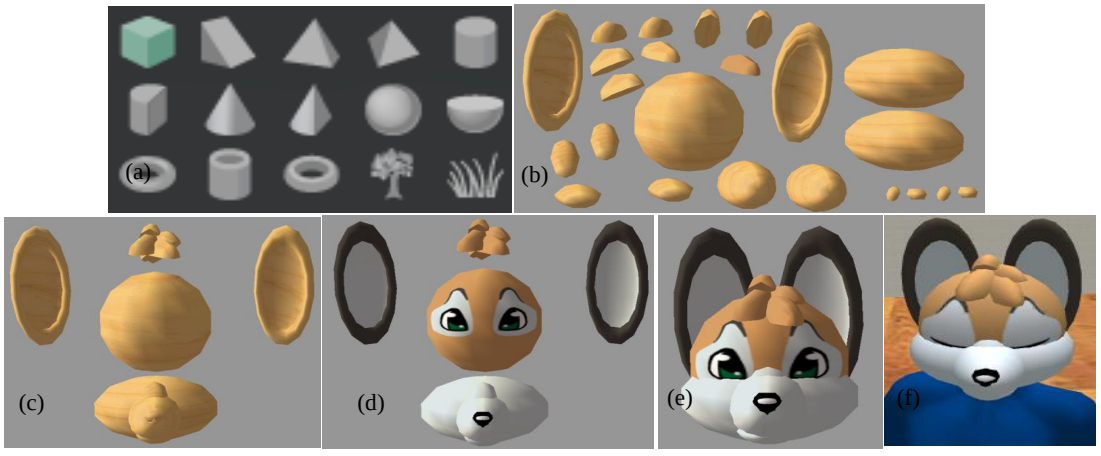


FIGURE 3.15: Modification of the Furry Avatar to Represent the Eye Blink and Head Pose

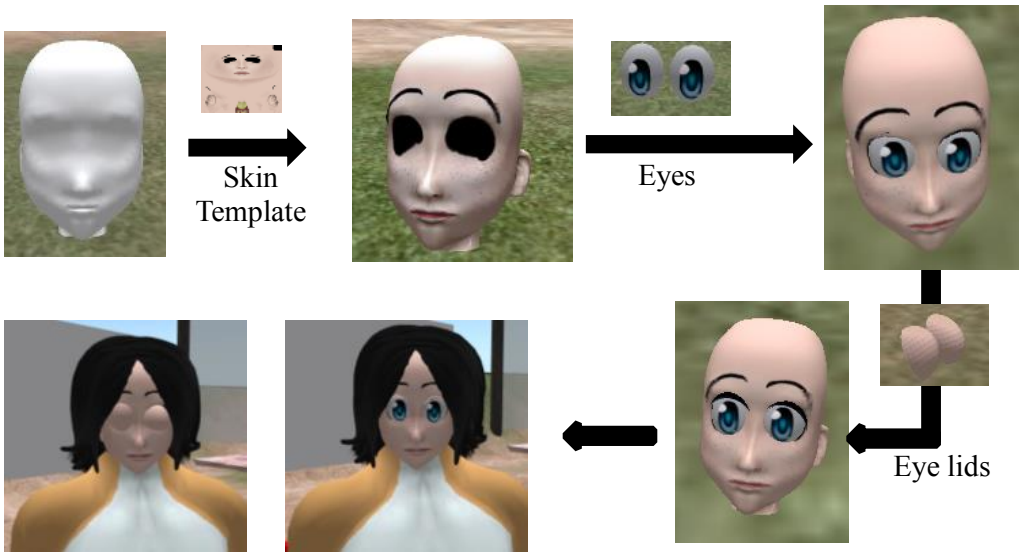


FIGURE 3.16: Modification of the Human Avatar to Represent the Eye Blink and Head Pose

The head model for the human avatar is constructed as shown in Figure 3.16. The head model was prepared in the real world by using graphical software and exported to the virtual learning environment. The eyeball and the eyelids are prepared using the prims in the virtual environment and attached to the head model. The completed head model is coupled to the avatar and modified to represent the behavior of non-verbal features of the real user. The rotation mechanism of the eye lids are used to represent the eye blink of the avatar and the completed rotation mechanism of the head model is used to represent the movement of the head.

3.2.3 Link the Virtual World and the Real World

The behaviors of the non-verbal features of an e-Learner are detected and the avatar in the virtual world is also modified to represent the behavior of the non-verbal features. The information regarding the behavior of non-verbal features are required to transfer to the virtual environment as the last and the third activity of the process of visualizing the behavior of non-verbal features of the real user. The process of transferring information from the real world to the virtual world is indicated in the Figure 3.17. The service of the external server is obtained as an intermediary to transfer the information from the real world to the virtual world through Wide Area Network (WAN). PHP, JavaScript are used to send the information from the real world and Http request is utilized in the virtual world to obtain the real e-Learner information. The behaviors of the non-verbal

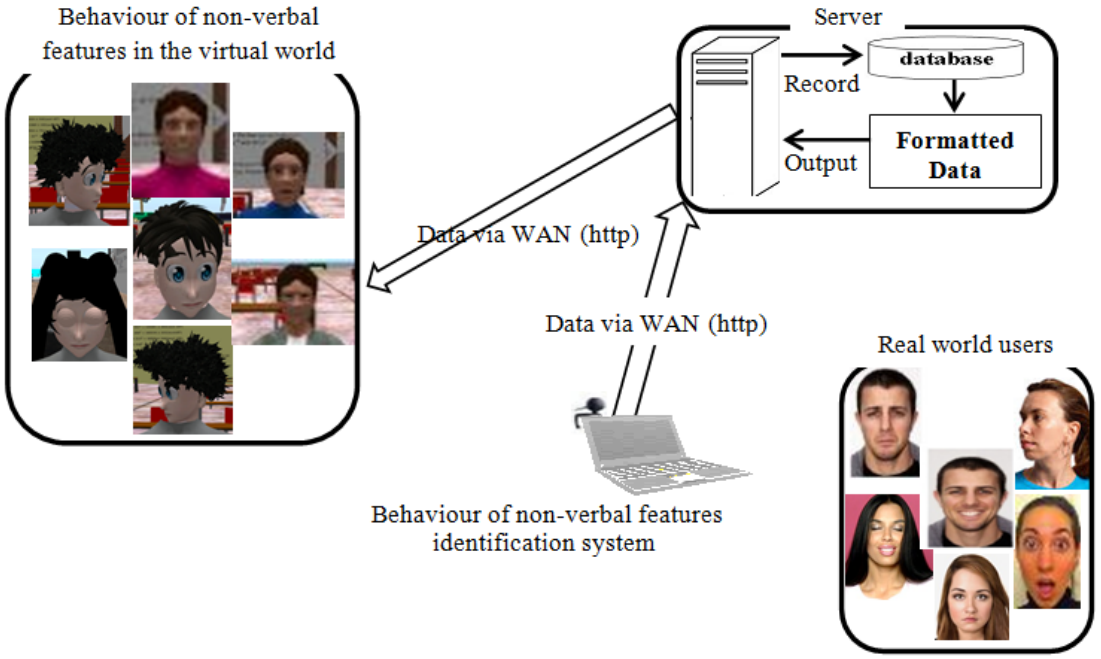


FIGURE 3.17: Process of Transferring the Behavior of Non-verbal Information

features of the real e-Leaner are successfully transferred to the virtual world through the server using this procedure.

3.2.4 Visualize the Behavior of Non-Verbal Information in the Virtual World

Having completed the three steps; detection of the real user non-verbal information, the avatar modification and the establishment of a connection from the real world to the virtual world, the real user non-verbal information are visualized in the virtual environment through the face of the avatar. The facial expression of the real user is appeared in the virtual environment as mentioned in Figure 3.18. When the real user blinks or/and moves the head around the three axes, theses actions are also visualized in the virtual environment as shown in Figure 3.19 and Figure 3.20 respectively. The way that the student engages with the non-verbal visualization system with the virtual learning activities is shown in Figure 3.21.

3.2.5 Pros and Cons of the Non-verbal Visualization System

Several benefits can be acquired through the implementation of this non-verbal visualization system. This system acts as a tool, which is providing the student's facial expression, the eye blink and the head pose information to their teacher and peers

FIGURE 3.18: Facial Expression Visualization System

and vice versa. The relevant decisions can be obtained in the aspect of the teacher to conduct the learning sessions effectively by using student information. The connection between the teacher and the student is enriched generally than the normal synchronous e-Learning class with non-verbal communication through this non-verbal visualization system.

This system deals with two worlds and the information about the non-verbal information cannot be transferred instantly. The non-verbal visualization system takes few second to visualize the real user information in the virtual world since the non-verbal information is transferred from the real user in the real world to the avatar in the virtual world through a server. Although, the detection of non-verbal behavior is continuously

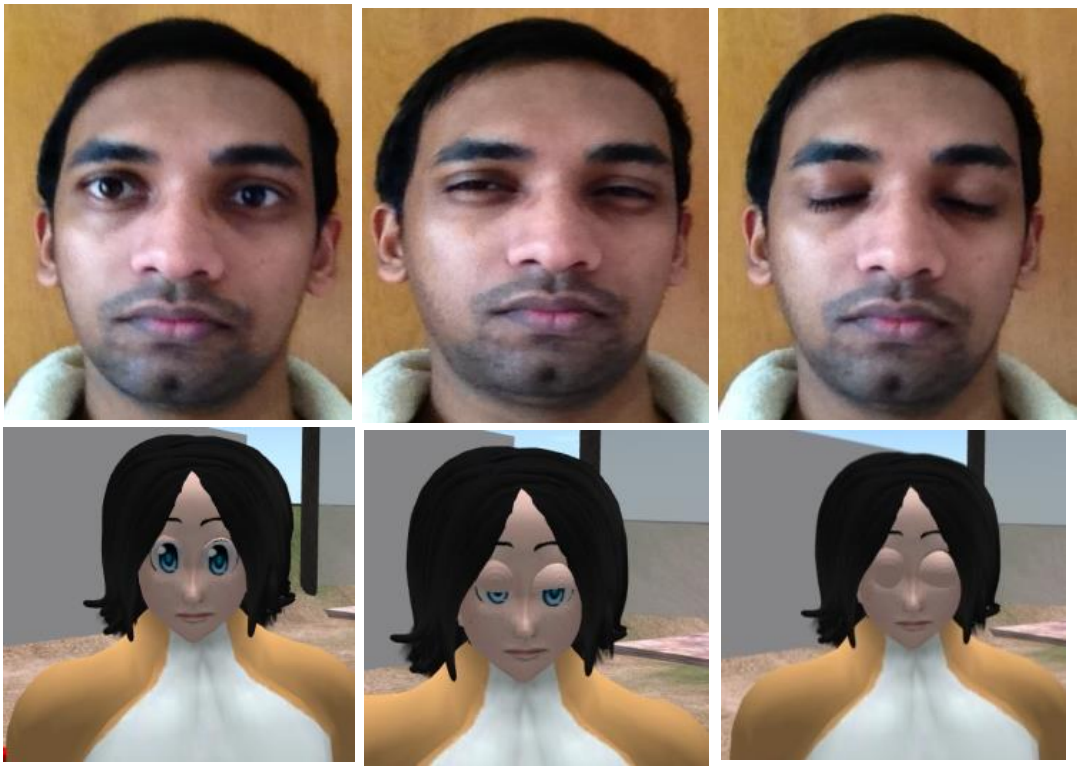


FIGURE 3.19: Eye Blink Visualization System

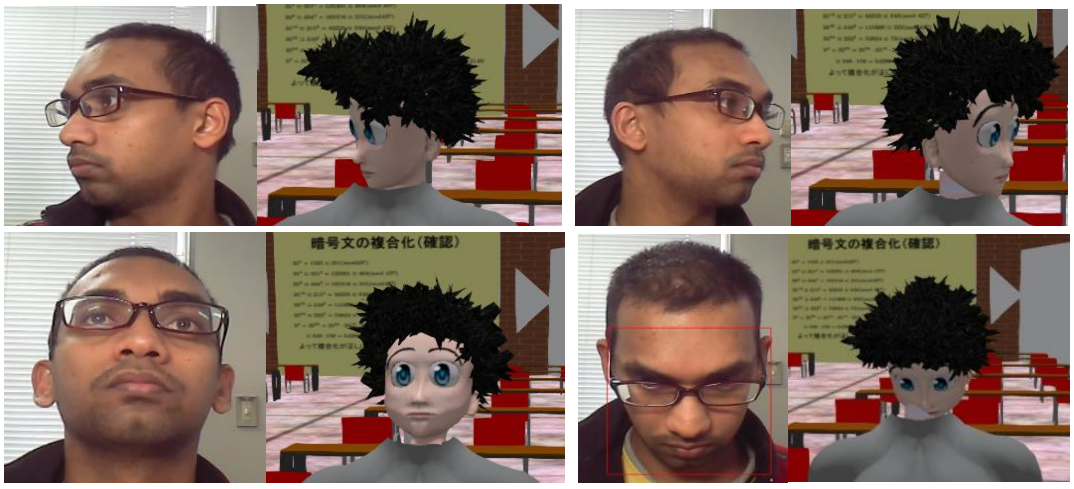


FIGURE 3.20: Head Pose Visualization System

processing, the system takes averagely one second to acquire the facial expression, the eye blink and the head pose information as shown in Table 3.3. Another one second is takes to transfer the identified non-verbal information to the server. Finally, the server takes 0.5 second to transfer the non-verbal information to the virtual world. This system provides the information to the virtual world within 2.5 seconds.

FIGURE 3.21: Engage with Non-verbal Visualization System

TABLE 3.3: Average Time to Transfer the Non-verbal Information

Transfer locations		
From	To	Average Time Taken (Seconds)
Real user	Eye Blink detection system	1
Eye Blink detection system	Server	1
Server	Avatar	0.5
Total time	Total time	2.5

Although the average time is measured to transfer the information, the required time to transfer the information through the server is depended on the network condition especially on the data volume. Therefore, the variation of the time for the information transferring based on the network condition is measured. The result is available in Table 3.4, which depicts the changes in different data volume and the required time to transfer the information. The analysis is indicated that the time to transfer the information is increased with the data volume. Thus visualization system takes at least 0.1255 second to visualize the behavior of non-verbal information in the virtual world and it is gradually increased with data volume.

Although this non-verbal visualization system takes considerable time to transfer the information, it is comparatively very short time since there is another research, which transfers the information of the basic activity to the virtual world through mobile phones and it takes comparatively long time to transfer the information among the worlds[85].

Table 3.4: Time for Transfer Data based on Network Condition

Network condition (b/s	Average time to transfer(s)
1-250	0.1255
250-500	0.3755
500-750	0.6255
750-1000	0.8755
1000-25000	2.96

3.3 Student Tracking System

The next major target is to implement the proper interaction between the student and the content. To establish the interaction between the student and the content, the teacher should modify the content according to the feedback of the students. Thus constructing the tracking system of the students with the behavioral information to obtain the precise feedback is the way to contribute for establish the interaction between the student and the content in this study.

The tracking system is constructed in this study with visualizing mainly the behavioral characteristics of the students and the most important segment is the status of the students, which is derived mainly from the uncontrollable behavior of the non-verbal features with few controllable behaviors as supportive information such as voice, and chat information. The preview of the student tracking system with behavioral information is appeared in Figure 3.22 and it is provided the student status, other supporting information to obtain the student feedback more properly.

The virtual classes in the virtual world are mapped into the web interface as shown in Figure 3.22 (c) and it is helped to visualize the student positions, the head direction and the eye blink information of the students in a given time period. Figure 3.22 (a) indicates the available student(s) in a given time. The available student(s) head pose and the eye blink information are appeared in Figure 3.22 (c) and the symbolization are indicated in Figure 3.22 (b), which indicate the different types of circles, arrows to represent the eye blink and the head directions respectively. The status of the available students is illustrated in the section of (d) in Figure 3.22. The detailed description of the student behaviors including the face components and the elements that are utilized to obtain the student status are appeared in Figure 3.22 (e). The chat and the voice are the possible communication methods among the students who are engaging in the virtual class. The recorded sound clips of the students during the learning sessions are uploaded to the web interface as shown in Figure 3.22 (f) and the teacher or any other viewer can listen to the discussion among the students. When they use the chat, it is also recorded in the database and appeared in the web interface respect to the given time as illustrated in Figure 3.22 (g). The tracking tool which is visualizing the complete set

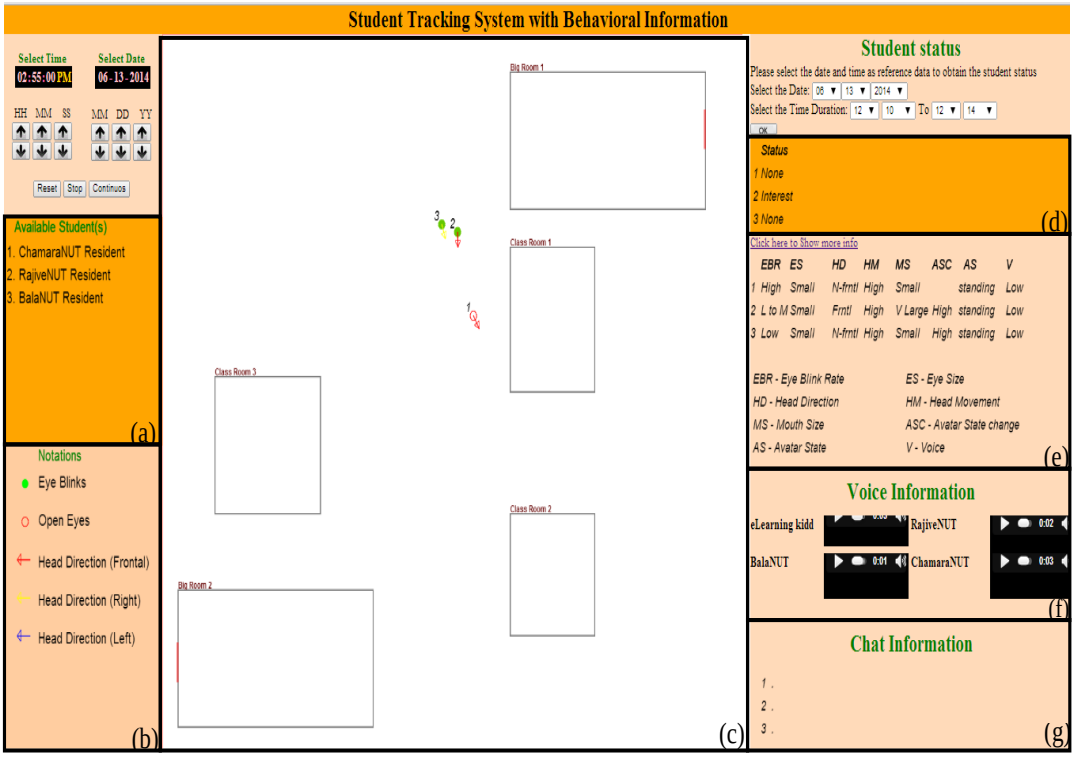


FIGURE 3.22: Student Tracking System with Behavioral Information (a) Available student(s) (b) Notations to indicate the student eye blink and head directions (c) Layout of the virtual classes. Locations, eye blink and head directions of the available students are visualized (d) Student status at a given minute

of behavioral information of the student including their status for the post analysis of the student behavior is successfully constructed to obtain the feedback of the students.

The various kinds of information are utilized to construct the tracking system. Most of the information such as position of the avatar, current activity of the avatar, the number of avatars with their names who are currently available in the virtual learning environment and the chat information among the avatars etc. are available in the virtual learning environment. Thus the sensors are located in the virtual classrooms to identify the information related to the virtual environment. The information which is captured by the sensors are transferred to the server and stored in the server. In addition, the information of the head pose, the eye blink and the other facial component information are stored in the server during the first approach, visualizing the behavior of non-verbal features in the virtual world. All those information are utilized to construct the tracking system as shown in Figure 3.22.

Teacher is able to adjust the learning elements; mainly the content of the lesson based on the feedback of the students through the tracking system is the major merit. The desires and requirements of the students can be identified with the student tracking system with their status. And the teacher can fulfill their requirements to enhance the

productivity of the virtual class.
The derivation of the status of the student is the most important and the major part of the student tracking system. The following steps are required to obtain the status of the students.

- Obtain the behavioral information of the student
  - ✓Behavioral information of the non-verbal features
  - ✓Behavioral information of the avatar
- Derive the student status via the behavioral information of the student

3.3.1 Obtain the Behavioral Information of the Student

- Behavioral information of the non-verbal features

To derive the status of the students, the non-verbal information is utilized mainly in this study since the behavior of the non-verbal features is better than the verbal information [114]. The eye blink and the head pose which are identified in the previous section 3.2 are employed to identify the status of the students as shown in Table 3.5. In addition, the behavior of some face components are involved to derive the status of the students as the face is the most expressive part of the body and the facial components such as eyes, nose and mouth are the major elements of the face to express the feeling of the humans [134]. The eyes and the mouth are identified and the size of the eyes and the mouth are also utilized to identify the status of the student as illustrate in Table 3.5.
The higher contribution for the process of identification of the status of the student is given by the behavioral information of the non-verbal features of the student and it consists the behavior of the eye blink, the head movement and the size of the eyes and the mouth as an overall viewpoint.

- Behavioral information of the avatar

TABLE 3.5: The Relation Between the Characteristics of the Students and Their Status

	Interest	Attentive	Not attentive	Frustrated/ struggling	Distracted/nerv ous	Tired/sleepy
Eye blink rate	low	none	none	high	high	none
Head direction	frontal	frontal	not a frontal	not a frontal	not a frontal	frontal
Size of the eyes	very large	very large	none	none	very large	very large
Size of the mouth	very large	none	none	very large	none	very large
Head movement	not equal to low	low	not equal to low	not equal to low	not equal to low	not equal to low
Avatar status	not away	not away	away	away	none	none
Avatar status change	none	low	none	low	low	low
Amplitude of the voice	none	none	low	none	high	none

The avatar is the icon that represents the students in the virtual class and the student is the active element that handles the puppet, avatar. The behaviors of the avatar denote the engagement of the learning activity of students. The avatar behavioral information is another kind of evidence to estimate the status of the students. In the virtual class, the avatar has posture based on the activity performs and the possible postures are,

- Walking – avatar walks and student handles the avatar by using the arrow keys in the computer
- Sitting - avatar sits on the objects in the virtual class and the student doesn't need to use the key board
- Running - avatar runs in the class and the student handles the avatar by using the arrow keys in the computer
- Standing - avatar stands on the land and student does not need to handle
- Away - avatar stands or sits with bending head and it happens when the avatar doesn't involve with the activity in few seconds. It reflects that the student doesn't involve with the computer in few seconds.
- Crouching – Avatars' knees are bent and the upper body is brought forward and down. The student has to use the key board to activate the avatar.
- Mouse look – student can view the virtual class through the avatar eyes of the avatar without seeing their avatar and the student has to involve with the computer
- Flying – avatar flies in the air and the student has to handle the avatar
- Typing – student types with the key board and it is represented by the avatar

Among those different avatar postures, the priority is given for the 'away' posture since it reflects the idle of the students. In addition, the number of times that the changes of the avatar postures within the specific time period also utilize as a measurement to identify the student status as shown in Table 3.5.

In addition to the information about the avatar and the student non-verbal behavior, communication information among the e-Learners is also utilized as a evidence to identify the status of the student. The communication in the virtual class is basically based on the chat and/or the voice. The chat and the voice of the students are recorded during the virtual class activities and it is also employed as an evident to confirm the student status as shown in Table 3.5.

3.3.2 Derive the Student Status via the Behavioral Information of the Student

The behavioral information of the student is gathered mainly with detecting the behavioral information and tracking the avatar. In this study, the basic status of the student which may important in the learning process are considered to derive from the students'

behavioral information and those status are the interest, attentive, not attentive, frustrated/struggling, distracted/nervous and tired/sleepy.

The eight input variables are employed to derive the student status and it is shown in Table 3.5. The each input variables are categorized into sub categories to transfer the input values into the linguistic form. As an example, the rate of the eye blink is categorized as low or high. The rules are constructed to obtain the student status with the relation of input behavioral information as indicated in Table 3.5. The relationship among the student status and the behavioral information is obtained from the empirical study and training the student information [135, 136].

The tracking system, specially the segment related to the student status which is derived by using the behavioral information of the student, is required to check whether the derived student status represent the actual status of the student or not. To check the accuracy of the system, there was an experiment that conducted with three sessions; introduction, discussion and evaluation. The each session conducted around five minutes and a descriptions about the experiment and the way of engage in the virtual class was explained in the introduction session. Then the session of the discussion was conducted around five minutes without a break and it was conducted as a problem based learning session. The students discussed about a topic of "best eco car in the twenty first century among the three options, nuclear car, fuel cell car and solar power car". Then the session of the evaluation was started and the students again continued the discussion for one minute and answered to a questionnaire. Similarly, the students continued the discussion and answered to the questionnaire in each minute until five minutes were completed. The questionnaire was designed to obtain the student status indirectly through several multiple-choice questions and it is illustrated in Appendix 2.1. In addition, the student reactions were recorded and there were small interviews that conducted in possible times to confirm the actual student status completely. The procedure was conducted as a group activity and each group was consisted with two or three students. Totally nineteen students were participated for the experiment.

The student real status is obtained by the analysis of questionnaire, the video of the student behavior and the few interviews. In addition, the student status was obtained via the tracking system. The comparison was done to check the accuracy of the system and the results are illustrated in Figure 3.23. The system could not catch all the student status and the 93% of the student status was identified. Among the identified information, some student statuses are identified correctly and some are differ with the real status of the students. Among the 93% of identified status, the 86% of status of the students are recognized correctly and the remaining 14% are identified incorrectly. Thus the overall correctness of the derivation of the student status in the tracking system has the 80% based on the summary of the result. The accuracy is reasonable since the feedback opportunities are scarce in most classrooms [49] even in the real world class.

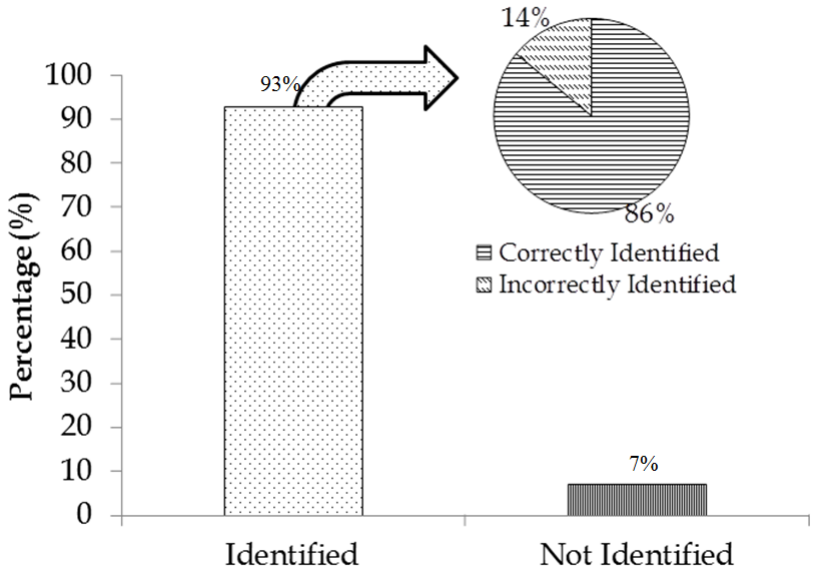


FIGURE 3.23: :Evaluation of the Derivation of Student Status

3.4 Identification of the Effective Factors Based on the Student Characteristics

The third section discusses the identification of the effective factors based on the student characteristics in the multi-model system to establish a proper interaction between the student and the environment with involving the teacher. There are so many factors that are affected to the learning process. Each and every factor that may affect to the learning process cannot be evaluated since some factors are uncontrollable by the teacher or the course designer such as family background, financial situation, etc. Thus the controllable factors for the teacher or the course designer are required to identify.

3.4.1 Identify the Controllable Factors

The procedure to identify the controllable factors has several steps, which are listed below.

1. Identify the whole factors that are affecting to the students in the learning process
2. Recognize and regret the outside factors that are uncontrollable by the course facilitator
   - Uncontrollable factors
     - ✓ Long term student characteristics
     - ✓ Short term student characteristics
3. Divide the remaining factors into two groups
   - Easily controllable factors

- ✓ Factors that are related to the environment, teacher and school

– Factors that are difficult to control

- ✓ Long term student characteristics
- ✓ Short term student characteristics – Help to evaluate the lesson (Include in the student tracking system as student status in section 3.3)

Initially, the whole factors those are affected to the learning process are identified as shown in Figure 3.24. Then the factors are divided into two sections, the internal and the external based on the characteristics of the factors whether it is directly related with the learning process or not due to the ease of the understandability. Then the uncontrollable factors of the teacher or the course designer are rejected in both sections, internal and external. The remaining factors are divided into two groups, easily controllable and difficult to control. Again the factors which are difficult to control is divided into two categories, long term student characteristics and short term student characteristics. Finally, there are three sectors under the controllable factors, easily controllable, difficult to control long term student characteristics and difficult to control short term student characteristics. The difficult to control long term student characteristics are not

TABLE 3.6: Adjusted Controllable Variables to Suit to the Virtual Environment

Environment of the virtual class	Within the class	
	Outside the class	
	With learning models	
	Without learning models	
	High attractiveness	
	Less attractiveness	
Way of deliver the knowledge	Use different communication ways	Voice
		Chat
	With presentation	
	Without presentation	
Characteristics of the lesson	Different time durations	Low (5 min)
		Middle (30 min)
		High (1 hour)
	Active and passive learning	Active learning
		Passive learning
	Content / Subject	Chemistry
		Mathematics
		Physics
		Biology
		Engineering
Characteristics of the teacher	With teacher	Volunteer
		Professional
	Without teacher	
	With awards/punishment	
	Without awards/punishment	
Characteristics of the peers	Education level	Same
		Different
	Gender	Same
		Different
	Country	Same
		Different

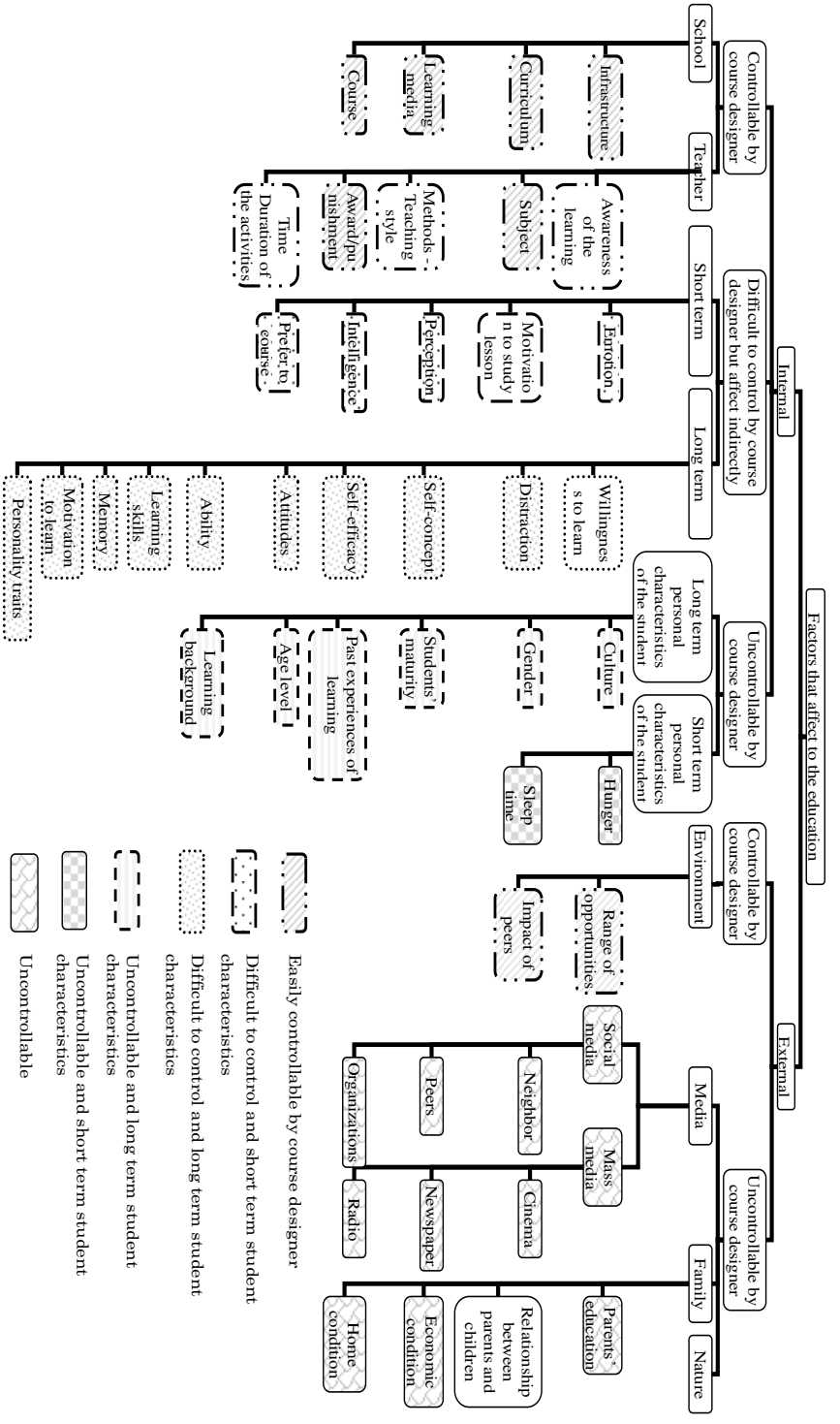


FIGURE 3.24: Whole Factors that Affect to the Education

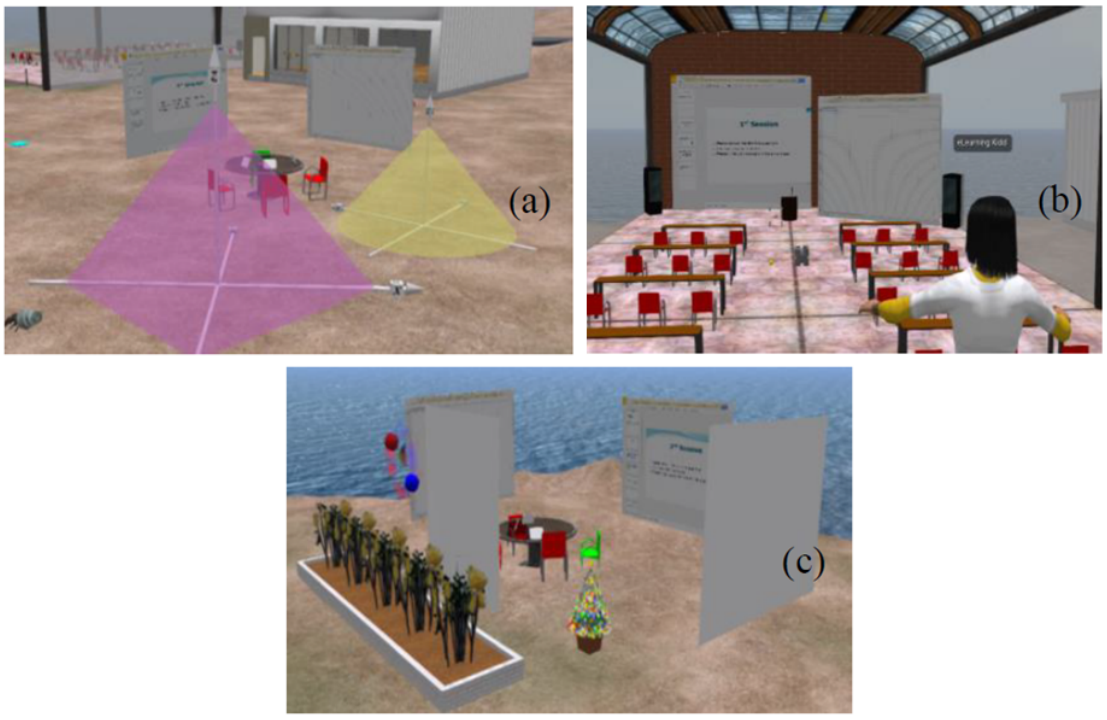


FIGURE 3.25: Modify the Virtual Environment (a)Learning Elements (b)Inside of the Virtual Class(c)Attractive Environment Outside the Virtual Class

included in the process of identification of the effective factors since the identification of the changes of those factors takes long time and such a long time is not available for this study. Then the difficult to control short term student characteristics such as emotion, perception are employed as the measurement to identify the effective factors since those feelings are tracked in the student tracking system as the student status according to the explanation in the section 3.3. The remaining, easily controllable factors are considered as the factors that are controllable by the course designer or the teacher in this study and the factors that are difficult to control short term student characteristics are employed to identify the effective factors through the tracking system.

The easily controllable factors are adjusted according to the virtual class environment, are listed in Table 3.6. The virtual environment is constructed to suit to the each condition and the environment with few conditions are illustrated in Figure 3.25. The 18 sessions are designed to evaluate all the controllable factors while changing one factor and keeping all other factors constant. During the sessions in the virtual class, the effectiveness of the each session can be identified through the student short term controllable factors via the status of the students in the tracking system.

TABLE 3.7: Matrix with the Effective Factors based on the Student Characteristics

		Education Level		Computer Literacy		Gender	
		Low	High	Low	High	Male	Female
Computer Literacy	Low	Friendly guidance as an active learning session Different gender members as peers	Prefer to learn subjects with perfect guidance Different education level members as peers passive learning without learning module				
	High	Perfect guidance with admiring as an active learning session Different education level members as peers Prefer to obtain knowledge regarding the subjects without learning modules	Friendly guidance with admiring as an active learning session in attractive environment Same education level members as peers Obtain knowledge regarding subjects with learning modules in small time durations Different country members				
Gender	Male	Friendly and perfect guidance in active learning	Less, perfect guidance without admiring in active learning Same characteristics (Educational level, country) except gender members as peers	Friendly guidance in active learning with admiring	Friendly, perfect guidance without admiring and engage with passive learning in small time as an active learning Different characteristics (Educational level and gender) members as peers		
	Female	Friendly guidance Different gender and different education level members as peers	Less time and guidance to engage with admiring as an active learning to obtain knowledge regarding the subjects.	Prefer to learn subjects in high attractive environment Different gender members as peers	Friendly, perfect guidance in active learning with admiring Obtain knowledge regarding the subjects with learning modules outside the class Different education level members as peers		
Age	Low	Friendly guidance as an active learning session with admiring	Same gender and same country members as peers Less guidance, active learning session with admiring and prefer to obtain knowledge regarding the subjects preciously	Friendly guidance as an active learning session with admiring	Friendly and perfect guidance in active learning Prefer to obtain knowledge regarding the subjects without admiring for small duration with normal environment Different education level members as peers	Friendly and perfect guidance in active learning	Friendly guidance with admiring Different gender members as peers
	High	Perfect guidance as an active learning session with admiring Different education level and different country members as peers Prefer to obtain knowledge regarding the subjects with learning modules	Friendly, less and perfect guidance without admiring in active learning and prefer to engage more without presentation Same education, same country but different gender members as peers	Different characteristics (education level, gender and country) members as peers Prefer to obtain knowledge regarding the subjects in high attractive environment	Friendly, perfect guidance without admiring as an active learning session in high attractive environment Prefer to obtain knowledge regarding the subjects with learning modules Different gender, education level members as peers	Friendly guidance with learning modules in high attractive active learning Different characteristics (education level, gender, country) of the members as peers	Prefer to obtain knowledge regarding the subjects without learning modules according to the less guidance and less admiring in active learning Different gender and different education level members as peers

3.4.2 Procedure to Identify the Effective Factors

The eighteen sessions are conducted with 21 students to evaluate all the controllable factors while changing one factor and keeping all other factors constant. During the sessions in the virtual class, the feedback of the student are obtained through the tracking system with the status of the students. An experiment was conducted for a group of students that consisted with three members in a group and as well as their basic characteristics such as education level, computer literacy level, age and gender were obtained. According to the characteristics of the participants, they were divided into two sections in each characteristic, low and high except their gender.

The student who follow the doctoral course are considered as the high educational students (11, 52%) and below the doctoral course considered as the low educational level (10, 48%). The ten (48%) students who have low computer literacy (5 to 10 year) and the eleven (52%) students have high computer literacy (10 to 15 years). The twelve (57%) students who belong to the age group of 25-30 years and they are classified as the low age students and the nine (43%) students who belongs to the age group of 30-35 years and they are classified as the high age students. According to the gender classification, there were thirteen (62%) male and eight (38%) female students.

The basic characteristics of the students and the effective factors for the each student are identified. The effective factors are categorized based on the similar characteristics of the students through the analysis of the collected information.

In addition, the behavior of the each factor were analyzed with the student characteristics to identify effective factors in another aspect. For the example, the behavior of the factor, "learn with the educational modules" is analyzed for the low educational level student and high educational level student. All the controllable factors are analyzed with the two by two characteristics of the students. Figures that indicate the behavior of controllable factors according to the changes of student characteristics are illustrated in Appendix 3. Based on those figures, table is constructed with the effective factors basis on the behavior of the factors according to the changes of student characteristics as shown in Appendix 3.4.

The effective factors are identified based on the student characteristics and analyzing the behavior of the controllable factors. To ease of the use and accessibility, the master matrix with consisting effective factors is derived as shown in Table 3.7.

To confirm the reliability of the effective factors in the matrix, the evaluation has been done with forty three students. The student preferences were obtained from a web based questionnaire which is illustrated in Appendix 2.2. The desired effective factors and student preferred factors were compared according to their basic characteristics. The accuracy of the each student category is indicated in Table 3.8. According to the

Table 3.8: Accuracy of the Identification of Effective Factors

		Education Level		Computer Literacy		Gender	
		Low	High	Low	High	Male	Female
Computer Literacy	Low	70%	73%				
	High	78%	81%				
Age	Low	85%	71%	62%	80%		
	High	58%	76%	71%	86%		
Gender	Male	84%	76%	68%	80%	74%	82%
	Female	87%	54%	74%	72%	74%	78%

evaluation as shown in Table 3.8, the average accuracy is 75% for the identification of the effective factors based on the characteristics of the student.

3.5 Summary

To establish a proper interaction among the teacher and the student as well as themselves, the behavior of non-verbal features of the real user is established in the virtual learning environment through the avatar. Facial expression, eye blink and head pose are detected from the real time web-camera video with geometric methods and transferred to the virtual learning environment through the server. The behavior of the real user, facial expression, eye blink and head pose are visualized through the modified avatar in the virtual learning environment. In the second approach, a student tracking system has been constructed with the students' behavioral information through mapping the layout of the virtual island into the web interface to establish the interaction between the student and the content. Further, the matrix has been developed with the effective factors based on the characteristics of the students after conducting several learning sessions. There were three approaches that completed in this study to establish a proper interaction among the learning elements to enhance the satisfactory level of the students.

Chapter 4

Process of the Evaluation

The three sections, 1) visualization system of the non-verbal behavior, 2) student tracking system and 3) identification of the effective factors are evaluated by the teachers and the students using web-based Likert scale questionnaires to identify whether the student satisfactory level can be enhanced or not and to analyze the affection to the virtual learning. Besides, there were three experiments that conducted primarily by using the visualization system with behavior of non-verbal features to analyze the behavior of non-verbal features during the virtual classroom activities and to identify the affection of non-verbal communication to the virtual learning.

4.1 Process of the Assessment

The web-based questionnaires were designed to evaluate the all three processes, the visualization system of the non-verbal behavior, the student tracking system and the identification of effective factors as illustrated in Appendix 2.3 and 2.4. The evaluation process is based on the responses of the learning parties for questionnaires of five point Likert scale.

The aim of the questionnaires is to identify the affection to the satisfactory level of the students and to the virtual learning with the three processes; the visualization of the behavior of non-verbal features, the student tracking system and the identification of the effective factors. The separate questionnaires were designed for the teachers and for the students to evaluate the non-verbal visualization system and the tracking system due to their different roles in the learning process. Only one questionnaire was designed to evaluate the matrix with effective factors since the environmental factors are external aspects for both teachers and students.

The responses were obtained from the 35 teachers and the 43 students in totally 78

subjects. All respondents were belongs to the university education. The participated students were categorized into three educational level, undergraduate (17, 39.5%), master (15, 34.9%) and doctoral level (11, 25.6%). The 25 (58.1%) male and 18 (41.9%) female students were evaluated. The 27 (62.8%) participants belonged to the (20-30) age group while 16 (37.2%) participants belonged to the (30-40) age group. Their computer literacy varies from 5 to 15 year experience.
The characteristics of the participated teachers are as follows. The 22 (62.9%) male teachers and the 13 (37.1%) female teachers were evaluated. The age of the teachers varies from 30 to 60 years with 17 (48.6%) participants from the (30-40) age group, the (40-50) age group was consisted 14 (40.0%) participants and 4 (11.4%) participants from the (50-60) age group. Their teaching experience varies from 1 to 17 years.

4.1.1 Non-verbal Visualization System

The questionnaires which are used to evaluate the non-verbal visualization system were designed with covering the following common criteria.

- How visualization of the behavior of non-verbal features affect to the connection between the teacher and the student
- The feelings about the non-verbal visualization system
- How non-verbal visualization system affects to the virtual learning environment

In addition, the questionnaire for the teacher was included about the affection of the non-verbal visualization system to measure the student behavior. The possibility of implementing the non-verbal visualization system alone was evaluated from the questionnaire, which was delivered to the students. The questionnaire was included several videos with explaining the virtual learning environment due to its novelty. In addition, the subjects had an opportunity to watch the videos that were explaining the way to install the non-verbal visualization system, how the non-verbal visualization system engages with the activities in the virtual learning environment and the view of the avatars with and without non-verbal visualization during the virtual classroom activities.

4.1.2 Student Tracking System

The questionnaires, which are distributed to the teachers and to the students to evaluate the tracking system, is discussed in this part. Although the separate questionnaires were designed for the teachers and for the students due to their different roles in the learning process, the highest weight was given to the questionnaire, which was delivered to the teacher since the tracking system is specially designed for the teacher. The questionnaires were covered the following criteria.

- How the tracking system affects to the virtual class

✓ As an evaluation tool

✓ Way of identify the student feedback

– How the tracking system affects to the relationship of the student and the teacher

– How the tracking system affects to the effectiveness of the virtual class

The details of the tracking system and its' preview also were included in the questionnaire to obtain the information about the tracking system before completing the questionnaire.

4.1.3 Identification of the Effective Factors

The questionnaire, which was used to evaluate the matrix with effective factors, was designed with covering the following common criteria.

– How the matrix with effective factors affect to the virtual learning

– Whether the student and the environment interaction can be enhanced with this matrix which include effective factors

– The importance of the identification of the effective factors for the virtual learning

The subjects had an opportunity to inspect carefully the matrix which consists the effective factors before completing the questionnaire.

4.2 Process of the Experiments

Three main experiments were conducted with the behavior of non-verbal feature visualization system. The first experiment was conducted with the visualization system of the facial expression. Having completed the eye blink visualization system, the second experiment was conducted. The third experiment was conducted at the end of the non-verbal visualization system with both eye blink and head pose.

4.2.1 Experiment with Facial Expression Visualization System

To evaluate the behavior of the visualization of the facial expression in the virtual learning environment, a discussion was carried out with utilizing the facial expression visualization system.

- Aim

The aim of the experiment is to evaluate the facial expression visualization system and to identify the affection way of facial expression to the student behavior during the learning session in the virtual class.

- Experiment Environment

FIGURE 4.1: Environment of the Experiment (a) Normal class consists of row based table chair system (b) Experiment conduct area looks like natural environment with the shady under the tree (c) Seeing distance from classroom and presentation board

Although the classrooms are available in the virtual learning environment, the discussion was carried out in outside of the classroom. Because classrooms are filled with tables and chairs which are located in raw wise and that is not suitable to conduct a face-to-face discussion as shown in Figure 4.1(a). The appearance of the location where the experiment was conducted, is illustrated in Figure 4.1(b). Although the experiment was conducted outside the classroom, the educational concept is not completely away from this experiment. That is why; the face-to-face chairs and tables were placed in a seeing distance from the classroom and presentation board according to Figure 4.1(c). Although chairs and tables were positioned in the discussion location, student had freedom to do any activity, which was provided by the virtual environment such as walking, running, flying, sitting, standing and typing.

- Experimental Procedure

The Japanese students conducted their discussion in their native tongue and others who belongs to the other nations used English language. The schedule of the experiment is indicated in Table 4.1. A introduction session was conducted in five minutes to give an instruction of the system and the virtual environment especially about the activities of Second Life. Then the instruction was given to participants regarding the way of utilizing the facial expression visualization system with graphical explanation in both

TABLE 4.1: Time Duration for Each Session

Groups	Activities	Time Duration
	Introduction	5 minutes
1st Group (3 students)	1st session	20 minutes
	Break	5 minutes
	2nd session	20 minutes
	Questionnaire	
2nd Group	1st session	20 minutes
	Break	5 minutes
	2nd session	20 minutes
	Questionnaire	

Japanese and English languages.

Each group had two sessions in twenty minutes. There was a discussion that carried out with a preferred topic among the participants and they conducted the discussion as shown in Figure 4.2 with and without the facial expressions. After the two sessions for each group, a questionnaire was delivered and gathered responses from participants. The version of Japanese and English questionnaire is available in Appendix 2.5.

- Subjects

The participant of the experiment consisted with two groups and each group consisted with three members. All of them had good educational background with the bachelor

FIGURE 4.2: Discussion with Facial Expressions

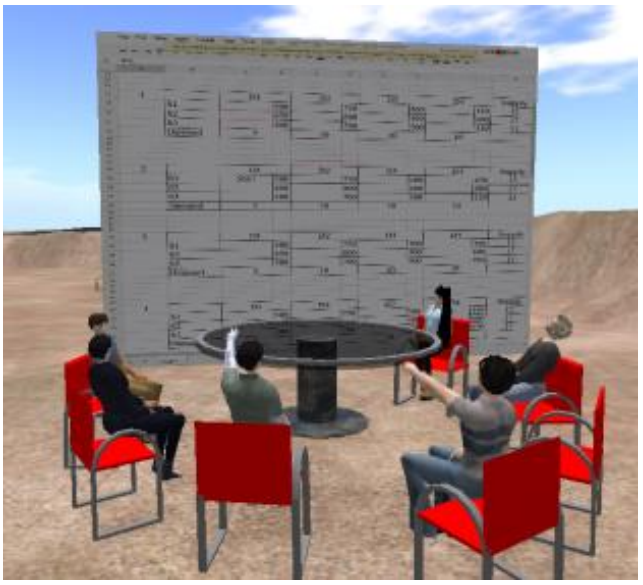


FIGURE 4.3: Way of Conduct the Group Discussion in Problem Based Learning Session

degree. The age of the participants vary from twenty to thirty five years. Totally six students including three Japanese and three international students participated in this event.

4.2.2 Experiment with Eye Blink Visualization System

The second experiment was conducted with the eye blink visualization system in the virtual learning environment and details of the experiment as follows.

- Aim

This experiment was conducted to identify the role of the eye blink during the virtual learning sessions and the possibility of conducting the experiment with implementing the eye blink visualization system.

- Experiment Environment

This experiment was mainly consisted with a lecture session and a group exercise with and without eye blinks respectively. The lecture session was consisted with a lecture and an individual exercise. The group exercise was conducted as a group discussion by using the problem based learning mechanism. The time for the each session is shown in Table 4.2. A questionnaire was distributed after the each session with a small break to obtain the ideas of the participants as shown in Appendix 2.6 and 2.7.
Two places were prepared to conduct the sessions in the virtual environment as shown in Figure 4.3 and 4.4. The lecture and the individual exercise were conducted inside the classroom and the group exercise was held outside the classroom with breezy air.

TABLE 4.2: Time Duration for Each Session

Session		***Time duration (min)***	
Lecture session	Lecture	25	with and without eye blink
	Individual exercise	15	
Break & questionnaire		5	
Group exercise		25	
Break & questionnaire		5	

A PowerPoint presentation was employed to explain the lesson and the voice was used to communicate among the participants. An Excel sheet was utilized to solve the problems.

- Experiment Procedure

Two activities were done before starting the experiment. The eye blink rate of all the participants was measured in a relaxing state and an introduction session was held to explain about the purpose of this observation, the way of accessing the virtual environment and way of control the eye blink visualization system.

The subjects were instructed to attend the four e-Learning sessions as shown in Figure 4.5; a lecture related to the subject of Operational Research with an individual exercise and a group exercise based on the Operational Research with and without the eye blink

FIGURE 4.4: Way of Conduct the Lecture Session

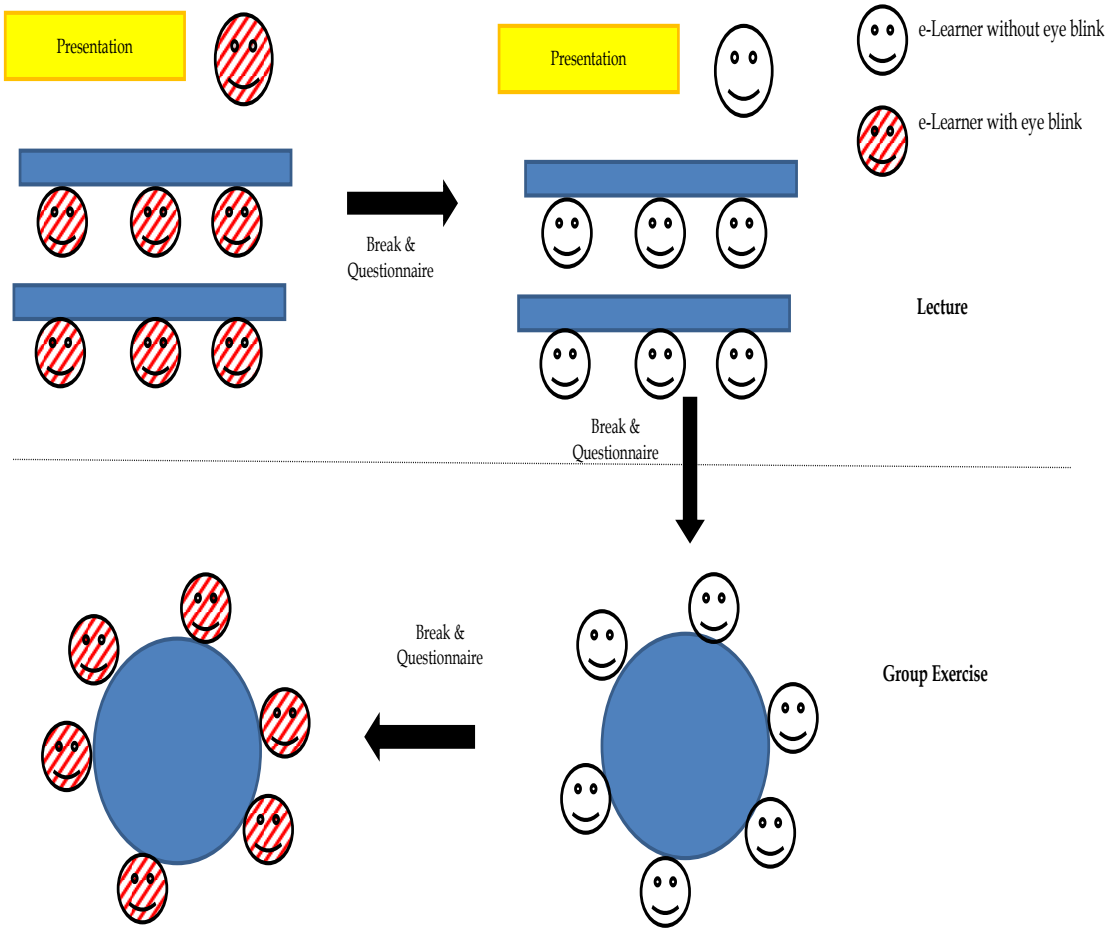


FIGURE 4.5: Layout of the Experiment

visualization system. Each student had a web-camera to detect the eye blink and a personal computer to engage the learning activities in the virtual classroom. The course materials were provided by the Department of Industrial Management of Wayamba university of Sri Lanka. The lecture on Operational Research was delivered as face-to-face lecture and the PowerPoint slides were used to explain the content in the virtual environment as shown in Figure 4.4. The individual exercise after the lecture was carried out by using an excel sheet that was appeared in front of their table and the zoomed view of the exercise sheet appear as shown in Figure 4.6. The excel sheet can be edited by the owner and no any other users has the permission to do it. The discussion was carried out to solve the group exercise and there was only one large excel sheet to enter the answer, which was possible to edit by any student as shown in Figure 4.4. All subjects were experienced by all the sessions (within-subjects experiment). The voices of the all participants were recorded and the eye blink was already stored with the time through the eye blink visualization system.

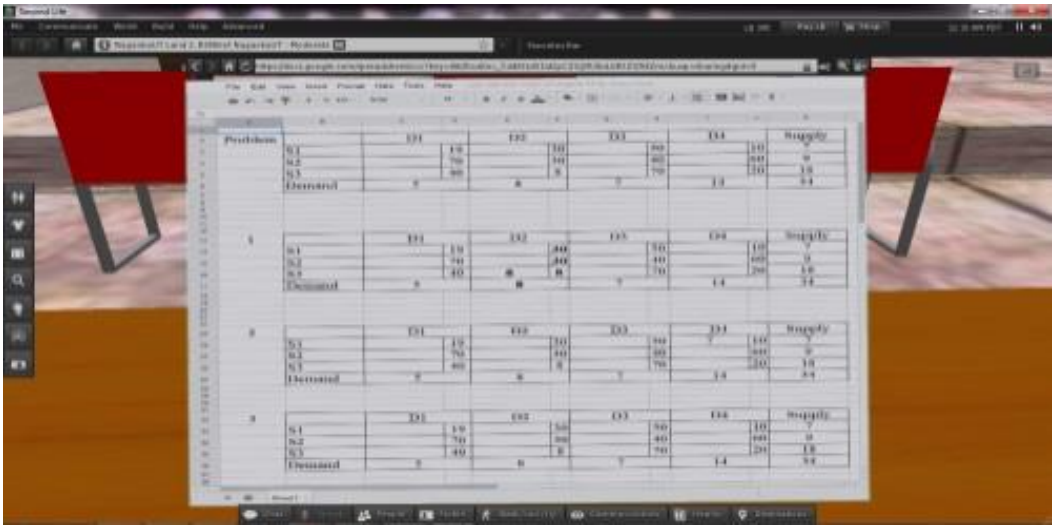


FIGURE 4.6: Screen View During the Individual Exercise

- Subjects

Eighteen students were participated including one female student and all of them are following the post graduate course with majoring in Management and Information Science Engineering. These students belong to different nations namely Sri Lanka, India and Nepal and they used English language to communicate. Their age vary from 25 to 35 years.

4.2.3 Experiment with Eye Blink and Head Pose Visualization System

Having completed the non-verbal visualization with both eye blink and head pose, the third experiment was conducted. The experiment was conducted with both eye blink and head pose visualization system to identify the affection of non-verbal behavior during the virtual learning.

- Aim

The experiment was conducted to identify the influence of the visualization system of the behavior of both eye blink and head pose in the virtual learning especially with regards to the establishment of non-verbal communication. In addition, the behavior of non-verbal features during the virtual learning is required to evaluate through this experiment.

- Experiment Environment

The experiment was designed with two sessions as a problem based learning with and without non-verbal visualization system respectively since the result of the first experiment was indicated that the non-verbal communication is highly affected to the problem

FIGURE 4.7: Discussion During the Experiment

based learning than the lecture session according to the section 5.4.1.

The both sessions were conducted outside the class room with breezy air as shown in Figure 4.7. A PowerPoint presentation was employed to explain the problem and the voice was used to communicate among the participants. An excel sheet was utilized to solve the problems.

- Experiment Procedure

The subjects were instructed to attend for two e-Learning sessions and both sessions had the same conditions except the visualization of the behavior of non-verbal features of the e-Leaner. These sessions were conducted as a problem based learning sessions. Subjects used English language to communicate among them. The first session was conducted with the visualization system of behavioral features and the second session was conducted without the visualization system. Each student had a web-camera to detect the behavior of non-verbal features and a personal computer to engage the e-Learning activities in the virtual environment. The problem for the discussion is based on the subject of Operational Research and the course materials were provided by the Department of Industrial Management of Wayamba university of Sri Lanka. There were large screens to present a power point presentation to indicate the details of the problem and a large excel sheet, which was possible to edit by any e-Learner to enter their answers. All subjects were experienced two sessions (within-subjects experiment). Each session was taken around 20-25 minutes. A pre-formatted questionnaire was distributed to obtain the response of the participants after the each session and it is available in Appendix 2.8. The voices and the behavior of the non-verbal features of the all participants were recorded with the time.

- Subjects

There were twenty four students that participated as the sample of this study and they belongs to the age group of 25-30 years. The participants are from different parts of Asia namely Sri Lanka, India and Nepal. They are following a postgraduate course and majoring in Management and Information Science Engineering.

4.2.4 Hypothesis for the Experiments

The role of the non-verbal communication in the virtual learning can be assessed by using the data obtained from second (Experiment with the eye blink visualization system) and third (Experiment with the eye blink and the head pose visualization system) experiments in following areas.

- The affection to the attitudes and feelings of the student when the non-verbal communication is used
- The affection of the non-verbal communication on the student performance

The hypotheses are derived from the previous studies regarding the above two aspects as follows.

- As a result of the establishment of the non-verbal communication in the virtual world, the appearance of the avatar will be changed. The avatar representation may change the student feeling and attitudes [137]. Specific facial expressions and body signs when being utilized individually by a human-like avatar were more attractive and enhanced users' preference. Proper use of an avatar's body simulation has the possibility to make the students feel more relaxed, attentive, interested and less confused in a virtual educational atmosphere [83]. The facial expressive avatar has been presented to be the key cause in the creation of positive emotions that have been associated to various considerable outcomes, such as enhanced user confidence, better interface friendliness and perceived trustworthiness. Human-like character that speaks and expresses numerous expressions simultaneously has the great advantageous to users such as enhance the confident, easy to understand the content and less mental work. Thus, the attractiveness of the expressive avatars cannot be ignored, all users felt that the system was clearly very smart and had a pleasant outlook [138]. Besides, researchers found that the human-like representations with higher realism produced more positive social interactions [139].

  Literature states that the establishment of non-verbal communication has potential to change the student feeling, attitudes positively and enriches the relation among the teacher and the student. Therefore, the avatar appearance with non-verbal characteristics can be able to make a huge effect to the viewer. It may increase the positive feeling and better attitudes of the e-Learners when they use the non-verbal communication. Thus the alternative hypothesis (H_1) is the implementation of the

non-verbal visualization system in the virtual environment can be enhanced the attitudes and feelings of the participants positively. The implementation of the non-verbal visualization system cannot make the any affect to the attitudes and the feelings of the participants is considered as the null hypothesis (H_0).

- Non-verbal features of the teacher assists in enhancing students' motivation in engaging in discussions and it helps them to improve their performance and understanding [82]. There are some evidences especially in the real world that the student performance increases through the non-verbal features. When the virtual lectures employ facial expression, the students achieved better by 86% in the lectures compared to the performance of the lectures that did not use facial expressions. The proper utilization of smiling increased the awareness of the students and consequently their performance [83]. Proper use of an avatar's body simulation has the possibility to make the students feel more relaxed, attentive, interested and less confused in a virtual educational atmosphere [83]. The successful connection equipped with non-verbal communication enhances the effectiveness of the learning process. It is fair to expect that the non-verbal communication is also behaved in such a manner in the virtual learning environment based on the previous researchers. We hypnotized that the student performance will be increased during a learning session with the non-verbal communication in the virtual learning environment and that is considered as the alternative hypothesis (H_1). The student performance is not changed even though they use non-verbal visualization system is the null hypothesis (H_0).

To check the validity of the hypotheses, the results of the two experiments were analyzed and it is explained in section 5.4.

4.3 Summary

To evaluate the three approaches 1) visualization of the behavior of non-verbal features, 2) the student tracking system and 3) development of a matrix with effective factors, an assessment was conducted based on the five point Likert scale web-based questionnaire through 78 subjects. In addition, the details of the three experiments 1) experiment with facial expression, 2) experiment with eye blink and 3) experiment with both eye blink and head pose are discussed in this session. Two main hypotheses 1) attitudes and feelings of the student become positive when the non-verbal communication is employed, 2) positively affection of the non-verbal communication on to the student performance 2) are formed based on the literature about the behavior and the affection of the non-verbal features in education process.

Chapter 5

Result

In this chapter, the results of the evaluation process of the three sections; 1) visualization of the non-verbal behavior in the virtual learning environment, 2) identification of the feedback of the student through tracking system and 3) identification of the effective factors by the teachers and the students using the web-based Likert scale questionnaire is illustrated. In addition, the results of the experiments using the visualization system with behavior of non-verbal features are discussed.

The result of the web based questionnaire under the three processes; 1) visualization system of non-verbal behavior, 2) student tracking system and 3) identification of effective factors are analyzed initially with obtaining the mean and the variance. Then the most important factors are identified using Categorical Principle Component Analysis (CATPCA) to identify whether the student satisfactory level can be enhanced or not while increasing or decreasing the effectiveness of the virtual learning.

5.1 Non-verbal Visualization System

The analysis has been done separately for the responses of the teachers and the students. Initially the analysis for the responses of the teacher has been done.

TABLE 5.1: Reliability of the Responses of the Teachers Regarding the Visualization System of the Non-verbal Behavior

Dimension	Cronbach's Alpha	Variance Accounted For	
		Total (Eigenvalue)	% of Variance
1	.802	2.787	55.742
2	.296	1.310	26.198
Total	.945[a]	4.097	81.940

a. Total Cronbach's Alpha is based on the total Eigenvalue.

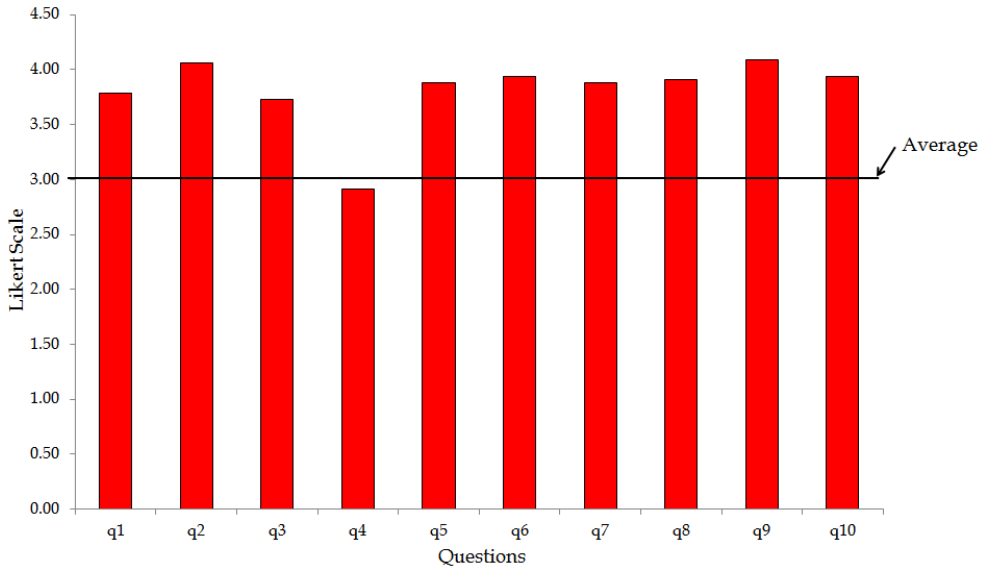


FIGURE 5.1: Responses of the Teachers Regarding the Visualization System of the Non-verbal Behavior

The responses of the 33 teachers regarding the 10 variables about the non-verbal visualization system are analyzed. The percentage of variance is accounted for each dimension using eigenvalues as shown in Table 5.1. The analysis is accounted for 81% of the variance in the optimally scaled items. Cronbach's alpha is 94.5% for the teachers' response and it indicates that the high accuracy of the data.

The mean values and the variances for the each variable of the teachers' responses are shown in Figure 5.1 and Table 5.2. The analysis of the response of the teacher indicated that the all variables are evaluated higher than the average value except one variable

TABLE 5.2: Responses of the Teachers Regarding the Visualization System of the Non-verbal Behavior

Question	Mean	Variance	Interpretation
Students' non-verbal behavior can be identified	3.79	.797	Agree
Identifying the non-verbal behavior is very important	4.06	.996	Agree
I prefer to work with the visualization system	3.73	1.205	Agree
I prefer to work without the visualization system	2.91	.773	Average
The reality of the VLE can be raised with this system	3.88	.922	Agree
Avatar gives the fair representation to the students	3.94	.934	Agree
Attractiveness can be enhanced	3.88	.797	Agree
Increased the effectiveness of the virtual class	3.91	1.023	Agree
Connection between student-teacher can be enhanced	4.09	.648	Agree
Instructor can engage virtual class activities properly	3.94	.559	Agree
Overall	**3.81**	**.865**	**Agree**

Above 4.5 - Strongly Agree 4.5-3.5 - Agree 3.5-2.5 - Average
2.5-1.5 - Disagree Below1.5 - Strongly Disagree

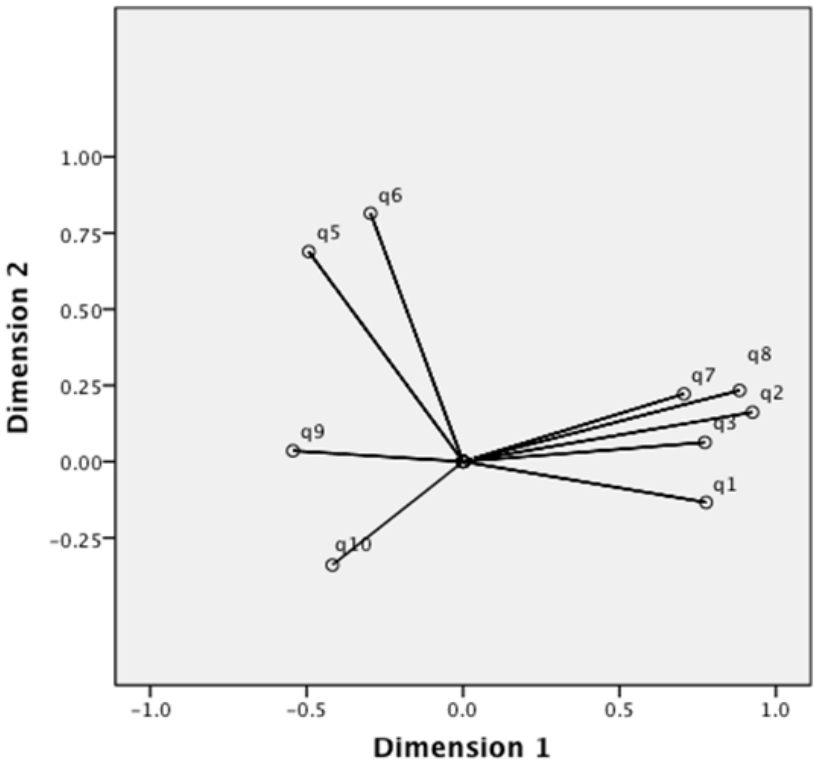


FIGURE 5.2: Component Loading for the Responses of the Teachers Regarding the Visualization System of the Non-verbal Behavior

and that is the only variable consists with negative statement. The negative statement is "I prefer to work without the visualization system". The negatively evaluation of this variable implies that the teachers prefer to work with the visualization system. The teachers agree with all other statements and "Connection between the teacher-student can be enhanced with this system" is the most highly evaluated variable.

In addition, the CATPCA is employed to identify the highly evaluated variable(s) from the positively evaluated variables without concerning the negative evaluated variable. According to the component loading as shown in Figure 5.2, the lengths of the each variable represent the mean value with reference to the Appendix 4.1. The length of the q1, q7, q9 and q10 are very short that represents the low mean values and these variables are in the negative side of the both dimensions indicate the low affection from those variables for the model according to the Appendix 4.1. Thus these variables are removed from the model and revised Figure 5.3 is constructed for component loading. The remaining five variables are considered as the highly evaluated variables considering the information in Figure 5.3 and Appendix 4.2. The highly evaluated five variables can be categorized into two groups "Visualization system is important since it is enhanced the effectiveness and their preferences", "The reality is enhanced in the virtual classroom with a proper link between the avatar and the real user" respectively as follows.

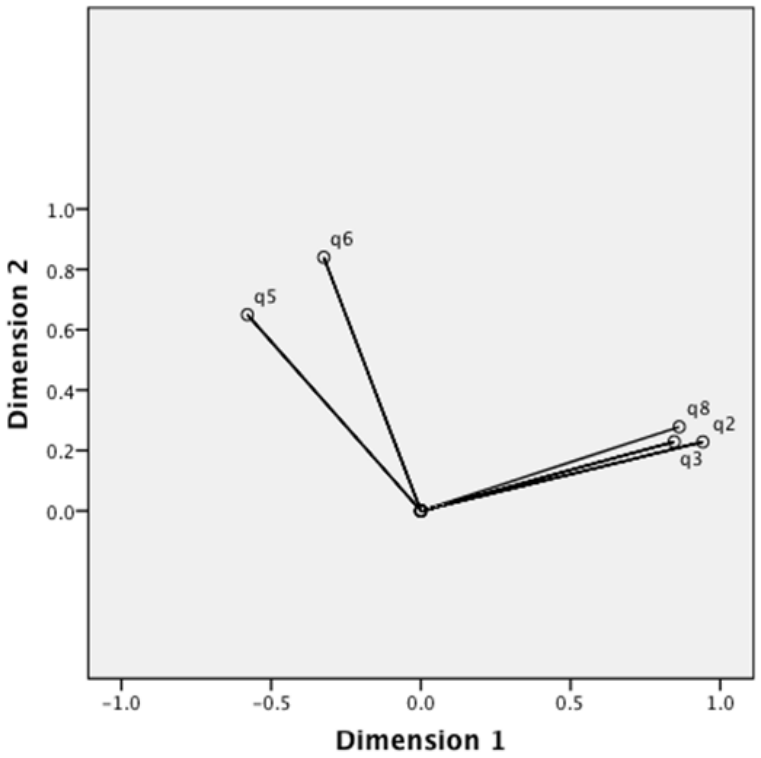


FIGURE 5.3: Revised Component Loading for the Responses of the Teachers Regarding the Visualization System of the Non-verbal Behavior

q2	Identifying the students` non-verbal behavior is very important.	Visualization system important since it is enhanced the effectiveness and their preferences.
q3	I prefer to work with the visualization system	
q8	The visualization system will be increased the affectivity of the virtual class	
q5	The reality of the virtual environment can be raised with this system	The reality is enhanced in the virtual class with proper link with avatar and real user.
q6	Avatar gives the fair representation to the students	

The positive statements are evaluated positively and negative statement is evaluated negatively indicate the preference to the virtual learning environment with the non-verbal visualization system. In addition, the above two groups "Visualization system is important since it is enhanced the effectiveness and their preferences", "The reality is enhanced in the virtual class with a proper link through the avatar and the real user" lead the enhancement of the student satisfactory level through the visualization system. It is a great statistic point to confirm the visualization system is affected to increase the effectiveness of the virtual classroom with establishing a proper interaction between learning elements.

The above discussion is for the responses of the teacher's point of view and then the responses about the non-verbal visualization system of the student are evaluated. There are 45 students evaluated with 15 variables in the questionnaire. According to the Table

TABLE 5.3: Reliability of the Responses of the Students Regarding the Visualization System of the Non-verbal Behavior

Dimension	Cronbach's Alpha	Variance Accounted For	
		Total (Eigenvalue)	% of Variance
1	.613	2.107	30.101
2	.491	1.727	24.675
Total	.862[a]	3.834	54.775

a. Total Cronbach's Alpha is based on the total Eigenvalue.

5.3, the total percentage of variance is 54.7% and Cronbach's alpha is 86.2% for the students' response indicates the high accuracy of the data.

The mean values of the students' responses shows in Figure 5.4 and the statistical information are appeared in Table 5.4. The students also evaluated almost all the variables positively except one variable, "I prefer virtual learning environment without visualization system". That is the only variable include in this questionnaire as a negative statement. That variable has been responded negatively implies that the students prefer to the virtual learning environment with the visualization system. The students strongly agreed with two variables, "I prefer virtual learning environment with visualization system" and "I can set up the visualization system". All the participated students have more than five years of computer literacy and it is the main reason that they indicated about the possibility of installation of the visualization system. In addition, the students agreed with the all other statements.

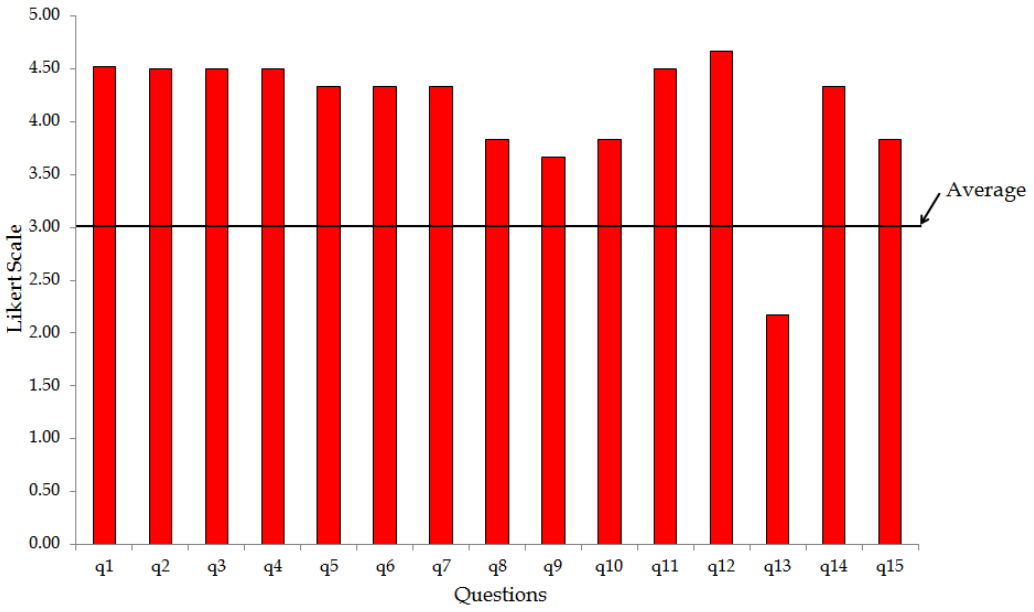


FIGURE 5.4: Responses of the Students Regarding the Visualization System of the Non-verbal Behavior

TABLE 5.4: Statistical Result of the Students' Response Regarding the Non-verbal Characteristics visualization System

Question	Mean	Variance	Interpretation
I can set up the visualization system	4.52	.451	Strongly Agree
Visualization system is easy to set-up	4.50	.402	Agree
Recognized the behavior of non-verbal features	4.50	.451	Agree
The attractiveness can be enhanced with this system	4.50	.354	Agree
I would like to engage activities with this system	4.33	.569	Agree
The visualization system is easy to use	4.33	.520	Agree
Avatar gives fair represent for the real user	4.33	.472	Agree
Virtual identity is possible with the visualization system	3.83	.972	Agree
The virtual class looks like real world class	3.67	.764	Agree
Virtual reality can be enhanced	3.83	.776	Agree
Enhance the effectiveness of the virtual class	4.50	.598	Agree
I prefer virtual learning environment with visualization system	4.67	.228	Strongly Agree
I prefer virtual learning environment without visualization system	2.17	1.069	Disagree
Appearance of the avatar is good	4.33	.374	Agree
Identify your avatar based on the non-verbal features	3.83	.728	Agree
Overall	4.26	0.58	Agree

Further, to identify the variables that are highly affected about the non-verbal visualization system, the CATPCA is employed to the variables that were positively evaluated. According to component loading as shown in Figure 5.5, the lengths of the each variable represent the mean value with reference to the Appendix 4.3. The variable(s) which has

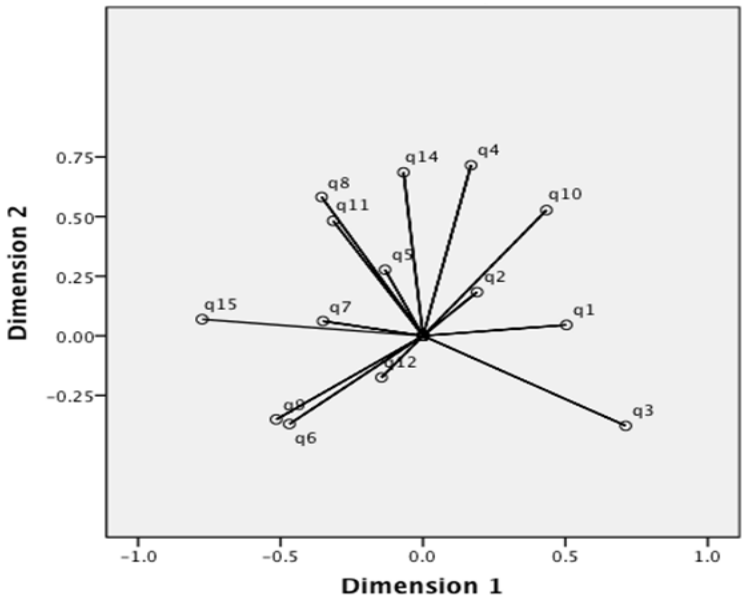


FIGURE 5.5: Component Loading for the Responses of the Students Regarding the Visualization System of the Non-verbal Behavior

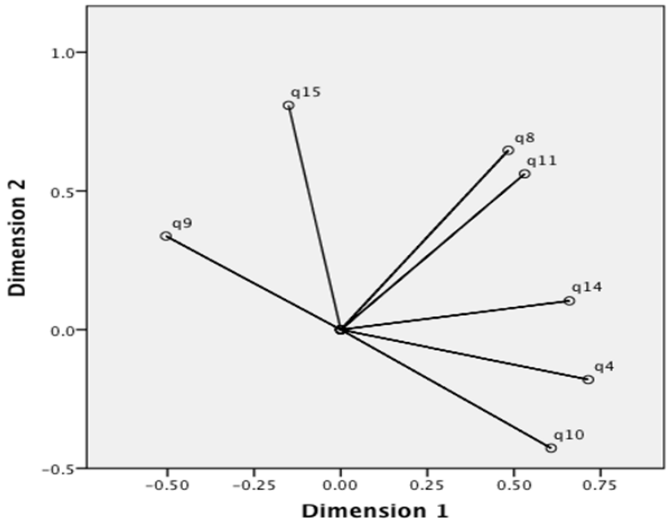


FIGURE 5.6: Revised Component Loading for the Responses of the Students Regarding the Visualization System of the Non-verbal Behavior

low mean value and/or located in the negative side of the dimensions indicate the low influence. According to the Figure 5.5 of the component loading and mean values of the Appendix 4.3, the affection of the vectors of the variables q1, q2, q3, q5, q6, q7 and q12 are very low and those variables are rejected from the model and revised Figure 5.6 is constructed for component loading.

Now the remaining variables have positive relationship according to Figure 5.6 and looking at the mean values of Appendix 4.4. Those variables are categorized into three groups "Enhance the student preference to engage with the activities of the virtual class", "Enhance the effectiveness of the virtual class through several benefits of the visualization system" and "The quality of the virtual class is enriched with proper avatar representation" as follows.

q4	The attractiveness can be enhanced with the visualization system	Enhance the student preference to engage with the activities of the virtual class
q10	Virtual reality can be enhanced with the visualization system	
q14	Appearance of the avatar is good	
q8	Virtual identity is possible with the visualization system	Enhance the effectiveness of the virtual class through several benefits of the visualization system.
q11	Visualization system is highly contribute to enhance the effectiveness of the virtual class	
q9	The virtual class looks like real world class with the visualization system	The quality of the virtual class is enriched with proper avatar representation
q15	Do you think that you can identify your avatar based on the behavior of non-verbal features	

No any statement responded negatively by the participants except the negative statement (q13). The three groups "Enhance the student preference to engage with the

activities of the virtual class", "Enhance the effectiveness of the virtual class through several benefits of the visualization system" and "The quality of the virtual class is enriched with proper avatar representation" are found from the highly evaluated variables indicate that the student preferences to the virtual learning environment can be enhanced with the increment of effectiveness, quality of the virtual classroom through the visualization of the non-verbal features as an overall evaluation by the students.
The result shows that the teachers and the students prefer to work with the visualization system and their satisfactory level can be enhanced with establishing a proper interaction between the learning elements while improving the effectiveness of the virtual classroom is the overall viewpoint by the teachers and the students regarding the non-verbal visualization system.

TABLE 5.5: Reliability of the Responses of the Teachers Regarding the Student Tracking System

Dimension	Cronbach's Alpha	Variance Accounted For	
		Total (Eigenvalue)	% of Variance
1	.930	5.775	64.166
2	.527	1.880	20.892
Total	.978[a]	7.655	85.058

a. Total Cronbach's Alpha is based on the total Eigenvalue.

TABLE 5.6: Statistical Result of the Teachers' Response Regarding the Tracking System

Question	Mean	Std. Dev.	Interpretation
Almost all the behavioral information is covered	3.70	.88335	Agree
The connection with the students can be enhanced	4.15	.91391	Agree
Type of guidance can be identified specifically	3.73	.83937	Agree
Instructor can engage with the virtual class activities by identifying requirement of the students	4.12	.92728	Agree
Instructor can identify student preferences, needs and requirements	3.73	.83937	Agree
Instructor can change the content/way of delivering the instruction based on the student status	4.12	.89294	Agree
Instructor can maintain the class effectively based on the students behavior	4.12	.73983	Agree
Can be used as an individual/group evaluation tool	3.85	.90558	Agree
Tracking system is important for the e-Learning	3.94	.96629	Agree
This effective of the virtual can be enhanced	4.09	.97991	Agree
Overall	3.93	.88878	Agree

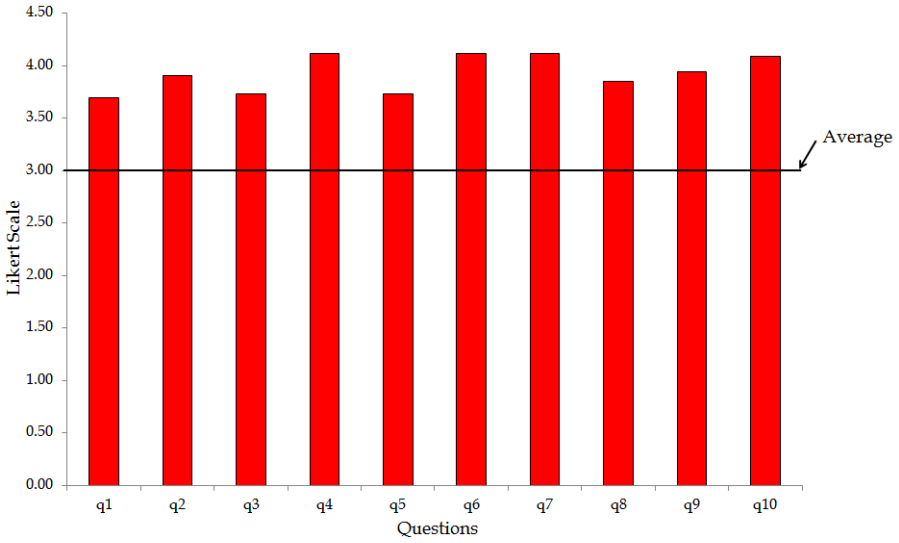


FIGURE 5.7: Responses of the Teachers Regarding the Tracking System

5.2 Student Tracking System

The separate questionnaires were distributed to teachers and students for the evaluation of the student tracking system. The result of the questionnaire, which was delivered to the teacher, was discussed initially.

Table 5.5 shows the total percentage of variance is 85.05% and the Cronbach's Alpha is very close to 1 for the data, which is obtained from the teachers. It indicates the high reliability of the data. The mean values of the teachers' responses are represented in Table 5.6 and Figure 5.7. All the variables were positively responded (above the average

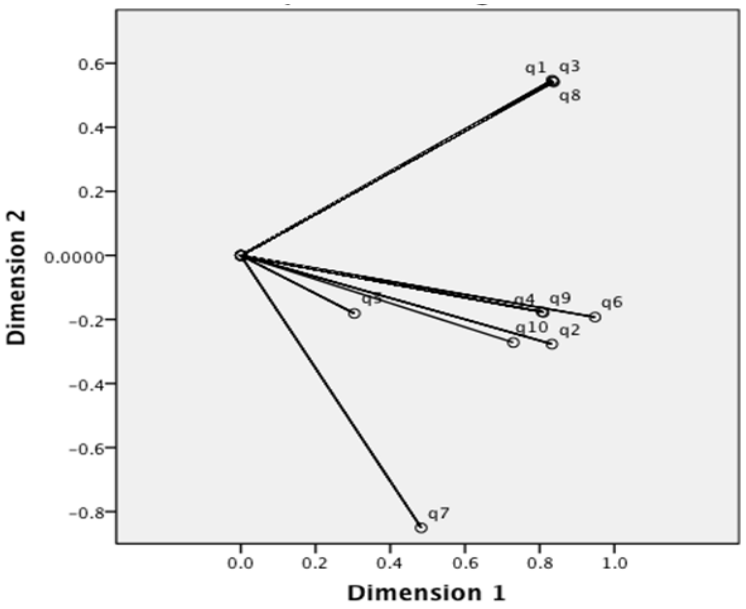


FIGURE 5.8: Component Loading for the Responses of the Teachers Regarding the Tracking System

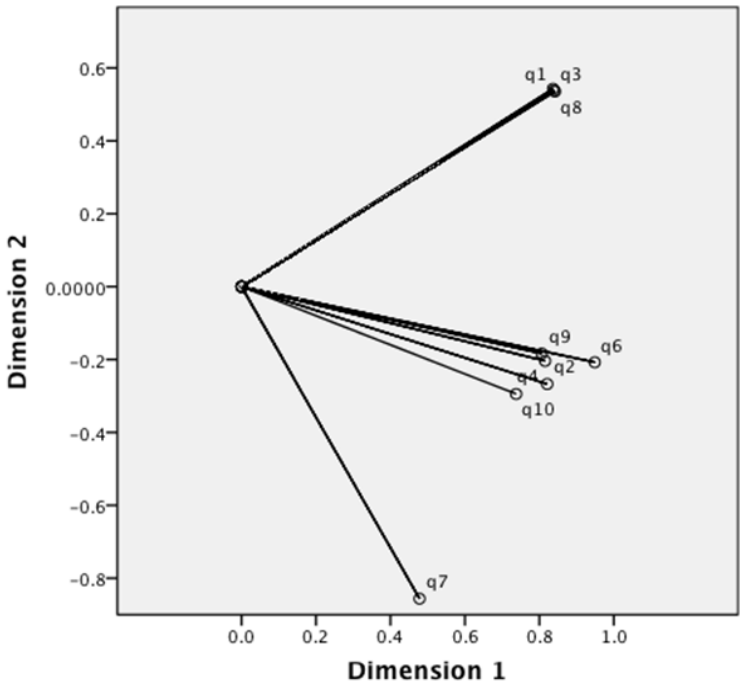


FIGURE 5.9: Revised Component Loading for the Responses of the Teachers Regarding the Tracking System

value) and they have agreed with all the variables. In addition, the most positively evaluated variable was "The connection with the students can be enhanced". Although, the variable of "Almost all the behavioral information is covered" has the lowest value, it was also responded as the above of the average value.

In addition, the CATPCA is employed to identify the highly evaluated variables from the positively evaluated variables. The component loading in Figure 5.8 imply that the almost all the variables have a strong positive affection since all vectors are in the same direction. But, q5 variable is rejected from the list of variables since the length of that variable is very short, represents the low mean according to Appendix 4.5.

Based on the new component loading without q5 as shown in Figure 5.9 and mean values (Appendix 4.6), variables can be divided in to 3 sectors: (q1, q3 and q8), (q2, q4, q6, q9 and q10) and q7. According to the variables include in each group, three factors are named as "Enhance the effectiveness of the virtual classroom through the benefits of the tracking system", "The connection between the student-content and the teacher-content can be enriched with the tracking system while enhancing the effectiveness of the virtual class" and "Instructor can maintain the class effectively based on the students behavior" respectively as follows.

q1	Almost all the behavioral information of the students can be identified with this system	Enhance the effectiveness of the virtual class through benefits of the tracking system.
q3	The requirement of the instructor guidance can be identified specifically with this system	
q8	This tracking system can be used as an individual/group evaluation tool	

q2	The connection with the students can be enhanced with this system	The connection between student-content and teacher-content can be enriched with tracking system while enhance the effectiveness of the virtual class
q4	Instructor can engage with the virtual class activities by identifying requirement of the students through this system	
q6	Instructor can change the content/way of delivering the instruction based on the student status	
q9	Tracking system is important for the e-Learning	
q10	The tracking system will be increased the effectiveness of the virtual class	
q7	Instructor can maintain the class effectively based on the students behavior	

The tracking system is an essential component of the virtual learning to establish a rich connection between the student-content and the teacher-content through the feedback of the students while enhancing the effectiveness of the virtual class is the corollary of the response of the teachers.

Then the responses of the 45 students about the student tracking system are discussed. The analysis is accounted for 62.59% of the variance in the optimally scaled items as shown in Table 5.7. The Cronbach's alpha is 85.1% for the students' response and it indicates the accuracy of the data is considerable.

TABLE 5.7: Reliability of the Responses of the Students Regarding the Student Tracking System

Dimension	Cronbach's Alpha	Variance Accounted For	
		Total (Eigenvalue)	% of Variance
1	.520	1.712	34.236
2	.368	1.418	28.357
Total	.851[a]	3.130	62.593

a. Total Cronbach's Alpha is based on the total Eigenvalue.

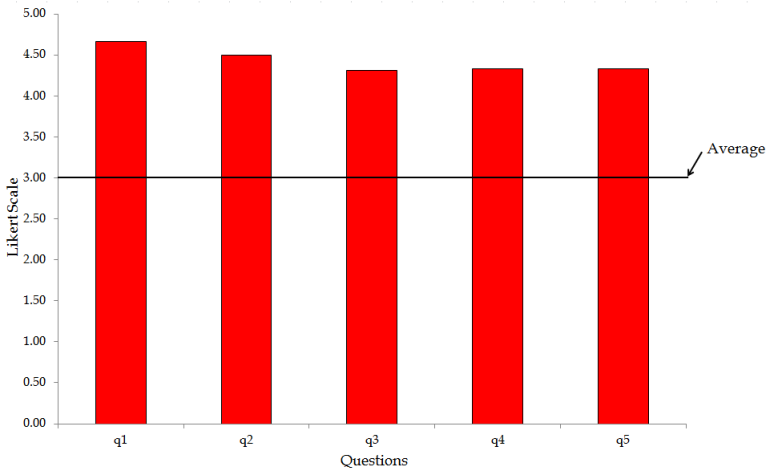


FIGURE 5.10: Responses of the Students Regarding the Tracking System

TABLE 5.8: Statistical Result of the Students' Response Regarding the Tracking System

Question	Mean	Std. Dev.	Interpretation
Can be used as an individual/group evaluation tool	4.67	0.477	Strongly Agree
Instructor can change the way of delivering the instruction based on the student status	4.50	0.594	Agree
Instructor can maintain the class effectively based on the students behavior	4.31	0.680	Agree
Tracking system is important for the e-Learning	4.33	0.611	Agree
Instructor can identify student preferences, needs and requirements	4.33	0.754	Agree
Overall	4.43	0.623	Agree

Figure 5.10 and Table 5.8 depict the mean values of the responses, which are responded by the students. The students also responded to all factors positively (above the average value). The most positively evaluated variable is "The tracking system can be used as an individual/group evaluation tool". Although, there is a variable that have low responded value, that value of a variable is also larger than the average value.
In addition, the CATPCA is employed to identify the highly evaluated variables from the positively evaluated variables. Figure 5.11 indicates the component loading and the direction of the all vectors are same, indicating that a strong positive affection from all the variables. According to the Figure 5.11 with the mean values of the Appendix 4.7, there are no variables to ignore as the all vectors are significant. But there is no link with the variables. Thus all the variables are considered as highly effective variables without any categories. Those variables are listed as follows.

q1 This tracking system can be used as an individual/group evaluation tool
q2 Instructor can change the content/way of delivering the instruction based on the student status
q3 Instructor can maintain the class effectively based on the students behavior
q4 Tracking system is important for the e-Learning
q5 Instructor can identify student preferences, needs and requirements

Looking at the all variables, which are positively evaluated, indicate that the tracking system is an essential component of the virtual class with enhancing the interaction between the teacher and the student through the identification of feedback of the students. The both teachers and the students were indicated that the tracking system is an essential component of the virtual classroom to enhance the effectiveness through the establishment of a rich connection between the student and the teacher with obtaining a precise feedback of the student about the learning content.

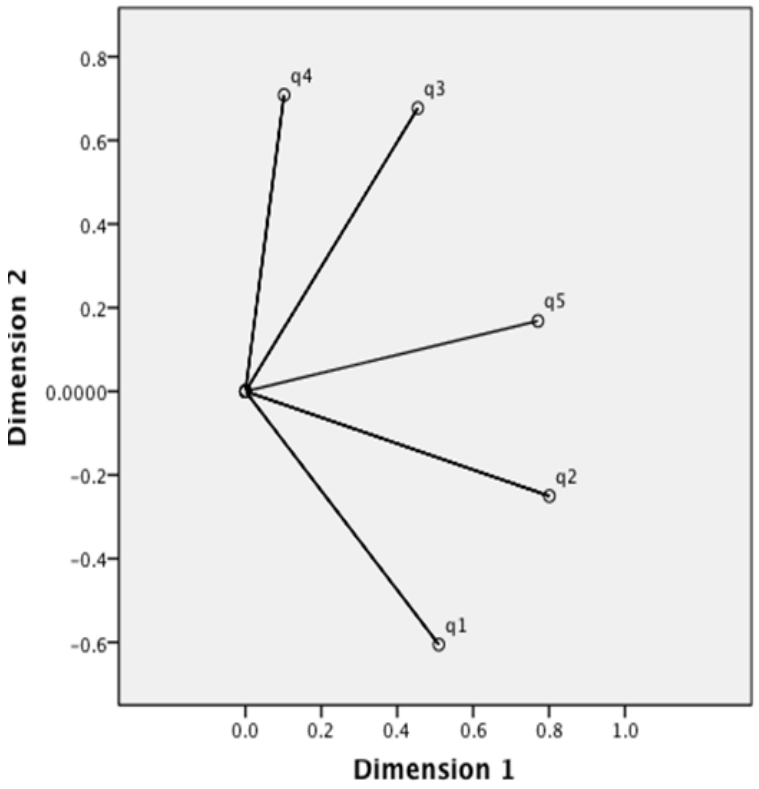


FIGURE 5.11: Component Loading for the Responses of the Students Regarding the Tracking System

5.3 Identification of the Effective Factors

The responses regarding the identification of the effective factors were obtained from the teachers and the students with the web-based questionnaire and initially, the responses of the teachers are discussed.

The 10 statements were analyzed by the 33 teachers. The percentage of variance is accounted for each dimension using eigenvalues as shown in Table 5.9. The analysis is accounted for 75.09% of the variance in the optimally scaled items. Cronbach's alpha is 96.3% for the teachers' response and it means the accuracy of this model is also high.

TABLE 5.9: Reliability of the Responses of the Teachers Regarding the Identification of the Effective Factors

Dimension	Cronbach's Alpha	Variance Accounted For	
		Total (Eigenvalue)	% of Variance
1	.931	6.184	61.837
2	.273	1.325	13.253
Total	.963[a]	7.509	75.090

a. Total Cronbach's Alpha is based on the total Eigenvalue.

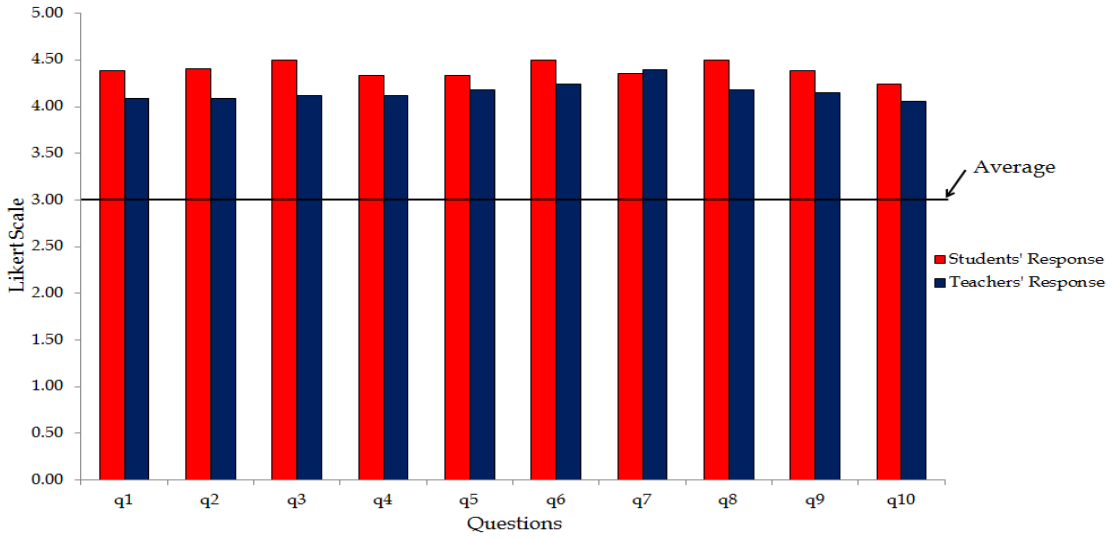


FIGURE 5.12: Responses of the Teachers and Students Regarding the Identification of the Effective Factors

The mean values of the teachers' responses are represented in Table 5.10 and Figure 5.12. The analysis of the responses of the teachers shows that the all variables are evaluated higher than the average value. The teachers agree with all the variables and "Providing preferred learning factors contribute to enhance the satisfactory level of the

TABLE 5.10: Statistical Result of the Teachers' and Students' Responses Regarding the Identification of Effective Factors

Question	Mean	Variance	Interpretation
Effective factors for the each student category can be identified by using this analysis	4.09	0.723	Agree
This analysis is facilitated to identify the environment which is preferred by Student	4.09	0.843	Agree
This analysis is especially important for the distance learning due to the distance barrier	4.12	0.927	Agree
This analysis provides the guidance to design the environment based on the student characteristics	4.12	0.857	Agree
Instructor can facilitate a better environment by utilizing this analysis	4.18	0.808	Agree
Identification of the effective factors for the each student category is important for effective learning	4.24	1.001	Agree
Providing preferred learning factors contribute to enhance the satisfactory level of the e-Learners	4.39	0.659	Agree
Providing a student preferred environment is better than providing a common environment to students	4.18	0.846	Agree
Identify the effective factors based on the student features is essential for the virtual class	4.15	0.795	Agree
Conducting the virtual class activities become ease with identifying the student preferred environment	4.06	0.933	Agree
Overall	4.16	0.839	Agree

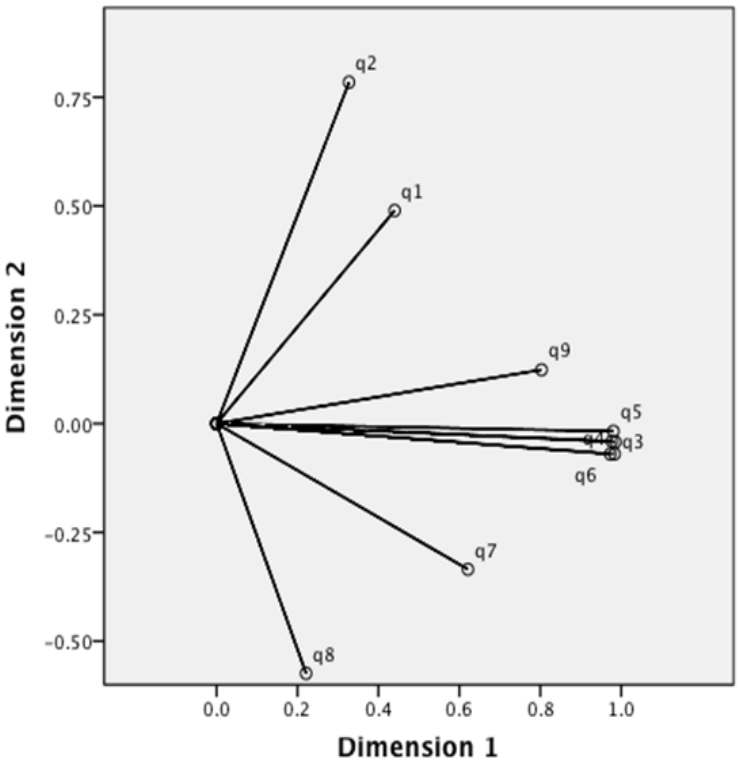


FIGURE 5.13: Component Loading for the Responses of the Teachers Regarding the Identification of Effective Factors

e-Learners" is evaluated very highly.

In addition, the CATPCA is employed to identify the highly evaluated variables from the positively evaluated statements while ignoring the negative evaluated statements. Figure 5.13 displays how the variables related to one another and to the two dimensions. A strong positive affection from all the variables is appeared since the direction of the all vectors towards the same. In addition, all the vectors in Figure 5.13 have substantial length, which represent the mean value (Appendix 4.8) indicate the all variables are considerable. The ten variables in Figure 5.13 can be formed into three groups. The first group (q3, q4, q5, q6 and q10) has five items tend to coalesce together in the upper range of dimension 1 and low in dimension 2. Those variables (q3, q4, q5, q6 and q10) can be named as "The identification of the effective factors is important and the connection between the student and the teacher with the environment can be enriched". The second group (q7 and q8) has high positive loading on the dimension 1 and high negative loading on the dimension 2. Those variables (q7 and q8) group is named as "The satisfactory level of the students can be enhanced". The third group (q1, q2 and q9) has high positive loading for the dimension 1 and dimension 2. These three variables (q1, q2 and q9) are named as "The benefits of the effective factors to enhance the effectiveness of the virtual class" as follows.

q3	This analysis is especially important for the distant learning due to the distant barrier between instructor and student	The identification of effective factors is important and the connection between student and teacher with the environment can be enriched
q4	This analysis provides the guidance to design the environment of the virtual class based on the student characteristics	
q5	Instructor can facilitate a better environment based on the student characteristics by utilizing this analysis	
q6	Identification of the effective factors for the each student category is important for effective learning	
q10	Conducting the virtual class activities become ease with identifying the student preferred environment	
q7	Providing preferred learning factors contribute to enhance the satisfactory level of the e-Learners	The satisfactory level of the students can be enhanced
q8	Providing a student preferred environment is better than providing a common environment to all students	
q1	The following two points can be identified by using this analysis Effective factors for the each student category The factors which are highly affected when the student characteristics are changed	The benefits of the effective factors to enhance the effectiveness of the virtual class
q2	This analysis is facilitated to identify the environment which is preferred by Student	
q9	Identification of the effective factors based on the student characteristics is essential for the virtual class as a latest learning platform	

Thus, the teachers responded for all variables positively and there are no any variables that identified to reject. Looking at the three groups with their variables, the teachers' responses are indicated that the student satisfactory can be enhanced with these effective factors and thus this identification of effective factors contribute to enhance the effectiveness of the virtual class with establishing an interaction between the student and the teacher through the environmental factors.

Then the responses of the students regarding the identification of effective factors are discussed. There are 45 students that evaluated the 10 variables in the questionnaire. Total percentage of variance for the students' response is 61.1% as shown in Table 5.11. The total Cronbach's alpha is 87.3% implies that the reliability of the data is high.

The result of the responses from the students is shown in Figure 5.12 and the statistical information is appeared in Table 5.12. Students are responded to all the variables

Table 5.11: Reliability of the Responses of the Students Regarding the Identification of the Effective Factors

Dimension	Cronbach's Alpha	Variance Accounted For	
		Total (Eigenvalue)	% of Variance
1	.586	1.954	32.560
2	.501	1.716	28.604
Total	.873[a]	3.670	61.164

a. Total Cronbach's Alpha is based on the total Eigenvalue.

Table 5.12: Statistical Result of the Students' Responses Regarding the Identification of Effective Factors

Question	Mean	Variance	Interpretation
Effective factors for the each student category can be identified by using this analysis	4.38	0.623	Agree
This analysis is facilitated to identify the environment which is preferred by Student	4.40	0.627	Agree
This analysis is especially important for the distance learning due to the distance barrier	4.50	0.506	Agree
This analysis provides the guidance to design the environment based on the student characteristics	4.33	0.650	Agree
Instructor can facilitate a better environment by utilizing this analysis	4.33	0.650	Agree
Identification of the effective factors for the each student category is important for effective learning	4.50	0.672	Agree
Providing preferred learning factors contribute to enhance the satisfactory level of the e-Learners	4.36	0.692	Agree
Providing a student preferred environment is better than providing a common environment to students	4.50	0.595	Agree
Identify the effective factors based on the student features is essential for the virtual class	4.38	0.731	Agree
Conducting the virtual class activities become ease with identifying the student preferred environment	4.24	0.726	Agree
Overall	4.39	0.647	Agree

positively and they have agreed with each and every variable. There are three variables which are responded more positively by the students; "This analysis is especially important for the distance learning due to the distance barrier", "Identification of the effective

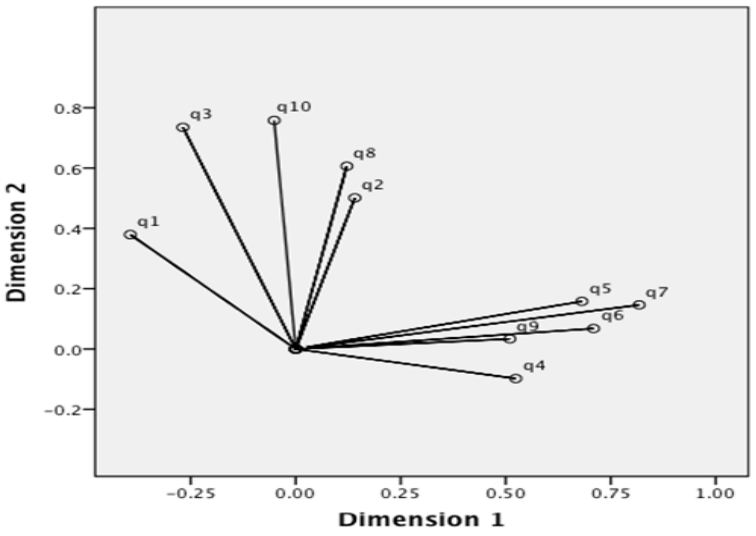


Figure 5.14: Component Loading for the Responses of the Students Regarding the Identification of Effective Factors

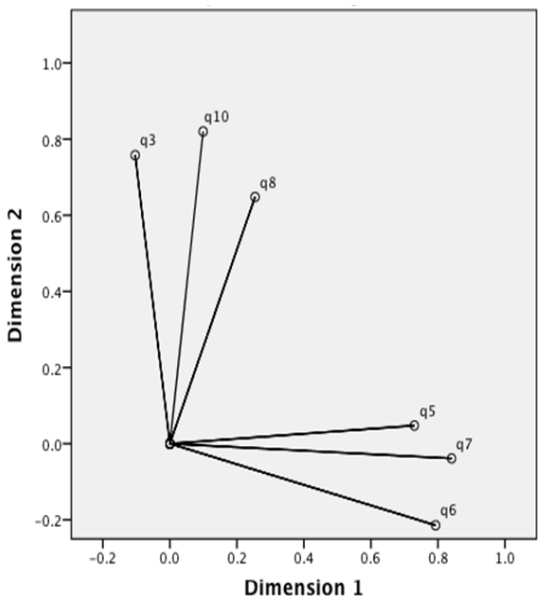


FIGURE 5.15: Revised Component Loading for the Responses of the Students Regarding the Identification of Effective Factors

factors for the each student category is important for effective learning" and "Providing a student preferred environment is better than providing a common environment to students".

In addition, the CATPCA is applied to identify the best significant variables that are responded by the students. According to Figure 5.14 of the component loading and mean values of Appendix 4.9, the variables of q1, q2, q4 and q9 have a short vector that indicate the low mean values. Thus those variables (q1, q2, q4 and q9) are ignored and construct the components loading again as shown in Figure 5.15 and Appendix 4.10. The variable vectors in Figure 5.15 clearly shows that there are two main categories (q5, q6 and q7) (q3, q8 and q10) in the graph of component loading and those are named as "Identify the effective factors are important with enhancing the satisfactory of the students" and "Enhance the effectiveness of the virtual class with several benefits" respectively as follows.

q5	Instructor can facilitate a better environment based on the student characteristics by utilizing this analysis	Identify the effective factors are important with enhancing the satisfactory of the students
q6	Identification of the effective factors for the each student category is important for effective learning	
q7	Providing preferred learning factors contribute to enhance the satisfactory level of the e-Learners	
q3	This analysis is especially important for the distant learning due to the distant barrier between instructor and student	Enhance the effectiveness of the virtual class with several benefits
q8	Providing a student preferred environment is better than providing a common environment to all students	
q10	Conducting the virtual class activities become ease with identifying the student preferred environment	

The students positively responded for these two groups and it indicates that the identification of the effective factors contribute to enhance the satisfactory level of the students while enhancing the effectiveness of the virtual class.
There was no any statement negatively evaluated and, the highly evaluated statements indicate that the identification of effective factors contribute to enhance the effectiveness of the virtual class with identifying the preferred environment of the student.
The responses of the both teachers and students indicate that the identification of the effective factors contribute to enhance the satisfactory level of the students while improving the effectiveness of the virtual class with establishing connection between the teacher and the student through the environment.

5.4 Impact of the Establishment of Non-verbal communication

The non-verbal communication is implemented in the virtual classroom as a result of this study by using the non-verbal visualization system. There were several experiments that conducted by using the non-verbal visualization system and the results of those experiments are discussed in this section. The discussion mainly based on the hypotheses which are derived in section 4.2.4. In addition, the behavior of the non-verbal features is also discussed in this session. Initially there are two hypotheses that discussed with the results of the experiments.

5.4.1 The Attitudes and Feelings of the Student with Non-Verbal Communication

- Analysis of the responses from the experiment which was utilized the visualization system of the facial expression

The end of the experiment with the visualization system of the facial expression, response of the participants was collected through a questionnaire. The questionnaire was available in both languages, Japanese and English (Appendix 2.7 and Appendix 2.8).
The questionnaire consists of multiple-choice questions regarding the facial expression system and the evaluation of those questions is indicated in Figure 5.16. The responses are very positive for the three variables and almost all the variables were responded higher than the average value except three variables.
"Easy to understand the learning content", "facial expression for e-Learning" are two variables which are highly evaluated since facial expressions of the teacher and other students may helpful to understand the learning content especially in the e-Learning

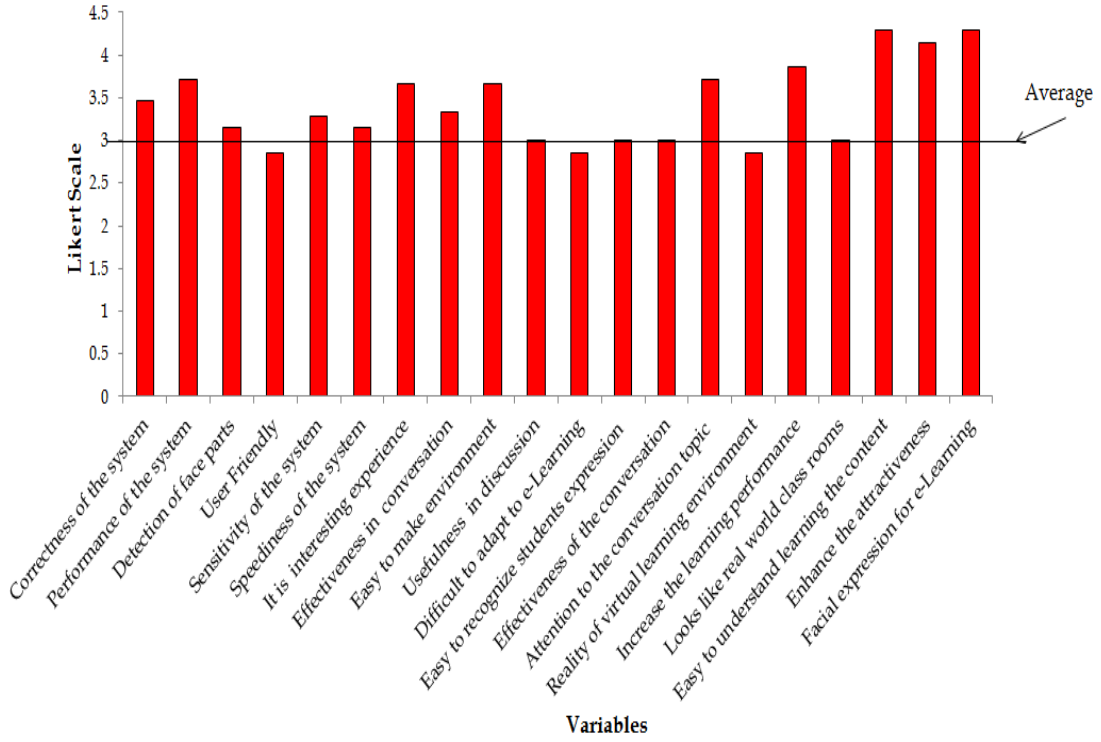


FIGURE 5.16: Result of the Questionnaire Analysis with and without Facial Expression Visualization System During the Group Discussion

due to the distance barrier. The other highly positive response for the variables of "Enhance the attractiveness" illustrates the increment of reality and attractiveness of the virtual education space with the users' facial expressions and with three-dimensional environment.

The response from the student is low for the variable of "user friendliness", because of some constraints of the visualization system of facial expression. When they obey the instructions of the facial expression system, it is slightly difficult to concentrate for the learning session. The attention to the learning session may be reduced when they focus to the visualization system of facial expression is another weak point of this process and that may be the reason for the low evaluation of the variable of "Difficult to adapt to e-Learning". In addition the facial expression visualization system doesn't make huge effect to the reality of the virtual learning since the facial expressions are represented through the avatars which are the artificial characters in the virtual environment, may be the reason for the low evaluation for "Reality of the virtual learning".

Although there are few weak points, almost all the variables are positively responded. In addition, when considering about the highly evaluated variables, it is clearly indicated that they prefer to engage with learning activities with the visualizing their facial expression in the virtual learning environment.

- Analysis the responses of the experiment which was utilized the eye blink visualization system

In the second experiment, which was conducted by using the visualization system of the eye blink, the responses of the participants were obtained through questionnaires after each session. Two questionnaires for the lecture session were delivered after the session with and without eye blink visualization system. Another two questionnaires were distributed after the group discussion session with and without eye blink visualization system.

The responses of the questionnaire during the lecture session with and without eye blinks are analyzed as shown in Figure 5.17. The positive feelings of the e-Learners were high when they were utilizing the eye blink visualization system than the session without the eye blink in generally. Most of the factors were rated highly except the variables of "positive look" and "Importance of the non-verbal communication" during the lecture session. When the session conducted without eye blink, the feeling about the "importance of the non-verbal communications" was high and when the eye blink was visualized, the importance became low. It may represent the normal human habits that the lack is highly felt when the item is absence and the importance becomes reduced when it is fulfilled. That may be the reason for the low evaluation for the variable of "Importance of the non-verbal communication". When the eyes fully open, the feeling of the student was positive and when the eyes close, time to time due to the blinking may feel negatively. That may be the reason for the low affection rate for the variables of "positive look". The variables of "Interesting", "Explanation" were accessed as a same level with and without eye blinks. The highest gap is appears at the variables of "pleasant" and "avatar gives fair to the real user".

The response of the e-Learners who were engaging with the group discussion, were also evaluated and it is shown in Figure 5.18. All the variables were rated highly during the session with eye blink than the session, which was not utilized the eye blink visualization system. There was a highest gap that appeared under the variable of "like to engage with communication".

The feeling and attitudes of the students were analyzed through an questionnaires and it is clearly shown that they were willing to engage with learning activity with visualizing their eye blink in the virtual learning environment specially during the group discussion.

- Analysis the response of the experiment which utilize both eye blink and head pose visualization system

During the third experiment, which was conducted by using the visualization system of both eye blink and head pose, the responses of the participants were obtained through a questionnaire after each sessions. One questionnaire was delivered after the discussion session which was utilized the visualization system of both eye blink and head pose and

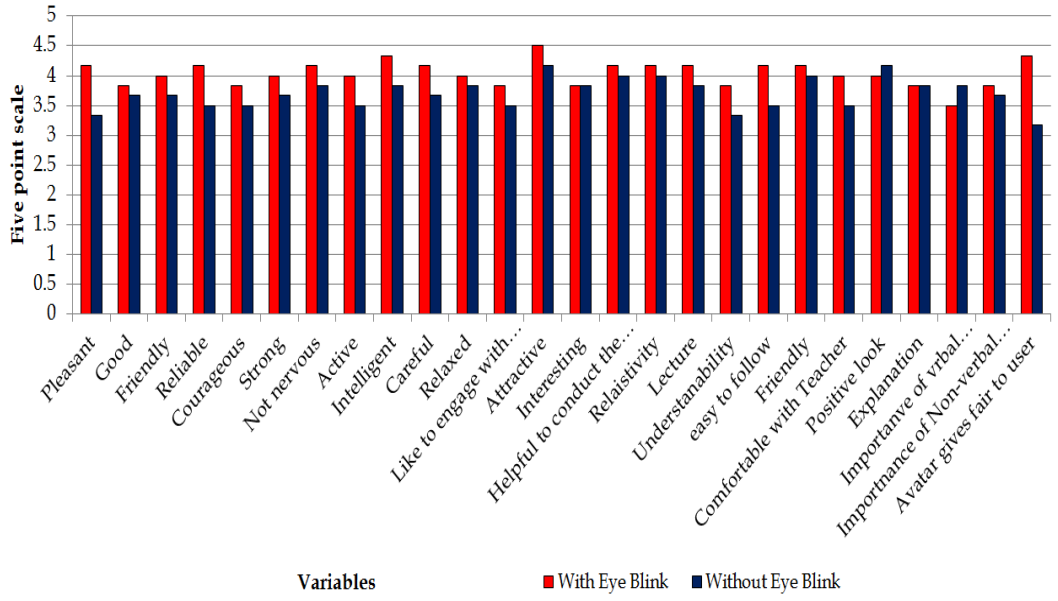


FIGURE 5.17: Result of the Questionnaire Analysis with and without Eye Blink Visualization System During the Lecture

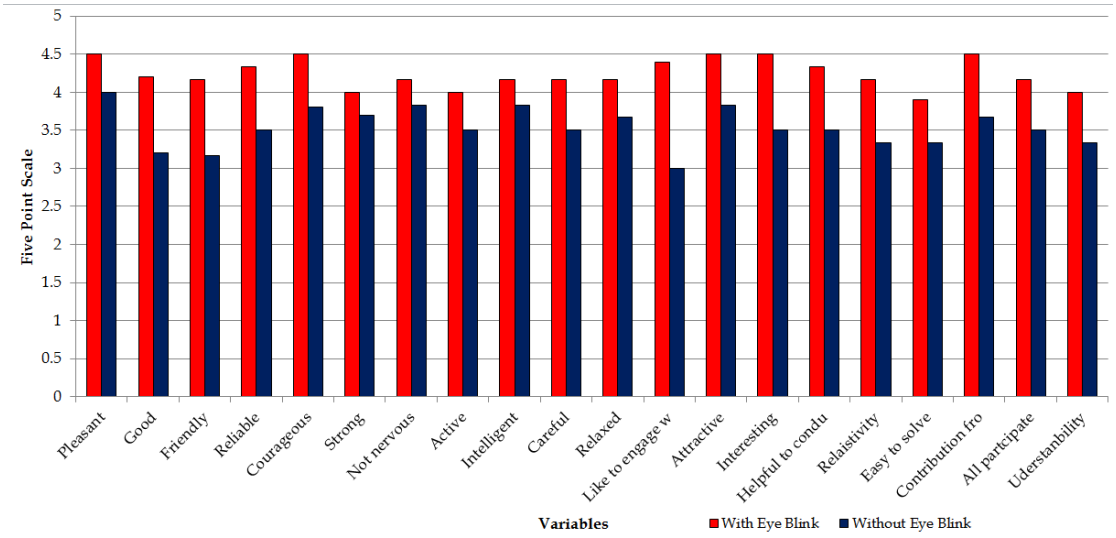


FIGURE 5.18: Result of the Questionnaire Analysis with and without Eye Blink Visualization System During the Group Discussion

same questionnaire was delivered after the group discussion which was conducted without using the visualization system of both eye blink and head pose.

The analysis of the questionnaires are illustrated in Figure 5.19. Almost all the variables included in the questionnaire were positively responded during the session that was utilized the behavior of non-verbal features than the session which was not utilized the non-verbal features except three variables. Two of those three variables were equally responded and the other one was negatively responded. The negatively responded variable was "Did you feel relax?". E-Learners might feel relax when they didn't involve with the detection of their non-verbal features. Because when they used the non-verbal

visualization system, the web-camera and the lighting equipment were occupied in front of the user to grab the behavior of non-verbal features and this situation was slightly disturb for the learning. They feel relax when they didn't use the non-verbal visualization system since their non-verbal behavior was not observed. The other two variables; "Did you behave carefully?" and "Didn't you feel nervous?" were responded equally. The both sessions were conducted as a problem based learning and that may be the reason to response equally for these two variables, nervous and behavior.

Other all variables were responded positively and the highly evaluated variables were "Attractiveness", "Avatar gives fair to the real user", "Interesting", "Identify yourself", "All participate" and "Active participation" respectively. The highest gaps between the two sessions are appeared under the variable of "Attractiveness". When the non-verbal behavior of the real user is appeared through the avatar, the appearance of the avatar become realistic and it may be affected to the viewer impression to enhance their feeling about the variables of "Attractiveness" due to the avatar appearance changes the viewer impression [83, 138]. The variables of "Avatar gives fair to the real user" was evaluated as the second highest variable and it was indicated the reflection of the real user non-verbal information through the avatar and it is a one way of making the live avatar with giving reasonable representation to the real user. The variables of "Interesting" and "Identify your-self" were evaluated highly due to the enhancement of the viewer impression with the realistic avatar appearance with non-verbal behaviors. The other positively evaluated variables were "All participate" and "Active participation". Those variables are indicated the enhancement of the virtual learning engagement through the establishment of non-verbal communication.

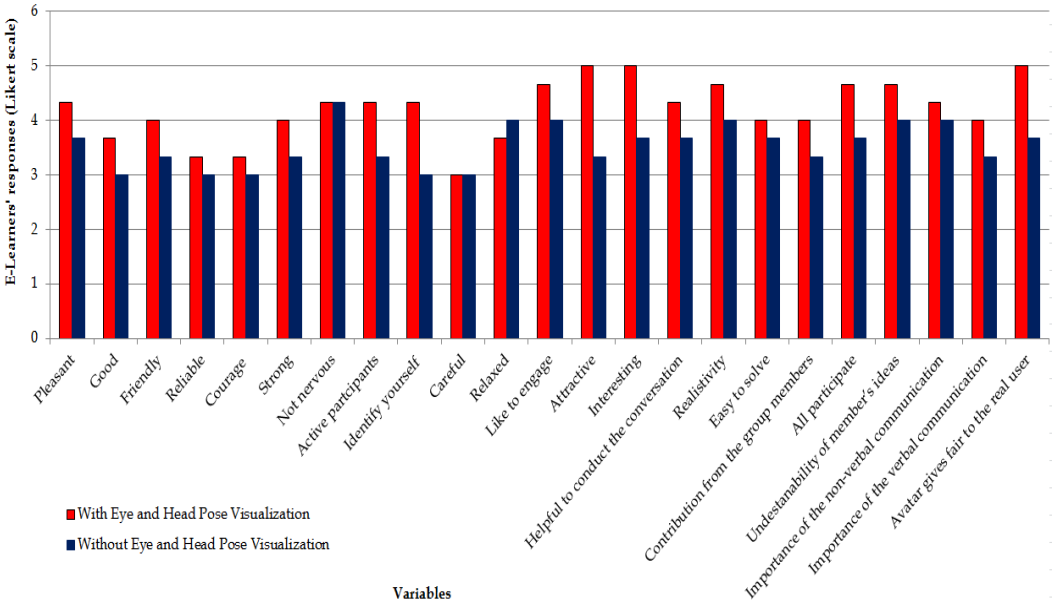


FIGURE 5.19: Result of the Questionnaire Analysis with and without Eye Blink and Head Pose Visualization System

TABLE 5.13: T-test for the Responses of the Student

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Responses	Equal variances assumed	.000	.984	-9.497	1.36	.000	-.55270	.05820	-.66779	-.43761
	Equal variances not assumed			-9.497	133.587	.000	-.55270	.05820	-.66781	-.43759

The avatar performs a reasonable representation to the real user with visualizing the non-verbal behavior in the virtual environment. Further, a rich communication is established in the virtual environment through a successful establishment of the real user's non-verbal behavior. Because of those factors mainly, the overall preferences and attitudes of the students regarding the virtual learning become very positive with the implementation of non-verbal communication in the virtual environment is the conclude indication of this experiment.

- T-test to prove the Hypothesis

According to the responses of the students about the non-verbal communication in experiments, the attitudes were very positive when they were utilizing the non-verbal communication in virtual class. But, to test the hypothesis, the t-test in SPSS is used and the results are indicated in Table 5.13. According to that table, Sig. value of "Levene's Test for Equality of Variances" is 0.984 which is greater than the 0.05 indicates more than 95% of data are belongs to this analysis and the almost all of the data are confirmed the result of this analysis. Sig. (2-tailed) of "t-test for Equality of Means" is zero which is less than the 0.05 indicates that there is a difference between the two groups, with non-verbal visualization system and without non-verbal visualization system about the attitudes of the students.

According to the t-test, the difference between the responses of the students during the learning activities with and without non-verbal communication is identified and the analysis of responses of students with the bar charts in the previous explanation, indicates the difference is positive when they utilize non-verbal communication. Thus the implementation of the non-verbal communication in the virtual classroom is affected fruitfully to the students with enhancing their attitudes and feelings positively, which is the confirmation with proofing the alternative hypothesis (H_1) and reject the null hypothesis (H_0).

TABLE 5.14: T-test for the Performance of the Students

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Performances	Equal variances assumed	.256	.614	-5.985	118	.000	-9.53333	1.59297	-12.68785	-6.37882
	Equal variances not assumed			-5.985	117.981	.000	-9.53333	1.59297	-12.68785	-6.37881

5.4.2 Affection of the Non-Verbal Communication on the Student Performance

The results of the exercises during the second (experiment with and without eye blink visualization system) and third (experiment with and without both eye blink and head pose visualization system) experiments are analyzed to test the second hypothesis as indicated in section 4.2.4, identify the way of effecting non-verbal communication for the performance of the student. The t-test from SPSS is used to test the second hypothesis and results are indicated in Table 5.14. According to that table, Sig. value of "Levene's Test for Equality of Variances" is 0.614 which is greater than the 0.05 indicate that more than 95% of data are belongs to this analysis and the almost all of the data confirm the result of this analysis. Sig. (2-tailed) of "t-test for Equality of Means" is zero which is less than the 0.05 indicates that there is a difference between the two groups, with non-verbal visualization system and without non-verbal communication regarding the performance of the students. The difference between the student performances is identified when they used and not used the non-verbal communication through the t-test.

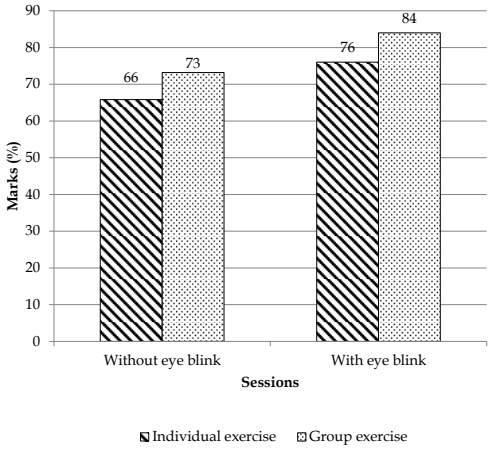


FIGURE 5.20: Performance of the Students During the Second Experiment

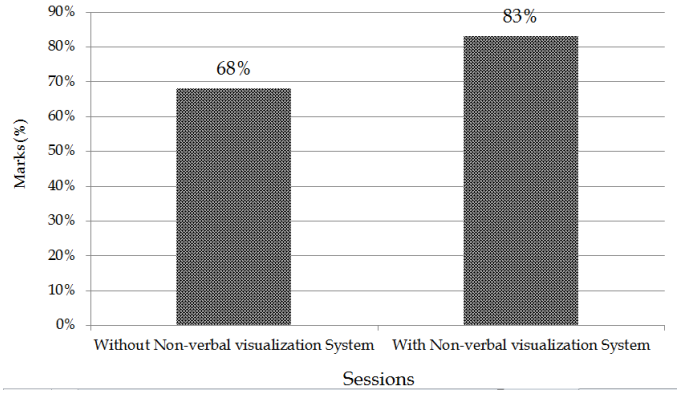


FIGURE 5.21: Performance of the Students During the Third Experiment

Then the performances of the students were evaluated to identify whether the non-verbal communication affect the student performance positively or negatively.
In the second experiment which was used the eye blink visualization system, an individual exercise was conducted at the end of the lecture session and the group exercise was held as a separate session with and without eye blinking. Figure 5.20 shows the result of the students during the two sessions and it is helpful to identify the way of effecting eye blink on the student performance. It shows that the student performance were high when they used the eye blink than the session without the eye blink. When they utilized the eye blink, student individual performance was increased by 10% and the group performance was raised by 11%. In addition, the results are high when they worked as a team than the individual performance.
In the third experiment, a group discussion was conducted with and without eye blink and head pose. Figure 5.21 shows the result of the students' performance during the two sessions. It shows that the student performance were high when they used the eye blink and head pose than the session without the behavior of non-verbal features by 15%.
The difference between the student performance with and without non-verbal communication is identified by using t-test and student performance was enhanced by 12.5% in averagely when they utilized the non-verbal communication is identified through the result of experiments which were conducted using non-verbal communication. Thus the alternative hypothesis (H_1) of the second hypothesis is proofed that the student performance can be enhanced with implementing the non-verbal communication in virtual learning with rejecting the null hypothesis (H_0).

5.4.3 The Impact of the Eye Blink Behavior

The eye blink information, which was obtained from the second (experiment with and without eye blink visualization system) and third (experiment with and without both

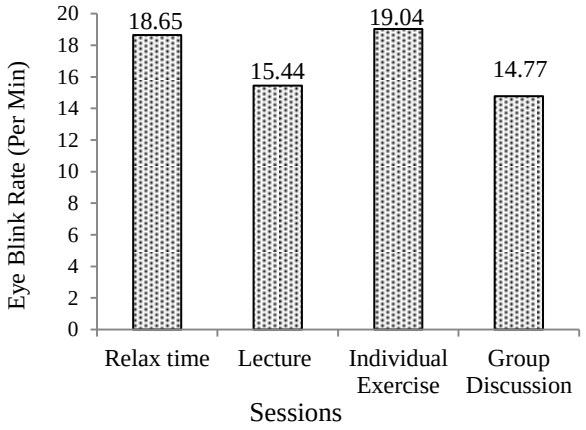


FIGURE 5.22: Average Rate of Eye Blink During the Second Experiment

eye blink and head pose visualization system) experiments are analyzed and discussed under three parts as follows.

- Rate of the eye blinking based on the learning activity

In the second experiment, two main sessions, lecture and group discussion were conducted with the system of eye blink visualization. The lecture session was divided into two sessions; lecture and the individual exercise and all together there were three sessions with using the eye blink visualization system. The mean eye blink rate was obtained during the three sessions and the relaxing time as shown in Figure 5.22. The minimal values are appeared during the group discussion and the lecture while higher rate were appeared during the individual exercise. The views of the student during the lecture session, individual exercise and group discussion were illustrated in Figure 5.23, 5.24 and 5.25 respectively. Each and every student was able to view others in the virtual classroom and they had to cover the whole area of the classroom including teacher as well as a powerpoint slides through their eyes during the lecture session. Same as the

FIGURE 5.23: View of the Student During the Lecture

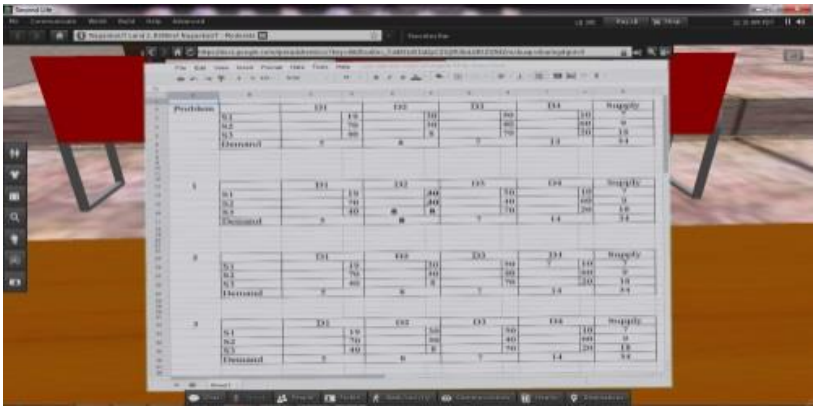


FIGURE 5.24: View of the Student During the Individual Exercise

group exercise, they had to cover whole area of the discussion place including an excel sheet. And especially the excel sheet could be edited by any other students. Therefore they needed to keep eyes open and minimized the blink to catch each and every moment. The result confirm that the student had a minimum eye blink rate during the lecture and the group exercise sessions.

They viewed only the excel sheet completely throughout the computer monitor during the individual exercise and the excel sheet could not be edited by any other user except the owner. Thus the eye blink rate went high during the individual exercise due to the less demand of the visual attraction as shown in Figure 5.24. The average rate of the eye blink indicates that the student try to control the eye blink to minimize the loss of visual information and it is confirmed with the previous studies also [112].

In addition, some other reasons also affect to the eye blink behavior, especially the stress level. According to the literature, low eye blink rate happens due to the low stress and vice versa [103]. Low eye blink rate was appeared during the lecture session and the

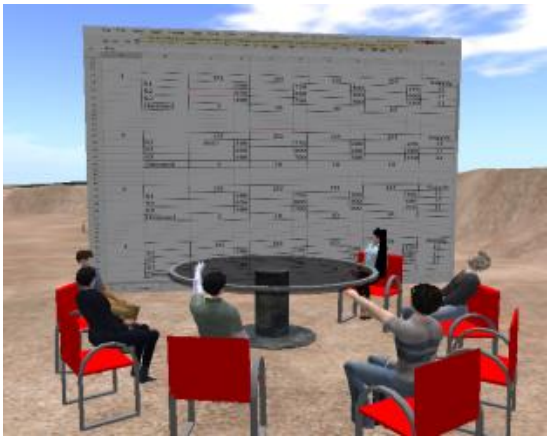


FIGURE 5.25: View of the Student During the Group Exercise

group exercise. It is obvious that the students had low stress during the lecture session since it was conducted as a passive learning session and the students had low responsibility. Even though, a high stress is expected in the group discussion since it is based on exercise, the stress level became low due to the shared responsibility of the group format. The highest eye blink rate was appeared during the individual exercise since each student had great responsibility, which increases the stress level. According to the second experiment, the rate of the eye blink depended on the visual attractions, the critical information and the stress level.

In the third experiment, the group discussion was conducted with the both eye blink and head pose visualization system. The average frequency of the eye blinks during the group discussion session and the relax time of the e-Learning participants' are illustrated in Figure 5.26. The graph clearly shows that the eye blink during the e-Learning activities was very low comparatively to the relaxing time and it was reduced by 35%. The frequency of the eye blinks may decrease due to the several reasons. E-Learners used the computer and the virtual environment. And that was also providing an attractive atmosphere to engage in this experiment. That might be a reason to decrease of the eye blink during the e-Learning activities since they had to keep the eyes openly to catch the critical attractive visuals while reducing the blink to avoid the loose of attractive visuals [112]. In addition, they were engaging with the problem-based learning and it was a group activity. Although e-Learning session was based on the problem, the stress might be decreased due to the shared responsibility of a group activity. Less cognitive load or low stress, rich critical information or attractive visual information and engage with a computer or visual equipment are some reasons to a low frequency of eye blink [106, 112].

The e-Learners conducted problem-based learning in this experiment and it was basically based on the communication among the participants. The eye blinks rate became high when they engage in the conversation according to the previous researchers [87]. But the average eye blink rate of the all e-Learners had a dramatic decrements during the problem based learning in virtual learning environment according to the Figure 5.26.

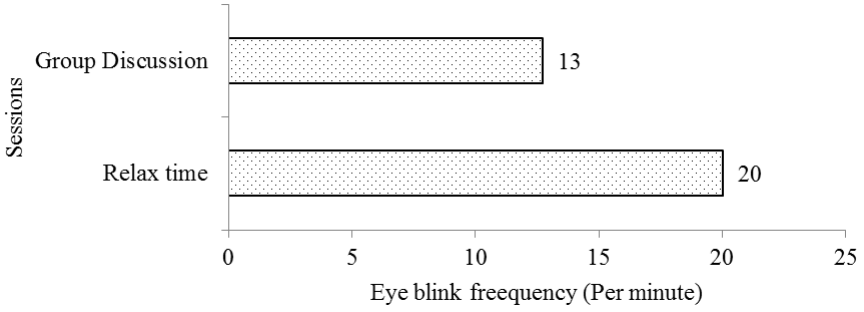


FIGURE 5.26: Average Rate of Eye Blink During the Third Experiment

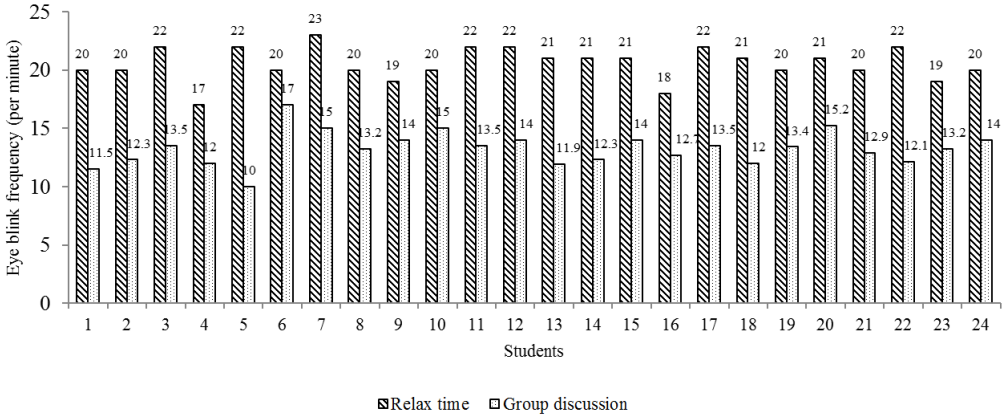


FIGURE 5.27: Eye Blink Frequencies of Each Student During the Relax and Group Discussion

Then the eye blink rate of the each e-Learner was analyzed with the rate of the conversation to find whether there was a relationship between the eye blink rate and the conversation. The eye blink rate of the each student during the e-Learning activities and the relaxing time are illustrated in Figure 5.27. The fifth and the sixth e-Learners had the lowest and highest eye blink rate during the problem-based learning respectively. The details of the conversation of the fifth and the sixth student are indicated as shown in Figure 5.28. The highest eye blink frequency was appeared under the sixth student and the rich conversation was also performed by the same e-Learner. As well as, the fifth student indicated the lowest eye blink rate and a poor conversation in comparison with the other students.

Thus the eye blink and the voice during the group exercise were analyzed to identify the variation of the eye blinking in the conversation process and the result of one student is appeared in Figure 5.29. The below chart of that figure indicates the eye blink rate of a

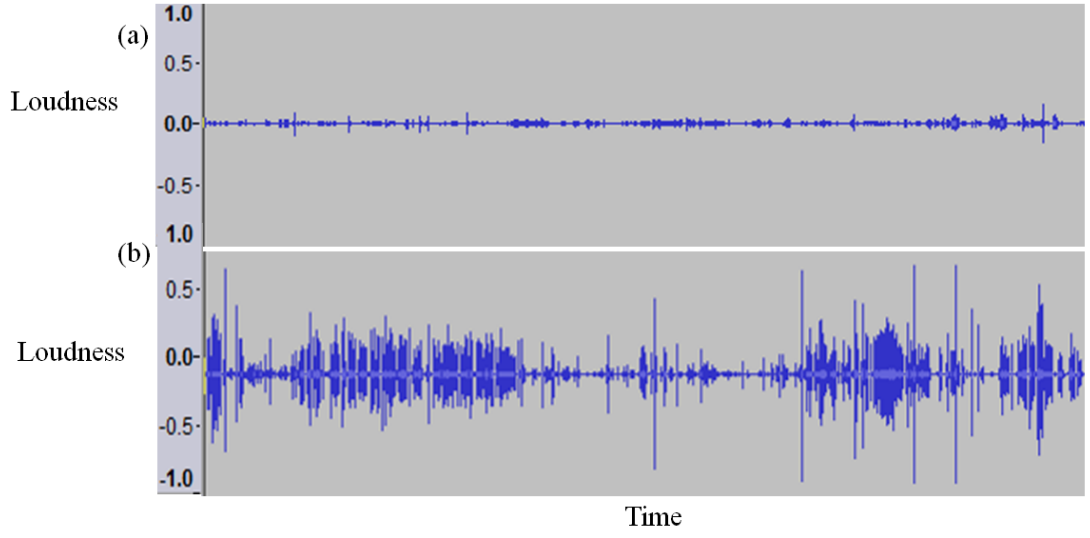


FIGURE 5.28: Conversation Information of the (a) Fifth and (b) Sixth Student

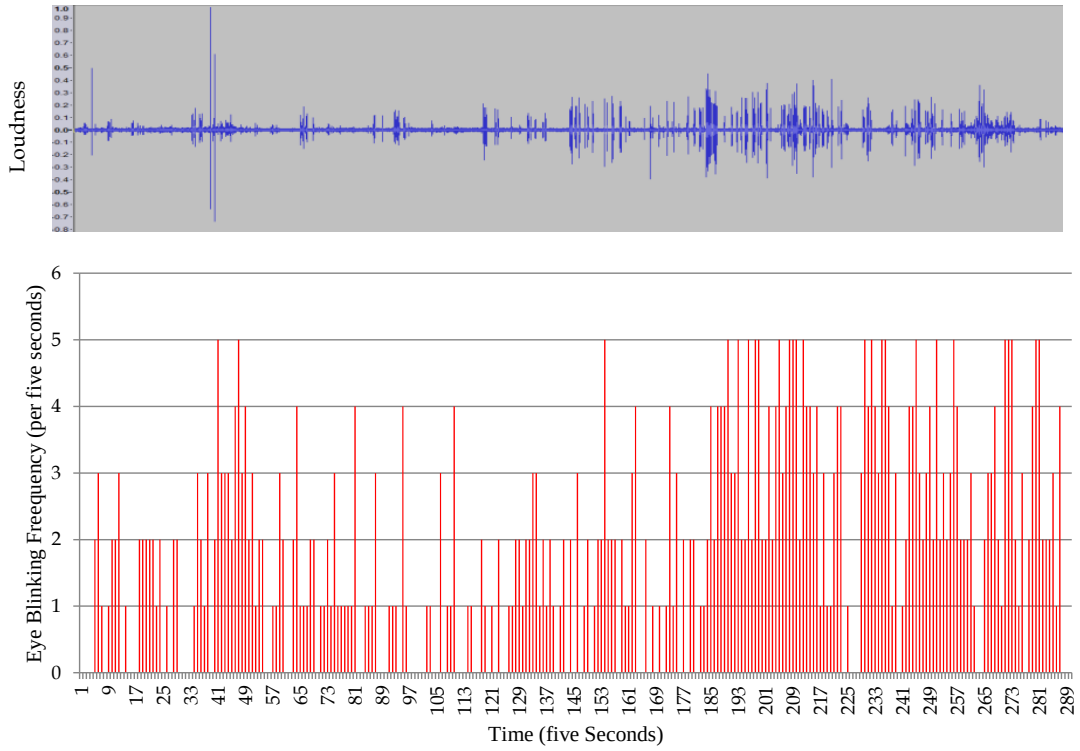


FIGURE 5.29: Relation Between Rate of Eye Blink and the Discussion

student per five seconds and the voice loudness of that particular student is appeared in the above chart of Figure 5.29. One of the students' voice and eye blinking information are included in Figure 5.29 and other students also showed the same behavior. It is obvious that the higher rate of eye blink was appeared during the speaking time and a less blink rate was illuminated during the listening time. Although the eye blink frequencies were reduced in this experiment, the top eye blink frequencies were appeared among the e-Learners who had a rich conversation.

Although the student has low eye blink rate due to the low stress, rich critical information with attractive visual information and engage with a computer or visual equipment, speaking increases the eye blink rate is the corollary of the results of experiments regarding the eye blink rates of the students.

- The relationship between the teacher and the student through their eye blink

The previous researchers found that the mirror behavior between the speaker and the listener. Although speech production and comprehension emerge as an independent process of the individual brains, verbal communication is a joint activity. Previous researchers used functional Magnetic Resonance Imaging (fMRI) to obtain brain activity from both speakers and listeners during a normal verbal communication. They utilized the speaker's spatiotemporal brain action to figure out listener's brain activity and discover that the speaker's activity is spatially and temporally together with the

listener's activity. This coupling disappears when members fail to communicate. Moreover, though on average the listener's brain action reflects the speaker's activity with a delay [140]. When a speaker shifts his/her posture, that is often mirrored by the listener. Such posture shifts, both for speakers and listeners, tend to occur at discourse segment boundaries and may function to help manage such transitions [141]. Therefore, there may be a relation among the speaker and the listener through a mirror eye blinking according to the previous finding. Thus the investigation of the mirror eye blink between the teacher and the student is conducted based on the data of the experiments.

The relation among the teacher (speaker) and the students (listeners) through the eye blinking was evaluated. The teacher's eye blink and the mirror eye blink of the students were calculated and the result is shown in Figure 5.30. The 15% of the teacher's eye blink occurred lonely without connecting the eye blinks of the students. The biggest remaining, 85% of the teacher's eye blink occurred with the students' eye blinks. It is useful to know how many students blinked concurrently with the teacher's eye blink to clarify the mirror posture clearly. Figure 5.31 shows the number of student who blinked

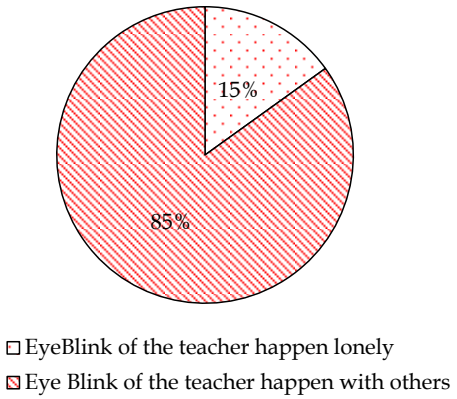


FIGURE 5.30: Mirror Eye Blink Relation of the Teacher and Students

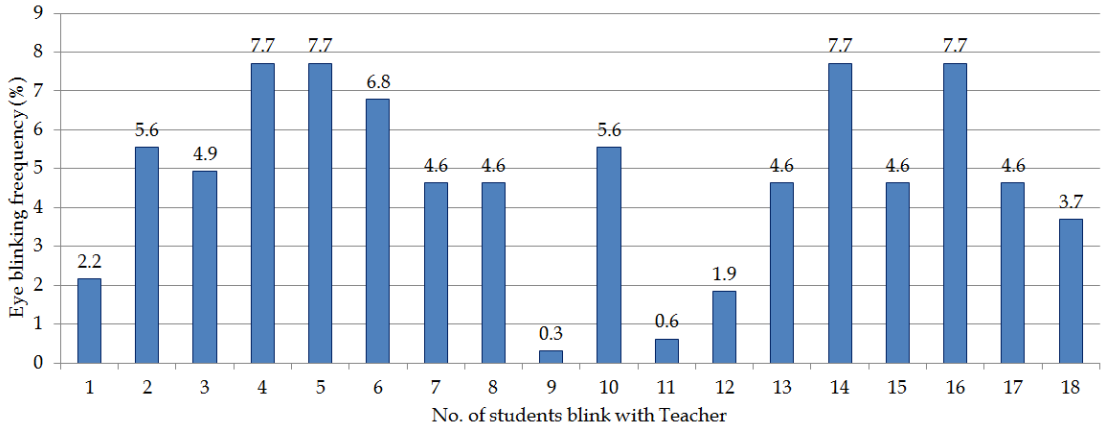


FIGURE 5.31: Relation of the Eye Blinks Among the Speaker and the Listener

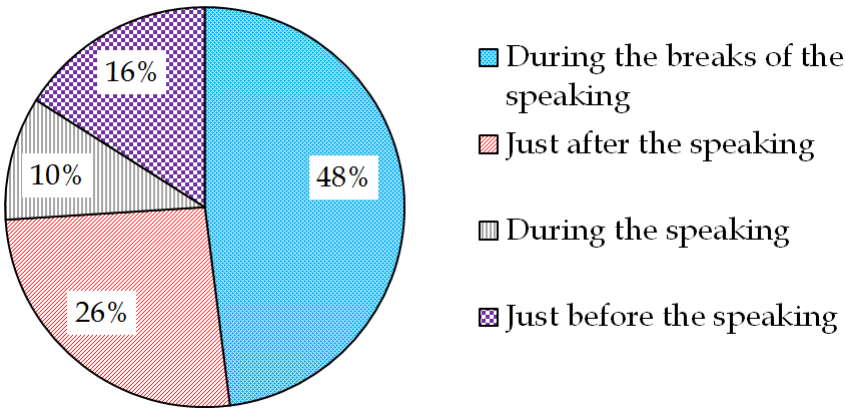


FIGURE 5.32: Occasion of the Eye Blink

when the teacher blinked her eyes. The 85% of portion consists with the occurrences that one or more e-Learners blinked with the teacher. This portion is divided relating to the number of e-Learners. More than half of the blink of teacher (54.8%) happened with seven or more e-Learners. It indicate that the mirror posture is occurred during the communication between the teacher and the e-Learners in some extent.

- The occasion of the eye blink

The eye blink information during the group discussion of the second experiment and the third experiment were utilized to identify the occasion of the eye blink. Previous studies have indicated that blink occasion is related to explicit breaks [142, 143]. Eye blinks are likely to occur at punctuation marks during the reading activity [142]. Blinks are normally suppressed throughout an activity and tend to happen immediately before and after the task [143]. However, it is hard to think that eye blink happens at the explicit breaks in our daily life [112]. Thus the investigation has been done to check whether the eye blink occur at explicit breaks or not.

The timing of the eye blinks during the speaking is investigated to identify the occasion of the eye blink. There are mainly four occasions where the eye blink happens in the conversation process. Just before or after the speaking, during the speaking and the break point during the speaking are the occasions that an eye blink can be happened in the conversation process. Figure 5.32 shows the allocations of students' eye blink timing under the major four occasions according to the experimental data.

Highest portion (48%) of eye blinking occurred during the breakpoints of the speaking. "Just after the speaking" obtained the second highest value (26%). During the speaking time, eye blink rate was very less and it is obtained only 10%.

The eye blink rarely occurred during the speaking time, which confirms that the eye blink do not occur during the middle of the task and most of the eye blink occurred at the breakpoints of the speaking.

5.5 Summary

The summary of this chapter is indicated in Figure 5.33.

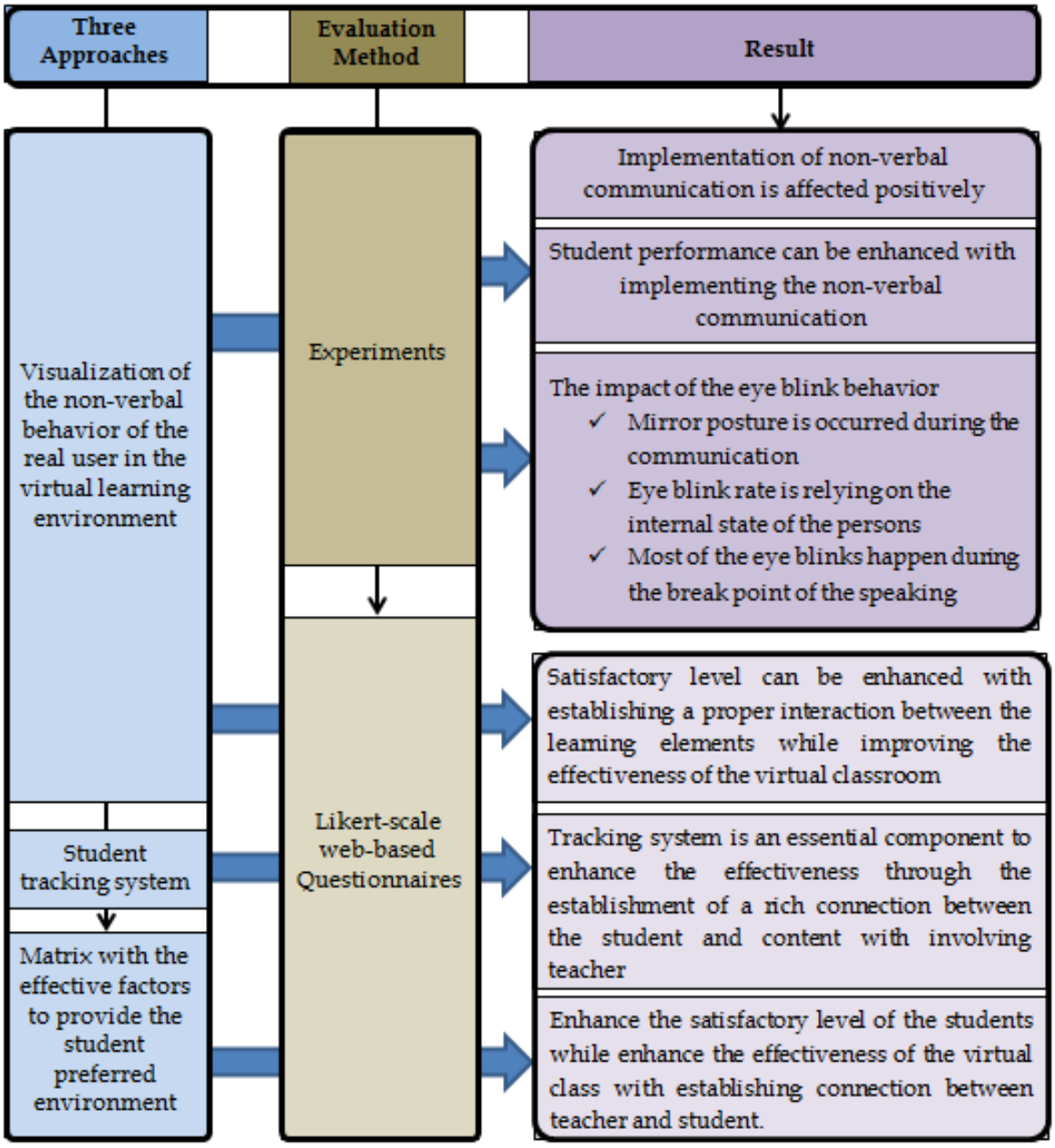


FIGURE 5.33: Summary of the Result

Chapter 6

Discussion

The knowledge delivering process has been materialized in formal or informal ways. The formal way is recognized as a classroom education. The education in conventional classroom is facing several disputes such as increment of cost, complex administration process, limited access and difficulty to meet the demand of education. Thus the e-Learning came to the stage with overcoming the barriers of the traditional classroom system with many advantageous.

The developments of the e-Learning system become strengthening with the advancement of the technology. There are many ways to deliver the knowledge through the e-Learning systems. Asynchronous and synchronous are the main two ways to deliver the e-Learning and it can be conducted as an individual basis or group basis [6]. The group-based synchronous e-Learning which has face to face format is very important and effective than the other methods due to the increment of the student commitment and motivation to engage in education with quick responses through instant messaging or chat. The virtual learning is one way of providing synchronous e-Learning. The virtual learning environment has become a very popular platform for conducting different kind of activities related to several fields, from education to games [8]. The virtual environment facilitates the three dimension atmospheres and it looks like the real world environment. Today, most of the universities use virtual platform to conduct their courses, assignments and tutorials etc. [144]. Although the e-Leaning comprises with the latest technologies, some problems are exist.

One of the main problems is the dropout of the e-Learning courses and it is higher than the conventional education system [26]. The higher dropout rate indicates that the low satisfactory of the students in an e-Learning sector [27, 28, 29]. Thus the low satisfactory level of the e-Learners is identified as a problem for this study since the success of the learning is depends on the satisfactory level of the students [23]. The satisfactory of the students with the aspects of education is enriched with a proper interaction between

learning elements according to the "Social Cognitive Theory" and "Interaction Equivalent Theory". This study aims to establish a proper interaction among the learning elements (students, teacher, content and environment) to enhance the satisfactory level of the student with enhancing the effectiveness of the virtual learning and it will cause to reduce the dropout rate automatically [26]. The interaction among the learning elements is divided into several categories based on the amount of learning elements. A multi-model system is developed in this study to establish the interaction among the learning elements. Initially the interaction among the student and the teacher as well as themselves is discussed. Then the interaction of the student and the content through the teacher are deliberated. Finally, the interaction among the student and the environment with the involvement of the teacher is considered in this study.

6.1 Development of the Multi-model System

- Implementation of the Non-verbal communication in the Virtual Learning Environment

The establishment of a proper communication among the student and the teacher is the way to build a proper interactions among the student and the teacher as well as themselves since the communication is one of the most important ingredients in any relationship [42]. The non-verbal communication plays a major role in the communication especially in the education process since 82% of all teachers' communication attempts are non-verbal [45]. Although the non-verbal communication is essential in the education process, it is lack in the virtual learning environment due to the poor connection between the student and the avatar in the virtual world. Thus, the establishment of non-verbal communication in the virtual world is a key area of this study to build a proper interaction between the student and the teacher as well as themselves.
The non-verbal is a broad area and it consists many characteristics such as facial expression, posture, eye blink, gestures with hands and arms, speech and tone of voice. To identify the most productive non-verbal characteristics of the education, an observation was conducted based on the real world conventional class [102]. The result of the observation have shown that the eye blink is one kind of important non-verbal characteristics for education. In addition, the eye blink is important since eye is the most expressive part on the face and the language of eyes is one of the most powerful tools in the communication process [88]. In addition, the facial expression is vital as it is one of the most powerful, natural and immediate means for human beings to communicate their expressions and intentions [86]. Furthermore, the head pose is an important indicator to focus of attention [89] since it allows the teacher to figure out who gives attention to the learning session. Thus the facial expression, eye blink and head pose are identified

as major non-verbal behaviors to implement the non-verbal communication in the virtual learning environment to establish a proper interaction between the student and the teacher as well as themselves.

The establishment of non-verbal communication through the implementation of facial expression, eye blink and head pose in the virtual learning environment is consisted with several steps. Those steps are 1) Detection of the students' behavior of non-verbal features, 2) modification the avatar to represent the behavior of non-verbal features, 3) transfer the identified non-verbal information to the virtual environment and visualize the students' facial expression, eye blink and head pose in the virtual learning environment. The first step, detection of non-verbal behavior is done using a web-camera video continuously as a real time process. The behavior of the shape and the size of the facial features are employed to recognize the facial expression through the geometric based method. Haar-feature based cascade classification and the methods of image analysis are utilized to detect the eye blink and the template matching with image coordination system is employed to estimate the head pose of the students. The eye blink detection has the 81% of accuracy. The 87% and the 84% of performance are achieved by the head pose estimation for the frontal/near frontal and non-frontal views respectively. Then the head model is prepared and attached to the avatar to represent the facial expression, the eye blink and the head pose in the virtual world since the default avatar hasn't way to represent the non-verbal characteristics. The detected non-verbal information is transferred to the virtual world using a server through the WAN. Ultimately, the transferred information is obtained through the Http request in the virtual world and represents the behavior of non-verbal features of the student in the virtual learning environment through the avatar.

Three experiments were conducted with employing the behavior of non-verbal features of the students in the virtual learning environment. The first experiment was utilized the visualization system of the facial expression and visualization system of the eye blink was utilized in the second experiment. The third experiment was conducted with visualization system of the both eye blink and the head pose. The well conduction of the three experiments was indicated that the non-verbal visualization system is successfully implemented in the virtual learning environment. The conducted experiment with the facial expressive avatar was confirmed that the facial expressions are important to e-Learning and it is increased the attractiveness and the reality of the learning environment. Further the experiment with facial expression visualization was shown that the students were willing to engage with education in the virtual world. The result of the second experiment which was conducted by using the visualization system of the eye blink indicates that the students prefer to engage with the non-verbal communication in the virtual learning environment and it is especially affected to the communication process. Thus the third experiment was limited to a group discussion. The result of the

third experiment which was used both the eye blink and the head pose indicated that the overall effectiveness of the virtual learning enhances with the implementation of the real user non-verbal information in the virtual learning environment.
As a byproduct of this visualization system of the non-verbal characteristics, there is a good opportunity to analyze the behavior of non-verbal features. This study mainly investigates the affection of the non-verbal communication to the attitudes/feelings of the e-Learner and their performance. In addition, the behaviors of the eye blink during the virtual class activities are also analyzed as follows.

- According to the responses of the students regarding the non-verbal communication in experiments, the t-test is confirmed that, there is a significant difference between the feelings/attitudes of the student with and without non-verbal communication. In addition, the analysis of the responses of students indicated that the difference is positive when they are utilizing the non-verbal communication. Thus the implementation of non-verbal communication in the virtual classroom is affected positively to the students with proofing the alternative hypothesis.
- The t-test is indicated that there is a difference in the student performances with and without non-verbal communication. The student performance was increased by 10% and 11%, when they worked as individually and as a group respectively with the eye blink visualization. When they utilized the eye blink and the head pose behavior in the virtual classroom, performance of the student was increased by 15% in the group work. The student performance is raised by 12.5% averagely with introducing the non-verbal communication in the virtual learning environment. Thus, the alternative hypothesis is confirmed that the student performance can be enhanced with the implementation of non-verbal communication in the virtual classroom.
- The behavior of eye blink is analyzed to discover the affection of the eye blink to the virtual classroom
  - ✓ The rate of eye blink is reduced with the cases of low stress, rich critical information with attractive visual information and engaging with a computer or visual equipment while the rate of eye blink is increased in a conversation. The rate of eye blink is relying on the internal state of the persons and it is based on the activity that he/she performs with the environmental factors.
  - ✓ The result of the investigation about the mirror eye blink relationship between the teacher and the student indicates that the 85% of teachers blink their eyes with the one or more students and more than half of the teachers blink their eyes (54.8%) with seven or more students. Thus the result suggests that there is a mirror eye blink relationship between the teacher and the student in some extent.

- ✓ The investigation about the occasion of eye blink indicates that the highest portion (48%) of the eye blinks are occurring during the breakpoints of the speaking time. The second highest value (26%) of eye blink occurrences obtains "Just after the speaking". During the speaking time, the eye blink rate is very less and it is obtained only 10%. The eye rarely blinks at the speaking time and most of the eye blinks are happened at the breakpoints of the speaking time.

The first part of this study is to implement the non-verbal communication in the virtual leaning environment and it has been accomplished with enhancing the effectiveness of the virtual class education in several aspects.

- Development of the Student Tracking System

The second part of this study is to establish a proper interaction between the student and the content through the involvement of a teacher. The teacher has to modify the content according to the requirements of the students to establish a proper interaction among the content and the student. To identify the student requirement, precise feedback of the students are vital. The feedback through the non-verbal behavior is a way to obtain the precise feedback from the students [51]. Thus, a student tracking system has been constructed in this study and it is almost based on the behavioral information of the students. The layout of the virtual land in the virtual learning environment is mapped into the web interface and the location of the available students in the virtual learning environment can be visualized by using the student tracking system. In addition, their eye blink and head pose information are also visualized through the avatar. The tracking system is facilitated to follow the discussion and view the chat among the participants in the virtual learning. Further, the status of the student can be viewed through the tracking system which is the most important part of the tracking system. The status of the students is obtained mainly by using the behavior of the facial features and way of engaging with the virtual class activities. The basic statuses of the students which may important in the learning process, are derived from the students' behavioral information and those statuses are categorized as; interest, attentive, not attentive, frustrated/struggling, distracted/nervous and tired/sleepy. The 80% of the student status are identified successfully in this tracking system and it is reasonable since the feedback opportunities are lack in most classrooms [49] even in the real world class. The construction of the student tracking system to obtain the feedback of the students precisely, is accomplished to modify the content based on the student requirement through establishing the proper interaction among the student and the content with involving the teacher as the second part of this study.

- Identification of the Effective Factors in Virtual Learning Environment

The third part of this study is to establish a proper interaction among the student and the environment with the involving a teacher. The teacher or facilitator of the course has to provide an ideal environment which is suit to the students. Currently, the common environment is provided to each and every student in the virtual learning environment and the preferred environment of the student is difficult to identify since the default characteristics of the e-Learning, especially the distance barrier. Thus the identification of the effective factors for the each student category will be highly contributed to establish a proper interaction between the student and the environment. Initially the whole factors affecting to the learning processes, are identified. Then the uncontrollable external factors by the teacher or the course designer are neglected. The remaining controllable factors are identified and a set of experiments was conducted to identify the effective factors for the each student category. The result of the experiments is analyzed and the effective factors are identified based on the student characteristics. A matrix including the effective factors was built for considering the basic student characteristics. Teacher can modify the virtual learning environment based on the effective factors that included in the developed matrix to provide a student preferred environment to establish a rich connection between the student and the environment.

6.2 Evaluation of the Multi-model system

The three processes, 1) implementation of the non-verbal communication in the virtual world, 2) development of the student tracking system and 3) identification of the effective factors based on the student characteristics are discussed to implement a proper interaction between the learning elements. An evaluation was conducted to identify whether the satisfactory level of the students was enhanced or not with these three processes. The responses were obtained from the teachers and the students by using a web-based five point Likert scale questionnaires. The responses were obtained from 78 subjects and it was consisted 45 (58%) students and 33 (42%) teachers. The CATPCA method is employed to recognize the highly evaluated variable(s) by the teachers and the students to identify the way of affection from three processes to the virtual learning.

– The teachers were responded concerning the non-verbal visualization system and the analysis of the responses of the teachers shows that the all statements are evaluated higher than the average value except one statement and that is the only negative statement. The positive statements are evaluated positively and negative statement is evaluated negatively. It indicates their preference to the virtual learning environment with the non-verbal visualization system. In addition, by looking at the two groups which are identified using CATPCA, "Visualization

system important since it is enhanced the effectiveness and their preferences", "The reality is enhanced in the virtual class with a proper link of the avatar and the real user", lead for the enhancement of the student satisfactory level with increasing the effectiveness of the virtual classroom through inducing a proper interaction between the learning elements.

- Then the students' response regarding the non-verbal visualization system is analyzed. All positive statements were responded positively and the negative statement is evaluated negatively by the students. In addition, three groups "Enhance the student preference to engage with the activities of the virtual class", "Enhance the effectiveness of the virtual class through several benefits of the visualization system" and "The quality of the virtual class is enriched with a proper avatar representation" were identified as the highly evaluated factors with CATPCA method, indicated that the student preferences to the virtual learning environment can be enhanced with the increment of effectiveness, quality of the virtual learning through the visualization of non-verbal features.

The teachers and the students willing to engage with the non-verbal visualization system and the proper interaction between the learning elements is enhanced. Thus the satisfactory level of the students can be raised while improving the effectiveness of the virtual classroom and it is the overall viewpoint of the teachers and the students by concerning the non-verbal visualization system.

Then the responses of the teachers and the students regarding the student tracking system is analyzed.

- All the statements were responded positively and agreed by the teachers. There were three factors that identified, "Enhance the effectiveness of the virtual classroom through benefits of the tracking system.", "The connection between student-content and teacher-content can be enriched with tracking system while enhancing the effectiveness of the virtual class" and "Instructor can maintain the class effectively based on the students behavior" from the highly evaluated variables through CATPCA. The tracking system is an essential component for the virtual learning to establish a rich connection between the student and the content through the feedback of the students while enhancing the effectiveness of the virtual learning is the corollary of the response of the teachers.
- Although the students were responded for all factors positively, there is no link among the variables. Thus all the variables are identified as highly evaluated factors by the students. According to the factors, the tracking system is an essential component of the virtual learning and especially it is enhanced the interaction between the teacher and the student through the identification of feedback of the students via the student tracking system.

The tracking system is an important part of the virtual learning to enhance the productivity through establishment of a rich connection between the student and the teacher with obtaining the precise feedback of the student about the learning content is the corollary of the responses of the teachers and the students.
The identification of the effective factors is the third and the last section of this multi-model process. And it is evaluated based on the responses of the teachers and the students.

- The analysis of the responses of the teachers shows that the all statements were responded higher than the average value. In addition, there are three factors were identified from the effective variables with CATPCA as "The identification of effective factors is important and the connection between the student and the teacher with the environment can be enriched", "The satisfactory level of the students can be enhanced" and "The benefits of the effective factors to enhance the effectiveness of the virtual class". Looking at the three factors, the teachers' responses are indicated that the student satisfactory can be enhanced with these effective factors and this identification of the effective factors contributes to enhance the effectiveness of the virtual learning with establishing an interaction between the student and the teacher through the environmental factors.
- Then the responses of the students were evaluated concerning the identification of the effective factors. All the statements were also positively responded and they agreed with all statements as same as the response of the teachers. Two factors are classified, "Identify the effective factors are important to enhance the satisfactory of the students" and "Enhance the effectiveness of the virtual class with several benefits" from the highly responded variables by using CATPCA. The identification of the effective factors contributes to enhance the effectiveness of the virtual learning and satisfaction of the students with identifying the preferred environment is the overall idea of the students.

The responses of the both teachers and students are indicated that the identification of effective factors contribute to enhance the satisfactory level of the students while escalating the effectiveness of the virtual learning with establishing a connection between the teacher and the student through the environment.
The three processes 1) implementation of the non-verbal communication in the virtual classroom, 2) development of the tracking system to obtain the student feedback and 3) identification of the effective factors, were responded by the teachers and the students and they indicated that the student satisfactory level can be enriched with raising the effectiveness of the virtual learning. Thus the multi-model system, which is constructed in this study contributes to amplify the satisfactory level of the student while creating a delighted student and it will be caused to reduce the dropout rate of the e-Learning.

6.3 Implementation

The work has done in this study, is implemented with collaborating the virtual learning environment and the real world. Further, National Institute of Technology in Gifu prefecture and National Institute of Technology, Suzuka in Mie Prefecture are already applied this research work for their Metaverse projects. They have done experimental works with implementing the result of this study.

6.4 Summary

The development of the e-Learning and the virtual learning which is kind of the e-Learning, facilitates the solutions to the drawbacks of the conventional learning system. Although the number of e-Learners is raised day by day tremendously, the persistence is low compare to the traditional education due to neap satisfactory level of the students. Thus, the creating a delighted e-Leaner with establishing effective and efficient learning atmosphere for the education while enhancing the utility of the virtual learning by using ICT (Information and Communications Technology) is the main task of this research. Building a balanced and meaningful interactivity among the learning elements is the way to create a delighted e-Learner with enhancing the learning efficiency. Thus there are three approaches that considered in this research. We have 1) established the non-verbal communication of the student in the virtual learning environment, 2) developed student tracking system to obtain the feedback of the students and 3) constructed a matrix with the effective factors to provide a preferred environment to students and to establish a proper interaction among the learning elements. The results of the experiments, which were conducted using non-verbal visualization system, indicate that the students prefer to engage in the virtual learning with the visualization system. In addition, the implementation of the non-verbal communication is enhanced the student performances by 12.5%. The analysis of the eye blink rate was indicated that, the eye blink was depended on the internal state of the person and it was based on the activity that he/she performed with the environmental factors. In addition, there is a mirror eye blink relationship between the teacher and the student. The most of the eye blink occur at the breakpoint of speaking. Then the evaluation of these three approaches was done with a web-based Likert-scale questionnaires with 78 subjects. The overall results of the responses indicate that the multi-model system including the three approaches were contributed to escalate the effectiveness of the virtual class while enhancing the satisfactory level of the students through a proper interaction among the learning elements and it will be caused to reduce the dropout rate of the e-Learning.

Chapter 7

Conclusion

The e-Learning has emerged to overcome the problems in the conventional education system such as neap quality, giant expenditures and limited access. The demand for the e-Learning becomes high with the increment of the online users through the great benefits of the e-Learning. Synchronous and asynchronous e-Learning in a group or individual format which are the major types of e-Learning methods and group based synchronous e-Learning is better due to the increment of the student commitment to engage in education with quick responses with instant messaging or chatting [7]. Virtual learning is an appropriate method for the education process among the other methods of synchronous learning as the virtual learning is especially designed for the education purpose and the other synchronous learning methods has different purposes like business meetings which are far from the education.

Although there are many ways to deliver the knowledge using electronic equipment, the quality of the knowledge delivering process has some problems since the dropout rate of e-Learning is high comparing to the conventional learning [26]. The main cause is the low satisfactory level of the student [25]. Enhancement of the satisfactory of the student is important aspect in the e-Learning. Therefore the aim of this study becomes enkindle the satisfactory of the student with creating a delighted student while enhancing the effectiveness of the virtual class with contributing ICT.

The establishment a proper interaction among the e-Learning elements is the way to enhance the satisfactory of the student based on the theorems "Social Cognitive Theory" and "Interaction Equivalence Theory". The establishment of an interaction among the learning elements (student, teacher, content and environment) is divided into three sections as follows,

- Interaction among the student and the teacher as well as themselves
- Interaction among the student and the content through the involvement of a teacher

- Interaction among the student and the environment with affiliation of a teacher

The first part of this study is to establish an interaction between the student and the teacher with themselves. The establishment of the non-verbal communication, which is lack in the virtual learning environment is a great opportunity to launch a proper communication in the virtual learning to set up a proper interaction between the student and the teacher since the communication is a key ingredient in any relationship and the non-verbal owns the priority in the communication process [58].

The facial expression, the eye blink and the head pose which are the important non-verbal behaviors [86, 87, 89] of the students, are detected using geometric method with the process of image analysis and those are transferred to the virtual learning environment. The modified avatar in the virtual learning environment represents the behavior of non-verbal features of the e-Learners. The facial expression of the e-Learner such as neutral, happy, sad and surprise are represented in the virtual learning environment through the avatar in real time. In addition, when the e-Learner blinks his/her eyes and moves the head, the avatar represents those actions in the virtual learning environment consequently. The visualization of the behavior of non-verbal features of the e-Learner is established in the virtual learning environment through the avatar to launch a proper interaction between the student and the teacher as well as themselves.

Having completed the non-verbal visualization system, there were three experiments that conducted with utilizing the facial expression, eye blink and head pose. The well conducted experiments indicate that the facial expression, eye blink and head pose are successfully implemented in the virtual learning environment. The analysis of the responses in the experiments were indicated that the overall effectiveness of the virtual learning is enhanced with the implementation of the real user non-verbal information in the virtual learning environment and it is especially affected to the group discussion. Besides, the implementation of the non-verbal communication in the virtual classroom is affected positively to the students. Further, the implementation of the non-verbal communication contributes to raise the student performance by 12.5%.

Then the behavior of the eye blink, which was obtained during the experiments, suggests that the eye blink rate is relying on the internal state of the persons and it is based on the activity that he/she performed with the environmental factors. In addition, there is a mirror eye blink relationship between the teacher and the student in some extent and most of the eye blinks occur during the breakpoints of the speaking is another finding of this study.

The second part of the study is concerning the establishment of a proper interaction between the student and the content through the involvement of the teacher. The teacher needs to implement the necessary adjustments to the content according to the students' reaction towards the learning. Thus there should be a good mechanism to obtain the precise reaction or feedback of the student to continue this flow smoothly. A student

tracking system was constructed to obtain such kind of precise feedback of the students who are engaging with the virtual learning. The layout of the virtual land including the virtual classrooms is mapped into the web interface to construct the tracking system. The tracking system is visualized the location of the students in the virtual classroom through the layout of the virtual land in the web interface. In addition, eye blink, head pose, voice and chat information also available with the tracking system. The most important portion of the tracking system is the derivation of the student status to identify students nature such as interest, attentive, not attentive, frustrated/struggling, distracted/nervous or tired/sleepy. The tracking system with the student status was constructed in this study to establish a proper interaction between the student and the content with the involvement of a teacher.

The establishment of a proper interaction among the student and the environment with a teacher involvement is the third part of this study. The default characteristic of the e-Learning, the distance between the learner and the teacher with low connection becomes a barrier to identify the preferred environment of the students. The guidance was prepared in this study with identifying the effective factors based on the student characteristics. The output of the set of experiments is the matrix which includes the effective factors based on the student characteristics. A matrix has been built based on the behavior of the students and the teacher can modify the environment according to the effective factors which are included in the matrix. The development of the matrix including the effective factors may contribute to establish a proper interaction between the student and the environment.

A multi-model system including the three processes was built in this study and the affection of those three processes was evaluated by using Likert-scale web-based questionnaire. The responses of 78 subjects were obtained including 45 students and 33 teachers. Initially, the non-verbal visualization system was evaluated. The analysis of the responses of the subjects was indicated that they prefer to engage in the virtual learning with non-verbal visualization system. In addition, the interaction between the teacher and the student is raised through the non-verbal visualization system. Thus, the enhancement of the preference of the learning parties to engage with the virtual learning and establishment of a rich interaction between the teacher and the students, are the major influencing factors of the non-verbal visualization system to enhance the satisfactory level of the students.

The analysis of the responses of the teachers and the students are indicated that the tracking system is a vital component of the virtual learning since it is raised the link between the teacher and the students with obtaining and modifying the course content according to the precise feedback of the students while enhancing the effectiveness. The establishment of a proper interaction between the student and the teacher through the

content is one way to enhance the satisfactory level of the students. Thus the development of the tracking system is cause to enhance the satisfactory level of the students with improving the effectiveness.
The identification of the effective factors and development of the matrix including the effective factors were evaluated by using the same subjects. The effectiveness of the virtual learning can be enhanced and raised the satisfactory level of the student with the identification of the effective factors through providing a preferred environment of the students, is the corollary of the responses of the participants.
The establishment of a proper interaction between the learning elements is done through implementing the multi-model system with consisting the three processes, 1) non-verbal visualization in the virtual learning environment, 2) development of the student tracking system and 3) identification of the effective factors. Thus, it will be caused to enhance the satisfactory level of the students according to "Social Cognitive Theory" and "Interaction Equivalent Theory". In addition, the increment of the student satisfactory level through this multi-model system is confirmed with the responses from the teachers and the students. Thus the delighted students can be generated with enhancing the effectiveness of the virtual classroom through this multi-model system and it will be caused to reduce the dropout rate of the e-Learning for the better e-Learning in future .

7.1 Major Contributions to the Research Domain

The main contribution of this research is the successful implementation of a multi-model system, which includes the three processes; 1) implementation of the non-verbal communication in the virtual learning with visualizing the behavior of non-verbal features of the student through the avatar, 2) construction of a student tracking system to obtain the precise feedback of the students and 3) identification of the effective factors based on the student characteristics to provide a preferred environment to establish the proper interaction among the learning elements (student, teacher, content and environment). The multi-model system enhances the satisfactory level of the student while raising the effectiveness of the virtual learning as desired to reduce the dropout rate.
Other than this major contribution, the followings can be treated as significant contributions of the research and those findings related to the establishment of the non-verbal communication in the virtual learning.

- The establishment of the non-verbal communication affects to the feelings/attitudes of the students positively.
- The performance of the students can be improved with the non-verbal communication
- The behavior of the eye blink

- Eye blink rate is relying on the internal state of the persons and it is based on the activity that he/she performs with the environmental factors
- There is a mirror eye blink relation among the teacher and the student
- Most of the eye blinks occur during the break point of the speaking

7.2 Limitations

There are some limitations that emerged throughout this study and those limitations are discussed as follows.

1. Difficult to Measure the Dropout Rate
   This research is designed to enhance the satisfactory level of the students who are engaging with the virtual learning. The key measurement of the student satisfactory level is the dropout rate of the learning process. Although the responses of the students and the teachers are indicated that the developed multi-model system is contributed to enhance the student satisfactory level, the dropout rate of the virtual learning could not be measured due to the time limitations. More time duration is needed to measure the affection of the multi-model system to the dropout rate.
2. Require More Experiments
   To analyze the behavior of the non-verbal features more accurately, many experiments with more subjects are required to conduct. Although several experiments were conducted in this study to check the accuracy of the systems and evaluate the non-verbal visualization system, it is better to obtain responses from large sample size with conducting many experiments. The large number of experiments couldn't be conducted in this study because of the lack of resources. For each experiment, the resources such as personal computer, web-camera, headset etc. should be allocated for each person and it was a tough work. In addition, the human resources were also very important and it was also very difficult to obtain for conducting the experiment.
3. Limited Non-verbal Behaviors
   The non-verbal is a broad area and it consists many characteristics such as facial expression, posture, eye blink, gestures with hands and arms, speech and tone of voice. Though the main non-verbal characteristics are considered, the whole non-verbal characteristics couldn't be considered in this study. In addition, the student status are also derived from basically based on the few non-verbal characteristics. The accuracy of the derivation of the student status can be improved when there are many non-verbal characteristics.

4. Assume that the All Students have the Same Learning Preference
   The third approach of the methodology of this research is identify the effective factors for the virtual learning. In that process, the affection of the the student characteristics which are taken long time duration to observe such as learning skills, personality traits are neglected to identify their effective factors. Because the time duration is not enough to measure those characteristics. Therefore the effective factors for the virtual learning is identified with assuming that all students has same learning preferences.
5. Few and Limited Range of Student Characteristics are Considered
   In the process of identification of the effective factors which is the third approach of this research has been done based on the basic student characteristics such as education level, computer literacy. But there are many personal characteristics which are difficult to measure using a questionnaire and it is needed to observe in different ways with allocating long time duration. Therefore few basic student characteristics are considered in this study due to the lack of time and resources. In addition, limited range of student characteristics (Ex: only master and doctoral levels are considered for the educational level) are employed in this study due to the limited human resources.

7.3 Problems Encountered

When developing the multi-model system in this study, there were certain problems that encountered especially based on the non-verbal visualization system.

1. Detection of the facial features
   The real user behavior of non-verbal features are detected to visualize the behavior of non-verbal features in the virtual learning environment. The detection of the facial features becomes complex process especially using the web-camera. To achieve a decent accuracy rate to detect the non-verbal behavior, the environment should be adjusted such as lighting, background appearance during the learning activities.
2. Voice
   The Second Life, which is used as a platform to conduct this study as the virtual learning environment, has opportunity to exchange the ideas among the participants by using voice. According to the restriction regarding the social media in our university, the voice in Second Life could not be used for the experiments. Hence there were different methods that used to conduct the experiment while changing the location of the experiment out of the university premises and using Skype to communicate.

7.4 Future Works

The next part of this study moves to the tablet users as the rapid global growth of tablet usage has reinforced the necessity of conducting the education via tablets. Thus the next section of this study is facilitated to obtain the feedback of the students who are engaging with the virtual class activities with their tablets to enhance the quality of the learning process in the virtual classroom.

The process of obtaining the information regarding the way of handling the tablet is begun when the student access the virtual class. The manners of using the tablet by the student is tracked and accumulate the several information concerning the method of using tablet such as number of touches/drags, the speed of touches/drags, time duration of the application and idle time duration. Since the tablets also are medicated social interactions and tablet usage could reflect the individual's characteristics such as personality, mood and status. The obtained information is the source for identifying the student status. A behavior capturing module is utilized to derive the corresponding status of the student based on their manner of handling the tablet. The ability to draw a connection between the behavioral aspects derived through the contextual data collected by tablets, as well as status, could lead to designing and applying machine learning methods to classify status of the users. Basic status of the student which may important in the learning process are considered to derive from the way of controlling the tablet and those status are; interest, attentive, not attentive, frustrated/struggling, distracted/nervous and tired/sleepy. When the status of the e-Learners is derived, the information will be provided to the responsible parties such as teacher, student and administrative officers to obtain the real benefits of the student information.

The student status is useful to evaluate the teacher efficiency for administrative purposes and evaluate the performance of the teachers. To assign the appropriate teachers based on the courses, update the salary scales, and design the grading system for teachers are some of the activities that can be done based on the student status which is derived from the proposed system. In addition, both teachers and students will be utilized the derived information from the system to identify their own drawbacks to their well-being. Students can identify the position that they are getting worse and teacher also has possible to identify the sessions that can be handled more efficiently than they have done. The few major advantageous are indicated here and there are more minor/major advantageous can be obtained through this future work.

7.5 Summary

The brief description about this study and findings are discussed in this section. Then we summarized the research findings by highlighting major contributions with stating its pros and cons. This research can be further improved in different aspects as we mentioned under the future works.

A. References

[1]. Dib, C. Z., Formal, Non-Formal and Informal Education: Concepts/Applicability. In Inter American Conference on Physics Education, Oaxtepec, Mexico, pp. 300-315, 1987.

[2]. Carol A. Twigg, Course redesign improves learning and reduces cost, National Center for Academic Transformation (NCAT), June 2005.

[3]. Claire Jones, Frontiers of New Media, February 2011.

[4]. H. J. Soch, Customer support via the Internet, MedicaMundi publication, Vol. 45, No.4, 2001.

[5]. Department for Education and Skills, Towards a Unified e-Learning Strategy, Consultation Document, Government of UK, July 2003.

[6]. Som N., E-Learning - A Guidebook of Principles, Procedures and Practices, Commonwealth of Learning, Commonwealth Educational Media for Asia, 2nd Revised Edition, 2006.

[7]. Leonard A. Annetta and Shawn Holmes, Creating Presence and Community in a Synchronous Virtual Learning Environment Using Avatars, International Journal of Instructional Technology and Distance Learning, Vol. 3, No. 8, pp. 27-41, 2006.

[8]. wiseGEEK, What is Second Life? Available at, http://www.wisegeek.com/what-is-second-life.htm, last visited January, 2015.

[9]. O'Leary, R. and Ramsden, A., Virtual learning environments, The Handbook for Economics Lecturers: Teaching, Bristol: Economics LTSN, 2002.

[10]. Cynthia M. Calongne, Learning in a virtual world, Educational Frontiers, EDUCAUSE Review, September/ October 2008.

[11]. John Helmer and Learning Light, Second Life and Virtual Worlds. Learning Light Limited, October 2007.

[12]. Messinger, P.R., E. Stroulia, K. Lyons, M. Bone, R.H. Niud, K. Smirnova and S. Perelgute, Virtual worlds past, present and future: New direction in social computing, Decision Support System, Vol. 47, pp. 204-228, 2009.

[13]. Nagy P., Second Life, Second Choice ? The effects of virtual identity on consumer behavior. A conceptual framework, Proceedings of FIKUSZ '10 Symposium for Young Researchers, 2010.

[14]. Linden Lab, Second Life Education: The Virtual Learning Advantage, 2011.

[15]. Pan, Z., Cheok, A.D., Yang, H., Zhu, J., Shi, J., Virtual reality and mixed reality for virtual learning environments, Computers & Graphics, Vol. 30, No.1, pp. 20–28, 2006.

[16]. Kirriemuir, J., A spring 2008 'snapshot' of UK Higher and Further Education developments in Second Life, Eduserv Virtual World Watch, pp. 58, 2008.

[17]. Raj sheth, Avatar Technology: Giving a Face to the e-Learning Interface, The e-Learning Developers' Journal, 2003.

[18]. Ben Salem and Nic Earle, Designing a Non-Verbal Language for Expressive Avatars, University of Plymouth, Proceedings of the third international conference on Collaborative virtual environment, pp. 93-101, 2000.

[19]. Hoorn, J. and Konijn E., Personification: Crossover between Metaphor and Fictional Character in Computer Mediated Communication, In The annual meeting of the International Communication Association, San Diego, CA, 2003.

[20]. Villa-Uriol, Maria-Cruz, Sainz, Miguel, Kuester, Falko, Bagherzadeh, Nader, Automatic Creation of Three-Dimensional Avatars, Proceedings of SPIE-IS&T Electronic Imaging, SPIE Vol. 5013, Santa Clara, California, USA, pp 14-25, 2003.

[21]. Moore, M. G., & Kearsley, G., Distance education: A Systems View of Online Learning, 3rd edition, USA, Wadsworth, 1996.

[22]. Yukselturk, E., & Yildirim, Z., Investigation of interaction, online support, course structure and flexibility as the contributing factors to students' satisfaction in an online certificate program. Educational Technology & Society, Vol. 11, No.4, pp.51-65, 2008.

[23]. DeLone, W. and McLean, E., Information Systems Success: The quest for the dependent variable, Information Systems Research, Vol. 3, No. 1, March 1992, pp. 60-95.

[24]. Kaminski, K., Switzer, J., & Gloeckner, G., Workforce readiness: A study of university students' fluency with information technology, Computers & Education, Vol. 53, No.2, pp. 228-233, 2009.

[25]. Cheyung, Y., Winiecki, D.J. & Fenner, J.A., A case study: increase enrolment by reducing dropout rates in adult distance education, Madison, W1, 1998.
[26]. Levy, Y., Comparing dropouts and persistence in e-learning courses, Computers & Education, Vol. 48, pp. 185-204, 2007.
[27]. Yang, Z. and Liu, Q., Research and development of web-based virtual online classroom, Computers & Education, Vol. 48, No. 2, pp. 171-18, 2007.
[28]. Anderson, K., Linking adult learner satisfaction with retention: The role of background characteristics, academic characteristics, and satisfaction upon retention, Doctoral dissertation Iowa State University, 2011.
[29]. Chyung, Y., Winiecki, D. J. & Fenner, J. A., A case study: increase enrollment by reducing dropout rates in adult distance education. In Proceedings of the annual conference on distance teaching & learning, Madison, WI, 1998.
[30]. Chen, K.C., & Jang, S.J., Motivation in online learning: Testing a model of self-determination theory. Computers in Human Behavior, Vol. 26, No. 4, pp. 741-752, 2010.
[31]. Rochester, C. D., & Pradel, F., Students' perceptions and satisfaction with a web-based human nutrition course, American Journal of Pharmaceutical Education, Vol. 72, No. 4, 2008.
[32]. Flood, J., Read all about it: online learning facing 80% attrition rates, TOJDE, Vol. 3, No. 2, 2002.
[33]. Dagger, D., Wade, V., Evaluation of Adaptive Course Construction Toolkit (ACCT), Third International Workshop on Authoring of Adaptive and Adaptable Educational Hypermedia at the 12th International Conference on Artificial Intelligence in Education, 2005.
[34]. Yukselturk, E., & Inan, F.A., Examining the Factors Affecting Student Dropout in an Online Certificate Program, Turkish Online Journal of Distance Education, Vol. 7, No.3, 2006.
[35]. Park, J.H., & Choi, H. J., Factors Influencing Adult Learners' Decision to Drop Out or Persist in Online Learning, Educational Technology & Society, Vol. 12, No. 4, pp. 207–217, 2009.
[36]. Nistor, N., & Neubauer,K., From participation to dropout: Quantitative participation patterns in online university courses, Computers & Education, Vol. 55 , pp. 663-672, 2010.
[37]. Park, J.H., & Choi, H.J., Factors influencing adult learners' decision to drop out or persist in online learning. Educational Technology & Society, Vol. 12, No. 4, pp. 207-217, 2009.
[38]. Rovai, A. P., & Downey, J. R., Why some distance education programs fail while others succeed in a global environment, The Internet and Higher Education, Vol. 13, No. 3, pp. 141-147, 2010.
[39]. Tello, S. F., An analysis of student persistence in online education, International Journal of Information and Communication Technology Education, Vol. 3, No. 3, pp. 47-62, 2007.
[40]. Rochester, C. D., & Pradel, F., Students' perceptions and satisfaction with a web-based human nutrition course, American Journal of Pharmaceutical Education, Vol. 72, No. 4, 2008.
[41]. Willging, P. A., & Johnson, S. D., Factors that influence students' decision to dropout of online courses, Journal of Asynchronous Learning Networks, Vol. 8, No. 4, pp. 105-118, 2004.
[42]. Learn To Communicate Effectively, Counseling and Psychological Services (CAPS), The University of Sydney, July 2011.
[43]. Emery, N. J., The eyes have it: the neuroethology, function and evolution of social gaze, Neuroscience, Bio behavioral Review, Vol. 24, pp. 581–604, 2000.
[44]. Virginia P. R., James C. McCroskey and Mark L. Hickson, Nonverbal Behavior in Interpersonal Relations, England, 2008.
[45]. Kellogg, P., & Lawson, B., Envoy: Your personal guide to classroom management, Battle Ground: Michael Grinder, 1993.
[46]. Teri Kwal Gamble and Michael W. Gamble, International Communication, Chapter 6 Nonverbal communication, Sage Publication, January 2013.
[47]. Annual Report of the Defense Acquisition University, pp. 7, 2012.
[48]. Stanford university newsletter on teaching, Speaking of teaching-Using Student Evaluations to Improve Teaching, Vol. 9, No. 1, 1997.
[49]. John D. Bransford, Ann L. Brown, and Rodney R. Cocking, How People Learn Brain, Mind, Experience, and School, National Research Council, National academy press, Washington, D.C., 1999.
[50]. Shusaku Nomura, Masako Hasegawa Ohira, Kuniaki Yajima, Santoso Handri, and Yoshimi Fukumura, Evaluating the Attitude of a Student in e-Learning Sessions by Physiological Signals, International Journal of Computer Information Systems and Industrial Management Applications, Vol. 4, No. 1, pp. 101-108, 2011.
[51]. Ali Biçki, Journal of Social Sciences, An Observation of Nonverbal Immediacy Behaviours of Native and Non-native Lecturers, Journal of Social Sciences, Vol. 5, No. 1, 2008.

[52]. Lau, L. K., Institutional factors affecting student retention, Education, Vol. 124, pp.126-136, 2003.
[53]. Fraser, B.J., Classroom environment instruments: Development, validity and applications. Learning Environment Research, Vol. 1, pp. 7-33, 1998.
[54]. Fraser B.J., Science learning environments: Assessments, effects, and determinants, 1998.
[55]. Goh, S. C., & Fraser, B. J., Teacher interpersonal behaviour, classroom environment and student outcomes in primary mathematics in Singapore, Learning Environments Research, Vol. 1, pp. 199-229, 1998.
[56]. Vygotsky, L.S., Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press, 1978.
[57]. Ramesh, Arti, Goldwasser, Dan, Huang, Bert, Daume, Hal, and Getoor, Lise, Learning latent engagement patterns of students in online course, In Proceedings of the Twenty-Eighth AAAI Conference on Artificial Intelligence. AAAI Press, 2014.
[58]. Rakesh Kumar, Bimal Anjum and Yohannes Ghiday, Role of communication in management teaching & Research in the international context, International Refereed Research Journal, Vol. II, No. 1, pp. 70-77, 2011.
[59]. Graham Attwell, Evaluating e-Learning A Guide to the Evaluation of e-Learning, Evaluate Europe Handbook Series, Vol. 2, pp. 7, 2006.
[60]. I. Elaine Allen and Jeff Seaman, Online Nation Five Years of Growth in Online Learning, Babson Survey Research Group, pp.1-2, 2007.
[61]. Kyong-Jee Kim and Curtis J. Bonk, The Future of Online Teaching and Learning in Higher Education: A survey substantiates some ideas about online learning and refutes others, EDUCAUSE Quarterly Magazine, Vol. 29, No. 4, 2006.
[62]. A.M. Paynea, J.E. Stephensonb, W.B. Morrisb H.G. Tempestb, A. Milehamc and D.K. Griffinb, The use of an e-Learning constructivist solution in workplace learning, International Journal of Industrial Ergonomics, Vol. 39, No. 3, pp. 548-553, 2009.
[63]. A.M. Payne, J.E. Stephenson, W.B. Morris, H.G., Tempest, A. Mileham and D.K. Griffin, The use of an e-learning constructivist solution in workplace learning, International Journal of Industrial Ergonomics, Vol. 39, No. 3, 2009, pp. 548-553.
[64]. Brent Gayle Wilson, what is a Constructivist Learning Environment? Constructivist Learning Environments: Case Studies in Instructional Design, pp. 8, 1996.
[65]. Noe, R.A., John Hollenbeck, Barry Gerhart, Patrick Wright, Fundamentals of Human Resource Management, Fourth edition, Published by McGraw-Hill/Irwin, The McGraw-Hill Companies, Inc., New York, 2011.
[66]. H. Kanematsu, Y. Fukumura, Dana M. Barry, So Young Sohn and R. Taguchi, Virtual classroom environment for multilingual problem based learning with US, Korean and Japanese students, JSEE annual conference international session proceedings, pp. 38-41, 2010.
[67]. Allen, I.E., & Seaman, J. Changing course: Ten years of tracking online education in the United States, Babson Survey Research Group and Quahog Research Group, 2013.
[68]. Kranzow, J., Faculty leadership in online education: Structuring courses to impact student satisfaction and persistence. MERLOT Journal of Online Learning and Teaching, Vol. 9, No. 1, pp. 131-139, 2013.
[69]. Lorenzo, G., A research review about online learning: Are students satisfied? Why do some succeed and others fail? What contributes to higher retention rates and positive learning outcomes?, Internet Learning, Vol. 1, No. 1, 2012.
[70]. Swan, K., Virtual interaction: Design factors affecting student satisfaction and perceived learning in asynchronous online courses, Distance Education, Vol. 22, No. 2, pp. 306-331, 2001.
[71]. Lim, D.H., Morris, M.L., & Kupritz, V.W., Online vs. blended learning: Differences in instructional outcomes and learner satisfaction, Journal of Asynchronous Learning Networks, Vol. 11, No. 2, 2007.
[72]. Arbaugh, J.B., Godfrey, M.R., Johnson, M., Pollack, B.L., Neindorf, B., & Wresch, W., Research in online and blended learning in the business disciplines: Key findings and possible future directions, Internet and Higher Education, Vol. 12, pp. 71-87, 2009.
[73]. Nguyen, N.D., Teacher-learner interactions in online learning at the Center for Online and Distance Training, Travinh Univerisity, Vietnam, 14th Annual Technology, Colleges, and Community Worldwide Online Conference, 2009.
[74]. Strachota, E., The use of survey research to measure student satisfaction in online courses, Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education, University of Missouri-St. Louis, Mo, 2006.

[75]. Bollinger, D.U., Key factors for determining student satisfaction in online courses, International Journal on E-Learning, Vol. 3, No. 1, pp. 61-67, 2004.
[76]. Drennan, J., Kennedy, J., & Pisarski, A., Factors affecting student attitudes toward flexible online learning in management education, The Journal of Educational Research, Vol. 98, No. 6, 2005.
[77]. Richardson, J.C., & Swan, K., Examining social presence in online courses in relation to students' perceived learning and satisfaction, Journal of Asynchronous Learning, Vol. 7, No. 1, pp. 68-88, 2003.
[78]. Sahin, I., Predicting student satisfaction in distance education and learning environments, Turkish Online Journal of Distance Education, Vol. 8, No. 2, 2007.
[79]. Learn To Communicate Effectively, Counseling and Psychological Services (CAPS), The University of Sydney, 2011.
[80]. Virginia Peck Richmond, James C. McCroskey, Mark L. Hickson, Nonverbal Behavior in Interpersonal Relations, England, 2008.
[81]. Jerome R. Freund., An Analysis of the non-verbal social behavior of a child in a kindergarten setting, University of Florida, 1972.
[82]. Albers, D L, Nonverbal immediacy in the classroom, Missouri Western State University Online article, 2001.
[83]. G. Theonas, D. Hobbsand D. Rigas, Employing Virtual Lecturers' Facial Expressions in Virtual Educational Environments, The International Journal of Virtual Reality, Vol. 7, No. 1, pp. 31-44, 2008.
[84]. Okon, John. J., Role of Non-Verbal Communication in Education, Mediterranean Journal of Social Sciences, Vol. 2, No. 5, pp. 35-40, 2011.
[85]. Musolesi M., Emiliano Miluzzo, Nicholas D. Lane, Shane B. Eisenman, Tanzeem Choudhury and Andrew T. Campbell, The Second Life of a Sensor: Integrating Real-world Experience in Virtual Worlds using Mobile Phones, 5th Workshop on Embedded Sensor Networks, 2008.
[86]. I. Cohen, G. Ashutosh, and T. S. Huang, Emotion recognition from facial expressions using multilevel HMM, In Neural Information Processing Systems, 2000.
[87]. Bentivoglio, A. R., Bressman, S. B., Cassetta, E., Carretta, D., Tonali, P., & Albanese, A. Analysis of blink rate patterns in normal subjects, Movement Disorders, Vol. 12, No. 6, pp. 1028–1034, 1997.
[88]. Priya Irabatti, Study on Increasing Importance of Nonverbal Communication in Retail Industry, Abhinav Publication, Vol. 1, No. 4, pp. 96-103, 2012.
[89]. J. Wu, Mohan M. Trivedi, A two-stage head pose estimation framework & evaluation, Pattern Recognition, Vol. 41, USA, pp. 1138–1158, 2008.
[90]. Y. Tian, T. Kanade, J. Cohn, Handbook of Face Recognition, Chapter 11: Facial Expression Analysis, Springer, 2005.
[91]. M. Valstar, M. Pantic, Fully automatic facial action unit detection and temporal analysis, IEEE Conference on Computer Vision and Pattern Recognition Workshop, pp. 149, 2006.
[92]. M. Pantic, L. Rothkrantz, Automatic analysis of facial expressions: the state of art, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 22, No. 12, pp. 1424–1445, 2000.
[93]. Gang Pan, Lin Sun, Zhaohui Wu , Shihong Lao, Eyeblink-based Anti-Spoofing in Face Recognition from a Generic Webcamera, In Computer Vision, IEEE 11th International Conference on Computer Vision, pp. 1–8, 2007.
[94]. Anton van Boxte, Filters for optimal smoothing of acoustic and electric blink reflex EMG responses to determine blink response magnitude, Biological Psychology, Vol. 85, pp. 299–305, 2010.
[95]. Dmitry O. Gorodnichy, Towards automatic retrieval of blink-based lexicon for persons suffered from brain-stem injury using video cameras, In Proceedings of the Conference on Computer Vision and Pattern Recognition Workshop - CVPRW, New York: IEEE, pp. 68 – 68, 2004.
[96]. Gang Pan, Zhaohui Wu and Lin Sun, Chapter 9 - Liveness Detection for Face Recognition, Recent Advances in Face Recognition, Printed in Croatia, pp. 109-124, 2008.
[97]. Erik Murphy-Chutorian, and Mohan Manubhai Trivedi, Head Pose Estimation in Computer Vision: A Survey, IEEE Transactions On Pattern Analysis And Machine Intelligence, Vol. 31, No. 4, pp. 607-626, 2009 cited by Virgilio F. Ferrario, Chiarella Sforza, Graziano Serrao, GianPiero Grassi, Erio Mossi, Active range of motion of the head and cervical spine: a three-dimensional investigation in healthy young adults, Journal of Orthopaedic Research, Vol. 20, pp.122-129, 2002.

[98]. Erik Murphy-Chutorian & Mohan Manubhai Trivedi, Head Pose Estimation in Computer Vision: A Survey, IEEE Transactions On Pattern Analysis And Machine Intelligence, Vol. 31, No. 4, pp.607-626, 2009.
[99]. Rosenberg-Kima, R. B., Baylor, A. L., Plant, E. A., and Doerr, C. E. , "Interface agents as social models for female students: The effects of agent visual presence and appearance on female students' attitudes and beliefs." Computers in Human Behavior, 24(6), pp. 2741-2756. 2008.
[100]. Stern, J. A., Walrath, L. C., and Goldstein, R., "The endogenous eyeblink", Psychophysiology, 21(1), pp. 22-33, 1984.
[101]. Amy, K., Murray, R. B., & Melinda, F., Applicant Impression Management: Dispositional Influences and Consequences for Recruiter Perceptions of Fit and Similarity, Journal of Management, Vol. 28, No. 1, pp. 27-46, 2002.
[102]. Dharmawansa, A., Nakahira, K. T., & Fukumura, Y., Identify the Relationship between Students' Non-Verbal Communication and Behavior to Introduce to the e-Learning World, The Institute of Electrical Engineers of Japan, CMN-13-003, pp. 11-17, 2013.
[103]. Harrigan, J. A. and O'Connell, D. M., How do you look when feeling anxious? Facial display of anxiety, Personality and Individual Differences, Vol. 21, pp. 205-212 1996.
[104]. K Takashima, Y Omori, Y Yoshimoto, Y Itoh, Y Kitamura, F Kishino, Effects of avatar's blinking animation on person impressions, In Proceedings of graphics interface, pp. 169-176, 2008.
[105]. Recarte, M. A., Perez, E., Conchillo, A., & Nunes, L. M., Mental workload and visual impairment: Differences between pupil, blink and subjective rating, Spanish Journal of Psychology, Vol. 11, No. 2, pp. 374-385, 2008.
[106]. Holland, M. K., & Tarlow, G., Blinking and thinking, Perceptual and Motor Skills, Vol. 41, No. 2, pp. 503–506, 1975.
[107]. Ponder, E., & Kennedy, W. P., On the act of blinking, Quarterly Journal of Experimental Psychology, Vol. 18, pp. 89-119, 1928.
[108]. C.K. Chang, G. D. Chen and K. L. Ou ,"Student Portfolio Analysis for Decision Support of Web Based Classroom Teacher by Data Cube Technology", Journal of Educational Computing Research, Vol. 19, No. 3, 1998.
[109]. G. D. Chen, C. C. Liu, K. L. Ou and B. J. Liu, "Discovering Decision Knowledge From Web Log Portfolio for Managing Classroom Processes by Applying Decision Tree and Data Cube Technology", Journal of Educational Computing Research, Vol. 23, No. 3, pp. 305-332, 2000.
[110]. J.E. Sharp, "Using Portfolio in Classroom", Proceedings of 27th Frontiers in Education Conference, pp. 272-279, 1997.
[111]. Al-Fahad, F. H., "Students' attitudes and perceptions towards the effectiveness of mobile learning in king saud university, Saudi Arabia", The Turkish Online Journal of Educational Technology, Vol. 8, No. 2, pp. 111-119, 2009.
[112]. Hussain, I., & Adeeb, M. A., "Role of mobile technology in promoting campus-wide learning environment", The Turkish Online Journal of Educational Technology, Vol. 8, No. 3, pp. 48-57, 2009.
[113]. Keskin, N. O., & Metcalf, D., The current perspectives, theories and practices of mobile learning, Turkish Online Journal of Educational Technology, Vol. 10, No. 2, pp. 202-208 2011.
[114]. Ali Biçki, An Observation of Nonverbal Immediacy Behaviours of Native and Non-native Lecturers", Journal of Social Sciences, Vol. 5, No. 1, 2008.
[115]. Dye M. W. G., and Bavelier D., Differential development of visual attention skills in school-age children, Vision Research, Vol. 50, pp. 452–459, 2010.
[116]. Sue T., Jill A. and Barry F., Development, validation and use of the Online Learning Environment Survey, Australasian Journal of Educational Technology, Vol. 21, No. 1, pp. 60-81, 2005, cited by Macnish, J., Trinidad, S., Fisher, D., and Aldridge, J., The online learning environment of a technology-rich secondary college, Annual meeting of the American Educational Research Association, Chicago, IL, 2003.
[117]. Abdul M., Barry J. Fraser and Jill M. Aldridge, Junior Secondary Mathematics Student's Learning Environment and Satisfaction in Brunei Darussalam cited by Goh, S., Young, D. and Fraser, B. J., Annual Conference of the Australian Association for Research in Education, Fremantle, Western Australia, 2001.
[118]. Biggs, J., Aligning the curriculum to promote good learning. Constructive Alignment in Action: Imaginative Curriculum Symposium, 2002.
[119]. Barry J. Fraser, Science Learning Environments: Assessment, Effects and Determinants, Curtin University of Technology, Perth, Australia.

[120]. Regina M. Oliver, Joseph H. Wehby, D. J. Reschly, Teacher classroom management practices: effects on disruptive or aggressive student behavior, Campbell Systematic Reviews, 2011.
[121]. Bandura, A., Social cognitive theory: An agentic perspective. Annual Review of Psychology, Vol. 52, pp. 1-26, 2001.
[122]. Espasa, A., & Meneses, J., Analyzing feedback processes in an online teaching and learning environment: An exploratory study, Higher Education, Vol. 59, No. 3, pp. 277-292, 2010.
[123]. Miyazoe, T. & Anderson, T., Empirical Research on Learners' Perceptions: Interaction Equivalency Theorem in Blended Learning, European Journal of Open, Distance and E-Learning, 2010.
[124]. Miyazoe, T. & Anderson, T., The Interaction Equivalency Theorem: Research Potential and its Application to Teaching, The 27th Annual Distance Teaching & Learning, 2011.
[125]. Miyazoe, T., & Anderson, T. D. (2010). The interaction equivalency theorem. Journal of Interactive Online Learning, 9(2), 94–104
[126]. Miyazoe, T.; Anderson, T., The interaction equivalency theorem: Research potential and its application to teaching, The 27th Annual Distance Teaching & Learning, Madison, WI, 2011.
[127]. M. Valstar, M. Pantic, Fully automatic facial action unit detection and temporal analysis, IEEE Conference on Computer Vision and Pattern Recognition Workshop, pp. 149, 2006.
[128]. Staffan Reinius, Object recognition using the OpenCV Haar cascade-classifier on the iOS platform, Department of Information Technology, Uppsala University, Sweden, 2013.
[129]. M. Nakanishi, Y. Mitsukura, Y. Wang, Y. T. Wang, T. P. Jung, Online Voluntary Eye Blink Detection Method using Electrooculogram, Proc. NOLTA, Majorca, Spain, pp. 114-117, 2012.
[130]. Richa Mehta, Manish Shrivastava, An Automatic Approach for Eye Tracking and Blink detection in Real time, International Journal of Engineering and Innovative Technology (IJEIT),Vol. 1, No. 5, pp. 140–143, 2012.
[131]. Divjak M, Bischof H. Real-time video-based eye blink analysis for detection of low blink-rate during computer use, In: Proceedings of the 1st international work shop on tracking humans for the evaluation of their motion in image sequence (THEMIS), pp. 99–107, 2008.
[132]. M. Voit, K. Nickel, and R. Stiefelhagen, A bayesian approach for multi-view head pose estimation, in IEEE Int'l. Conf. Multisensor Fusion and Integration for Intelligent Systems, pp. 31–34, 2006.
[133]. S. Ba and J.M. Odobez, A probabilistic framework for joint head tracking and pose estimation, Int'l. Conf. Pattern Recognition, pp. 264–267, 2004.
[134]. Reena, Body Language in Patient Counselling, Education Department, Aravind Eye Hospital, Madurai, Paramedical, Vol. V, No I, pp. 25-27, 2005.
[135]. Ba SO, Odobez JM, A study on visual focus of attention recognition from head pose in a meeting room, Third Joint Workshop on Multimodal Interaction and Related Machine Learning Algorithms, pp. 1-3, 2006.
[136]. Stiefelhagen R, Yang J, Waibel, A Estimating focus of attention based on gaze and sound, Proceedings of the Workshop on Perceptive User Interfaces, 2001.
[137]. Bailenson, J. N., Yee, N., Merget, D., & Schroeder, R., The effect of behavioral realism and form realism of real-time avatar faces on verbal disclosure, nonverbal disclosure, emotion recognition, and copresence in dyadic interaction, Presence: Teleoperators and Virtual Environments, Vol. 15, No. 4, pp. 359–372, 2006.
[138]. Mutlaq B. Alotaibi & D. I. Rigas, The role of avatars with facial expressions to communicate customer knowledge, International Journal of Computers, Vol. 3, No. 1, pp. 1-10, 2009.
[139]. Nick Yee, Jeremy N. Bailenson, Kathryn Rickertsen, A Meta-Analysis of the Impact of the Inclusion and Realism of Human-Like Faces on User Experiences in Interfaces, In proceeding of conference on Human factors in computing systems, 2007.
[140]. Greg J. Stephens, Lauren J. Silbert and Uri Hasson, Speaker–listener neural coupling underlies successful communication, In proceedings of the National Academy of Sciences of the United States of America, Vol. 107, pp. 14425-14430, 2010.
[141]. Cassell, J., Nakano, Y., Bickmore, T., Sidner, C., Rich, C., Non-Verbal Cues for Discourse Structure, In proceedings of the 41st Annual Meeting of the Association of Computational Linguistics, pp. 106-115, 2001.
[142]. Hall A., The origin and purposes of blinking, British Journal of Opthalmol, Vol. 29, pp. 445–467, 1945.
[143]. Fogarty C., Stern J. A., Eye movements and blinks: their relationship to higher cognitive processes, Int. Journal of Psychophysiol, Vol. 8, pp. 35–42, 1989.
[144]. Cynthia M. Calongne, Educational Frontiers:Learning in a Virtual World, EDUCAUSE Review, Vol. 43, No. 5, pp.36-48, September/October 2008.

Appendix 1

Awards and Publications of the Research

Awards

(1) 2014, June, Study Group Award from Institute of Electrical Engineers of Japan, "The Application of Eye Blinking Information for the Virtual e-Learning Class", Asanka D. Dharmawansa, Katsuko T. Nakahira and Yoshimi Fukumura.

(2) 2015, February, Encouragement Award from Japan e -Learning Association, "Identification of the Effective Factors for the Virtual Learning", Asanka D. Dharmawansa, Yoshimi Fukumura.

Journal Publications

(1) 2012, December, Kansei Engineering International Journal, Vol. 11, No. 4, pp. 267-276, "On-line Visualization of Student Facial Emotion in Virtual e-Learning Environment", Asanka D. Dharmawansa, Katsuko T. Nakahira and Yoshimi Fukumura.

(2) 2014, November, International Journal of Science and Advanced Technology, ISSN 2221-8386, Vol. 4, No. 10 , pp. 6-13, "Development of a Tracking System Including the Student Status through Their Behavioral Information in the Virtual Class", Asanka D. Dharmawansa, Yoshimi Fukumura, Ashu Marasinghe, R.A.M. Madhuwanthi.

(3) 2015, March, International journal of Computer Science Issues, Vol. 12, No. 2 , pp. 22-31, "Evaluating the Affection of Eye Blinking in the Virtual Learning Environment", Asanka D. Dharmawansa, Yoshimi Fukumura, Ashu Marasinghe and R.A. Manjula Madhuwanthi.

(4) 2015, June, International Education Studies, Vol. 8, No. 6, pp. 82-94, "Introducing and Evaluating the Behavior of Non-verbal Features in the Virtual Learning", Asanka D. Dharmawansa, Yoshimi Fukumura, Ashu Marasinghe and R.A.M. Madhuwanthi.

International Conference Publications

(1) 2014, October, Transactions on GIGAKU, Vol. 2, No. 2, pp. S01002/1-7, "Introducing and Identifying the Role of Eye Blinking in the Virtual e-Learning Environment", Asanka D. Dharmawansa, Katsuko T. Nakahira, Yoshimi Fukumura and Ashuboda Marasinghe.

(2) 2014, April, ASIAGRAPH 2015 International Conference, Vol. 10, No. 1, pp. 47-52, "A Novel Approach to Attain the Feedback of the Students in the Virtual Learning", Asanka D. Dharmawansa , Ashu Marasinghe, Yoshimi Fukumura, R.P.C. Janaka Rajapakse, R.A.M. Madhuwanthi.

(3) 2014, September, International Conference in Knowledge Based and Intelligent Information and Engineering Systems, Vol. 35, pp. 1229–1238, "Introducing eye blink of a student to the virtual world and evaluating the affection of the eye blinking during the e-Learning", Asanka D. Dharmawansa, Yoshimi Fukumura, Hideyuki Kanematsu, Toshiro Kobayashi, Nobuyuki Ogawa and Dana M. Barry.

(4) 2014, June, International GIGAKU conference in Nagaoka, pp. 84, "Investigate the Affection of Non-Verbal Features to the Virtual E-Learning Environment", Asanka D. Dharmawansa, Yoshimi Fukumura, Hideyuki Kanematsu, Toshiro Kobayashi, Nobuyuki Ogawa, Dana M.

Barry.

(5) 2013, December, International Conference on Energy, Environment and Human Engineering, pp. 144, “Introducing and Identifying the Role of Eye Blinking in the Virtual e-Learning Environment”, Asanka D. Dharmawansa Katsuko T. Nakahira Yoshimi Fukumura and Ashuboda Marasinghe.

(6) 2013, September, International Conference in Knowledge Based and Intelligent Information and Engineering Systems, Vol. 22, pp. 717–726, “Detecting Eye Blinking of a Real-world Student and Introducing to the virtual e-Learning Environment”, Asanka D. Dharmawansa, Katsuko T. Nakahira and Yoshimi Fukumura.

(7) 2012, May, International Conference on Intelligent Decision Technologies, pp. 107–116, “Creating More Realistic E-Learning Environment with Student Real Time Facial Features”, Asanka D. Dharmawansa, Katsuko T. Nakahira and Yoshimi Fukumura.

(8) 2011, September, International Conference on Biometrics and Kansei Engineering (ICBAKE 2011), pp. 134 – 139, “Develop a Monitoring Tool and Extract Facial Expression towards the Analyzing Student Behavior in 3D Virtual Environment”, Asanka D. Dharmawansa, Katsuko T. Nakahira and Yoshimi Fukumura.

(9) 2014, September, International Conference in Knowledge Based and Intelligent Information and Engineering Systems, Vol. 35, pp. 1255–1261, Hideyuki Kanematsu, Toshiro Kobayashi, Dana M. Barry, Yoshimi Fukumura, Asanka Dharmawansa and Nobuyuki Ogawa.

(10) 2014, June, International GIGAKU conference in Nagaoka, pp. 224, “Adoption of Cleaner Production Into Small And Medium Sized Enterprises In Western Province of Sri Lanka”, Manjula Madhuwanthi, Ashuboda Marasignhe, Dharshana Deegahawathure, Asanka Dharmawansa and Janaka Rajapaksha.

Local Conferences

(1) 2015, February, 17th academic lecture program of Japan e -Learning Association, pp. 87-94, “Identification of the Effective Factors for the Virtual Learning”, Asanka D. Dharmawansa, Yoshimi Fukumura.

(2) 2014, November, The Institute of Electrical Engineers of Japan, CMN-14-054-077, pp 49-54, “A Proposal to Identify the Effective Factors for the Virtual e-Learning Class",Asanka D. Dharmawansa, Yoshimi Fukumura, R.A.M. Madhuwanthi, Hideyuki Kanematsu, Dana M. Barry.

(3) 2014, November, Information and Communication Engineers, The Shinetsu Section of The IEEE. Hoku-Shin-Etsu-Section, JSiSE, “Introducing Non-Verbal Behavior of the Students and Developing a Monitoring System to the Virtual Class”, Asanka D. Dharmawansa, Yoshimi Fukumura, R.A.M.Madhuwanthi, Hideyuki Kanematsu, Dana M. Barry.

(4) 2013, November, Institute of Electric Engineers of Japan, CMN-13-046, “The Application of Eye Blinking Information for the Virtual e-Learning Class”, Asanka D. Dharmawansa, Katsuko T. Nakahira and Yoshimi Fukumura.

(5) 2013, January, Institute of Electrical Engineers and Communications Technology Association, Vol. CMN-13, Issue: 1-8, Pages: 11-16, “Identify the Relationship between Students' Non-Verbal Communication and Behaviour to Introduce to the e-Learning World”, Asanka D. Dharmawansa, Katsuko T. Nakahira and Yoshimi Fukumura.

(6) 2012, June, The Institute of Electrical Engineers of Japan (IEEJ), Vol. CMN-12, Issue: 8-17, pp. 31-36, “Creating Dynamic Avatar with Real Student Facial Expressions in Virtual E-Learning Environment”, Asanka D. Dharmawansa, Katsuko T. Nakahira and Yoshimi Fukumura.

(7) 2012, March, Japan Society for Information and Systems in Education (JSiSE), pp. 54-55, “Transferring Real World Learner's Factual Information to E-Learning Environment for Creating More Realistic Atmosphere”, Asanka D. Dharmawansa, Katsuko T. Nakahira and Yoshimi Fukumura.

(8) 2011, May, Collaboration and Learning Environment (CLE), Information Processing Society of Japan, Vol. 2011-CLE-4 No.5, “Analyze the Student Behavior in Virtual Classroom with Problem Based Learning Environment”, Asanka D. Dharmawansa, Katsuko T. Nakahira and Yoshimi Fukumura.

Appendix 2

This appendix includes the supplementary questionnaires which are delivered to check the accuracy of the tracking system and evaluate the multi-model system.

Followings are the supplementary questionnaires that have been listed under this appendix.

1. Questionnaire for identify the student status during the virtual class activities
2. Questionnaire for identify the effective factors based on the studuent characteritrics
3. Web based qestionnaire to identy the satisfactory level of the students – For teachers
4. Web based qestionnaire to identy the satisfactory level of the students – For students
5. Questionnaire for obatin the student responses after the experiment with facial expression visualization system
6. Questionnaire for obatin the student responses after the lecture with eye blink visualization system
7. Questionnaire for obatin the student responses after the group exercise with eye blink visualization system
8. Questionnaire for obatin the student responses after the experiment with eye blink and head pose visualization system

2.1. Questionnaire for identify the student status during the virtual class activities

Questionnaire for Obtain the Student feeling during the Virtual World Activities

Dear participants,

This questionnaire is designed to obtain the student attitude during the activities of the virtual world. Thank you for your participation and contributions, and please be assured that the collected information is only for research purpose.

Researcher: Asanka D. Dharamawansa, Dept. of Information science and control Engineering, Nagaoka university of Technology, Niigata, Japan.
Advisor: Yoshimi Fukumura., Department of Management and information system Engineering, Nagaoka university of Technology, Niigata, Japan.

Please fill your information below.

I. Gender:_____

II. Nationality:_____

Please circle the most suitable answer

1 - Very Much 2 - Much 3 - Average 4 - Low 5 - Very Low

[1]. During the first minute

No	Variables	Response				
1	Do you want more time to engage in virtual world?	1	2	3	4	5
2	Did you have some remarkable thing in discussion?	1	2	3	4	5
3	Did you feel monotonous during the discussion?	1	2	3	4	5
4	Did you involve the conversation successfully?	1	2	3	4	5
5	Did you have some issues of the discussion topic?	1	2	3	4	5

[2]. During the second minute

No	Variables	Response				
1	Do you want more time to engage in virtual world?	1	2	3	4	5
2	Did you have some remarkable thing in discussion?	1	2	3	4	5
3	Did you feel monotonous during the discussion?	1	2	3	4	5
4	Did you involve the conversation successfully?	1	2	3	4	5
5	Did you have some issues of the discussion topic?	1	2	3	4	5

[3]. During the third minute

No	Variables	Response				
1	Do you want more time to engage in virtual world?	1	2	3	4	5
2	Did you have some remarkable thing in discussion?	1	2	3	4	5
3	Did you feel monotonous during the discussion?	1	2	3	4	5
4	Did you involve the conversation successfully?	1	2	3	4	5
5	Did you have some issues of the discussion topic?	1	2	3	4	5

[4]. During the fourth minute

No	Variables	Response				
1	Do you want more time to engage in virtual world?	1	2	3	4	5
2	Did you have some remarkable thing in discussion?	1	2	3	4	5
3	Did you feel monotonous during the discussion?	1	2	3	4	5
4	Did you involve the conversation successfully?	1	2	3	4	5
5	Did you have some issues of the discussion topic?	1	2	3	4	5

[5]. During the fifth minute

No	Variables	Response				
1	Do you want more time to engage in virtual world?	1	2	3	4	5
2	Did you have some remarkable thing in discussion?	1	2	3	4	5
3	Did you feel monotonous during the discussion?	1	2	3	4	5
4	Did you involve the conversation successfully?	1	2	3	4	5
5	Did you have some issues of the discussion topic?	1	2	3	4	5

2.2. Questionnaire for identify the effective factors based on the studuent characteritrics

Effective factors for the virtual class based on the student characteristics

Please evaluate each factor indicated in the following table according to your preference.

1-Strongly Agree 2-Agree 3-Neither Agree or Disagree 4-Disagree 5-Strongly Disagree

Ex: 1. Do you prefer to work within the class in the virtual environment
if you strongly agree with this sentence, please select like this

Within the class	(•) 1	( ) 2	( ) 3	( ) 4	( ) 5

You can get the idea about the most of the following factors using this link.

			1	2	3	4	5
1	Within the class		( )	( )	( )	( )	(•)
2	Outside the class		( )	( )	( )	( )	( )
3	With learning models		( )	( )	( )	( )	( )
4	Without learning models		( )	( )	( )	(•)	( )
5	High attractiveness		( )	( )	( )	( )	( )
6	Less attractiveness		( )	( )	( )	( )	( )
7	**Use different communication methods**	Voice	( )	( )	( )	( )	( )
8		Chat	( )	( )	( )	( )	( )
9	**With presentation**		( )	( )	( )	( )	( )
10	**Without presentation**		( )	(•)	( )	( )	( )
11	**Different time durations**	Low (5 min)	( )	( )	( )	( )	( )
12		Middle (30 min)	( )	( )	( )	( )	( )
13		High (1 hour)	( )	( )	( )	( )	( )
14	**Active and passive learning**	Active learning	( )	( )	( )	( )	( )
15		Passive learning	( )	( )	( )	( )	( )
16	**Content / Subject**	Chemistry	( )	( )	( )	( )	( )
17		Mathematics	( )	( )	( )	( )	(•)
18		Physics	( )	( )	(•)	( )	( )
19		Biology	( )	( )	( )	( )	( )
20		Engineering	( )	( )	( )	( )	( )
21	**With teacher**	Volunteer	( )	( )	( )	( )	( )
22		Professional	( )	( )	( )	( )	( )
23	Without teacher		( )	( )	( )	( )	( )
24	With awards/punishment		( )	( )	( )	( )	( )
25	Without awards/punishment		( )	( )	( )	( )	( )
26	**Peer Characteristics**	Education level	Same	( )	( )	( )	( )	( )
27			Different	( )	( )	( )	( )	( )
28		Gender	Same	( )	( )	( )	( )	( )
29			Different	( )	( )	( )	( )	( )
30		Country	Same	( )	( )	( )	( )	( )
31			Different	( )	( )	( )	( )	( )

Your suggestions, comments or any ideas regarding the effective factors in the virtual class are welcome

……

……

2.3. Web based qestionnaire to identy the satisfactory level of the students – For teachers

Identify the satisfaction level through the questionnaire (For teachers).

Thank you for agreeing to take this questionnaire.

The purpose of this questionnaire is to identify the affection of the constructed multi-model system to the satisfactory level of the student when they are engaging with the virtual class activities.

All of the answers you provide in this questionnaire will be kept confidential. No identifying information will be provided to the any other party without your permission and all this information are utilized only for the research purpose. The result of the questionnaire will be reported in a summary fashion only and will not be identified any individual person. We appreciate your response. We are seeking to understand the opinions of veterans. Thank you for your time. The questionnaire has been designed by the following researcher under the advisory of the supervisor belongs to the Educational Engineering Laboratory at Nagaoka University of Technology.

Researcher: Asanka D. Dharamawansa, Dept. of Information Science and Control Engineering, Nagaoka University of Technology, Niigata, Japan.

Advisor: Yoshimi Fukumura., Dept. of Management and Information System Engineering, Nagaoka University of Technology, Niigata, Japan.

If you want to know about the activities in the Virtual Environment, please watch the following video.
Introduction to virtual world

This questionnaire consists with three parts as mentioned below.

- Part 1 – Visualization the behavior of non-verbal features in the virtual class
- Part 2 – Student tracking system with behavioral information
- Part 3 – Identify the effective factors for the virtual class based on the student characteristics

The explanation of the constructed system related to the each part will be facilitated to view before filling. We really appreciate if you could complete the all parts of this questionnaire.

Personal Information

1. Gender:……
2. Nationality:……..
3. Age Group: (20 - ☐)(31-40) ☐ (41-50) ☐ (51-60) ☐ (61-70) ☐
4. University/School:……..
5. Department/Section:……..
6. Teaching experience (in years) :……..

Part 1 – Visualization the Behavior of Non-Verbal Features In Virtual Class

Please watch the following videos to get the idea about the non-verbal visualization system and to identify the affection of the visualization system to the virtual world.

The way of set-up and the behavior of non-verbal visualization system
Second Life with the non-verbal visualization system
Second Life without the non-verbal visualization system
Please evaluate the following statements according to your feelings.

1-Strongly Agree 2-Agree 3-Neither Agree or Disagree 4-Disagree 5-Strongly Disagree

1	Students' non-verbal behavior can be identified with this system	○ 1	○ 2	○ 3	○ 4	○ 5
2	Identifying the students` non-verbal behavior is very important.	◉ 1	○ 2	○ 3	○ 4	○ 5
3	I prefer to work with the visualization system	○ 1	○ 2	○ 3	○ 4	○ 5
4	I prefer to work without the visualization system	○ 1	○ 2	○ 3	○ 4	○ 5
5	The reality of the virtual environment can be raised with this system	○ 1	○ 2	○ 3	○ 4	○ 5
6	Avatar gives the fair representation to the students	○ 1	○ 2	○ 3	○ 4	○ 5
7	Attractiveness of the virtual class can be enhanced with the avatar including the non-verbal behavior	○ 1	○ 2	○ 3	○ 4	○ 5
8	The visualization system will be increased the effectiveness of the virtual class	○ 1	○ 2	○ 3	○ 4	○ 5
9	The connection between the student-student and the teacher-student can be enhanced with this system	○ 1	○ 2	○ 3	○ 4	○ 5
10	Instructor can engage the virtual class activities with identifying the students of non-verbal behavior through this system	○ 1	○ 2	○ 3	○ 4	○ 5

Your suggestions, comments or any ideas regarding the visualization system are welcome.

……

• Part 2 – Student Tracking System with Behavioral Information

Preview of the tracking system
please evaluate the following statements according to your feelings.

5-Strongly Agree 4-Agree 3-Neither Agree or Disagree 2-Disagree 1-Strongly Disagree

1	Almost all the behavioral information of the students can be identified with this system	○ 1	○ 2	○ 3	○ 4	○ 5
2	The connection with the students can be enhanced with this system	○ 1	○ 2	○ 3	○ 4	○ 5
3	The requirement of the instructor guidance can be identified specifically with this system	○ 1	○ 2	○ 3	○ 4	○ 5
4	Instructor can engage with the virtual class activities by identifying requirement of the students through this system	○ 1	○ 2	○ 3	○ 4	○ 5
5	Instructor can identify student preferences, needs and requirements	○ 1	○ 2	○ 3	○ 4	○ 5
6	Instructor can change the content/way of delivering the instruction based on the student status	○ 1	○ 2	○ 3	○ 4	○ 5
7	Instructor can maintain the class effectively based on the students behavior	○ 1	○ 2	○ 3	○ 4	○ 5
8	This tracking system can be used as an individual/group evaluation tool	○ 1	○ 2	○ 3	○ 4	○ 5
9	Tracking system is important for the e-Learning	◉ 1	○ 2	○ 3	○ 4	○ 5
10	The tracking system will be increased the effectiveness of the virtual class	○ 1	○ 2	○ 3	○ 4	○ 5

Your suggestions, comments or any ideas regarding the visualization system are welcome.

……

• Part 3 – Effective factors for the students in the virtual class

Effective factors for the students
Please evaluate the following statements according to your feelings.

1-Strongly Agree 2-Agree 3-Neither Agree or Disagree 4-Disagree 5-Strongly Disagree

1	The following two points can be identified by using this analysis Effective factors for the each student category The factors which are highly affected when the student characteristics are changed	○ 1	○ 2	○ 3	○ 4	○ 5
2	This analysis is facilitated to identify the environment which is preferred by Student	○	◉	○	○	○
3	This analysis is especially important for the distant learning due to the distant barrier between instructor and student	○	○	○	○	○
4	This analysis provides the guidance to design the environment of the virtual class based on the student characteristics	◉ 1	○ 2	○ 3	○ 4	○ 5
5	Instructor can facilitate a better environment based on the student characteristics by utilizing this analysis	○ 1	○ 2	○ 3	○ 4	○ 5
6	Identification of the effective factors for the each student category is important for effective learning	○ 1	○ 2	○ 3	○ 4	○ 5
7	Providing preferred learning factors contribute to enhance the satisfactory level of the e-Learners	○ 1	○ 2	○ 3	○ 4	○ 5
8	Providing a student preferred environment is better than providing a common environment to all students	○ 1	○ 2	○ 3	○ 4	○ 5
9	Identification of the effective factors based on the student characteristics is essential for the virtual class as a latest learning platform	○ 1	○ 2	○ 3	○ 4	○ 5
10	Conducting the virtual class activities become ease with identifying the student preferred environment	◉ 1	○ 2	○ 3	○ 4	○ 5

Your suggestions, comments or any ideas regarding the visualization system are welcome.

……

2.4. Web based questionnaire to identify the satisfactory level of the students – For students

Identify the satisfaction level through the questionnaire (For students).

Thank you for agreeing to take this questionnaire.

The purpose of this questionnaire is to identify the affection of the constructed multi-model system to the satisfactory level of the student when they are engaging with the virtual class activities.

All of the answers you provide in this questionnaire will be kept confidential. No identifying information will be provided to the any other party without your permission and all this information are utilized only for the research purpose. The result of the questionnaire will be reported in a summary fashion only and will not be identified any individual person. We appreciate your response. We are seeking to understand the opinions of veterans. Thank you for your time. The questionnaire has been designed by the following researcher under the advisory of the supervisor belongs to the Educational Engineering Laboratory at Nagaoka University of Technology.

Researcher: Asanka D. Dharamawansa, Dept. of Information Science and Control Engineering, Nagaoka University of Technology, Niigata, Japan.

Advisor: Yoshimi Fukumura., Dept. of Management and Information System Engineering, Nagaoka University of Technology, Niigata, Japan.

If you want to know about the activities in the Virtual Environment, please watch the following video.
Introduction to virtual world

This questionnaire consists with three parts as mentioned below.

- Part 1 – Visualization the behavior of non-verbal features in the virtual class
- Part 2 – Student tracking system with behavioral information
- Part 3 – Identify the effective factors for the virtual class based on the student characteristics

The explanation of the constructed system related to the each part will be facilitated to view before filling. We really appreciate if you could complete the all parts of this questionnaire.

Personal Information

1. Gender:……
2. Nationality:……..
3. Age Group: (20 - ☐)(31-40) ☐ (41-50) ☐ (51-60) ☐ (61-70) ☐
4. University/School:……..
5. Department/Section:……..
6. Grade:……..
7. Computer experience (in years):…….

Part 1 – Visualization the Behavior of Non-Verbal Features In Virtual Class

Please watch the following videos to get the idea about the non-verbal visualization system and to identify the affection of the visualization system to the virtual world.

The way of set-up and the behavior of non-verbal visualization system
Second Life with the non-verbal visualization system
Second Life without the non-verbal visualization system

Please evaluate the following statements according to your feelings.

1-Strongly Agree 2-Agree 3-Neither Agree or Disagree 4-Disagree 5-Strongly Disagree

1	I can set up the visualization system	1	2	3	4	5
2	Visualization system is easy to set-up	1	2	3	4	5
3	I recognized the behavior of non-verbal features (eye blink, head pose) of the students.	1	2	3	4	5
4	The attractiveness can be enhanced with the visualization system	1	2	3	4	5
5	I would like to engage activities of the Second Life with the visualization system	1	2	3	4	5
6	The visualization system is easy to use	1	2	3	4	5
7	Avatar gives fair representation for the real user with the visualization system	1	2	3	4	5
8	Virtual identity is possible with the visualization system	1	2	3	4	5
9	The virtual class looks like real world class with the visualization system	1	2	3	4	5
10	Virtual reality can be enhanced with the visualization system	1	2	3	4	5
11	Visualization system is highly contribute to enhance the effectiveness of the virtual class	1	2	3	4	5
12	I prefer virtual environment with visualization system	1	2	3	4	5
13	I prefer virtual environment without visualization system	1	2	3	4	5
14	Appearance of the avatar is good	1	2	3	4	5
15	Identify your avatar based on the behavior of non-verbal features	1	2	3	4	5

Your suggestions, comments or any ideas regarding the visualization system are welcome.

.....

• Part 2 – Student Tracking System with Behavioral Information

Preview of the tracking system
please evaluate the following statements according to your feelings.

5-Strongly Agree 4-Agree 3-Neither Agree or Disagree 2-Disagree 1-Strongly Disagree

1	This tracking system can be used as an individual/group evaluation tool	1	2	3	4	5

2	Instructor can change the content/way of delivering the instruction based on the student status	1	2	3	4	5
3	Instructor can maintain the class effectively based on the students behavior	1	2	3	4	5
4	Tracking system is important for the e-Learning	1	2	3	4	5
5	Instructor can identify student preferences, needs and requirements	1	2	3	4	5

Your suggestions, comments or any ideas regarding the visualization system are welcome.

……

• **Part 3 – Effective factors for the students in the virtual class**

Effective factors for the students

Please evaluate the following statements according to your feelings.

1-Strongly Agree 2-Agree 3-Neither Agree or Disagree 4-Disagree 5-Strongly Disagree

1	The following two points can be identified by using this analysis Effective factors for the each student category The factors which are highly affected when the student characteristics are changed	1	2	3	4	5
2	This analysis is facilitated to identify the environment which is preferred by Student	1	2	3	4	5
3	This analysis is especially important for the distant learning due to the distant barrier between instructor and student	1	2	3	4	5
4	This analysis provides the guidance to design the environment of the virtual class based on the student characteristics	1	2	3	4	5
5	Instructor can facilitate a better environment based on the student characteristics by utilizing this analysis	1	2	3	4	5
6	Identification of the effective factors for the each student category is important for effective learning	1	2	3	4	5
7	Providing preferred learning factors contribute to enhance the satisfactory level of the e-Learners	1	2	3	4	5
8	Providing a student preferred environment is better than providing a common environment to all students	1	2	3	4	5
9	Identification of the effective factors based on the student characteristics is essential for the virtual class as a latest	1	2	3	4	5

	learning platform					
10	Conducting the virtual class activities become ease with identifying the student preferred environment	1	2	3	4	5

Your suggestions, comments or any ideas regarding the visualization system are welcome.

……

2.5. Questionnaire for obtain the student responses after the experiment with facial expression visualization system

Questionnaire (Japanese)

調査票(Real world and virtual world Facial Expression)

当てはまるものに○をつけてください。

年齢:☐ (10-25) ☐(25-40) ☐40-55) ☐5-70)

性別: ☐ 男/☐女

学年: ☐修士課程 / ☐士課程 / ☐他…….

大学・専攻名: …….

Regarding facial expression system　表情認識システムについて					
精度	☐ とても良い	☐ 良い	☐ ふつう	☐ 悪い	☐ とても悪い
システムのパフォーマンス	☐ とても良い	☐ 良い	☐ ふつう	☐ 悪い	☐ とても悪い
顔パーツの検出率	☐ とても良い	☐ 良い	☐ ふつう	☐ 悪い	☐ とても悪い
使いやすさ	☐ とても良い	☐ 良い	☐ ふつう	☐ 悪い	☐ とても悪い
システムのスピード	☐ とても良い	☐ 良い	☐ ふつう	☐ 悪い	☐ とても悪い
会話の効果	☐ とても良い	☐ 良い	☐ ふつう	☐ 悪い	☐ とても悪い
それは興味深い経験ですか？	☐ とても良い	☐ 良い☐い	☐ ふつう	☐悪い	☐ とても悪い
会話の効果	☐ とても良い	良い	☐ ふつう	☐ 悪い	☐ とても悪い
環境を作るのは簡単	☐ とても低い	☐ 低い	☐ ふつう	☐ 悪い	☐ とても高い
Regarding facial expression in education　教育の表情認識について					
教育への利用の貢献度	☐とても高い	☐ 高い	☐ふつう	☐ 低い	☐とても低い
教育への利用のしやすさ	☐とても高い	☐ 高い	☐ふつう	☐ 低い	☐とても低い
システムに基づくふるまいと教育との連動	☐ とても簡単	☐ 簡単	☐ふつう	☐ 難しい	とても難しい☐
顔の特徴を用いる学習への注意	☐ とても必要	☐ 必要	☐ ふつう	☐あまり必要ない	☐ 必要ない
Regarding facial expression in Virtual world　仮想空間での表情認識について					
仮想学習環境のリアリティを向上させてほしい	☐ とてもそう思う	☐そう思う	☐ふつう	☐ あまり思わない	☐ そう思わない
仮想空間での学習の完成度を向上させてほしい	☐ とてもそう思う	☐ そう思う	☐ふつう	☐ あまり思わない	☐ そう思わない
実際のクラスの教室のようになってほしい	☐ とてもそう思う	☐そう思う	☐ふつう	☐あまり思わない	☐ そう思わない

学習内容を理解することを簡単にしてほしい	☐ とてもそう思う	☐ そう思う	☐ ふつう	☐ あまり思わない	☐ そう思わない
仮想空間の魅力を高めてほしい	☐ とてもそう思う	☐ そう思う	☐ ふつう	☐ あまり思わない	☐ そう思わない
e ラーニングのための表情は必要か	☐ 必要	☐ どちらかといえ	☐ どちらでもない	☐ どちらかといえば必要な	☐ 必要ない
学習セッションの間、教師のアドバイスを増やしてほしいか	☐ 増やしてほしい	☐ 少し増やしてほしい	☐ この程度がいい	☐ 少し減らしてほしい	☐ 減らしてほしい

Questionnaire (English)

Questionnaire (Real world and virtual world Facial Expression)

Personal information

Age: ☐ 10-25) ☐ 25-40) ☐)-55) (☐ 70)

Gender: ☐ Male / ☐ Female

Position: ☐ Master Student/ ☐ Doctor Student/ ☐ Other……..

University/Department: …….

• **Regarding facial expression system**					
Correctness of the system	☐ Best	☐ Good	☐ Adequate	☐ Poor	☐ Inadequate
Performance of the system	☐ Best	☐ Good	☐ Adequate	☐ Poor	☐ Inadequate
User Friendly	☐ Best	☐ Good	☐ Adequate	☐ Poor	☐ Inadequate
Sensitivity of the system	☐ Best	☐ Good	☐ Adequate	☐ Poor	☐ Inadequate
Speediness of the system	☐ Best	☐ Good	☐ Adequate	☐ Poor	☐ Inadequate
Effectiveness in conversation	☐ Highest	☐ High	☐ Average	☐ Low	☐ Less
Easy to make environment	☐ Highest	☐ High	☐ Average	☐ Low	☐ Less
• **Regarding facial expression in education**					
Usefulness in discussion	☐ Best	☐ Good	☐ Adequate	☐ Poor	☐ Inadequate
Difficult to adapt to e-Learning	☐ Less	☐ Low	☐ Average	☐ High	☐ Highest
Easy to recognize other students expression	☐ Very Easy	☐ Easy	☐ Normal	☐ Difficult	☐ More difficult
Effectiveness of the active conversation	☐ Highest	☐ High	☐ Average	☐ Low	☐ Less
Attention to the conversation topic with facial expression	☐ Highest	☐ High	☐ Average	☐ Low	☐ Less
• **Regarding facial expression in Virtual world**					
Increase the reality of virtual learning environment	☐ Definitely	☐ Somewhat	☐ Undecided	☐ Not really	☐ Not at all
Increase the virtual world learning performance	☐ efinitely	☐ Somewhat	☐ Undecided	☐ Not really	☐ Not at all
Looks like real world	☐ efinitely	☐	☐ Undecided	☐ Not	☐ Not at all

class rooms		Somewhat		really	
Easy for understanding learning content	☐ efinitely	☐ Somewhat	☐ Undecided	☐ Not really	☐ Not at all
Enhance the attractiveness of the virtual world	☐ efinitely	☐ Somewhat	☐ Undecided	☐ Not really	☐ Not at all
Facial expression for e-Learning	☐ ecessity	☐ Somewhat	☐ Undecided	☐ Not necessary	☐ Not at all

2.6. Questionnaire for obtain the student responses after the lecture with eye blink visualization system

Questionnaire for evaluate the "Nonverbal Communication" in Virtual learning

Dear participants,

This questionnaire is designed to investigate the affection of the nonverbal communication in the virtual e-Learning education. Thank you for your participation and contributions, and please be assured that the collected information is only for research purpose.

Researcher: Asanka D. Dharamawansa, Dept. of Information science and control Engineering, Nagaoka university of Technology, Niigata, Japan.
Advisor: Yoshimi Fukumura., Department of Management and information system Engineering, Nagaoka university of Technology, Niigata, Japan.

Please fill your information below.

III. Gender:_____

IV. Nationality:_____

V. Age Group: (15 - 20) (20-25) (25-30) (30-35) (35-40)

Please circle the most suitable answer

1 - Very low 2 - Low 3 - Average 4 - High 5 - Very high

No	Variables	Response				
1	Did you feel pleasant?	1	2	3	4	5
2	Is it a good experience?	1	2	3	4	5
3	Did you feel friendly with students?	1	2	3	4	5
4	Did you reliable others?	1	2	3	4	5
5	Others courageous you	1	2	3	4	5
6	Did you feel strong?	1	2	3	4	5
7	Didn't you feel nervous?	1	2	3	4	5
8	Other participants were active	1	2	3	4	5
9	All are given the intelligent ideas	1	2	3	4	5
10	Did you behave carefully?	1	2	3	4	5
11	Did you feel relax?	1	2	3	4	5
12	Do you like to engage with communication?	1	2	3	4	5
13	Was the environment attractive?	1	2	3	4	5
14	Was the session interesting?	1	2	3	4	5
15	Was the conversation helpful to conduct?	1	2	3	4	5
16	Reality of the virtual environment	1	2	3	4	5
17	Is the lecture is good?	1	2	3	4	5
18	Understandability of the lecture	1	2	3	4	5
19	Easy to follow the lecture	1	2	3	4	5
20	Friendliness with the teacher	1	2	3	4	5
21	Comfortable with the teacher	1	2	3	4	5
22	Positive look of the participants	1	2	3	4	5
23	Explanation of the lecture	1	2	3	4	5
24	Importance of the non-verbal communication	1	2	3	4	5
25	Importance of the verbal communication	1	2	3	4	5
26	Avatar gives fair to the real user	1	2	3	4	5

27. Any suggestions or comments

_____

Thank you very much!!!

2.7. Questionnaire for obatin the student responses after the group exercise with eye blink visualization system.

Questionnaire for evaluate the "Nonverbal Communication" in Virtual learning

Dear participants,

This questionnaire is designed to investigate the affection of the nonverbal communication in the virtual e-Learning education. Thank you for your participation and contributions, and please be assured that the collected information is only for research purpose.

Researcher: Asanka D. Dharamawansa, Dept. of Information science and control Engineering, Nagaoka university of Technology, Niigata, Japan.
Advisor: Yoshimi Fukumura., Department of Management and information system Engineering, Nagaoka university of Technology, Niigata, Japan.

Please fill your information below.

VI. Gender:_____

VII. Nationality:_____

VIII. Age Group: (15 - 20)(20-25) (25-30) (30-35) (35-40)

Please circle the most suitable answer

1 - Very low 2 - Low 3 - Average 4 - High 5 - Very high

No	Variables	Response				
1	Did you feel pleasant?	1	2	3	4	5
2	Is it a good experience?	1	2	3	4	5
3	Did you feel friendly with others?	1	2	3	4	5
4	Did you reliable others?	1	2	3	4	5
5	Others courageous you	1	2	3	4	5
6	Did you feel strong?	1	2	3	4	5
7	Didn't you feel nervous?	1	2	3	4	5
8	Other participants were active	1	2	3	4	5
9	All are given the intelligent ideas	1	2	3	4	5
10	Did you behave carefully?	1	2	3	4	5
11	Did you feel relax?	1	2	3	4	5
12	Do you like to engage with communication?	1	2	3	4	5
13	Was the environment attractive?	1	2	3	4	5
14	Was the session interesting?	1	2	3	4	5
15	Was the conversation helpful to conduct?	1	2	3	4	5
16	Reality of the virtual environment	1	2	3	4	5
17	Easy to solve the problem	1	2	3	4	5
18	Contribution from the group members	1	2	3	4	5
19	All participate to solve the problem	1	2	3	4	5
20	Understandability of member's ideas	1	2	3	4	5

21. Any suggestions or comments

_____

Thank you very much!!!

2.8. Questionnaire for obtain the student responses after the experiment with eye blink and head pose visualization system

Questionnaire for evaluate the "Nonverbal Communication" in Virtual learning

Dear participants,

This questionnaire is designed to investigate the affection of the nonverbal communication in the virtual e-Learning education. Thank you for your participation and contributions, and please be assured that the collected information is only for research purpose.

Researcher: Asanka D. Dharamawansa, Dept. of Information science and control Engineering, Nagaoka university of Technology, Niigata, Japan.
Advisor: Yoshimi Fukumura., Department of Management and information system Engineering, Nagaoka university of Technology, Niigata, Japan.

Please fill your information below.

I. Gender:_____

II. Nationality:_____

III. Age Group: (15 - 20) (20-25) (25-30) (30-35) (35-40)

IV.

Please circle the most suitable answer

1 - Very low 2 - Low 3 - Average 4 - High 5 - Very high

No	Variables	Response				
1	Did you feel pleasant?	1	2	3	4	5
2	Is it a good experience?	1	2	3	4	5
3	Did you feel friendly with others?	1	2	3	4	5
4	Did you reliable others?	1	2	3	4	5
5	Others courageous you	1	2	3	4	5
6	Did you feel strong?	1	2	3	4	5
7	Didn't you feel nervous?	1	2	3	4	5
8	Other participants were active	1	2	3	4	5
9	Did you identify yourself in that environment?	1	2	3	4	5
10	Did you behave carefully?	1	2	3	4	5
11	Did you feel relax?	1	2	3	4	5
12	Do you like to engage with communication?	1	2	3	4	5
13	Was the environment attractive?	1	2	3	4	5
14	Was the session interesting?	1	2	3	4	5
15	Was the conversation helpful to conduct?	1	2	3	4	5
16	Reality of the virtual environment	1	2	3	4	5
17	Is the problem easy to solve?	1	2	3	4	5
18	Contribution from the group members	1	2	3	4	5
19	All participate to the discussion	1	2	3	4	5
20	Easy to understand the member's ideas	1	2	3	4	5
21	Importance of the non-verbal communication	1	2	3	4	5
22	Importance of the verbal communication	1	2	3	4	5
23	Avatar gives fair to the real user	1	2	3	4	5

24. Any suggestions or comments

_____

Thank you very much!!!

Appendix 3

This appendix includes the supplementary figures with the details that depict the effective factors when the student characteristics are changed which is discussed in section 3.4.2. Followings are the supplementary parts that have been listed under this appendix.

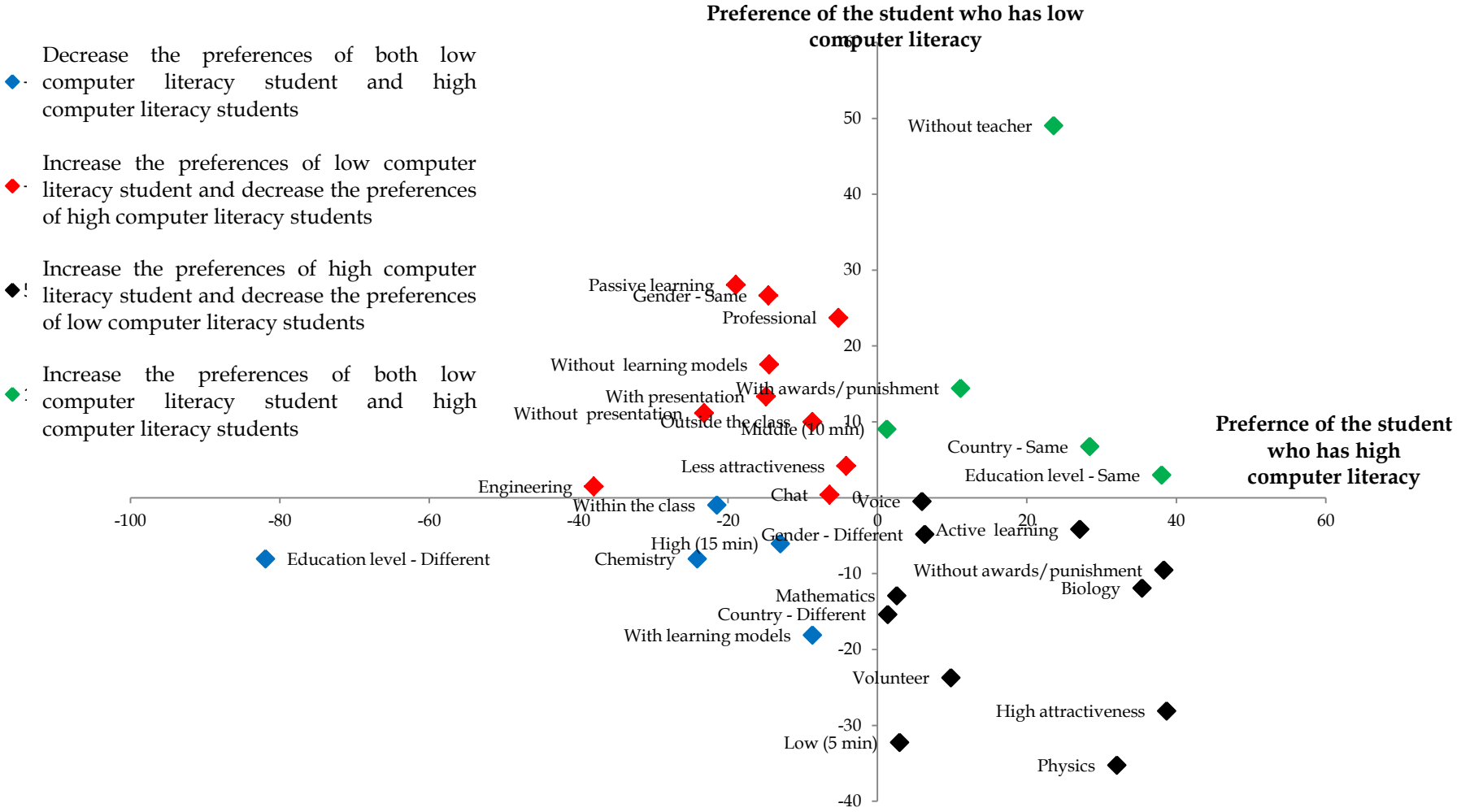
1.1. Identification of the effective factors when the education level moves from low level to high level.
   1.1. For low and high computer literacy students
   1.2. For young and middle-age students
   1.3. For male and female students

2.1. Identification of the effective factors when the computer literacy moves from low level to high level.
   2.1. For low and high education level students
   2.2. For young and middle-age students
   2.3. For male and female students

3.1. Identification of the effective factors when the age moves from young to middle aged level.
   3.1. For low and high education level students
   3.2. For low and high computer literacy students
   3.3. For male and female students

4.1. Matrix with the effective factors based on the changes of student characteristics

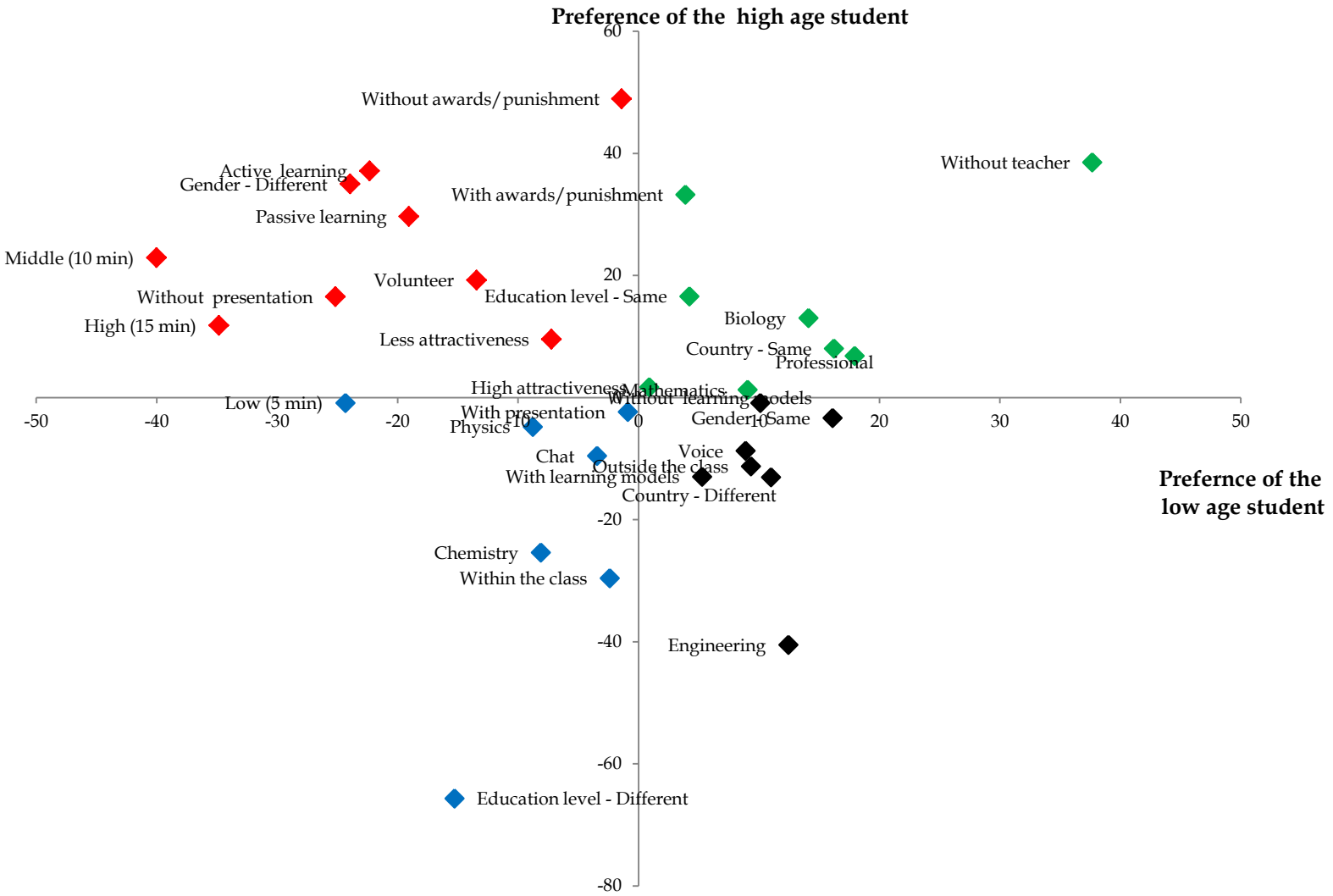
3.1.1. The behaviour of the factors when the student moving from low education to high education level



Behavior of the Learning elements based on the student characteristics - Summary

		Computer Literacy	
		Low	High
Estimated marginal means for the affectivity	Increase	When they move from low educational level to high educational level, they feel interest with the following factors • Less perfect guidance consists admiring in passive learning without learning module But they cannot enjoy with the virtual learning because their computer literacy is low.	When they move to low educational level to high educational level, they interest with the following factors • Prefer to obtain knowledge regarding subjects without admiring in attractive environment • Same education level members as peers They can observe the smell of the virtual learning with the above factors because they are fulfilled with the computer literacy.
	Decrease	When they move to low educational level to high educational level, they feel bore with the following factors • Obtain knowledge regarding subjects with learning modules according to the friendly guidance in attractive environment for low time duration They cannot observe the real validity of virtual learning due to the above factors and their low computer literacy.	When they move to low educational level to high educational level, they feel bore with the following factors • Different education level members as peers • Obtain knowledge regarding subjects without presentation inside the class They cannot observe the real validity of virtual learning due to the above factors.

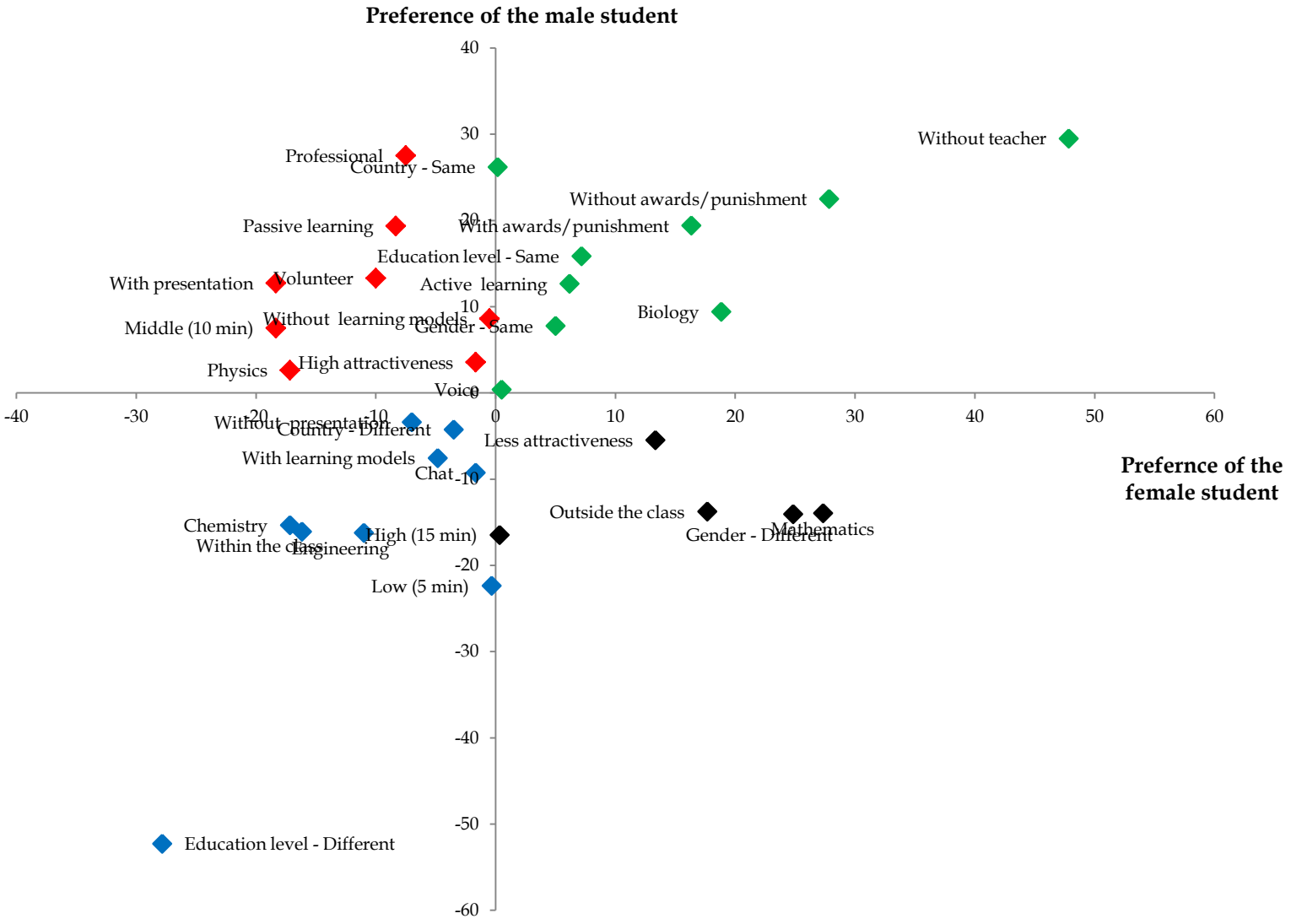
3.1.2. The behaviour of the factors when the student moving from low education to high education level



Behavior of the Learning elements based on the student characteristics - Summary

		Age level of the student	
		Low	High
Estimated marginal means for the affectivity	Increase	When the students move from low educational level to high educational level, they feel interest with the following factors • Same gender and same country members as peers • Less guidance and prefer to obtain knowledge regarding the subjects preciously	When the students move from low educational level to high educational level, they interest with the following factors • Less guidance without admiring active learning and prefer to engage more • Same education, same country but different gender members as peers
	Decrease	When the students move from low educational level to high educational level, they feel bore with the following factors • Different education level and different gender members as peers • Engage more time without basic	When the students move from low educational level to high educational level, they feel bore with the following factors • Obtain knowledge regarding the subjects with learning modules inside the class • Different educational level members as peers

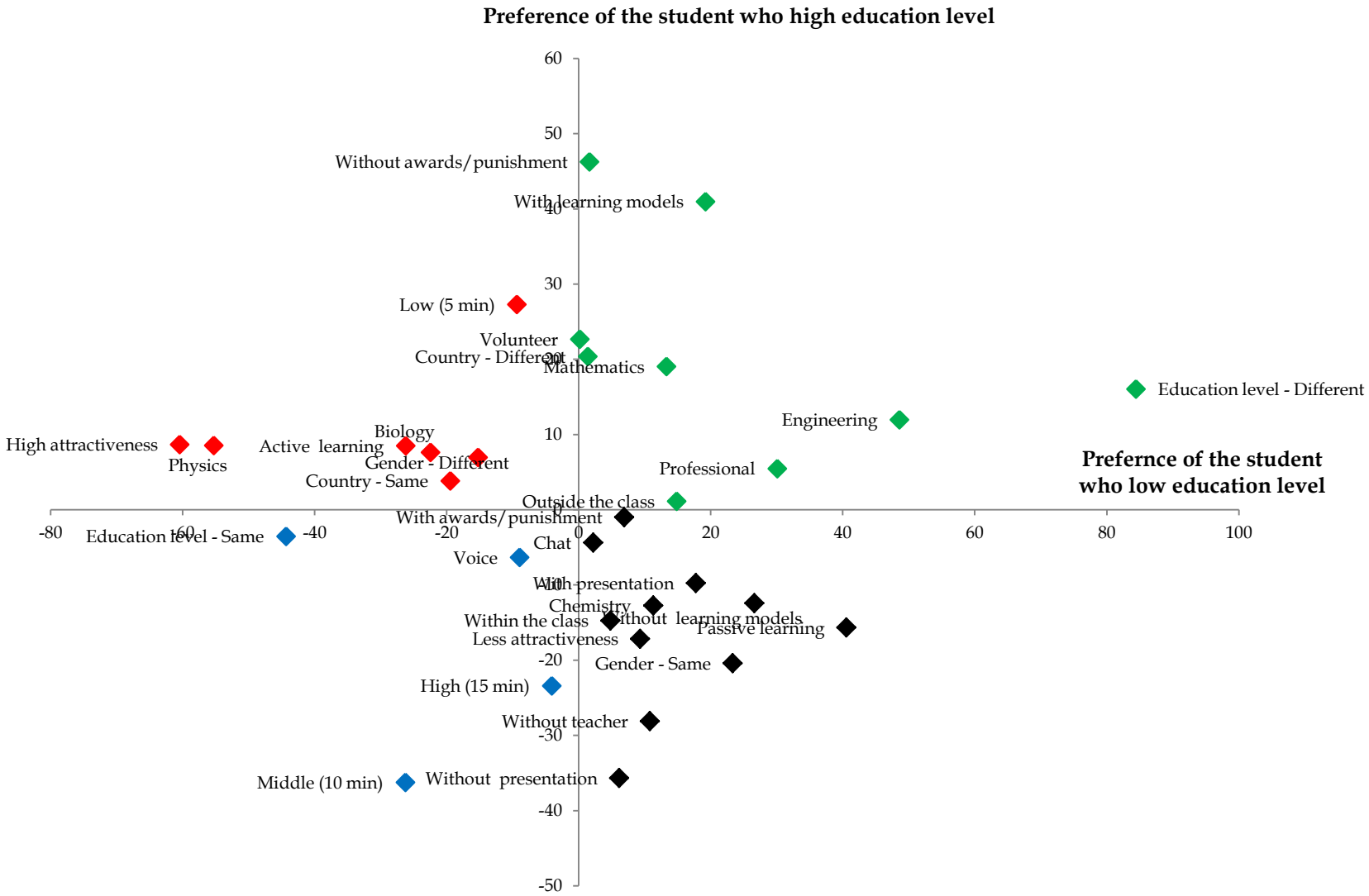
3.1.3. The behaviour of the factors when the student moving from low education to high education level



Behavior of the Learning elements based on the student characteristics - Summary

		Gender of the student	
		Female	Male
Estimated marginal means for the affectivity	Increase	When the students move from low educational level to high educational level, they feel interest with the following factors • Less guidance without admiring and prefer to obtain knowledge regarding the subjects.	When the students move from low educational level to high educational level, they interest with the following factors • Less guidance but perfect without admiring passive learning • Same characteristics (Educational level, country and gender) members as peers
	Decrease	When the students move from low educational level to high educational level, they feel bore with the following factors • Different education level members as peers • obtain knowledge regarding the subjects with presentation in middle time durations	When the students move from low educational level to high educational level, they feel bore with the following factors • Different education level and gender members as peers • Obtain knowledge regarding the subjects with low or high time durations in the class

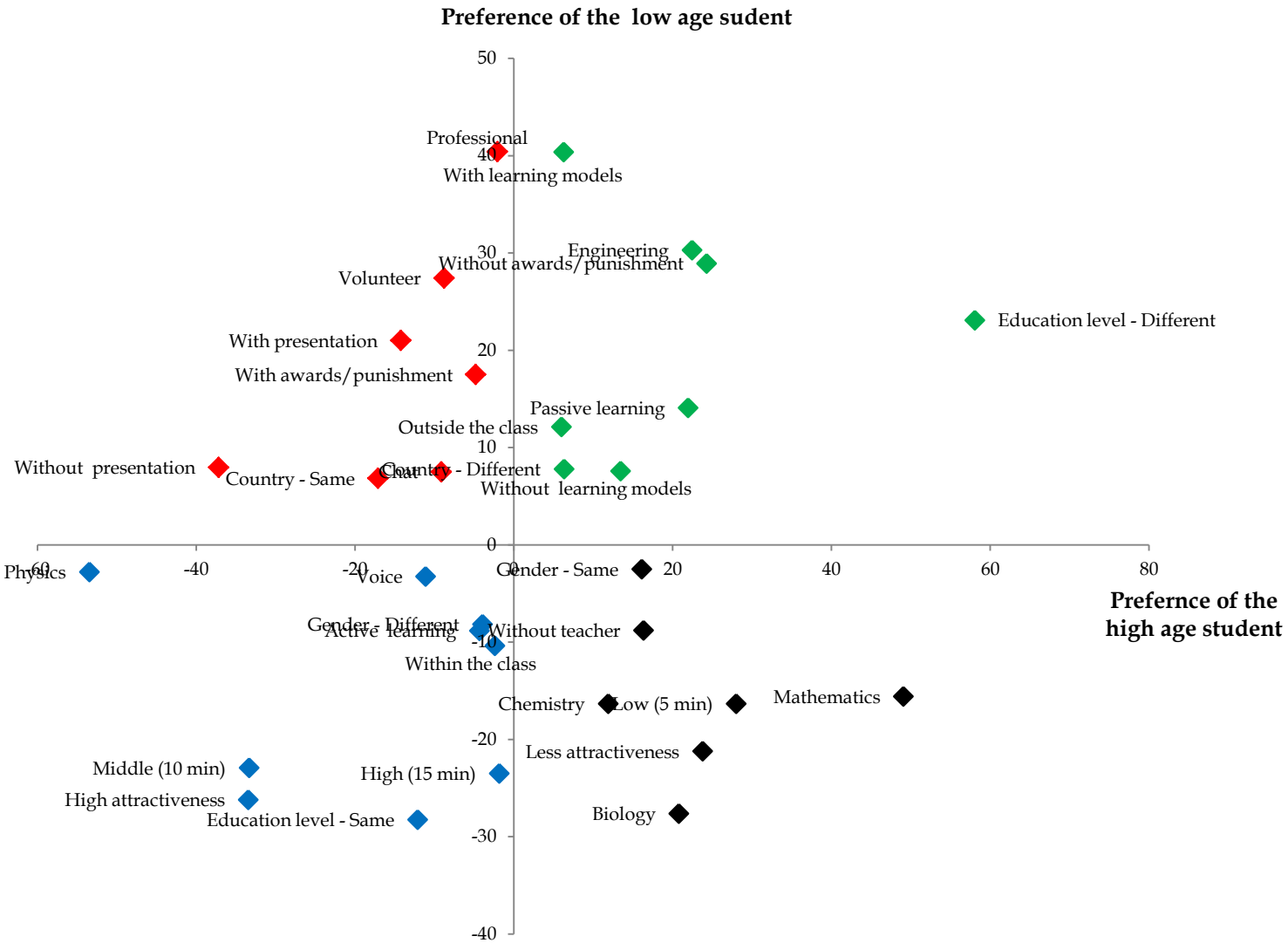
3.2.1 . The behaviour of the factors when the student moving from low experience to high experience level



Behavior of the Learning elements based on the student characteristics - Summary

		Education level of the student	
		Low	High
Estimated marginal means for the affectivity	Increase	When the students move from low computer literacy level to high computer literacy level, they feel interest with the following factors • Different education level members as peers • Prefer to obtain knowledge regarding the subjects without learning modules according to the perfect guidance in passive learning	When the students move from low computer literacy level to high computer literacy level, they feel interest with the following factors • Friendly guidance with learning modules and less admiring in small time durations • Different country members as peers
	Decrease	When they move from low computer literacy level to high computer literacy level, they feel bore with the following factors • Obtain the knowledge regarding the subjects in attractive environment in average time duration as active learning. • Same education level members as peers	When they move from low computer literacy level to high computer literacy level, they feel bore with the following factors • Engage with more time duration without guidance and without presentation. • Same gender members as peers

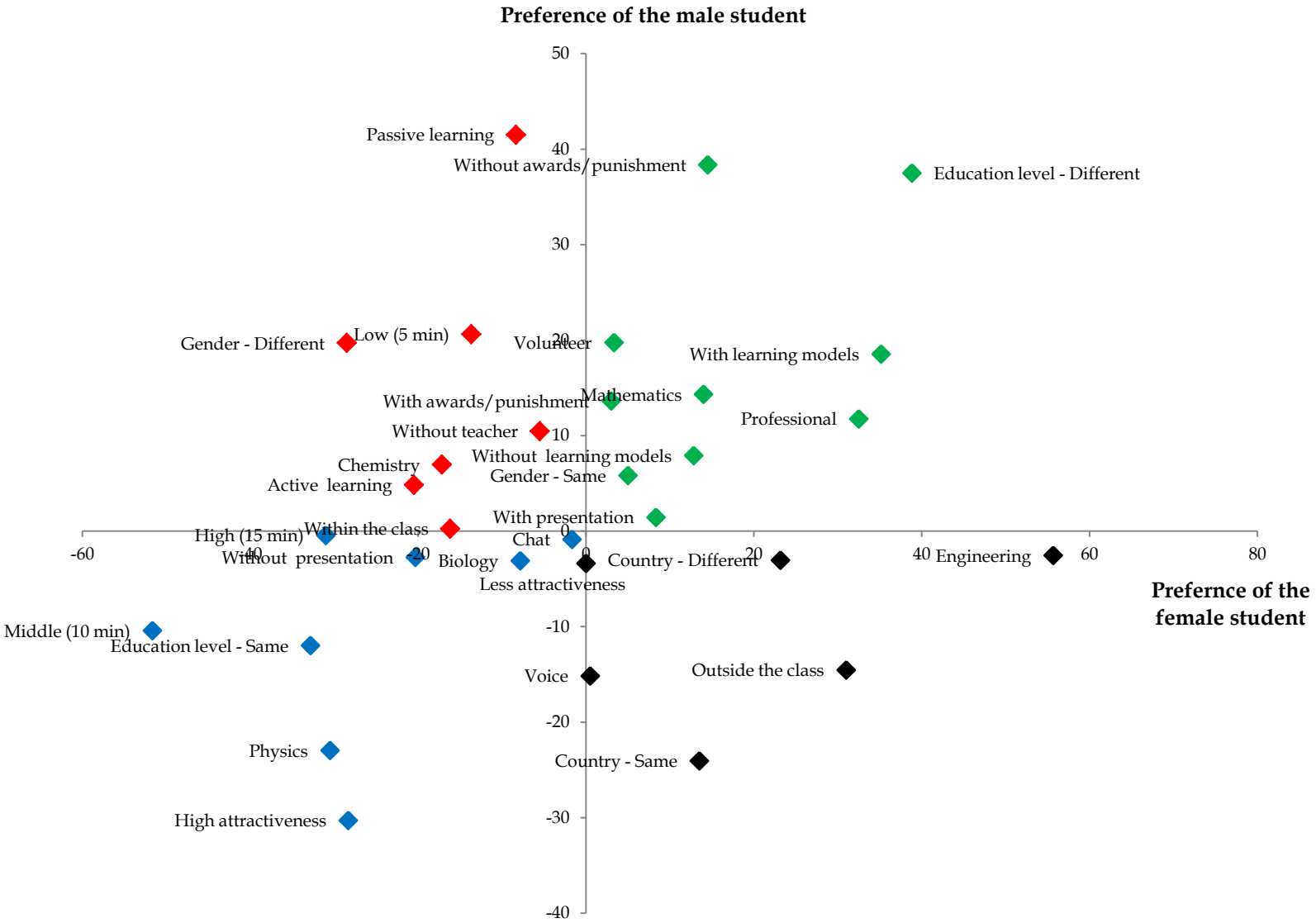
3.2.2 The behaviour of the factors when the student moving from low experience to high experience level



Behavior of the Learning elements based on the student characteristics - Summary

		Age of the student	
		Low	High
Estimated marginal means for the affectivity	Increase	When the students move from low computer literacy level to high computer literacy level, they feel interest with the following factors • Different education level members as peers • Prefer to obtain knowledge regarding the subjects without admiring for small duration with normal environment	When the students move from low computer literacy level to high computer literacy level, they feel interest with the following factors • Prefer to obtain knowledge regarding the subjects with learning modules according to the perfect guidance without admiring • Different education level members as peers
	Decrease	When they move from low computer literacy level to high computer literacy level, they feel bore with the following factors • Obtain the knowledge regarding the subjects in attractive environment without presentation in average time duration. • Same education level and same country members as peers	When they move from low computer literacy level to high computer literacy level, they feel bore with the following factors • Same education level members as peers • Engage with more time duration to obtain the knowledge regarding the subjects in less attractive environment.

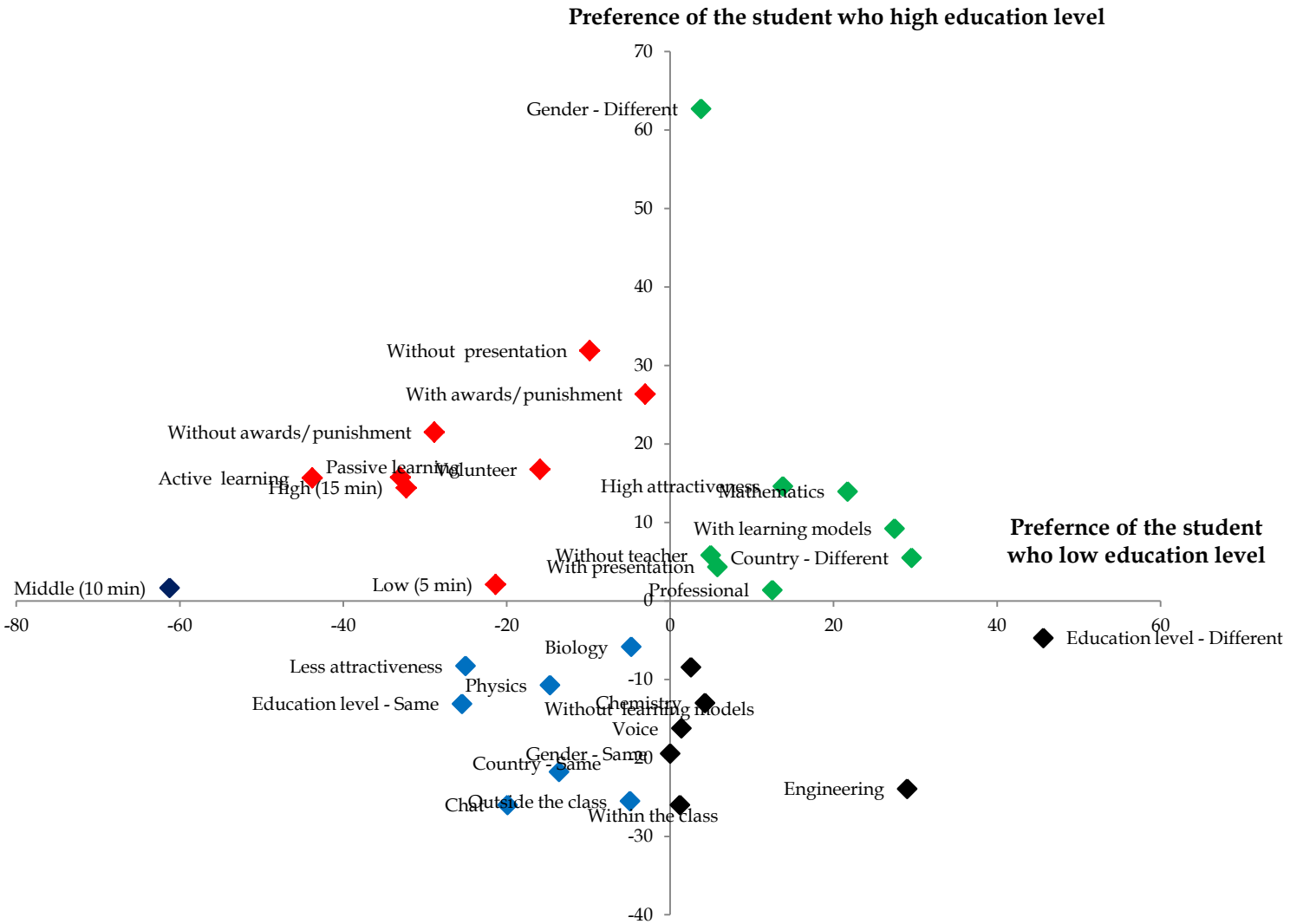
3.2.3. The behaviour of the factors when the student moving from low Experience to high experience level



Behavior of the Learning elements based on the student characteristics -

		Gender of the student	
		Female	Male
Estimated marginal means for the affectivity	Increase	When the students move from low computer literacy level to high computer literacy level, they feel interest with the following factors • Different education level members as peers • Prefer to obtain knowledge regarding the subjects with learning modules by perfect guidance out the class	When the students move from low computer literacy level to high computer literacy level, they feel interest with the following factors • Friendly guidance without admiring and engage with passive learning in small time • Different characteristics (Educational level and gender) members as peers
	Decrease	When they move from low computer literacy level to high computer literacy level, they feel bore with the following factors • More time to engage for obtain the knowledge regarding the subjects in attractive environment. • Same education but different gender members as peers	When they move from low computer literacy level to high computer literacy level, they feel bore with the following factors • Different education level and gender members as peers • Obtain knowledge regarding the subjects with low or high time durations in the class

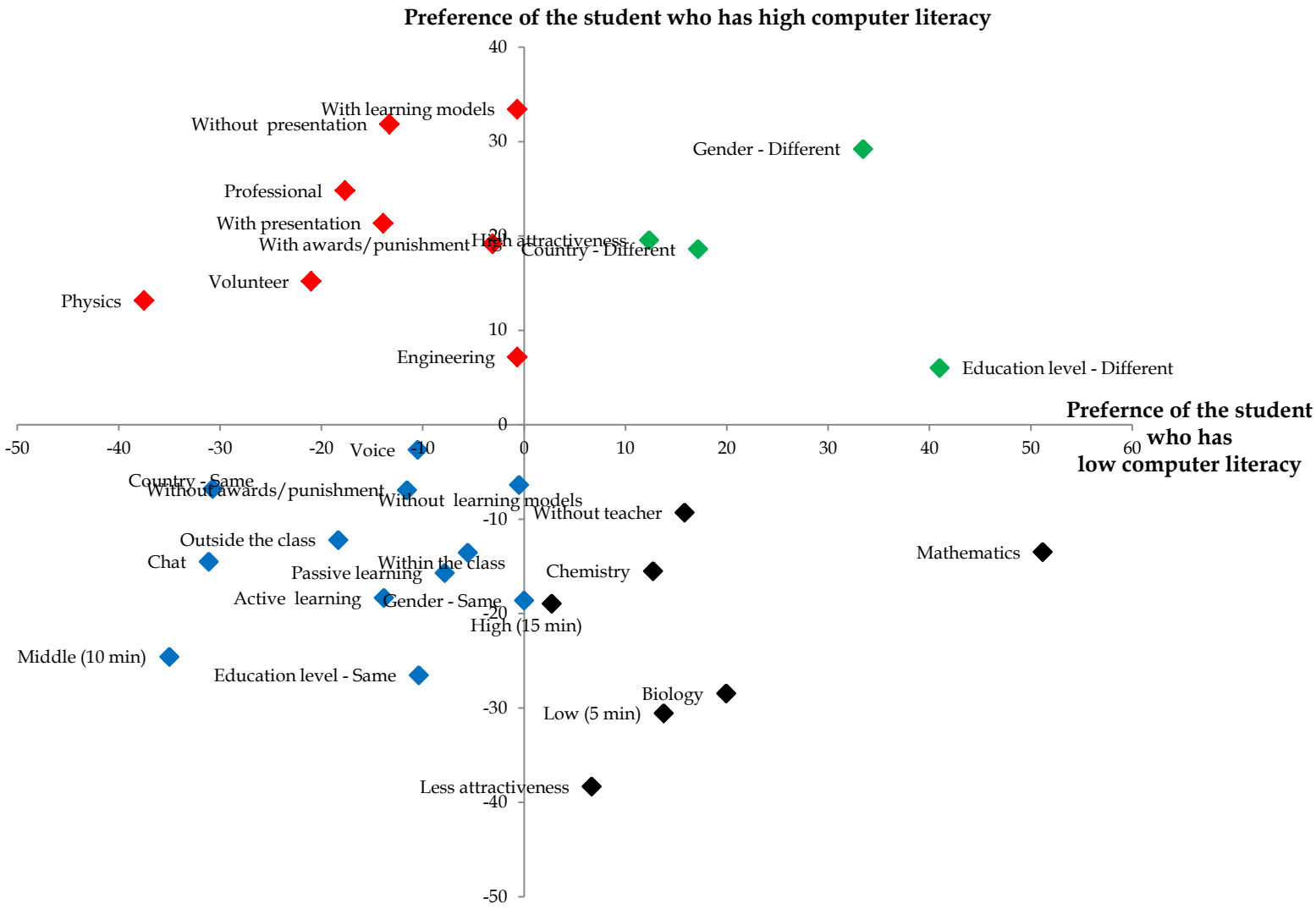
3.3.1. The behaviour of the factors when the student moving from low age to high age level



Behavior of the Learning elements based on the student characteristics - Summary

		Education level of the student	
		Low	High
Estimated marginal means for the affectivity	Increase	When students move from low age level to high age level, they feel interest with the following factors • Different education level and different country members as peers • Prefer to obtain knowledge regarding the subjects with learning modules	When students move from low age level to high age level, they feel interest with the following factors • Different gender members as peers • Friendly guidance without presentation and engage with passive learning
	Decrease	When students move from low age level to high age level, they feel bore with the following factors • Engage with more time duration without admiring as an active or passive learning	When students move from low age level to high age level, they feel bore with the following factors • Obtain the knowledge regarding the subject using chat in or outside the class. • Same country members as peers

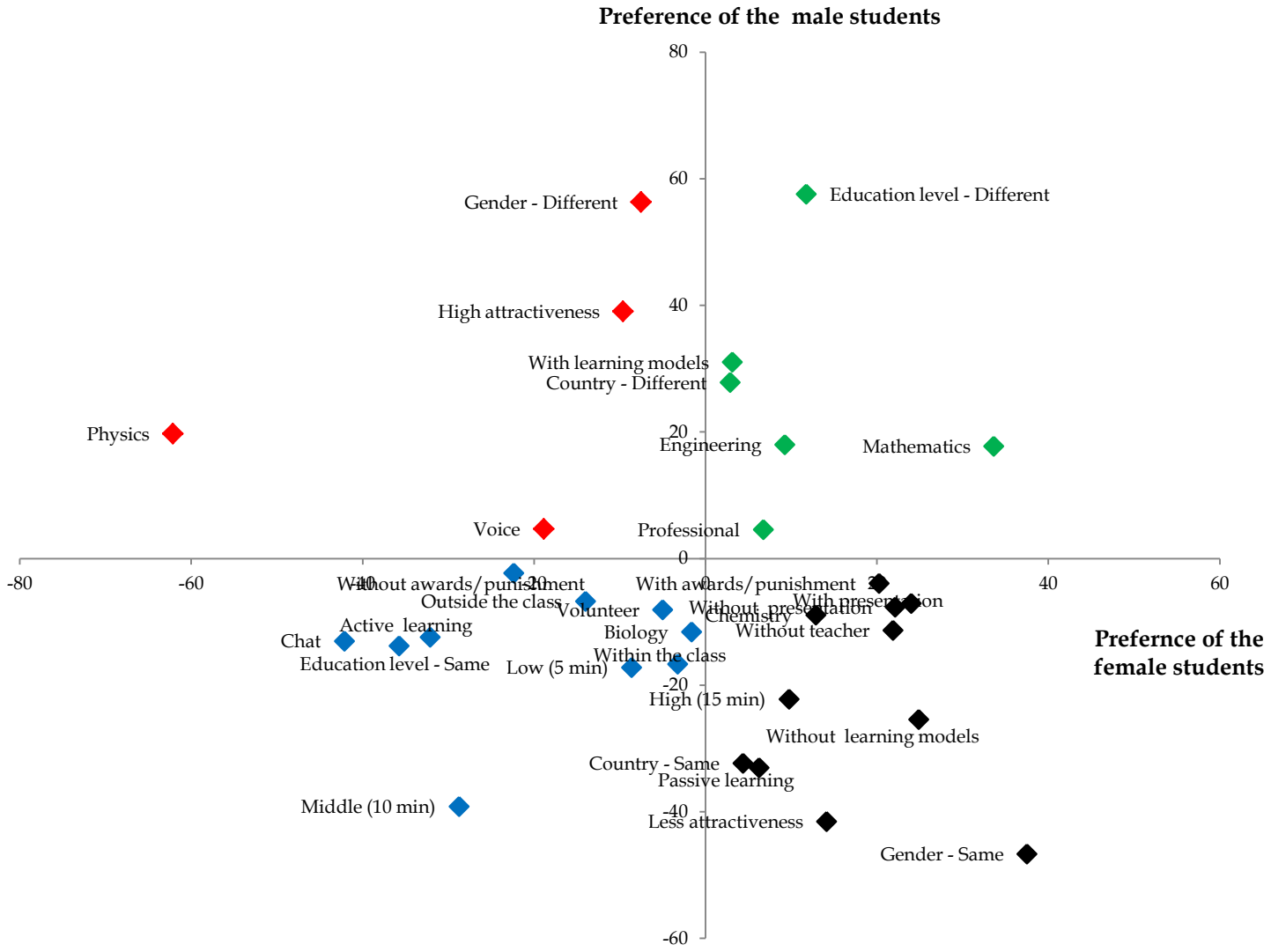
3.3.2. The behaviour of the factors when the student moving from low age to high age level



Behavior of the Learning elements based on the student characteristics - Summary

		Computer Literacy level of the student	
		Low	High
Estimated marginal means for the affectivity	Increase	When students move from low age level to high age level, they feel interest with the following factors • Different characteristics (education level, gender and country) members as peers • Prefer to obtain knowledge regarding the subjects	When students move from low age level to high age level, they feel interest with the following factors • Prefer to learn with learning modules and perfect guidance including admiring in high attractive environment • Different gender members as peers
	Decrease	When students move from low age level to high age level, they feel bore with the following factors • Obtain the knowledge regarding the subject using in average time duration with friendly guidance • Same country members as peers	When students move from low age level to high age level, they feel bore with the following factors • Obtain the knowledge regarding the subject in less attractive environment in any time duration • Same education level members as peers

3.3.3. The behaviour of the factors when the student moving from low age to high age level



Behavior of the Learning elements based on the student characteristics - Summary

		Gender of the student	
		Female	Male
Estimated marginal means for the affectivity	Increase	When students move from low age level to high age level, they feel interest with the following factors • Different gender members as peers • Prefer to obtain knowledge regarding the subjects without learning modules according to the less guidance and less admiring	When students move from low age level to high age level, they feel interest with the following factors • Different characteristics (education level, gender, country) of the members as peers • Prefer to learn with learning modules in high attractive environment
	Decrease	When students move from low age level to high age level, they feel bore with the following factors • Obtain the knowledge regarding the subjects using the chat in average time duration as active learning. • Same education level members as peers	When students move from low age level to high age level, they feel bore with the following factors • Same gender and country members as peers • Engage with average time duration in less attractive environment as passive learning

3.4 Matrix with the effective factors based on the changes of student characteristics

Summary of the result							
		Education		Computer Literacy		Age	
		Low	High	Low	High	Low	High
Education	Low			• Different education level members as peers • Prefer to obtain knowledge regarding the subjects without learning modules according to the perfect guidance in passive learning		• Different education level and different country members as peers • Prefer to obtain knowledge regarding the subjects with learning modules	
	High			• Friendly guidance with learning modules and less admiring in small time durations • Different country members as peers		• Different gender members as peers • Friendly guidance without presentation and engage with passive learning	
Computer Literacy	Low	• Less, perfect guidance consists admiring in passive learning without learning module				• Different characteristics (education level, gender and country) members as peers • Prefer to obtain knowledge regarding the subjects	
	High	• Prefer to obtain knowledge regarding subjects without admiring in attractive environment • Same education level members as peers				• Prefer to learn with learning modules and perfect guidance including admiring in high attractive environment • Different gender members as peers	

Age	Low	• Same gender and same country members as peers • Less guidance and prefer to obtain knowledge regarding the subjects preciously	• Different education level members as peers • Prefer to obtain knowledge regarding the subjects without admiring for small duration with normal environment	
	High	• Less guidance without admiring active learning and prefer to engage more • Same education, same country but different gender members as peers	• Prefer to obtain knowledge regarding the subjects with learning modules according to the perfect guidance without admiring • Different education level members as peers	
Gender	Male	• Less guidance but perfect without admiring passive learning • Same characteristics (Educational level, country and gender) members as peers	• Friendly guidance without admiring and engage with passive learning in small time • Different characteristics (Educational level and gender) members as peers	• Different characteristics (education level, gender, country) of the members as peers • Prefer to learn with learning modules in high attractive environment
	Female	• Less guidance without admiring and prefer to obtain knowledge regarding the subjects.	• Different education level members as peers • Prefer to obtain knowledge regarding the subjects with learning modules out the class	• Different gender members as peers • Prefer to obtain knowledge regarding the subjects without learning modules according to the less guidance and less admiring

Appendix 4

This appendix includes the supplementary questionnaires, discussed in section 5.1, 5.2 and 5.3.

Followings are the supplementary graphs that have been listed under this appendix.

1. Mean value of the each variables from the responses of the teachrs reagrding the non-verbal visualization system
2. Mean value of the effective variables from the responses of the teachrs reagrding the non-verbal visualization system
3. Mean value of the each variables from the responses of the students reagrding the non-verbal visualization system
4. Mean value of the effective variables from the responses of the students reagrding the non-verbal visualization system
5. Mean value of the each variables from the responses of the teachrs reagrding the tracking system
6. Mean value of the effective variables from the responses of the teachers reagrding the tracking system
7. Mean value of the each variables from the responses of the students reagrding the tracking system
8. Mean value of the each variables from the responses of the teachrs reagrding the identification of effective factors
9. Mean value of the each variables from the responses of the students reagrding the identification of effective factors
10. Mean value of the effective variables from the responses of the students reagrding the identification of effective factors

4.1. Mean value of the each variables from the responses of the teachrs reagrding the non-verbal visualization system

Variance Accounted For

	Centroid Coordinates			Total (Vector Coordinates)		
	Dimension		Mean	Dimension		Total
	1	2		1	2	
q1	.604	.019	.312	.603	.018	.621
q2	.857	.182	.520	.856	.026	.882
q3	.598	.051	.324	.597	.004	.601
q5	.273	.476	.375	.243	.475	.718
q6	.095	.665	.380	.087	.664	.751
q7	.507	.050	.279	.499	.049	.548
q8	.789	.107	.448	.781	.055	.835
q9	.297	.002	.149	.296	.001	.297
q10	.175	.116	.145	.175	.115	.290
Active Total	4.196	1.668	2.932	4.137	1.407	5.543
% of Variance	46.620	18.528	32.574	45.963	15.630	61.593

4.2. Mean value of the effective variables from the responses of the teachrs reagrding the non-verbal visualization system

Variance Accounted For

	Centroid Coordinates			Total (Vector Coordinates)		
	Dimension		Mean	Dimension		Total
	1	2		1	2	
q2	.890	.185	.538	.887	.052	.939
q3	.718	.090	.404	.716	.052	.768
q5	.336	.425	.380	.336	.422	.758
q6	.111	.707	.409	.105	.706	.811
q8	.764	.126	.445	.744	.077	.821
Active Total	2.819	1.533	2.176	2.787	1.310	4.097
% of Variance	56.379	30.658	43.518	55.742	26.198	81.940

4.3. Mean value of the each variables from the responses of the students reagrding the non-verbal visualization system

Variance Accounted For

	Centroid Coordinates			Total (Vector Coordinates)		
	Dimension		Mean	Dimension		Total
	1	2		1	2	
q1	.254	.039	.147	.254	.002	.256
q2	.040	.037	.038	.036	.034	.070
q3	.516	.233	.374	.506	.142	.649
q4	.101	.516	.308	.028	.512	.540
q5	.028	.077	.053	.018	.077	.095
q6	.243	.139	.191	.220	.137	.357
q7	.131	.005	.068	.123	.004	.127
q8	.137	.342	.240	.126	.338	.465
q9	.268	.128	.198	.265	.123	.388
q10	.201	.287	.244	.188	.278	.466
q11	.124	.242	.183	.100	.233	.332
q12	.021	.031	.026	.021	.031	.052
q14	.009	.481	.245	.005	.470	.474
q15	.605	.005	.305	.601	.005	.606
Active Total	2.677	2.563	2.620	2.492	2.384	4.876
% of Variance	19.123	18.306	18.715	17.799	17.029	34.829

4.4. Mean value of the effective variables from the responses of the students reagrding the non-verbal visualization system

Variance Accounted For

	Centroid Coordinates			Total (Vector Coordinates)		
	Dimension		Mean	Dimension		Total
	1	2		1	2	
q4	.514	.088	.301	.510	.032	.543
q8	.245	.424	.334	.234	.418	.652
q9	.256	.117	.186	.254	.114	.368
q10	.374	.193	.284	.369	.182	.551
q11	.290	.318	.304	.282	.316	.598
q14	.442	.046	.244	.436	.011	.446
q15	.024	.675	.350	.023	.654	.677
Active Total	2.144	1.862	2.003	2.107	1.727	3.834
% of Variance	30.632	26.596	28.614	30.101	24.675	54.775

4.5. Mean value of the each variable from the responses of the teachrs reagrding the tracking system

Variance Accounted For

	Centroid Coordinates			Total (Vector Coordinates)		
	Dimension		Mean	Dimension		Total
	1	2		1	2	
q1	.715	.345	.530	.695	.300	.994
q2	.695	.087	.391	.694	.077	.770
q3	.719	.348	.534	.699	.295	.994
q4	.653	.048	.351	.650	.031	.681
q5	.127	.037	.082	.092	.033	.125
q6	.900	.048	.474	.899	.037	.936
q7	.246	.739	.493	.233	.724	.957
q8	.958	.900	.929	.701	.293	.994
q9	.656	.034	.345	.656	.032	.688
q10	.532	.076	.304	.532	.074	.606
Active Total	6.201	2.663	4.432	5.852	1.895	7.746
% of Variance	62.007	26.630	44.319	58.516	18.949	77.465

4.6. Mean value of the effective variable from the responses of the teachers reagrding the tracking system

Variance Accounted For

	Centroid Coordinates			Total (Vector Coordinates)		
	Dimension		Mean	Dimension		Total
	1	2		1	2	
q1	.723	.350	.536	.700	.295	.995
q2	.676	.085	.380	.674	.071	.746
q3	.725	.343	.534	.705	.289	.995
q4	.668	.056	.362	.665	.041	.706
q6	.901	.054	.478	.900	.043	.943
q7	.245	.741	.493	.229	.733	.962
q8	.964	.921	.943	.708	.287	.995
q9	.651	.038	.344	.650	.034	.684
q10	.544	.087	.316	.544	.087	.630
Active Total	6.096	2.676	4.386	5.775	1.880	7.655
% of Variance	67.739	29.733	48.736	64.166	20.892	85.058

4.7. Mean value of the each variable from the responses of the students reagrding the tracking system

Variance Accounted For

	Centroid Coordinates			Total (Vector Coordinates)		
	Dimension		Mean	Dimension		Total
	1	2		1	2	
q1	.260	.366	.313	.260	.366	.626
q2	.641	.063	.352	.641	.063	.704
q3	.223	.484	.354	.206	.459	.665
q4	.076	.503	.290	.010	.502	.512
q5	.594	.029	.312	.594	.028	.622
Active Total	1.794	1.446	1.620	1.712	1.418	3.130
% of Variance	35.879	28.918	32.398	34.236	28.357	62.593

4.8. Mean value of the each variable from the responses of the teachrs reagrding the identification of effective factors

Variance Accounted For

	Centroid Coordinates			Total (Vector Coordinates)		
	Dimension		Mean	Dimension		Total
	1	2		1	2	
q1	.234	.272	.253	.194	.240	.433
q2	.175	.627	.401	.107	.615	.722
q3	.975	.088	.532	.972	.002	.974
q4	.947	.042	.495	.947	.005	.952
q5	.962	.231	.597	.962	.000	.962
q6	.959	.238	.599	.954	.002	.956
q7	.388	.119	.253	.386	.112	.498
q8	.196	.467	.331	.049	.329	.378
q9	.648	.115	.382	.645	.015	.660
q10	.968	.009	.488	.968	.005	.973
Active Total	6.452	2.208	4.330	6.184	1.325	7.509
% of Variance	64.523	22.080	43.301	61.837	13.253	75.090

4.9. Mean value of the each variable from the responses of the students reagrding the identification of effective factors

Variance Accounted For

	Centroid Coordinates			Total (Vector Coordinates)		
	Dimension		Mean	Dimension		Total
	1	2		1	2	
q1	.162	.219	.191	.155	.144	.299
q2	.025	.251	.138	.020	.251	.271
q3	.072	.540	.306	.072	.540	.612
q4	.298	.015	.156	.274	.010	.284
q5	.464	.025	.245	.464	.025	.489
q6	.503	.042	.272	.503	.005	.507
q7	.669	.021	.345	.669	.021	.690
q8	.153	.412	.283	.015	.367	.382
q9	.301	.012	.157	.260	.001	.261
q10	.043	.618	.331	.003	.575	.577
Active Total	2.690	2.156	2.423	2.435	1.939	4.373
% of Variance	26.901	21.561	24.231	24.346	19.388	43.734

4.10. Mean value of the effective variables from the responses of the students reagrding the identification of effective factors

Variance Accounted For

	Centroid Coordinates			Total (Vector Coordinates)		
	Dimension		Mean	Dimension		Total
	1	2		1	2	
q1	.162	.219	.191	.155	.144	.299
q2	.025	.251	.138	.020	.251	.271
q3	.072	.540	.306	.072	.540	.612
q4	.298	.015	.156	.274	.010	.284
q5	.464	.025	.245	.464	.025	.489
q6	.503	.042	.272	.503	.005	.507
q7	.669	.021	.345	.669	.021	.690
q8	.153	.412	.283	.015	.367	.382
q9	.301	.012	.157	.260	.001	.261
q10	.043	.618	.331	.003	.575	.577
Active Total	2.690	2.156	2.423	2.435	1.939	4.373
% of Variance	26.901	21.561	24.231	24.346	19.388	43.734

Appendix 5

This appendix includes the programing codes which are contributed to develop the multi-model system. Followings are the parts of the codes that have been listed under this appendix.

1. Non-verbal visualization system
2. Student tracking system
3. Avatar modification in Virtual learning environment

5.1. Non-verbal Visualization System

```
//Header files
#include "14.h"
#include "stdafx.h"
#include <iostream>
#include <cv.h>
#include <highgui.h>
#include <math.h>
#include <string>
#include <cxcore.h>
#include <stdlib.h>
#include <stdio.h>
#include <string.h>
using namespace cv;
using namespace std;
FILE *fptrb = fopen("blines.csv","a+");
FILE *file=fopen("data1.txt","w");
FILE *filex=fopen("data.txt","w");
//variables
int it=0;
int xm=0;
int ym=0;
int x2=0;
int          y2=0;
int xc;
int yc;
int s=0;
int xx=0;
int maxX=0;
int minX=100000;
int maxPixel=0;
int  minPixel=1000000;
int Pitch_value=0;
float Pitch=0;
int yaw=0;
int degrees =0;
double result = 0;
const char* status="None";
int Head_direction=0;
int array1=0;
int dValues[4] ;
int arrayY=0;
int YValues[4] ;
int arrayP=0;
int PValues[4] ;
int arrayH=0;
double hValues[4] ;
int arrayE=0;
double eValues[4] ;
int hand=0;
int eyes=1;
int IWhitePixel=0;
int yy=0;

CvCapture *capture;

int high_switch_value = 0;
int highInt = 0;
int low_switch_value = 0;
int lowInt = 0;
int square1=0;
int squarem=0;
int squareNew=0;

bool destroy=false;
CvRect box;
bool drawing_box = false;
```

```
CvRect R;
CvRect R1;

CvHaarClassifierCascade *cascade_f;
CvHaarClassifierCascade *cascade_e;
CvHaarClassifierCascade *cascade_m;

CvMemStorage   *storage;

//Function headers
int Hand_detection(IplImage *camImage );
int detectFaces(IplImage *image, CvRect *face);
int detectFaceFeatures(IplImage *edges,IplImage *edges1,IplImage *edges2,IplImage *edges3,IplImage *edges4,
CvRect *face);
Point MatchingMethod( IplImage *templ,IplImage * src, int, void*  );
void my_mouse_callbackLEye( int event, int x, int y, int flags, void* param );
void my_mouse_callbackREye( int event, int x, int y, int flags, void* param );
void my_mouse_callbackNose( int event, int x, int y, int flags, void* param );
void my_mouse_callbackMouth( int event, int x, int y, int flags, void* param );

//Find Bjggest Contour
cv::Mat FC_FindBiggestContours(cv::Mat mat_src)
  {
   IplImage temp=mat_src;
   IplImage *src_img=cvCreateImage(cvSize(temp.width,temp.height),IPL_DEPTH_32S,1);
   IplImage *dest=cvCreateImage(cvSize(temp.width,temp.height),IPL_DEPTH_8U,1);
   CvArr* _mask=&temp;
   int poly1Hull0=1;
   CvPoint offset;
   offset.x=0;
   offset.y=0;
            CvMat mstub, *mask = cvGetMat( _mask, &mstub );
            CvMemStorage* tempStorage = cvCreateMemStorage();
            CvSeq *contours, *c;
            int nContours = 0;
            double largest_length = 0,len = 0;
            CvContourScanner scanner;

  // clean up raw mask
  cvMorphologyEx( mask, mask, 0, 0, CV_MOP_OPEN, 1 );
  cvMorphologyEx( mask, mask, 0, 0, CV_MOP_CLOSE, 1 );

  // find contours around only bigger regions
  scanner = cvStartFindContours( mask, tempStorage,sizeof(CvContour), CV_RETR_EXTERNAL,
CV_CHAIN_APPROX_SIMPLE, offset );
  while( (c = cvFindNextContour( scanner )) != 0 )
  {
   len = cvContourPerimeter( c );
            CvSeq* hull = cvConvexHull2(c, 0, CV_CLOCKWISE, 0);
            CvSeq* defect = cvConvexityDefects(c, hull, NULL);
            CvSeq *tmpHull = cvConvexHull2(c);
            cvDrawContours( src_img, tmpHull, CV_RGB( 255,255,255), CV_RGB( 255,255,255), 1, 2, 8,
cvPoint(0,0));

            if(len > largest_length)
   {
     largest_length = len;
   }
  }
  contours=cvEndFindContours( &scanner );
  scanner = cvStartFindContours( mask, tempStorage, sizeof(CvContour), CV_RETR_EXTERNAL,
CV_CHAIN_APPROX_SIMPLE, offset );
  while( (c = cvFindNextContour( scanner )) != 0 )
  {
   len = cvContourPerimeter( c );
   double q = largest_length ;
   if( len < q ) //Get rid of blob if it's perimeter is too small
     cvSubstituteContour( scanner, 0 );
```

```
    else  //Smooth it's edges if it's large enough
    {
     CvSeq* newC;
     if( poly1Hull0 ) //Polygonal approximation of the segmentation
       newC = cvApproxPoly( c, sizeof(CvContour), tempStorage, CV_POLY_APPROX_DP, 2, 0 );
     else //Convex Hull of the segmentation
       newC = cvConvexHull2( c, tempStorage, CV_CLOCKWISE, 1 );
     cvSubstituteContour( scanner, newC );
     nContours++;
     R1=cvBoundingRect(c,0);

                double minVal=0;
                double maxVal=0;

    }
   }

   contours = cvEndFindContours( &scanner );
     // paint the found regions back into the image
   cvZero( src_img );
   cvZero( _mask );
   for( c=contours; c != 0; c = c->h_next )
   {
    cvDrawContours( src_img, c, cvScalarAll(1), cvScalarAll(1), -1, -1, 8, cvPoint(-offset.x,-offset.y));
   }
    cvReleaseMemStorage( &tempStorage );

              // convert to 8 bit IplImage
  for( int i = 0; i < src_img->height; i++ )
    for( int j = 0; j < src_img->width; j++ )
    {
     int idx = CV_IMAGE_ELEM( src_img, int, i, j );  //get reference to pixel at (col,row),
     uchar* dst = &CV_IMAGE_ELEM( dest, uchar, i, j );                    //for multi-channel images (col) should
be multiplied by number of channels */
     if( idx == -1 || idx == 1 )
      *dst = (uchar)255;
     else if( idx <= 0 || idx > 1 )
      *dst = (uchar)0; // should not get here
     else {
      *dst = (uchar)0;
       }
      }

             //Draw Rectangle covering the contour
             //cvLine(dest, Point(R.x,R.y), Point(R.x+R.width,R.y), Scalar(255,255,255),12,8, 0);
             //cvLine(dest, Point(R.x,R.y), Point(R.x,R.y+R.height) ,Scalar(255,255,255),12,8, 0);
             //cvLine(dest, Point(R.x+R.width ,R.y), Point(R.x+R.width ,R.y+R.height),Scalar(255,255,255),12,8, 0);

  cvReleaseImage(&src_img);
  Mat ret=cvarrToMat(dest);
  return ret;
 }

//This function threshold the HSV image and create a binary image
IplImage* GetThresholdedImage(IplImage* imgHSV)
            {
       IplImage* imgThresh=cvCreateImage(cvGetSize(imgHSV),IPL_DEPTH_8U, 1);
                    cvInRangeS(imgHSV, cvScalar(140,1,1), cvScalar(200,256,256), imgThresh);
                //cvInRangeS(imgHSV, cvScalar(0,0.23,60), cvScalar(50,0.68,256), imgThresh);

                    //cvScalar(30,67,40), cvScalar(200,256,256)
                    //cvScalar(140,1,1), cvScalar(200,256,256)
                    int TotalNumberOfPixels = imgThresh->height * imgThresh->width;
                    int ZeroPixels = TotalNumberOfPixels - countNonZero(imgThresh);

                    int pixel=countNonZero(imgThresh);
                    cv::Mat src_binary=FC_FindBiggestContours(imgThresh);
```

```
                IplImage* image2=cvCloneImage(&(IplImage)src_binary);

                int TPixel =  countNonZero(image2);

                //Biggest contour Right half
                cvSetImageROI(image2, cvRect(R1.x+R1.width/2, R1.y, R1.width/2, R1.height));
                int RPixel=countNonZero(image2);
                cvResetImageROI(image2);

                //Biggest contour Left half
                cvSetImageROI(image2, cvRect(R1.x, R1.y, R1.width/2, R1.height));
                int LPixel = countNonZero(image2);
                cvResetImageROI(image2);

                //Biggest contour upper half
                cvSetImageROI(image2, cvRect(R1.x, R1.y, R1.width, R1.height/2));
                int UPixel = countNonZero(image2);
                cvResetImageROI(image2);

                //Biggest contour lower half
                cvSetImageROI(image2, cvRect(R1.x, R1.y+R1.height/2, R1.width, R1.height/2));
                int DPixel = countNonZero(image2);
                cvResetImageROI(image2);

                //if (TPixel<10000  && DPixel>(UPixel)*1.2 && (abs(LPixel-RPixel)<1000))
                //if (TPixel>15000){

                 if (LPixel>(RPixel)*1.5){
                        status="Left";
                        Head_direction=2;
                }else if (RPixel>(LPixel)*1.5){
                        status="Right";
                        Head_direction=3;
                }else if (TPixel>20000){
                        status="Down";
                        Head_direction=4;}
                else if (TPixel<5000 )
                {
                        status="UP";
                        Head_direction=1;
                }
        //      else if (UPixel>(DPixel)*1.2 && (abs(LPixel-RPixel)<3000) && TPixel>15000){


                //std::cout << "R = " <<Head_direction << std::endl;


                cout<<status<<endl;
        //cvReleaseImage(&imgHSV);
        cvReleaseImage(&imgThresh);

    return image2;
}
//Templete Matching
Point MatchingMethod(IplImage *templ,IplImage * src, int, void* )
{
 // Allocate Output Images:
        int iwidth = src->width - templ->width + 1;
        int iheight = src->height - templ->height + 1;
        IplImage *ftmp;

        ftmp= cvCreateImage( cvSize( iwidth, iheight ), 32, 1 );

        // Do the matching of the template with the image
        cvMatchTemplate( src, templ, ftmp, CV_TM_SQDIFF);
        cvNormalize( ftmp, ftmp, 1, 0, CV_MINMAX );

        // Localizing the best match with minMaxLoc
```

```
	double minVal=0; double maxVal=0;
	CvPoint matchLoc;
	CvPoint minLoc,  maxLoc;
	cvMinMaxLoc( ftmp, &minVal, &maxVal, &minLoc, &maxLoc );

	/// For SQDIFF and SQDIFF_NORMED, the best matches are lower values. For all the other methods, the higher the better
	matchLoc = minLoc;

	/// Show me what you got
	//rectangle( src, matchLoc, Point( matchLoc.x + templ.cols , matchLoc.y + templ.rows ), Scalar::all(0), 2, 8, 0 );
	cvRectangle( src, cvPoint(matchLoc.x, matchLoc.y), cvPoint(matchLoc.x + templ->width, matchLoc.y + templ->height),  CV_RGB(255, 0, 0), 1, 8, 0);

	//cvShowImage( "result",src);

	return minLoc;
}

//Euclidiance distance
float euclideanDist(Point p, Point q)
{
   Point diff = p - q;

	float xx=(diff.x*diff.x + diff.y*diff.y)^1/2;
   return xx;
}

int detectFaceFeatures(IplImage *image1, IplImage *image2, IplImage *image3, IplImage *image4, IplImage *edges, CvRect *face)
{
	int i;
	bool hasEyes = false;
	bool hasNose = false;
	bool hasMouth = false;
	IplImage *templ1= cvLoadImage( "RightEye.jpg");
	IplImage *templ2= cvLoadImage( "Nose.jpg");
	IplImage *templ3= cvLoadImage( "Mouth.jpg");
	IplImage *templ4= cvLoadImage( "LeftEye.jpg");

	Point e1=MatchingMethod(templ1,image1, 0, 0 );
	Point n=MatchingMethod(templ2,image2, 0, 0 );
	Point m=MatchingMethod(templ3,image3, 0, 0 );
	Point e2=MatchingMethod(templ4,image4, 0, 0 );

	#define pi 3.14159265


	//Nose Marks
	//cvCircle(image, cvPoint(n.x, n.y+(templ2->height/2)), 2, CV_RGB(255,0,0), 4, 8, 0);
	//cvCircle(image2, cvPoint(image2->width/2, image2->height/2), 2, CV_RGB(255,0,0), 4, 8, 0);
	//cvCircle(image, cvPoint(n.x+(templ2->width), n.y+(templ2->height/2)), 2, CV_RGB(255,0,0), 4, 8, 0);

	int xN=n.x+(templ2->width/2);
	int yN= n.y+(templ2->height/2);

	//Eyes Marks
	//cvCircle(image, cvPoint(e1.x+(templ1->width/2), e1.y+(templ1->height/2)), 2, CV_RGB(255,0,0), 4, 8, 0);
	//cvCircle(image, cvPoint(e2.x+(templ4->width/2), e2.y+(templ4->height/2)), 2, CV_RGB(255,0,0), 4, 8, 0);

	int xRE=e1.x+(templ1->width/2);
	int yRE=e1.y+(templ1->height/2);

	int xLE=e2.x+(templ4->width/2);
	int yLE=e2.y+(templ4->height/2);
```

```
		//Eye line and horizontal line.....rotation
		float opposite_lenght = (yLE-yRE);
		float Adjacent= (xLE-xRE);

		double result = atan (opposite_lenght/Adjacent);
		degrees = result * (180/(pi*10));
		//degrees = result ;
		//cout <<  "Resulttttttttttt" <<degrees<< endl;

		//Eye line
		//cvLine(image, cvPoint(e1.x+(templ1->width/2), e1.y+(templ1->height/2)), cvPoint(e2.x+(templ4->width/2), e2.y+(templ4->height/2)), CV_RGB(255,0,0), 1, 8, 0 );

		//Mouth
		//cvCircle(image, cvPoint(m.x, m.y+(templ3->height/2)), 2, CV_RGB(255,0,0), 4, 8, 0);
		//cvCircle(image, cvPoint(m.x+(templ3->width/2), m.y+(templ3->height/2)), 2, CV_RGB(255,0,0), 4, 8, 0);
		//cvCircle(image, cvPoint(m.x+(templ3->width), m.y+(templ3->height/2)), 2, CV_RGB(255,0,0), 4, 8, 0);

		int xM=m.x+(templ3->width/2);
		int yM=m.y+(templ3->height/2);

		//mouth & eye line connection
		//cvCircle(image, cvPoint((e1.x+(templ1->width/2)+e2.x+(templ4->width/2))/2, (e1.y+(templ1->height/2)+e2.y+(templ4->height/2))/2), 2, CV_RGB(255,0,0), 4, 8, 0);
		//cvLine(image, cvPoint((e1.x+(templ1->width/2)+e2.x+(templ4->width/2))/2, (e1.y+(templ1->height/2)+e2.y+(templ4->height/2))/2), cvPoint(m.x+(templ3->width/2), m.y+(templ3->height/2)), CV_RGB(255,0,0), 1, 8, 0 );

		int xEyeMiddle=((e1.x+(templ1->width/2)+e2.x+(templ4->width/2))/2);
		int yEyeMiddle=((e1.y+(templ1->height/2)+e2.y+(templ4->height/2))/2);

		int xMouthMiddle=(m.x+(templ3->width/2));
		int yMouthMiddle=(m.y+(templ3->height/2));

		double EyeToMouth = ((xEyeMiddle-xMouthMiddle)^2 + (yEyeMiddle-yMouthMiddle)^2)^1/2;
		double NoseToMouth = ((xN-xMouthMiddle)^2 + (yN-yMouthMiddle)^2)^1/2;

		//up & down
		double UpDown=EyeToMouth/NoseToMouth;
		//yaw=6.2424*UpDown-14.037;
		yaw = 2.761*UpDown - 9.8254;
		//cout << "P" <<yaw<< endl;

		//left & right
		int Pitch=xN-xM;
		Pitch_value= (-1.7858*Pitch - 6.2361)/10;
		//Pitch_value=-1.5628*Pitch+1.6731;
		//cout <<  "hellloooooooooooo" <<Pitch_value<< endl;

		//cout <<   "R" <<degrees<<"P" <<UpDown <<"Y" <<Pitch<< endl;
		//cout <<   "P" <<UpDown << endl;
		//cvLine(edges, cvPoint(n.x, n.y), 12, CV_RGB(255,0,0), 2, 8, 0);
//		CvFont font;
//cvInitFont(&font, CV_FONT_HERSHEY_SIMPLEX, 0.6f, 0.6f, 0, 2);

		//fprintf(fptrb,"%d\n",Pitch_value);
   //fprintf(f,"%d\n",Pitch_value);

			//printf("\n");


		//fclose(f);

		CvRect *r;
		cvMoveWindow("Nose", 0, 0);
```

```
		cvMoveWindow("Mouth",0, 0);
		cvMoveWindow("Left Eye", 0, 0);
		cvMoveWindow("Right Eye", 0, 0);

		//cvMoveWindow("Nose", 500, 90);
		//cvMoveWindow("Right Eye", 1775, 90);
		//cvMoveWindow("Mouth", 500, 210);
		//cvMoveWindow("Left Eye", 775, 210);

		cvShowImage( "Mouth",image3);
		cvShowImage( "Nose",image2);
		cvShowImage( "Right Eye",image1);
		cvShowImage( "Left Eye",image4);

		CvRect mouthROI = cvRect(face->x, face->y + (face->height/1.5), face->width, face->height/2.5);
		//CvRect *r;

   // detect eyes
		cvSetImageROI(edges, mouthROI);

		CvSeq* mouths = cvHaarDetectObjects( edges, cascade_m, storage,1.1, 3, 0, Size(30, 30));
		cvResetImageROI(edges);

		for( i = 0; i < (mouths ? mouths->total : 0); i++ )
		{
			r = (CvRect*)cvGetSeqElem( mouths, i );

			 xm = r->width;
				ym = r->height;
		}



		CvRect eyeROI = cvRect(face->x, face->y + (face->height/5.5), face->width, face->height/3.0);
		//CvRect *r;

   // detect eyes
		cvSetImageROI(edges, eyeROI);

		CvSeq* eyes = cvHaarDetectObjects(edges, cascade_e, storage, 1.15, 3, 0, cvSize(25, 15));
		cvResetImageROI(edges);

		int s=0;
		// draw a rectangle for each eye found
		for(int i = 0; i <(eyes ? eyes->total : 0) ; i++ )
		{
			r = (CvRect*)cvGetSeqElem( eyes, i );
		//	int x1 = r->x + eyeROI.x;
		//	int yy = r->y + eyeROI.y;
			 x2 = r->width;
				y2 = r->height;
			//int xc = (x1 + x2)/2;
			//int yc = (yy + y2)/2;
			//cvRectangle(edges, cvPoint(x1, yy), cvPoint(x2, y2), CV_RGB(255, 0, 0), 1, 8, 0);

			s=1;
		}


		int t=(eyes->total);
		return t;
}

double GetMode(int daArray[], int iSize) {
   // Allocate an int array of the same size to hold the
   // repetition count
   int* ipRepetition = new int[iSize];
   for (int i = 0; i < iSize; ++i) {
```

```
      ipRepetition[i] = 0;
      int j = 0;
      bool bFound = false;
      while ((j < i) && (daArray[i] != daArray[j])) {
         if (daArray[i] != daArray[j]) {
            ++j;
         }
      }
      ++(ipRepetition[j]);
   }
   int iMaxRepeat = 0;
   for (int i = 1; i < iSize; ++i) {
      if (ipRepetition[i] > ipRepetition[iMaxRepeat]) {
         iMaxRepeat = i;
      }
   }
   delete [] ipRepetition;
   return daArray[iMaxRepeat];
}

double GetMean(double daArray[], int iSize) {
   double dSum = daArray[0];
   for (int i = 1; i < iSize; ++i) {
      dSum += daArray[i];
   }
   return dSum/iSize;
}

//detect face
int detectFaces(IplImage *edges, CvRect *face)
{
   // detect faces
            CvSeq       *faces      =      cvHaarDetectObjects(edges,      cascade_f,      storage,      1.1,      2,
CV_HAAR_DO_CANNY_PRUNING, cvSize( 50, 50 ) );

            CvRect* _face = (CvRect*)cvGetSeqElem(faces, 0);
            if (faces->total == 0)
            {
                        bool exit=true;
                        //cout <<  "eye" <<"open"<< endl;
                        eyes=1;
                        CvCapture* capture =0;
                        capture = cvCaptureFromCAM(1);
    if(!capture){
        printf("Capture failure\n");
        return 1;
                        }
                        //cvNamedWindow("Video", CV_WINDOW_AUTOSIZE);
                        cvNamedWindow("Ball", CV_WINDOW_AUTOSIZE);
                        //cvMoveWindow("Ball", 500, 100);
                        cvMoveWindow("Ball", 100, 100);
                        //iterate through each frames of the video
                        while(exit){

                                    IplImage*   frame = cvQueryFrame(capture);
        if(!frame) break;

        frame=cvCloneImage(frame);
        cvSmooth(frame, frame, CV_GAUSSIAN,3,3); //smooth the original image using Gaussian kernel

        IplImage* imgHSV = cvCreateImage(cvGetSize(frame), IPL_DEPTH_8U, 3);
        cvCvtColor(frame, imgHSV, CV_BGR2HSV); //Change the color format from BGR to HSV
        IplImage* imgThresh = GetThresholdedImage(imgHSV);
                                    //cvRectangle(imgThresh,       Point(R.x,R.y),       Point(R.x+R.width,R.y+R.height),
Scalar(255,255,255),12,8, 0);
        cvSmooth(imgThresh, imgThresh, CV_GAUSSIAN,3,3); //smooth the binary image using Gaussian kernel

        cvShowImage("Ball", imgThresh);
```

```
        //cvShowImage("Video", frame);

        //Clean up used images
        cvReleaseImage(&imgHSV);
        cvReleaseImage(&imgThresh);
        cvReleaseImage(&frame);

        //Wait 50mS
        int c = cvWaitKey(10);
                                break;
    }
                int c = cvWaitKey(100);
                cvDestroyWindow("Ball");
            //cvDestroyWindow("Video");
    cvDestroyAllWindows() ;
    // cvReleaseCapture(&capture);

                                xm = 0;
                                ym = 0;
                                x2 = 0;
                                y2 = 0;
            } else if (faces->total == 1){

                //status="None";
                Head_direction=0;
                face->x = _face->x;
                face->y = _face->y;
                face->width = _face->width;
                face->height = _face->height;
                squareNew=face->width*face->height;
cvRectangle(edges, cvPoint(face->x, face->y), cvPoint(face->x + face->width, face->y + face->height), CV_RGB(255, 0, 0), 1, 8, 0);

                if (face->width>100 && face->height>100){

                IplImage *subImg1;
            cvSetImageROI(edges, cvRect(face->x, face->y + (face->height/5.5), face->width/2, face->height/3.0));
                subImg1 = cvCreateImage(cvGetSize(edges), edges->depth, edges->nChannels);
                cvCopy(edges, subImg1, NULL);

                IplImage *subImg4;
cvSetImageROI(edges, cvRect(face->x+face->width/2, face->y + (face->height/5.5), face->width/2, face->height/3.0));
                subImg4 = cvCreateImage(cvGetSize(edges), edges->depth, edges->nChannels);
                cvCopy(edges, subImg4, NULL);

                IplImage *subImg2;
cvSetImageROI(edges, cvRect(face->x, face->y + (face->height/2.5), face->width, face->height/3.0));
                subImg2 = cvCreateImage(cvGetSize(edges), edges->depth, edges->nChannels);
                cvCopy(edges, subImg2, NULL);

                IplImage *subImg3;
cvSetImageROI(edges, cvRect(face->x, face->y + (face->height/1.5), face->width, face->height/2.5));
                subImg3 = cvCreateImage(cvGetSize(edges), edges->depth, edges->nChannels);
                cvCopy(edges, subImg3, NULL);

                int b=detectFaceFeatures( subImg1, subImg2, subImg3, subImg4,edges, face);

                        //int a[] = {b};
                        //CvMat A = cvMat(1, 1, CV_32F, a);
                        //cvSave( "eye_blink.txt",&A );
                        if(b==1 ||  b==2) {
                                eyes=1;
                                cout <<  "eye" <<"open"<< endl;
                        }
                        if(b==0) {
                                eyes=0;
                                cout <<   "eye" <<"close"<< endl;
```

```
                }

            cvResetImageROI(edges);

            int LWhitePixel= Hand_detection(edges );
            //if (squareNew>0 && square1>0){
                if(LWhitePixel>(IWhitePixel)*1.5)
                {
                    hand=1;
                }else hand=0;
            //  }
            //cout <<  "Y" <<hand<< endl;

            FILE *file=fopen("data1.txt","w");
//std::cout << "Rotationnnnnnnnnnnnnnnn = " << degrees << std::endl;
            fprintf(file,"%d\n",eyes);
            fprintf(file,"%d\n",hand);
            fprintf(file,"%d\n",Pitch_value);
            fprintf(file,"%d\n",yaw);
            fprintf(file,"%d\n",degrees);
            fprintf(file,"%d\n",result);
            // fprintf(file,"%d\n",hand);
            //
            fclose(file);

            //fprintf(filex,"%d",Head_direction);
            //fclose(filex);

            if(arrayY<5){
            eValues[arrayE]=eyes;
            hValues[arrayH]=hand;
            //cout <<  "Y" <<hValues[arrayH]<< endl;
            dValues[array1]=degrees;
            YValues[arrayY]=yaw;
            PValues[arrayP]=Pitch_value;
            arrayY=arrayY+1;
            array1=array1+1;
            arrayP=arrayP+1;
            arrayE=arrayE+1;
            arrayH=arrayH+1;
            //cout <<  "eye" <<eyes<< endl;
            //fprintf(file,"%d\n",eyes);

        if(arrayY==4 && array1==4 && arrayP==4 && arrayE==4 && arrayH==4){
            int iArraySize =5;
            //float E=GetMean(eValues, iArraySize);
            int H=GetMean(hValues, iArraySize);
            int P=GetMode(PValues, iArraySize);
            int Y=GetMode(YValues, iArraySize);
            int R=GetMode(dValues, iArraySize);
            //std::cout << "E = " << E << std::endl;
            //std::cout << "H = " << H << std::endl;
            std::cout << "P = " << P << std::endl;
            std::cout << "Y = " << Y << std::endl;
            std::cout << "R = " << R << std::endl;
            arrayY=0;
            array1=0;
            arrayP=0;
            arrayE=0;
            arrayH=0;
            //FILE *file=fopen("data1.txt","w");
            //fprintf(file,"%d\n",eyes);
            //fprintf(file,"%d\n",H);
            //fprintf(file,"%d\n",P);
            //fprintf(file,"%d\n",Y);
            //fprintf(file,"%d\n",R);
            //fprintf(file,"%d\n",eyes);
```

```
		//fclose(file);
		}
			}
			}
		}
		return 1;
}

//Draw boxes
void draw_box(IplImage* img, CvRect rect)
		{
			cvRectangle(img, cvPoint(box.x, box.y),
cvPoint(box.x+box.width,box.y+box.height),cvScalar(0,0,255) ,1.5);
			CvRect rect2=cvRect(box.x,box.y,box.width,box.height);
		}

// Implement mouse callback for Right Eye
void my_mouse_callbackREye( int event, int x, int y, int flags, void* param )
		{
		IplImage* frame = (IplImage*) param;

		switch( event )
		{
    case CV_EVENT_MOUSEMOVE:
    {
       if( drawing_box )
       {
          box.width = x-box.x;
          box.height = y-box.y;
       }
    }
    break;

    case CV_EVENT_LBUTTONDOWN:
    {
       drawing_box = true;
       box = cvRect( x, y, 0, 0 );
    }
    break;

    case CV_EVENT_LBUTTONUP:
    {
       drawing_box = false;
       if( box.width < 0 )
       {
          box.x += box.width;
          box.width *= -1;
       }

       if( box.height < 0 )
       {
          box.y += box.height;
          box.height *= -1;
       }

       draw_box(frame, box);
			cvSetImageROI(frame, cvRect(box.x+1, box.y+1, box.width-1, box.height-1));
			const char* REname = "RightEye.jpg";

			IplImage *tmp= cvCreateImage(cvGetSize(frame),frame->depth, frame->nChannels);

			cvCopy(frame, tmp, NULL);
			cvSaveImage(REname , tmp);
			cvResetImageROI(frame);

    }
    break;
```

```
    case CV_EVENT_RBUTTONUP:
    {
       destroy=true;
    }
    break;

    default:
    break;

  }
}

// Implement mouse callback for Left Eye
void my_mouse_callbackLEye( int event, int x, int y, int flags, void* param )
{
 IplImage* frame = (IplImage*) param;

 switch( event )
 {
    case CV_EVENT_MOUSEMOVE:
    {
       if( drawing_box )
       {
          box.width = x-box.x;
          box.height = y-box.y;
       }
    }
    break;

    case CV_EVENT_LBUTTONDOWN:
    {
       drawing_box = true;
       box = cvRect( x, y, 0, 0 );
    }
    break;

    case CV_EVENT_LBUTTONUP:
    {
       drawing_box = false;
       if( box.width < 0 )
       {
          box.x += box.width;
          box.width *= -1;
       }

       if( box.height < 0 )
       {
          box.y += box.height;
          box.height *= -1;
       }

       draw_box(frame, box);
                        cvSetImageROI(frame, cvRect(box.x+1, box.y+1, box.width-1, box.height-1));
                        const char* LEname = "LeftEye.jpg";

                        IplImage *tmp= cvCreateImage(cvGetSize(frame),frame->depth, frame->nChannels);

                        cvCopy(frame, tmp, NULL);
                        cvSaveImage(LEname , tmp);
                        cvResetImageROI(frame);
    }
    break;


    case CV_EVENT_RBUTTONUP:
    {
```

```
        destroy=true;
    }
    break;

    default:
    break;

  }
}

// Implement mouse callback for Nose
void my_mouse_callbackNose( int event, int x, int y, int flags, void* param )
{
 IplImage* frame = (IplImage*) param;

 switch( event )
 {
    case CV_EVENT_MOUSEMOVE:
    {
       if( drawing_box )
       {
          box.width = x-box.x;
          box.height = y-box.y;
       }
    }
    break;

    case CV_EVENT_LBUTTONDOWN:
    {
       drawing_box = true;
       box = cvRect( x, y, 0, 0 );
    }
    break;

    case CV_EVENT_LBUTTONUP:
    {
       drawing_box = false;
       if( box.width < 0 )
       {
          box.x += box.width;
          box.width *= -1;
       }

       if( box.height < 0 )
       {
          box.y += box.height;
          box.height *= -1;
       }

       draw_box(frame, box);
                        cvSetImageROI(frame, cvRect(box.x+1, box.y+1, box.width-1, box.height-1));
                        const char* Nname = "Nose.jpg";

                        IplImage *tmp= cvCreateImage(cvGetSize(frame),frame->depth, frame->nChannels);

                        cvCopy(frame, tmp, NULL);
                        cvSaveImage(Nname , tmp);
                        cvResetImageROI(frame);
    }
    break;


    case CV_EVENT_RBUTTONUP:
    {
       destroy=true;
    }
    break;
```

```
    default:
    break;

  }
}

// Implement mouse callback for Mouth
void my_mouse_callbackMouth( int event, int x, int y, int flags, void* param )
{
 IplImage* frame = (IplImage*) param;

 switch( event )
 {
    case CV_EVENT_MOUSEMOVE:
    {
       if( drawing_box )
       {
          box.width = x-box.x;
          box.height = y-box.y;
       }
    }
    break;

    case CV_EVENT_LBUTTONDOWN:
    {
       drawing_box = true;
       box = cvRect( x, y, 0, 0 );
    }
    break;

    case CV_EVENT_LBUTTONUP:
    {
       drawing_box = false;
       if( box.width < 0 )
       {
          box.x += box.width;
          box.width *= -1;
       }

       if( box.height < 0 )
       {
          box.y += box.height;
          box.height *= -1;
       }

       draw_box(frame, box);
                        cvSetImageROI(frame, cvRect(box.x+1, box.y+1, box.width-1, box.height-1));
                        const char* Mname = "Mouth.jpg";
                        IplImage *tmp= cvCreateImage(cvGetSize(frame),frame->depth, frame->nChannels);
                        cvCopy(frame, tmp, NULL);
                        cvSaveImage(Mname , tmp);
                        cvResetImageROI(frame);
    }
    break;

    case CV_EVENT_RBUTTONUP:
    {
       destroy=true;
    }
    break;

    default:
    break;

  }
}

//Hand Detection
```

```
int Hand_detection(IplImage *camImage ){


	IplImage *YCrCb = cvCreateImage(cvSize(640,480),IPL_DEPTH_8U,3);
	IplImage *Skin = cvCreateImage(cvSize(640,480),IPL_DEPTH_8U,1);

	int x = 0 , y = 0;
	int Cr = 0, Cb = 0,w=0,h=0;


	cvCvtColor(camImage,YCrCb,CV_BGR2YCrCb);
	w = YCrCb->width, h = YCrCb->height;
	for (y = 0; y < h ; y++)
	for (x = 0; x < w ; x++)
	{
		Cr= (int)((unsigned char*)(YCrCb->imageData + YCrCb->widthStep*(y)))[(x)*3+1];
		Cb =(int)((unsigned char*)(YCrCb->imageData + YCrCb->widthStep*(y)))[(x)*3+2];

		if ( (Cr>140 && Cr<160 ) && (Cb>70 && Cb<125))
			((unsigned char*)(Skin->imageData + Skin->widthStep*(y)))[(x)] = 255;
		else
			((unsigned char*)(Skin->imageData + Skin->widthStep*(y)))[(x)] = 0;
	}

	int WhitePixel=cvCountNonZero(Skin);
	//cout <<WhitePixel <<endl;
	//cvShowImage("RGB_IMAGE",camImage);
	//cvShowImage("YCrCb_IMAGE",YCrCb);
	//cvShowImage("SKIN_IMAGE",Skin);
	cvWaitKey(10);

 //cvReleaseImage(&camImage);
 //cvReleaseImage(&YCrCb);
// cvReleaseImage(&Skin);

	return WhitePixel;
}

int main()
{
  const char* nameRE = "Right Eye";
  const char* nameLE = "Left Eye";
  const char* nameN = "Nose";
  const char* nameM = "Mouth";

  cvNamedWindow( nameRE );
  cvNamedWindow( nameLE );
  cvNamedWindow( nameN );
  cvNamedWindow( nameM );

  box = cvRect(0,0,1,1);

  CvCapture* capture = cvCaptureFromCAM(1);

  //cvSetCaptureProperty(capture,CV_CAP_PROP_FPS,10000);
  double rates = cvGetCaptureProperty(capture,CV_CAP_PROP_FPS);
  //printf("%f\n",rates);

  if (!capture)
  {
    printf("!!! Failed cvCaptureFromCAM\n");
    return 1;
  }

  IplImage* image = cvQueryFrame(capture);
  if (!image)
  {
    printf("!!! Failed cvQueryFrame #1\n");
```

```
  return 2;
 }

        const char *file1 = "haarcascade_frontalface_alt.xml";
        const char *file2 = "haarcascade_eye.xml";
        const char *file3 = "haarcascade_mcs_mouth.xml";

        cascade_f = (CvHaarClassifierCascade*)cvLoad(file1, NULL, NULL, NULL);
        cascade_e = (CvHaarClassifierCascade*)cvLoad(file2, NULL, NULL, NULL);
        cascade_m = (CvHaarClassifierCascade*)cvLoad(file3, NULL, NULL, NULL);

        //setup memory storage, needed by the object detector
        storage = cvCreateMemStorage(0);
cvShowImage("Example3", image);
        if( !cascade_f)
        printf("ERROR: Could not load classifier cascade\n" );

        //cvShowImage("Example2", image);
        IplImage* temp= cvCloneImage(image);

 // Set up the callback
        while(1) {

                if(yy==0){ //temp = cvCloneImage(image);
                        cvSetMouseCallback(nameRE, my_mouse_callbackREye, (void*) image);
                        cvSetMouseCallback(nameLE, my_mouse_callbackLEye, (void*) image);
                        cvSetMouseCallback(nameN, my_mouse_callbackNose, (void*) image);
                        cvSetMouseCallback(nameM, my_mouse_callbackMouth, (void*) image);

                        //CvRect face;
        //CvSeq *faces = cvHaarDetectObjects(image, cascade_f, storage, 1.1, 2,
CV_HAAR_DO_CANNY_PRUNING, cvSize( 50, 50 ) );

                        //CvRect* _face = (CvRect*)cvGetSeqElem(faces, 0);
                        //yy=yy+1;
                        //if (faces->total == 1){
                                //face.width = _face->width;
                                //face.height=_face->height;
                                //square1=face.width*face.height;

                        //}
                        IWhitePixel=Hand_detection(image );
                }

        // Main loop
        cvWaitKey(100);

  if (destroy)
        {
   cvDestroyWindow(nameRE);
         cvDestroyWindow(nameLE);
         cvDestroyWindow(nameN);
         cvDestroyWindow(nameM);
         break;
        }

  cvCopyImage(image, temp);

  if (drawing_box)
    draw_box(temp, box);

                cvMoveWindow(nameRE, 0, 0);
        //cvMoveWindow(nameRE,50, 50);
                cvShowImage(nameRE, temp);

                cvMoveWindow(nameLE, 0, 0);
                //cvMoveWindow(nameRE,60, 50);
                cvShowImage(nameLE, temp);
```

```
                    cvMoveWindow(nameN, 0, 0);
                    //cvMoveWindow(nameRE,70, 50);
                    cvShowImage(nameN, temp);

                    cvMoveWindow(nameM, 700, 0);
                    //cvMoveWindow(nameRE,80, 50);
                    cvShowImage(nameM, temp);

  if (cvWaitKey(15) == 27)
     break;
                    yy=yy+1;
          }
yy=yy+1;
cvReleaseImage(&temp);
cvDestroyWindow(nameRE);
cvDestroyWindow(nameLE);
cvDestroyWindow(nameN);
cvDestroyWindow(nameM);
//cvNamedWindow("Example2", CV_WINDOW_AUTOSIZE);
//cvMoveWindow("Example2", 150, 150);
// Retrieve a single frame from the device  and set the ROI
IplImage* vid_frame = cvQueryFrame(capture);
if (!vid_frame)
{
  printf("!!! Failed cvQueryFrame #2\n");
  return 2;
}
while(1)

{
  if (!vid_frame)
  {
     vid_frame = cvQueryFrame(capture);

     if (!vid_frame)
     {
        printf("!!! Failed cvQueryFrame #3\n");
        break;
     }
  }

// detect faces and display video
                    CvRect face;



                    if (detectFaces(image, &face))
                    {
                              cout << "Features detected" << endl;
                              cout << Head_direction << endl;
                              int a[] = {Head_direction};
                              CvMat A = cvMat(1, 1, CV_32F, a);
                              cvSave( "data.txt",&A );

                               cvDestroyWindow(nameRE);
          cvDestroyWindow(nameLE);
          cvDestroyWindow(nameN);
          cvDestroyWindow(nameM);
                    //          cvShowImage("Example10", image);
                    int square1=x2*y2;
                              int squarem=xm*ym;

                    FILE *filef=fopen("dataf.txt","w");
                    fprintf(filef,"%d\n",Head_direction);
                    fprintf(filef,"%d\n",square1);
                    fprintf(filef,"%d\n",squarem);
                    fprintf(file,"%d\n",result);
```

```
                        // fprintf(file,"%d\n",hand);
                                cout <<   "Eye amount" <<square1 << endl;
                        cout <<   "mouth amount" <<squarem << endl;
                        fclose(filef);
                                if(Head_direction  != 0 || eyes==0){
                                cvWaitKey(250);
                                }
                        }
                        double rates = cvGetCaptureProperty(capture,CV_CAP_PROP_FPS);
                        //printf("%f\n",rates);
                         cvShowImage("Example2", vid_frame);
                        char c = cvWaitKey(33);
                        if( c == 27 ) break;

                        vid_frame = NULL;
 }
                        assert(cascade_f &&  storage && capture);
                        cvClearMemStorage(storage);
 cvReleaseCapture( &capture );
 cvDestroyWindow( "Example2" );

cvDestroyAllWindows() ;
 return 0;
}
```

5.2 Student Tracking System

```
<html>
<head>
<title>Eye moving</title>

<div id="header"  align="center" style="background-color:#FFA500;">
<h1  style="margin-bottom:0;">Student Tracking System with Behavioral Information</h1></div>

<style>
body {
	margin: 0px;
}

canvas#canvas1 {
	background: #ffffff;
}


</style>
<!--[if IE]><![endif]-->
<script language="JavaScript" src="http://oberon.nagaokaut.ac.jp/fz/asanka/js/excanvas.js"></script>

<script language="JavaScript" src="http://oberon.nagaokaut.ac.jp/fz/asanka/js/prototype.js"></script>

<script language="javascript"><!--

var island_name = "BSNInet NagaokaUT";
var sensor_id = 1;

var currentTime = new Date();
var hh= currentTime.getHours();
var nn = currentTime.getMinutes();
var ss = 00;
var time = hh + ":" + nn + ":" + ss;
var timenew1 = hh + ":" + nn + ":" + ss;
var timenew2 = hh + ":" + nn + ":" + ss;

//var date = "";
//var time = "";

var month = currentTime.getMonth() + 1;
var day = currentTime.getDate();
var year = currentTime.getFullYear();
var date= year + "-" + month + "-" + day;
var datenew=year + "-" + month + "-" + day;

var AMPM = "AM";
var timer_id;



var penWidth = 4
var ctx;
var currentColor = "rgb(0, 0, 0)";
var currentColor1 = "rgb(0, 0, 0)";
var arrow_length = 20;
var arrow_length2 = 10;
var arrow_sharpness = 30;

var fontSize="15px";
var fontFamiliyName = ["bold 12px sans-serif"].join(', ');
var CanvasW = 1110;
var CanvasH = 1000;
var CanvasW1 = 300;
var CanvasH1 = 790;
var HourDif=0;
var MinDif=0;
```

```
var ActualMin=0;
var selectedText=0;
var selectedText1=0;
var selectedText2=0;
var selectedText3=0;
var selectedText4=0;
var selectedText5=0;
var selectedText6=0;
var namesArray=new Array(100);
var namesnewArray=new Array(100);
var voice_avgArray=new Array(100);
var voice_avgnewArray=new Array(100);
var voice_minArray=new Array(100);
var voice_minnewArray=new Array(100);
var voice_maxArray=new Array(100);
var voice_maxnewArray=new Array(100);
var eye_avgArray=new Array(100);
var eye_avgnewArray=new Array(100);
var eye_minArray=new Array(100);
var eye_minnewArray=new Array(100);
var eye_maxArray=new Array(100);
var eye_maxnewArray=new Array(100);
var eyesizeArray=new Array(100);
var eyesizenewArray=new Array(100);
var eyesizeminArray=new Array(100);
var eyesizeminnewArray=new Array(100);
var eyesizemaxArray=new Array(100);
var eyesizemaxnewArray=new Array(100);
var mouthsizeArray=new Array(100);
var mouthsizenewArray=new Array(100);
var mouthsizeminArray=new Array(100);
var mouthsizeminnewArray=new Array(100);
var mouthsizemaxArray=new Array(100);
var mouthsizemaxnewArray=new Array(100);
var avatarstatuschange_avgArray=new Array(100);
var avatarstatuschange_avgnewArray=new Array(100);
var avatarstatuschange_minArray=new Array(100);
var avatarstatuschange_minnewArray=new Array(100);
var avatarstatuschange_maxArray=new Array(100);
var avatarstatuschange_maxnewArray=new Array(100);
var head_change_avgArray=new Array(100);
var head_change_avgnewArray=new Array(100);
var head_change_minArray=new Array(100);
var head_change_minnewArray=new Array(100);
var head_change_maxArray=new Array(100);
var head_change_maxnewArray=new Array(100);

var name=0;
var eye=0;
var name1=0;
var moving_datas=0;
var eye_elements=0;
var xx=0;
var index=0;
function Status_date(){
        var skillsSelect = document.getElementById("Month");
                selectedText = skillsSelect.options[skillsSelect.selectedIndex].text;

        var skillsSelect1 = document.getElementById("Day");
                selectedText1 = skillsSelect1.options[skillsSelect1.selectedIndex].text;

        var skillsSelect2 = document.getElementById("Year");
                selectedText2 = skillsSelect2.options[skillsSelect2.selectedIndex].text;

        var skillsSelect3 = document.getElementById("Hour1");
                selectedText3 = skillsSelect3.options[skillsSelect3.selectedIndex].text;

        var skillsSelect4 = document.getElementById("Min1");
```

```
                selectedText4 = skillsSelect4.options[skillsSelect4.selectedIndex].text;

        var skillsSelect5 = document.getElementById("Hour2");
                selectedText5 = skillsSelect5.options[skillsSelect5.selectedIndex].text;

        var skillsSelect6 = document.getElementById("Min2");
                selectedText6 = skillsSelect6.options[skillsSelect6.selectedIndex].text;
        //document.writeln(selectedText);
        //document.writeln(selectedText1);
        //document.writeln(selectedText2);
        //document.writeln(selectedText3);
        //document.writeln(selectedText4);
        //document.writeln(selectedText5);
        //document.writeln(selectedText6);

        if(selectedText3<10) {selectedText3="0"+selectedText3;}
   if(selectedText4<10) {selectedText4="0"+selectedText4;}
   if(selectedText5<10) {selectedText5="0"+selectedText5;}
   if(selectedText6<10) {selectedText6="0"+selectedText6;}
   if(selectedText1<10) {selectedText1="0"+selectedText1;}

        datenew = selectedText2 + "-" + selectedText + "-" + selectedText1;
        timenew1 = selectedText3+ ":" + selectedText4 + ":00" ;
        timenew2 = selectedText5+ ":" + selectedText6 + ":00" ;

        if(selectedText3<=selectedText5 && selectedText6>=selectedText4){
                HourDif= selectedText5 - selectedText3;
                MinDif=selectedText6 - selectedText4;
                }
        else if (selectedText3==selectedText5 && selectedText6>selectedText4){
                        HourDif= 0;
                        MinDif=selectedText6 - selectedText4;
                        }else if(selectedText3<selectedText5 && selectedText6<selectedText4){
                                HourDif = (selectedText5 - selectedText3)-1;
                                MinDif = 60-(selectedText4 - selectedText6);
                                }
        ActualMin = HourDif*60 + MinDif;


        //document.writeln(datenew);
        //document.writeln(timenew1);
        //document.writeln(timenew2);
}

function draw_text(x, y, text, id){

   var canvas = document.getElementById(id);
   ctx = canvas.getContext('2d');

ctx.font        = 'Italic 18px Sans-Serif';
//ctx.font = [fontSize, fontFamiliyName].join(' ');
 ctx.fillStyle = currentColor1;
// var txt =text.substring(0,4);
ctx.fillText(text,(x-5), (y-5));
}

function Status_info(){

        Status_date();
  async:  false
            new
Ajax.Request( 'Status.php?date='+datenew+'&time1='+timenew1+'&time2='+timenew2+'&island_name='+island_
name+'&sensor_id='+sensor_id, {
                        onSuccess: function( transport ) {

                                document.writeln(timenew1);
                                document.writeln(datenew);
                        var   moving_datas = transport.responseXML.getElementsByTagName( 'data' );
```

```
                        var   voice_avg_elements = transport.responseXML.getElementsByTagName( 'voice_avg' );
                        var   voice_min_elements = transport.responseXML.getElementsByTagName( 'voice_min' );
                        var   voice_max_elements =
transport.responseXML.getElementsByTagName( 'voice_max' );
                        var   eye_avg_elements = transport.responseXML.getElementsByTagName( 'eye_avg' );
                        var   eye_min_elements = transport.responseXML.getElementsByTagName( 'eye_min' );
                        var   eye_max_elements = transport.responseXML.getElementsByTagName( 'eye_max' );
                        var   eye_size_elements = transport.responseXML.getElementsByTagName( 'eye_size' );
                        var   eye_size_count_elements =
transport.responseXML.getElementsByTagName( 'eye_size_count' );
                        var   eye_size_min_elements =
transport.responseXML.getElementsByTagName( 'eye_size_min' );
                        var   eye_size_max_elements =
transport.responseXML.getElementsByTagName( 'eye_size_max' );
                       var   mouth_size_elements =
transport.responseXML.getElementsByTagName( 'mouth_size' );
                      // var   voice_sum_elements =
transport.responseXML.getElementsByTagName( 'voice_sum' );
                      // var   voice_avg_elements =
transport.responseXML.getElementsByTagName( 'voice_avg' );
                      // var   voice_min_elements =
transport.responseXML.getElementsByTagName( 'voice_min' );
                      // var   voice_max_elements =
transport.responseXML.getElementsByTagName( 'voice_max' );
                        var   mouth_size_min_elements =
transport.responseXML.getElementsByTagName( 'mouth_size_min' );
                        var   mouth_size_max_elements =
transport.responseXML.getElementsByTagName( 'mouth_size_max' );
  var   avatar_status_change_avg_elements =
transport.responseXML.getElementsByTagName( 'Avatar_change_avg' );
var   avatar_status_change_min_elements =
transport.responseXML.getElementsByTagName( 'Avatar_change_min' );
 var   avatar_status_change_max_elements =
transport.responseXML.getElementsByTagName( 'Avatar_change_max' );
                       var   head_change_avg_elements =
transport.responseXML.getElementsByTagName( 'head_change_avg' );
                        var   head_change_min_elements =
transport.responseXML.getElementsByTagName( 'head_change_min' );
                        var   head_change_max_elements =
transport.responseXML.getElementsByTagName( 'head_change_max' );
                                    // document.writeln(eye_avg_elements);

                           for( var i = 0; i < moving_datas.length; i++ )
                           {
                                    var  name = moving_datas[i].getAttribute('name');
                                   var voice_avg = voice_avg_elements[i].firstChild.nodeValue;
                                    var voice_min = voice_min_elements[i].firstChild.nodeValue;
                                    var voice_max = voice_max_elements[i].firstChild.nodeValue;
                                   var eye_avg = eye_avg_elements[i].firstChild.nodeValue;
                                   var eye_min = eye_min_elements[i].firstChild.nodeValue;
                                   var eye_max = eye_max_elements[i].firstChild.nodeValue;
                                   var eye_size = eye_size_elements[i].firstChild.nodeValue;
                                    var   eye_size_count = eye_size_count_elements[i].firstChild.nodeValue;
                                    var   eye_size_min = eye_size_min_elements[i].firstChild.nodeValue;
                                   var   eye_size_max = eye_size_max_elements[i].firstChild.nodeValue;
                                   var  mouth_size = mouth_size_elements[i].firstChild.nodeValue;
                                   var  mouth_size_min = mouth_size_min_elements[i].firstChild.nodeValue;
                                    var  mouth_size_max = mouth_size_max_elements[i].firstChild.nodeValue;
                                    var  avatar_status_change_avg =
avatar_status_change_avg_elements[i].firstChild.nodeValue;
                                    var  avatar_status_change_min =
avatar_status_change_min_elements[i].firstChild.nodeValue;
                                    var  avatar_status_change_max =
avatar_status_change_max_elements[i].firstChild.nodeValue;
                                    var  head_change_avg = head_change_avg_elements[i].firstChild.nodeValue;
                                    var  head_change_min = head_change_min_elements[i].firstChild.nodeValue;
                                    var  head_change_max = head_change_max_elements[i].firstChild.nodeValue;
```

```
                        // document.writeln(timenew1);
                            //document.writeln(eye_avg);
                           // document.writeln(timenew1);
                    name1=name;

                    namesArray[i]=name;
                  //eyeArray[i]=(eye/ActualMin).toFixed(2);
                  voice_avgArray[i]=voice_avg;
                voice_minArray[i]=voice_min;
                voice_maxArray[i]=voice_max;
                eye_avgArray[i]=eye_avg;
                eye_minArray[i]=eye_min;
                eye_maxArray[i]=eye_max;
                  eyesizeArray[i]=(eye_size/eye_size_count).toFixed(2);
                 eyesizeminArray[i]=eye_size_min;
                eyesizemaxArray[i]=eye_size_max;
                 mouthsizeArray[i]=mouth_size;
                mouthsizeminArray[i]=mouth_size_min;
                mouthsizemaxArray[i]=mouth_size_max;
                avatarstatuschange_avgArray[i]=avatar_status_change_avg;
                avatarstatuschange_minArray[i]=avatar_status_change_min;
                avatarstatuschange_maxArray[i]=avatar_status_change_max;
                //headchangeAvgArray[i]=(head_change/ActualMin).toFixed(2);
                //headchangeArray[i]=head_change;
                head_change_avgArray[i]=head_change_avg;
                head_change_minArray[i]=head_change_min;
                head_change_maxArray[i]=head_change_max;
                        draw_text(100, 30*3, 'ok' , 'canvas_status_new');


                 //document.writeln(eye_size_count);
                     // document.writeln(eye/ActualMin);
Status();

                     //  document.writeln(namesArray[i]);
                      }

                   },

                   onFailure: function( transport ) {
                        draw_text(100, 30*3, 'Fail' , 'canvas_status_new');
                   },

                   onTimeout: function( transport ) {
                        draw_text(100, 30*3, 'Time' , 'canvas_status_new');
                   }

                  } );


                }


function Status(){
        namesnewArray[xx]=namesArray[xx];
        voice_avgnewArray[xx]=voice_avgArray[xx];
        voice_minnewArray[xx]=voice_minArray[xx];
        voice_maxnewArray[xx]=voice_maxArray[xx];
        eye_avgnewArray[xx]=eye_avgArray[xx];
        eye_minnewArray[xx]=eye_minArray[xx];
        eye_maxnewArray[xx]=eye_maxArray[xx];
        eyesizenewArray[xx]=eyesizeArray[xx];
        eyesizeminnewArray[xx]=eyesizeminArray[xx];
        eyesizemaxnewArray[xx]=eyesizemaxArray[xx];
        mouthsizenewArray[xx]=mouthsizeArray[xx];
        mouthsizeminnewArray[xx]=mouthsizeminArray[xx];
        mouthsizemaxnewArray[xx]=mouthsizemaxArray[xx];
        avatarstatuschange_maxnewArray[xx]=avatarstatuschange_maxArray[xx];
```

```
            avatarstatuschange_minnewArray[xx]=avatarstatuschange_minArray[xx];
            avatarstatuschange_avgnewArray[xx]=avatarstatuschange_avgArray[xx];

            head_change_avgnewArray[xx]=head_change_avgArray[xx];
            head_change_minnewArray[xx]=head_change_minArray[xx];
            head_change_maxnewArray[xx]=head_change_maxArray[xx];
            //headchangenewArray[xx]=headchangeArray[xx];
            //headchangeAvgnewArray[xx]= headchangeAvgArray[xx];

            //document.writeln( namesnewArray[xx]);
            var xy=xx+1;
            //  draw_text(10, 30*xy, namesnewArray[xx], 'canvas_status');
 // draw_text(300, 30*xy, mouthsizenewArray[xx], 'canvas_status');
            xx=xx+1;

            var  substr = 'Bala', //months = ["december", "november", "feb"];
            index = namesnewArray.indexOf( namesnewArray.filter(function(v){ return v.indexOf(substr) >=
0;})[0]);
            //draw_text(400, 30*xy, index, 'canvas_status');
            //Status(function(){
                        //document.writeln(name1);
                          // here you use the output
                        //});

            //  document.writeln(eyeArray[1]);
}

function clock(){
                        var currentTime = new Date();
                        var hour= currentTime.getHours();
                        var min = currentTime.getMinutes();

                        var suffix = "AM";
                        if (hour >= 12) {
                        suffix = "PM";
                        hour = hour - 12;
                        }
                        if (hour == 00) {
                        hour = 12;
                        }

                        if (hour < 10)hour = "0" + hour;
                        if (min < 10)min = "0" + min;

                        document.writeln("<TABLE border=0 cellspacing=0><TR>");
                document.write(defWatchTD(hour,"pink","idHH"));
                document.write(defWatchTD(":","hotpink"));
                document.write(defWatchTD(min,"pink","idNN"));
                document.write(defWatchTD(":","hotpink"));
                document.write(defWatchTD("00","pink","idSS"));
                document.write(defWatchTD("  ","hotpink"));
                document.write(defWatchTD(suffix,"gold","idXM"));
                document.write("</TR></TABLE>");
  //  setTime();
}


 function Date_ymd(){

             var currentTimer = new Date();
                        var day= currentTimer.getDate();
                        var month = currentTimer.getMonth() + 1;
                        var year = currentTimer.getFullYear();
/*
                        var mm=month.toString();
                        var dd=day.toString();

                        var ml=mm.length;
```

```
                        var d1=dd.length;
                                //if() hh="0"+hour;
                                //if (min < 10)min = "0" + min;

                                if (ml = 1) month="0"+month;
                                if (dl = 1) day="0"+day;
*/
                                 if(day<10) day="0"+day;
                                 if(month<10) month="0"+month;


            document.writeln("<TABLE ><TR>");
            //document.writeln(ml);
    document.write(defWatchTD(month,"pink","idMM"));
    document.write(defWatchTD("-","hotpink"));
    document.write(defWatchTD(day,"pink","idDD"));
    document.write(defWatchTD("-","hotpink"));
    document.write(defWatchTD(year,"pink","idYY"));
    document.write("</TR></TABLE>");
//  setTime();
}

function defWatchTD(str, iro, divID){
            return "<TD align='center'><B><FONT size=4 color='" + iro + "'><DIV id='" + divID + "'>" + str +
"</DIV></FONT></B></TD>";
            }


function setTime(){
    var now = new Date();
    var hh = now.getHours().toString();
    var nn = now.getMinutes().toString();
    var ss = now.getSeconds().toString();

    if(hh>=12){
        document.getElementById("idXM").innerHTML="PM";
        hh-=12;
    }else{
        document.getElementById("idXM").innerHTML="AM";
    }



                        //if(hour<10) hh="0"+hour;
                        //if (min < 10)min = "0" + min;


    if(hh<10) hh="0"+hh;
    if(nn<10) nn="0"+nn;
    if(ss<10) ss="0"+ss;

    document.getElementById("idHH").innerHTML=hh;
    document.getElementById("idNN").innerHTML=nn;
    document.getElementById("idSS").innerHTML=ss;

    setTimeout("setTime()",1000);
}


function make_searchdata(){

    var hh_temp2=hh;
    var nn_temp2=nn;
    var ss_temp2=ss;
    var month_temp = month;
    var day_temp = day;
```

```
    if(AMPM == "PM"){
        hh_temp2 += 12;
    }


    if(hh_temp2<10) hh_temp2="0"+hh_temp2;
    if(nn_temp2<10) nn_temp2="0"+nn_temp2;
    if(ss_temp2<10) ss_temp2="0"+ss_temp2;
    if(month_temp<10) month_temp="0"+month_temp;
    if(day_temp<10) day_temp="0"+day_temp;


    date = year + "-" + month_temp + "-" + day_temp;
    time = hh_temp2 + ":" + nn_temp2 + ":" + ss_temp2;
    //document.writeln(time);
}


function changeTime(hns){
            var d=0;
    if(hns == "h+"){
        d=1;
            hh+=1;
    }else if(hns == "n+"){
       d=2;
        nn+=1;
    }else if(hns == "s+"){
        d=3;
        ss+=3;
    }else if(hns == "h-"){
        d=4;
        hh-=1;
    }else if(hns == "n-"){
        d=5;
        nn-=1;
    }else if(hns == "s-"){
        d=6;
        ss-=3;
    }


    if(ss>=60){
        ss-=60;
        nn+=1;
        d=5;
    }else if(ss<0){
        ss+=60;
        nn-=1;
        d=5;
    }


    if(nn>=60){
        nn-=60;
        hh+=1;
        d=5;
    }else if(nn<0){
        nn+=60;
        hh-=1;
        d=5;
    }


    if(hh>=12){
        if(AMPM == "AM"){
            AMPM = "PM";
            document.getElementById("idXM").innerHTML = AMPM;
            //document.getElementById("debug").innerHTML = AMPM;
```

```
        }else if(AMPM == "PM"){
            AMPM = "AM";
            document.getElementById("idXM").innerHTML = AMPM;
            //document.getElementById("debug").innerHTML = AMPM;
        }
        hh-=12;
    }else if(hh<0){
        if(AMPM == "AM"){
            AMPM = "PM";
            document.getElementById("idXM").innerHTML= AMPM;
            //document.getElementById("debug").innerHTML = AMPM;
        }else if(AMPM == "PM"){
            AMPM = "AM";
            document.getElementById("idXM").innerHTML= AMPM;
            //document.getElementById("debug").innerHTML = AMPM;
        }
        hh+=12;
    }


    var hh_temp=hh;
    var nn_temp=nn;
    var ss_temp=ss;




    if(hh<10) hh_temp="0"+hh;
    if(nn<10) nn_temp="0"+nn;
    if(ss<10) ss_temp="0"+ss;


    document.getElementById("idHH").innerHTML=hh_temp;
    document.getElementById("idNN").innerHTML=nn_temp;
    document.getElementById("idSS").innerHTML=ss_temp;

    time = hh + ":" + nn + ":" + ss;
    //make_searchdata();
    //draw_moving_new();

 if(d==3 || d==6){
    make_searchdata();
   draw_moving_new();

   }
  else  if(d==1 || d==2 || d==4 || d==5){
    make_searchdata();
    draw_moving_new();
              draw_moving();
   }

   // getChatdata();
}


function changeDate(hns){

    if(hns == "y+"){
              year+=1;
    }else if(hns == "m+"){
        month+=1;
    }else if(hns == "d+"){
        day+=1;
    }else if(hns == "y-"){
        year-=1;
    }else if(hns == "m-"){
        month-=1;
    }else if(hns == "d-"){
```

```
    day-=1;
  }


  if(day>31){
    day-=31;
    month+=1;
  }else if(day<1){
    day+=31;
    month-=1;
  }


  if(month>=13){
    month-=12;
    year+=1;
  }else if(month<1){
    month+=12;
    year-=1;
  }



  var year_temp=year;
  var month_temp=month;
  var day_temp=day;




  if(month<10) month_temp="0"+month;
  if(day<10) day_temp="0"+day;

  document.getElementById("idYY").innerHTML=year_temp;
  document.getElementById("idMM").innerHTML=month_temp;
  document.getElementById("idDD").innerHTML=day_temp;

  date= year + "-" + month + "-" + day;

 make_searchdata();

 //// draw_moving_new();
////  draw_moving();
  // getChatdata();
}

function make_X(x){
        return x;
  ///return (((x-11)*10));
}

function make_Y(y){
        return ((250-y)*10);
  ///return ((232-y)*10);
}

function draw_arc_fill(x, y, Color){

    var canvas = document.getElementById('canvas1');
    ctx = canvas.getContext('2d');


  ctx.beginPath();
  ctx.fillStyle = Color;
  ctx.strokeStyle=Color;
  ctx.arc(x,y,6,0,2*Math.PI);
  ctx.stroke();
  //ctx.arc(x, y, penWidth, 4, Math.PI*2, false);
```

```
    ctx.fill();

}

function draw_arc(x, y, Color){

    var canvas = document.getElementById('canvas1');
    ctx = canvas.getContext('2d');


ctx.beginPath();
ctx.fillStyle = Color;
ctx.strokeStyle= "#FF0000";
ctx.arc(x,y,6,0,2*Math.PI);
ctx.stroke();
//ctx.arc(x, y, penWidth, 4, Math.PI*2, false);
//  ctx.fill();

}


function draw_line(x, y, last_x, last_y, width, color){

            var canvas = document.getElementById('canvas1');
            ctx = canvas.getContext('2d');


    ctx.strokeStyle = color;
    ctx.lineWidth = width;

    ctx.beginPath();
    ctx.moveTo(last_x, last_y);
    ctx.lineTo(x, y);
    ctx.stroke();
}

function draw_image(){
            //var canvas = document.getElementById('canvas1');
            //ctx = canvas.getContext('2d');
            //var img=document.getElementById('up1.gif');
            //ctx.drawImage(img,x,y);

            var c=document.getElementById('canvas1');
            var ctx=c.getContext('2d');
            //var img=document.getElementById('http://oberon.nagaokaut.ac.jp/fz/asanka/images/up1.gif');
            //ctx.drawImage(img,500,500);

            var imageObj = new Image();
  //  imageObj.src = 'http://oberon.nagaokaut.ac.jp/fz/setu/images/1.gif';
 // imageObj.src = 'http://oberon.nagaokaut.ac.jp/fz/setu/images/up1.gif';
    ctx.drawImage(imageObj,200,420);
}



function draw_arrow(x, y, rot, color){

    var x2 = x - arrow_length * Math.cos(rot / 180 * Math.PI);
    var y2 = y + arrow_length * Math.sin(rot / 180 * Math.PI);


    var x3 = x2 + arrow_length2 * Math.cos((rot+arrow_sharpness) / 180 * Math.PI);
    var y3 = y2 - arrow_length2 * Math.sin((rot+arrow_sharpness) / 180 * Math.PI);
    var x4 = x2 + arrow_length2 * Math.cos((rot-arrow_sharpness) / 180 * Math.PI);
    var y4 = y2 - arrow_length2 * Math.sin((rot-arrow_sharpness) / 180 * Math.PI);


       var canvas = document.getElementById('canvas1');
```

```
        ctx = canvas.getContext('2d');

        ctx.strokeStyle=color;
    ctx.beginPath();
    ctx.moveTo(x, y);
    ctx.lineTo(x2, y2);
    ctx.lineTo(x3, y3);
    ctx.lineTo(x4, y4);
    ctx.lineTo(x2, y2);
    ctx.closePath();
    ctx.stroke();

   // var canvas = document.getElementById('canvas1');
  //  ctx = canvas.getContext('2d');
   // ctx.beginPath();
   // ctx.arc(x,y,4,0,2*Math.PI);
   // ctx.stroke();
}



function  text_only(x, y, text){

    var canvas = document.getElementById('content3');
    ctx = canvas.getContext('2d');
    ctx.fillStyle = 'green';
    ctx.font = "20px Arial";
                ctx.fillText("Available Student(s)",20,20);

//ctx.font         = '16px Sans-Serif';
 ctx.fillStyle = currentColor1;
 //var txt =text.substring(0,20);
ctx.fillText(text,(x), (y));
}



function draw_Note()
{

                var canvas = document.getElementById("content3");
                var ctx = canvas.getContext("2d");
                ctx.fillStyle = 'green';
                ctx.font = "20px Arial";
                ctx.fillText("Available Student",65,20);


  var canvas = document.getElementById("mycanvas");
                if (canvas.getContext) {
                                //var ctx = canvas.getContext('webgl') || canvas.getContext("experimental-webgl");
                  var ctx = canvas.getContext("2d");

 //ctx.fillStyle = Color;
                ctx.fillStyle= "#00FF00";
                 ctx.beginPath();
                 ctx.arc(40,50,6,0,2*Math.PI);
                ctx.fill();
                //ctx.stroke();
                // ctx.fillStyle = Color;

                //ctx.stroke();

                //ctx.arc(x, y, penWidth, 4, Math.PI*2, false);
                 // ctx.fill();
                 ctx.beginPath();
                ctx.fillStyle = 'green';
                ctx.font = "20px Arial";
```

```
            ctx.fillText("Notations",65,20);
            ctx.strokeStyle= "#FF0000";
            ctx.arc(40,100,6,0,2*Math.PI);
            ctx.stroke();

            ctx.fillStyle = 'black';
            ctx.font = "20px Arial";
            ctx.fillText("Eye Blinks",65,55);

            ctx.fillText("Open Eyes",65,105);


            ctx.strokeStyle="#FF0000";
   ctx.beginPath();
   ctx.moveTo(50, 150);
   ctx.lineTo(25, 150);
   ctx.lineTo(32, 142);
   ctx.lineTo(32, 157);
   ctx.lineTo(25, 150);
   ctx.closePath();
   ctx.stroke();

   ctx.fillText("Head Direction (Frontal)",65,160);

   ctx.strokeStyle="#FFFF00";
   ctx.beginPath();
   ctx.moveTo(50, 200);
   ctx.lineTo(25, 200);
   ctx.lineTo(32, 192);
   ctx.lineTo(32, 207);
   ctx.lineTo(25, 200);
   ctx.closePath();
   ctx.stroke();

   ctx.fillText("Head Direction (Right)",65,210);


   ctx.strokeStyle="#0000FF";
   ctx.beginPath();
   ctx.moveTo(50, 250);
   ctx.lineTo(25, 250);
   ctx.lineTo(32, 242);
   ctx.lineTo(32, 257);
   ctx.lineTo(25, 250);
   ctx.closePath();
   ctx.stroke();

   ctx.fillText("Head Direction (Left)",65,260);


            //
}
             }



function draw_class()
{


  var canvas = document.getElementById("canvas1");
            if (canvas.getContext) {
                        //var ctx = canvas.getContext('webgl') || canvas.getContext("experimental-webgl");
              var ctx = canvas.getContext("2d");
              ctx.beginPath();
                ctx.strokeRect(0, 0, 1110, 1000);
               ctx.strokeStyle = currentColor;
                //ctx.lineWidth = penWidth;
```

```
//Draw class room
                ctx.strokeRect(660, 280, 160, 190);
                ctx.strokeRect(660, 630, 160, 160);
                ctx.strokeRect(100, 450, 200, 180);
                ctx.strokeRect(660, 50, 370, 180);
                ctx.strokeRect(30, 730, 370, 180);
//Draw white board
                ctx.strokeStyle = "rgb(255, 0, 0)";
                        ctx.strokeRect(1028, 100, 2, 50);
                        ctx.strokeRect(28, 800, 2, 50);
//write the name of the class room
                        ctx.fillStyle = "rgb(100,0,0)";
                        ctx.font = "bold 12px sans-serif"
                        ctx.fillText("Class Room 1", 660, 278);
                ctx.fillText("Class Room 2", 660, 628);
                ctx.fillText("Class Room 3", 100, 448);
                ctx.fillText("Big Room 1", 660, 48);
                ctx.fillText("Big Room 2", 30, 728);



}
            }

function yourFunction(){
draw_class();draw_Note();

}

function clearCanvas(id, color, w, h){

            var canvas = document.getElementById(id);
            var c = canvas.getContext('2d');
            c.fillStyle =color;
            c.fillRect(0, 0,w, h);

}

function showHideDiv(id){
              var obj = document.getElementById(id);
                if (obj.style.display=="none"){
                  obj.style.display='block';
                } else if(obj.style.display=="block"){
                  obj.style.display='none';
                }
            }




function draw_moving_new(){

            make_searchdata();
   //document.writeln(time);
             new
Ajax.Request( 'draw_moving.php?date='+date+'&time='+time+'&island_name='+island_name+'&sensor_id='+sen
sor_id, {
                            onSuccess: function( transport ) {
                                        //document.writeln(time);
                                       // document.writeln(date);
                             var moving_datas = transport.responseXML.getElementsByTagName( 'data' );
                              var X_elements = transport.responseXML.getElementsByTagName( 'X' );
                              /*var Y_elements = transport.responseXML.getElementsByTagName( 'Y' );
                             var Z_elements = transport.responseXML.getElementsByTagName( 'Z' );
                              var rot_elements = transport.responseXML.getElementsByTagName( 'rot' );
                              var info_elements = transport.responseXML.getElementsByTagName( 'info' );
```

```
                        var head_direction_sec_elements =
transport.responseXML.getElementsByTagName( 'head_direction_sec' );
                       var eye_sec_elements = transport.responseXML.getElementsByTagName( 'eye_sec' );
                         var content_datas = transport.responseXML.getElementsByTagName( 'chatdata' );
                        */
                        clearCanvas('canvas1', "#ffffff", 1110, 1000);
                         clearCanvas('content3',"#FFA500", 300, 300);
                         clearCanvas('canvaschat',"#ffdab9", 610, 500);
                         draw_class();
                         //document.writeln(date);

                        //clearCanvas('canvas_status_new', "#FFA500", 610, 300);
                        //clearCanvas('canvas_status', "#ffdab9", 610, 300);

                      for( var i = 0; i < moving_datas.length; i++ )
                          {
                           var name = moving_datas[i].getAttribute('name');
                           var X = X_elements[i].firstChild.nodeValue;
                          /* var Y = Y_elements[i].firstChild.nodeValue;
                           var Z = Z_elements[i].firstChild.nodeValue;
                           var rot = rot_elements[i].firstChild.nodeValue;
                           var info = info_elements[i].firstChild.nodeValue;
                          var head_direction_sec = head_direction_sec_elements[i].firstChild.nodeValue;
                          var eye_sec = eye_sec_elements[i].firstChild.nodeValue;
                           var content = content_datas[i].getAttribute('content');
                          */
                           var Color = "rgb(100, 200, 0)";
                           var id='canvas1';
                           var idchat='canvaschat';
                           var s=i+1;
                          text_only(5, (parseFloat(i*30)+53), "" + s + ""+". "+ "" + x + "");
/*
      if(eye_sec==0){
                                                draw_arc(make_X(X), make_Y(Y),  Color);
                                          }
                                          else
                                                draw_arc_fill(make_X(X), make_Y(Y),  Color);



                                                  draw_text(make_X(X-1), make_Y(Y), (s), id);
                                                //   draw_text(make_X(X-1), make_Y(parseFloat(Y)+3), "("
+ eye + ")", id);
                                                  draw_text(25, (parseFloat(s*30)), "" + s + ""+"  . "+ "" +
content + "" , idchat);
                                                  draw_image();
                                                   //draw_Image(img,30,720);
                                                   //var ctx = canvas.getContext("2d");
                                                                // ctx.beginPath();
                                                                // ctx.drawImage(img,30,720);
                                                //  // draws the image at the specified x and y location
//text_only(5, 30, name);

                                                  if (head_direction_sec==2){ //left
                                                        draw_arrow(make_X(X), make_Y(Y),
parseFloat(rot-90), '#0000FF');
                                                           }
                                    else if(head_direction_sec==3){//right
                                                        draw_arrow(make_X(X), make_Y(Y),
parseFloat(rot+90), '#FFFF00');
                                                           }
                                     else {
                                          draw_arrow(make_X(X), make_Y(Y), parseFloat(rot), '#FF0000');
                                             }
                                          */

                                                   //draw_arrow(make_X(X), make_Y(Y),
parseFloat(rot+90));
```

```
                                                    //draw_arrow(make_X(X), make_Y(Y), parseFloat(rot-
90));
                                                  /*
                                                   for( var r = 0; r < content_datas.length; r++ )
                                                   {
                                                            var id='canvaschat';
                                                            var x=r+1;
                                                            var content =
content_datas[i].getAttribute('content');
                                                            draw_text(25, (parseFloat(s*30)), "" + x + ""+"  . "+
"" + content + "" , id);
                                                   }
                                                  */
                                                  }


                },

                onFailure: function( transport ) {
                        document.writeln(time);
                },

                onTimeout: function( transport ) {
                        document.writeln(time);
                }
               } );

              }




              function draw_moving(){

                        make_searchdata();
                //document.writeln(time);

                         new
Ajax.Request( 'draw_moving.php?date='+date+'&time='+time+'&island_name='+island_name+'&sensor_id='+sen
sor_id, {
                                        onSuccess: function( transport ) {
                                                document.writeln(time);
                                               // document.writeln(date);
                                         var moving_datas = transport.responseXML.getElementsByTagName( 'data' );

                                          var head_direction_sec_elements =
transport.responseXML.getElementsByTagName( 'head_direction_sec' );
                                          var eye_sec_elements =
transport.responseXML.getElementsByTagName( 'eye_sec' );
                                          var eye_elements = transport.responseXML.getElementsByTagName( 'eye' );
                                          var voice_status_elements =
transport.responseXML.getElementsByTagName( 'voice_status' );
                                          var eye_status_elements =
transport.responseXML.getElementsByTagName( 'eye_status' );
                                          var eye_size_minute_elements =
transport.responseXML.getElementsByTagName( 'eye_size' );
                                          var mouth_size_minute_elements =
transport.responseXML.getElementsByTagName( 'mouth_size' );
                                          var head_direction_minute_elements =
transport.responseXML.getElementsByTagName( 'head_direction' );
                                          var head_status_change_minute_elements =
transport.responseXML.getElementsByTagName( 'head_status_change' );
                                          var avatar_status_elements =
transport.responseXML.getElementsByTagName( 'avatar_status' );
                                          var avatar_status_change_minute_elements =
transport.responseXML.getElementsByTagName( 'avatar_status_change' );
```

```
                                    var content_datas =
transport.responseXML.getElementsByTagName( 'chatdata' );
                                    //document.writeln(date);

                                   // clearCanvas('canvas1', "#ffffff", 1110, 1000);
                                   // clearCanvas('content3',"#FFA500", 300, 300);
                                    //clearCanvas('canvaschat',"#ffdab9", 610, 500);
                                   // draw_class();


                                  clearCanvas('canvas_status_new', "#FFA500", 610, 300);
                                   clearCanvas('canvas_status', "#ffdab9", 610, 300);
                                    for( var i = 0; i < moving_datas.length; i++ )
                                    {
                                      var name = moving_datas[i].getAttribute('name');

                                       var head_direction_sec =
head_direction_sec_elements[i].firstChild.nodeValue;
                                       var eye_sec = eye_sec_elements[i].firstChild.nodeValue;
                                      var eye = eye_elements[i].firstChild.nodeValue;
                                      var voice_status = voice_status_elements[i].firstChild.nodeValue; //voice rate
per minute
                                      var eye_status = eye_status_elements[i].firstChild.nodeValue; //blink rate per
minute
                                      var eye_size_minute = eye_size_minute_elements[i].firstChild.nodeValue;
                                      var mouth_size_minute =
mouth_size_minute_elements[i].firstChild.nodeValue;
                                      var head_direction_minute =
head_direction_minute_elements[i].firstChild.nodeValue;
                                      var head_status_change_minute =
head_status_change_minute_elements[i].firstChild.nodeValue;
                                      var avatar_status = avatar_status_elements[i].firstChild.nodeValue;
                                      var avatar_status_change_minute =
avatar_status_change_minute_elements[i].firstChild.nodeValue;
                                                var content = content_datas[i].getAttribute('content');
                                       var Color = "rgb(100, 200, 0)";
                                       var id='canvas1';
                                       var idchat='canvaschat';
                                       //document.writeln(parseFloat(rot));
                                       var s=i+1;

                                            if(s==1){
                                       draw_text(10, 30*(s+3+2), 'EBR - Eye Blink Rate' , 'canvas_status');
                                            draw_text(300, 30*(s+3+2), 'ES - Eye Size' , 'canvas_status');
                                            draw_text(10, 30*(s+3+3), 'HD - Head Direction' , 'canvas_status');
                                            draw_text(300, 30*(s+3+3), 'HM - Head Movement' , 'canvas_status');
                                            draw_text(10, 30*(s+3+4), 'MS - Mouth Size' , 'canvas_status');
                                            draw_text(300, 30*(s+3+4), 'ASC - Avatar State change' ,
'canvas_status');
                                            draw_text(10, 30*(s+3+5), 'AS - Avatar State' , 'canvas_status');
                                            draw_text(300, 30*(s+3+5), 'V - Voice' , 'canvas_status');
                                                      }



                                       draw_text(25, 30, 'EBR' , 'canvas_status');
                                       draw_text(80, 30, 'ES' , 'canvas_status');
                                       draw_text(160, 30, 'HD' , 'canvas_status');
                                       draw_text(220, 30, 'HM' , 'canvas_status');
                                       draw_text(280, 30, 'MS' , 'canvas_status');
                                       draw_text(350, 30, 'ASC' , 'canvas_status');
                                       draw_text(410, 30, 'AS' , 'canvas_status');
                                       draw_text(490, 30, 'V' , 'canvas_status');
                                       draw_text(25, 30, 'Status' , 'canvas_status_new');
                                       if(s>3){
                                            draw_text(90, 30*(s+1-3), s , 'canvas_status_new');
                                                 }
```

```
                                        else{
                                        draw_text(10, 30*(s+1), s , 'canvas_status_new');
                                        }
                                        draw_text(5, 30*(s+1), s , 'canvas_status');

                                        //  img=new Image(); //creates a variable for a new image
                                              // var img.src=
"http://oberon.nagaokaut.ac.jp/fz/asanka/images/up1.gif"; // specifies the location of the image
                                                var eye_blink = 'none';
                                                var eye_size='none';
                                                var head_direction='none';
                                                var head_change='none';
                                                var mouth_size='none';
                                                var avatar_change='none';

                                             // draw_text(480, 30*(s+1), 'Low' , 'canvas_status');


                                        var a = namesnewArray.indexOf(name);


                                        var dif_min_voice=(voice_avgnewArray[a]-voice_minnewArray[a])/2;
                                                        var dif_max_voice=(voice_maxnewArray[a]-
voice_avgnewArray[a])/2;
                                                                if(voice_status<dif_min_voice){
                                                                        var voice = 'Low';
                                                                        draw_text(490, 30*(s+1), 'Low' ,
'canvas_status');
                                                                }
                                                                else if(voice_status>dif_max_voice){
                                                                        var voice = 'High';
                                                                        draw_text(490, 30*(s+1), 'High' ,
'canvas_status');
                                                                }
                                                                else if(voice_status>=dif_min_voice &&
voice_status<=voice_avgnewArray[a]){
                                                                        var voice = 'L to M';
                                                                        draw_text(490, 30*(s+1), 'L to M' ,
'canvas_status');
                                                                }
                                                                else if(voice_status>voice_avgnewArray[a] &&
voice_status<=dif_max_voice){
                                                                        var voice = 'M to H';
                                                                        draw_text(490, 30*(s+1), 'M to H' ,
'canvas_status');
                                                                }




                                        var dif_min_eyeblink=(eye_avgnewArray[a]-eye_minnewArray[a])/2;
                                                        var dif_max_eyeblink=(eye_maxnewArray[a]-
eye_avgnewArray[a])/2;
                                                                if(eye_status<dif_min_eyeblink){
                                                                        var eye_blink = 'Low';
                                                                        draw_text(25, 30*(s+1), 'Low' ,
'canvas_status');
                                                                }
                                                                else if(eye_status>dif_max_eyeblink){
                                                                        var eye_blink = 'High';
                                                                        draw_text(25, 30*(s+1), 'High' ,
'canvas_status');
                                                                }
                                                                else if(eye_status>=dif_min_eyeblink &&
eye_status<=eye_avgnewArray[a]){
                                                                        var eye_blink = 'L to M';
```

```
                draw_text(25, 30*(s+1), 'L to M' ,
'canvas_status');
        }
        else if(eye_status>eye_avgnewArray[a] &&
eye_status<=dif_max_eyeblink){
                var eye_blink = 'M to H';
                draw_text(25, 30*(s+1), 'M to H' ,
'canvas_status');
        }//else draw_text(15, 30*(s+1), eye_status ,
'canvas_status');



        var dif_min_eye=(eyesizenewArray[a]-
eyesizeminnewArray[a])/2;
        var dif_max_eye=(eyesizenewArray[a]-
eyesizemaxnewArray[a])/2;

        if
(eye_size_minute>(eyesizenewArray[a]+dif_max_eye)){
                eye_size='Large';
                draw_text(80, 30*(s+1), 'V Large' ,
'canvas_status');
        }
                else if
(eye_size_minute<(eyesizenewArray[a]-dif_min_eye)){
                        eye_size='Normal';
                        draw_text(80, 30*(s+1), 'V
Small' , 'canvas_status');
                }
                        else {
                                eye_size='Small';
                                draw_text(80,
30*(s+1), 'Small' , 'canvas_status');
                        }



        if(head_direction_minute>75.0){
                head_direction='Frontal';
                draw_text(160, 30*(s+1), 'Frntl' ,
'canvas_status');
        }
        else {
                head_direction='Non-frontal';
                draw_text(160, 30*(s+1), 'N-frntl' ,
'canvas_status');
        }




        //head_change_maxnewArray


                var
dif_min_headchange=(head_change_avgnewArray[a]-head_change_minnewArray[a])/2;
                var
dif_max_headchange=(head_change_maxnewArray[a]-head_change_avgnewArray[a])/2;

        if(head_status_change_minute<dif_min_headchange){
                                var head_change =
'Low';
                                draw_text(220,
30*(s+1), 'Low' , 'canvas_status');
```

```
                                                                    }
                                                                    else
if(head_status_change_minute>dif_max_headchange){
var head_change = 'High';
draw_text(220, 30*(s+1), 'High' , 'canvas_status');
}
if(head_status_change_minute>=dif_min_headchange &&
head_status_change_minute<=head_change_avgnewArray[a]){
head_change = 'L to M';
_text(220, 30*(s+1), 'L to M' , 'canvas_status');
}
else if(head_status_change_minute>head_change_avgnewArray[a] &&
head_status_change_minute<=dif_max_headchange){
var head_change = 'M to H';
draw_text(220, 30*(s+1), 'M to H' , 'canvas_status');
}//else draw_text(210, 30*(s+1), 'Low' , 'canvas_status');
var dif_min_mouth=(mouthsizenewArray[a]-mouthsizeminnewArray[a])/2;
var dif_max_mouth=(mouthsizenewArray[a]-mouthsizemaxnewArray[a])/2;
if (mouth_size_minute>(mouthsizenewArray[a]+dif_max_mouth)){
mouth_size='Large';
draw_text(280, 30*(s+1), 'V Large' , 'canvas_status');
}
else if (mouth_size_minute<(mouthsizenewArray[a]-dif_min_mouth)){
mouth_size='Small';
draw_text(280, 30*(s+1), 'V Small' , 'canvas_status');
}
else {
mouth_size='Avg';
draw_text(280, 30*(s+1), 'Small' , 'canvas_status');
}

var dif_min_avatarchange=(avatarstatuschange_avgnewArray[a]-avatarstatuschange_minnewArray[a])/2;
var dif_max_avatarchange=(avatarstatuschange_maxnewArray[a]-avatarstatuschange_avgnewArray[a])/2;
if(avatar_status_change_minute<dif_min_headchange){
var avatar_change = 'Low';
draw_text(350, 30*(s+1), 'Low' , 'canvas_status');
}
else if(avatar_status_change_minute>dif_max_avatarchange){
var avatar_change = 'High';
draw_text(350, 30*(s+1), 'High' , 'canvas_status');
}
else if(avatar_status_change_minute>=dif_min_avatarchange &&
avatar_status_change_minute<=avatarstatuschange_avgnewArray[a]){
var avatar_change = 'L to M';
draw_text(350, 30*(s+1), 'L to M' , 'canvas_status');
}
else if(avatar_status_change_minute>avatarstatuschange_avgnewArray[a] &&
avatar_status_change_minute<=avatarstatuschange_maxnewArray){
var avatar_change = 'M to H';
draw_text(350, 30*(s+1), 'M to H' , 'canvas_status');
}//else draw_text(210, 30*(s+1), 'Low' , 'canvas_status');

draw_text(400, 30*(s+1), avatar_status , 'canvas_status');
draw_text(400, 30*xy, index, 'canvas_status');
draw_text(10, 30*s, name, 'canvas_status');
 draw_text(500, 30*s, eyenewArray[a], 'canvas_status');
draw_text(540, 30*s, eye_status , 'canvas_status');
            //    draw_text(110, 30*s, eyesizenewArray[a] , 'canvas_status');
          //       draw_text(210, 30*s, eye_size_minute , 'canvas_status');
          //draw_text(210, 30*s, avatar_status , 'canvas_status');
          //draw_text(160, 30*s, avatar_status_change_minute , 'canvas_status');
          //draw_text(210, 30*s, avatarstatuschangenewArray[a] , 'canvas_status');


          //draw_text(210, 30*s, head_status_change_minute , 'canvas_status');
          //draw_text(230, 30*s, headchangenewArray[a] , 'canvas_status');
          //  draw_text(310, 30*s, eyesizeminnewArray[a] , 'canvas_status');
          //draw_text(210, 30*s, mouthsizenewArray[a] , 'canvas_status');
```

```
//      draw_text(10, 30*s, mouthsizemaxnewArray[a] , 'canvas_status');
//      draw_text(310, 30*s, mouthsizeminnewArray[a] , 'canvas_status');
//      draw_text(500, 30*s, mouth_size_minute , 'canvas_status');
   //   draw_text(500, 30*s, head_direction_minute , 'canvas_status');


if (s>3){
if(head_direction== 'Frontal' && eye_size!='Small' && head_change =='Low' && avatar_status !='Away'){
draw_text(100, 30*(s+1-3), 'Attentive' , 'canvas_status_new');
}else if(head_direction== 'Non-frontal' && head_change !='Low' && head_change !='Low' && avatar_status
=='Away' ){
draw_text(100, 30*(s+1-3), 'Not attentive' , 'canvas_status_new');
}else if(eye_blink != 'Low' && head_direction== 'Non-frontal' && head_change !='Low' && mouth_size!='Small'
&& avatar_status =='Away' ){
draw_text(100, 30*(s+1-3), 'Frustrated/struggling' , 'canvas_status_new');
}else if(eye_blink != 'Low' && head_direction== 'Non-frontal' && eye_size!='Small' && head_change !='Low' ){
draw_text(100, 30*(s+1-3), 'Distracted/nervous' , 'canvas_status_new');
}else if(head_direction== 'Frontal' && eye_size!='Small' && head_change !='Low' && mouth_size!='Small' ){
draw_text(100, 30*(s+1-3), 'Tired/sleepy' , 'canvas_status_new');
}else if(eye_blink != 'High' && head_direction== 'Frontal' && mouth_size!='Small' && head_change !='Low'
&& avatar_status !='Away'){
draw_text(100, 30*(s+1-3), 'Interest' , 'canvas_status_new');
}else
draw_text(100, 30*(s+1-3), 'None' , 'canvas_status_new');
}
else{
if(head_direction== 'Frontal' && eye_size!='Small' && head_change =='Low' && avatar_status !='Away'){
draw_text(25, 30*(s+1), 'Attentive' , 'canvas_status_new');
}else if(head_direction== 'Non-frontal' && head_change !='Low' && head_change !='Low' && avatar_status
=='Away' ){
draw_text(25, 30*(s+1), 'Not attentive' , 'canvas_status_new');
}else if(eye_blink != 'Low' && head_direction== 'Non-frontal' && head_change !='Low' && mouth_size!='Small'
&& avatar_status =='Away' ){
draw_text(25, 30*(s+1), 'Frustrated/struggling' , 'canvas_status_new');
}else if(eye_blink != 'Low' && head_direction== 'Non-frontal' && eye_size!='Small' && head_change !='Low' ){
draw_text(25, 30*(s+1), 'Distracted/nervous' , 'canvas_status_new');
}else if(head_direction== 'Frontal' && eye_size!='Small' && head_change !='Low' && mouth_size!='Small' ){
draw_text(25, 30*(s+1), 'Tired/sleepy' , 'canvas_status_new');
}else if(eye_blink != 'High' && head_direction== 'Frontal' && mouth_size!='Small' && head_change !='Low'
&& avatar_status !='Away'){
draw_text(25, 30*(s+1), 'Interest' , 'canvas_status_new');
}else
draw_text(25, 30*(s+1), 'None' , 'canvas_status_new');
}
//draw_arrow(make_X(X), make_Y(Y), parseFloat(rot+90));
      //draw_arrow(make_X(X), make_Y(Y), parseFloat(rot-90));    /*
                  for( var r = 0; r < content_datas.length; r++ )
                  {
                        var id='canvaschat';
                        var x=r+1;
                        var content = content_datas[i].getAttribute('content');
                        draw_text(25, (parseFloat(s*30)), "" + x + ""+"  . "+ "" + content + "" , id);
                  }
                 */
                    }


                  },

                  onFailure: function( transport ) {

                  },

                  onTimeout: function( transport ) {

                  }
                 } );
```

```
        }
var myvar;
        function reset(){
                window.location.reload(true);
        }

        function continous(){
           if(timer_id != ""){
              window.clearTimeout(timer_id);
           }
           timer_id = setTimeout(continous, 3000);
           changeTime('s+');
           //timer_id = window.setTimeout  { alert("Hi") }, 1000)};

          //timer_id = window.setTimeout( continous, 3000 );
           //timer_id =  window.setInterval( continous, 3000 );
        }


        function stop(){
           if(timer_id != ""){
              window.clearTimeout(timer_id);
           }
        }

        function eye_text(x, y, text){

              var canvas = document.getElementById('mycanvas');
              ctx = canvas.getContext('2d');


           ctx.font        = '16px Sans-Serif';
           //ctx.font = [fontSize, fontFamiliyName].join(' ');
                   ctx.fillStyle = currentColor1;
                   var txt =text.substring(0,20);
           ctx.fillText(txt,(x), (y));
        }

        function clearCanvas2(){

                var canvas = document.getElementById('mycanvas');
                var c = canvas.getContext('2d');
                c.fillStyle = "#ffcda0";
                c.fillRect(0, 0, CanvasW1, CanvasH1);

        }

        function Avg_eyeblink(){
                make_searchdata();

                 new Ajax.Request( 'Avg_eyeblink.php?date='+date+'&time='+time, {
                        onSuccess: function( transport ) {

                                var eye_datas =
transport.responseXML.getElementsByTagName( 'data' );
                                var Avgeye_elements =
transport.responseXML.getElementsByTagName( 'X' );

                                clearCanvas2();

                               for( var i = 0; i < eye_datas.length; i++ )
                               {
                                    var name = eye_datas[i].getAttribute('name');
                                var Avgeye = Avgeye_elements[i].firstChild.nodeValue;
                                eye_text(5, (parseFloat(i*30)+33),  "" + name + "");
                                eye_text(206, (parseFloat(i*30)+33), "" + Avgeye + "");
                               }
```

```
                                        },

                                        onFailure: function( transport ) {
                                                document.writeln("ok");
                                        },

                                        onTimeout: function( transport ) {
                                                document.writeln("ok");
                                        }
                                       } );

                                      }

//              make_searchdata();
//              draw_moving();

</script>

<body onload="yourFunction();">

<div id="menux"  style="height:1000px;width:300px;float:left;">

<div id="menu1"  style="height:190px;width:150px;float:left;background-color:#ffdab9;">
<br>
<div ALIGN=center>
<font color="green"><b>Select Time</b></font>

<br>

<TABLE bgColor="black"><TR><TD><TR><TD>
<SCRIPT type="text/JavaScript">
<!--

clock();
//-->
</SCRIPT>
</TD></TR></TABLE>
<br>
<table>
<tr>
<td align="center" width="40px">
HH
</td>
<td align="center" width="40px">
MM
</td>
<td align="center" width="40px">
SS
</td>
</tr>
</table>

<BUTTON type="button" value="" onclick="changeTime('h+')">
<IMG src="http://oberon.nagaokaut.ac.jp/fz/asanka/images/north.tif">
</BUTTON>

<BUTTON type="button" value="" onclick="changeTime('n+')">
<IMG src="http://oberon.nagaokaut.ac.jp/fz/asanka/images/north.tif">
</BUTTON>

<BUTTON type="button" value="" onclick="changeTime('s+')">
<IMG src="http://oberon.nagaokaut.ac.jp/fz/asanka/images/north.tif">
</BUTTON>
<br>
<BUTTON type="button" value="" onclick="changeTime('h-')">
<IMG src="http://oberon.nagaokaut.ac.jp/fz/asanka/images/north.tif">
</BUTTON>
```

```
<BUTTON type="button" value="" onclick="changeTime('n-')">
<IMG src="http://oberon.nagaokaut.ac.jp/fz/asanka/images/north.tif">
</BUTTON>

<BUTTON type="button" value="" onclick="changeTime('s-')">
<IMG src="http://oberon.nagaokaut.ac.jp/fz/asanka/images/north.tif">
</BUTTON>
<br>




</div>

</div>


<div id="menu2" style="height:190px;width:150px;float:left;background-color:#ffdab9;">

<div ALIGN=center>
<br>
<font color="green" ><b>Select Date</b></font>
<br>
<TABLE bgColor="black"><TR><TD>
<SCRIPT type="text/JavaScript">
<!--
Date_ymd();
//-->
</SCRIPT>
</TD></TR>
</TABLE>

<br>
<table>
<tr>
<td align="center" width="40px">
MM
</td>
<td align="center" width="40px">
DD
</td>
<td align="center" width="40px">
YY
</td>
</tr>
</table>

<BUTTON type="button" value="" onclick="changeDate('m+')">
<IMG src="http://oberon.nagaokaut.ac.jp/fz/asanka/images/north.tif">
</BUTTON>

<BUTTON type="button" value="" onclick="changeDate('d+')">
<IMG src="http://oberon.nagaokaut.ac.jp/fz/asanka/images/north.tif">
</BUTTON>

<BUTTON type="button" value="" onclick="changeDate('y+')">
<IMG src="http://oberon.nagaokaut.ac.jp/fz/asanka/images/north.tif">
</BUTTON>
<br>
<BUTTON type="button" value="" onclick="changeDate('m-')">
<IMG src="http://oberon.nagaokaut.ac.jp/fz/asanka/images/north.tif">
</BUTTON>

<BUTTON type="button" value="" onclick="changeDate('d-')">
<IMG src="http://oberon.nagaokaut.ac.jp/fz/asanka/images/north.tif">
</BUTTON>
```

```
<BUTTON type="button" value="" onclick="changeDate('y-')">
<IMG src="http://oberon.nagaokaut.ac.jp/fz/asanka/images/north.tif">
</BUTTON>
<br>
</div>
</div>
<br>
<div id="menu3" style="height:50px;width:300px;float:left;background-color:#ffdab9;">
<div ALIGN=center>

<input type="button"  value="Reset" onclick="reset()">
<input type="button"  value="Stop" onclick="stop()">
<input type="button" value="continous" onclick="continous()">
<br>

</div>
</div>




<div id="contentmy" style="background-color:#FFA500;height:300px;width:300px;float:left;">
<canvas id='content3' width='300' height='300' style='float:top;'></canvas>

</div>




<div id="contentnew" style="background-color:#ffcda0;height:790px;width:300px;float:left;">
<canvas id='mycanvas' width='300' height='790' style='float:top;'></canvas>

</div>

</div>

<div id="content" style="background-color:#EEEEEE;height:1000px;width:1100px;float:left;">
<canvas id="canvas1" width="1100" height="1000"></canvas>
</div>
<div id="div-1" style="width:610px;float:right;background-color:#ffdab9;">
<div ALIGN=center>
<font size="6" color="green" ><b>Student status</b></font>
</div>
<font size="4">
Please select the date and time as reference data to obtain the student status
<br>
Select the Date:

        <?php
        date_default_timezone_set("Japan");
        $m=date("m");

        echo "<SELECT NAME=Month id=Month><OPTION> $m </OPTION>";
        echo "<OPTION VALUE=01>01</OPTION>";
        echo "<OPTION VALUE=02>02</OPTION>";
        echo "<OPTION VALUE=03>03</OPTION>";
        echo "<OPTION VALUE=04>04</OPTION>";
        echo "<OPTION VALUE=05>05</OPTION>";
        echo "<OPTION VALUE=06>06</OPTION>";
        echo "<OPTION VALUE=07>07</OPTION>";
        echo "<OPTION VALUE=08>08</OPTION>";
        echo "<OPTION VALUE=09>09</OPTION>";
        echo "<OPTION VALUE=10>10</OPTION>";
        echo "<OPTION VALUE=11>11</OPTION>";
        echo "<OPTION VALUE=12>12</OPTION>";
        echo "</SELECT>";
        $d=date("j");
```

```
		echo "<SELECT NAME=Day id=Day><OPTION>$d</OPTION>n";
		$Day = 1;
		while ($Day <= 31) {
		if ($Day<10)
			echo "<OPTION VALUE=0$Day>$Day</OPTION>n";
			else
			echo "<OPTION VALUE=$Day>$Day</OPTION>n";
			$Day++;
			}
			echo "</SELECT>";

		$y=date("Y");
		echo "<SELECT NAME=Year id=Year><OPTION>$y</OPTION>n";
		$EndYear = $y - 10;
		while ($y >= $EndYear) {
		echo "<OPTION VALUE=$EndYear>$EndYear</OPTION>n";
		$EndYear++;
		}
		echo "</SELECT>";
		?>

		<br>
Select the Time Duration:
		<SELECT NAME=Hour1 id=Hour1><OPTION> hh </OPTION>
<?php
$hour = 1;
while ($hour <= 23) {
if ($hour<10)
echo "<OPTION VALUE=0$hour>$hour</OPTION>n";
else
echo "<OPTION VALUE=$hour>$hour</OPTION>n";
$hour++;
}
?>
</SELECT>

<SELECT NAME=Min1 id=Min1><OPTION> mm </OPTION>
<?php
$minute = 1;
while ($minute <= 59) {
if ($minute<10)
echo "<OPTION VALUE=0$minute>$minute</OPTION>n";
else
echo "<OPTION VALUE=$minute>$minute</OPTION>n";
$minute++;
}
?>
</SELECT>
To

<SELECT NAME=Hour2 id=Hour2><OPTION> hh </OPTION>
<?php

$hour11 = 1;
while ($hour11 <= 23) {
if ($hour11<10)
echo "<OPTION VALUE=0$hour11>$hour11</OPTION>n";
else
echo "<OPTION VALUE=$hour11>$hour11</OPTION>n";
$hour11++;
}

?>
</SELECT>

<SELECT NAME=Min2 id=Min2><OPTION> mm </OPTION>
<?php
$minute1 = 1;
```

```
while ($minute1 <= 59) {
if ($minute1<10)
echo "<OPTION VALUE=0$minute1>$minute1</OPTION>n";
else
echo "<OPTION VALUE=$minute1>$minute1</OPTION>n";
$minute1++;
}
?>
</SELECT>
		</font>


		<br>

<BUTTON type="button" value="" onclick="Status_info()">
<IMG src="http://oberon.nagaokaut.ac.jp/fz/setu/images/north.tif">
</BUTTON>
<canvas id="canvas_status_new" width="610" height="130" >
		</canvas>


<a href="#" onclick="showHideDiv('div-11')">
		Click here to Show more info
</div>
</a><br />

<div id="div-11" style="display:none;width:610px;float:right;background-color:#ffdab9;">
<canvas id="canvas_status" width="610" height="300" >
		</canvas>
</div>

<div id="menuxx" style="height:50px;width:610px;float:right;background-color:#ffdab9;">
<div ALIGN=center>
<font size="6" color="green" ><b>Voice Information</b></font>
</div>
</div>

<div id="menux" style="height:150px;width:610px;float:right;background-color:#ffdab9;">
<div id="menux1" style="height:50px;width:140px;float:left;background-color:#ffdab9;">
<font size="4" color="black"><b>eLearning kidd</b></font>
</div>
<div id="menux2" style="height:50px;width:165px;float:left;background-color:#ffdab9;">
<object height="40" width="160" data="http://oberon.nagaokaut.ac.jp/fz/setu/1.ogv"></object>
</div>
<div id="menux3" style="height:50px;width:150px;float:left;background-color:#ffdab9;">
<object height="60" width="160"> <font size="4" color="black"><b>RajiveNUT</b></font></object>
</div>
<div id="menux4" style="height:50px;width:155px;float:left;background-color:#ffdab9;">
<object height="60" width="160" data="http://oberon.nagaokaut.ac.jp/fz/setu/11.mp4"></object>
</div>
<div id="menux5" style="height:50px;width:140px;float:left;background-color:#ffdab9;">
<object height="60" width="160"> <font  size="4" color="black"><b>BalaNUT</b></font></object>
</div>
<div id="menux6" style="height:50px;width:165px;float:left;background-color:#ffdab9;">
<object height="60" width="160" data="http://oberon.nagaokaut.ac.jp/fz/setu/22.wav"></object>
</div>
<div id="menux7" style="height:50px;width:150px;float:left;background-color:#ffdab9;">
<object height="60" width="160"> <font size="4" color="black"><b>ChamaraNUT</b></font></object>
</div>
<div id="menux8" style="height:50px;width:155px;float:left;background-color:#ffdab9;">
<object height="60" width="160" data="http://oberon.nagaokaut.ac.jp/fz/setu/22.wav"></object>
</div>

</div>
<div id="menu5" style="height:50px;width:610px;float:right;background-color:#ffdab9;">
<div ALIGN=center>
<font size="6" color="green" ><b>Chat Information</b></font>
</div>
```

```
</div>


<div id="contentchat" style="background-color:#ffdab9;height:500px;width:610px;float:Right;">
<canvas id="canvaschat" width="610" height="200"></canvas>
</div>
</body>


</head>

</html>
```

5.3. Avatar Modification in the Virtual Learning Environment

```
key requestid;
string NUM;
float gap = 1.0;
integer i=44;
string firstName;
list myList;
list values;
rotation gRotDoorSwing;

default{
   state_entry(){
       llSay(0, "ok");
   llSetTimerEvent(gap);
 llSetRot( llEuler2Rot( <0.03, 0.05, 1.4 > ) );
  // gRotDoorSwing = llEuler2Rot( <0.0,  0.0, vgIntDoorSwing >* DEG_TO_RAD);
  gRotDoorSwing =llEuler2Rot( <0.0,0.0,00.0> * DEG_TO_RAD );
       llSetLocalRot( (gRotDoorSwing = ZERO_ROTATION / gRotDoorSwing) * llGetLocalRot() );
     }

    timer(){
          requestid = llHTTPRequest("http://oberon.nagaokaut.ac.jp/cgi-bin-
fz/setu/Eye_Blinking/Rajive/Rajive1.php?var=",[HTTP_METHOD,"POST"],"");
        }
    http_response(key request_id, integer status, list metadata, string body){
      if (request_id == requestid){
            //    llSay(0, body);
    myList = [];
             string result3 = llGetSubString(body,68,78);// gets "abcd"
             integer spaceIndex3 = llSubStringIndex(result3, "</X>");
             integer spaceIndexN3 = llSubStringIndex(result3, "<X>");
             string Yaw = llGetSubString(result3, spaceIndexN3+3, spaceIndex3-1);
          //  llSay(0,Yaw );

             string result1 = llGetSubString(body,84,204);//gets "abcd"
             integer spaceIndex1 = llSubStringIndex(result1, "</X>");
             integer spaceIndexN1 = llSubStringIndex(result1, "<X>");
             string hand = llGetSubString(result1, spaceIndexN1+3, spaceIndex1-1);
       //llSay(0,hand);

            // string result4 = llGetSubString(body,116,136);//gets "abcd"
            //  integer spaceIndex4 = llSubStringIndex(result4, "</X>");
            //  integer spaceIndexN4 = llSubStringIndex(result4, "<X>");
            //  string hand1 = llGetSubString(result4, spaceIndexN4+3, spaceIndex4-1);
       //llSay(0,hand1);

              string result2 = llGetSubString(body,110, 148);//ets "abcd"
             integer spaceIndex2 = llSubStringIndex(result2, "</X>");
             integer spaceIndexN2 = llSubStringIndex(result2, "<X>");
             string pitch = llGetSubString(result2, spaceIndexN2+3, spaceIndex2-1);
          //   llSay(0,pitch);

              string result4 = llGetSubString(body,136,190);//gets "abcd"
             integer spaceIndex4 = llSubStringIndex(result4, "</X>");
             integer spaceIndexN4 = llSubStringIndex(result4, "<X>");
             string direction = llGetSubString(result4, spaceIndexN4+3, spaceIndex4-1);
     // llSay(0,direction);

              values = [firstName, Yaw, hand, pitch, direction];
              string list_parameter = llDumpList2String(values, "|");
              ////////////////////////////////////////////////second values
                string result33 = llGetSubString(body,162,292);// gets "abcd"
             integer spaceIndex33 = llSubStringIndex(result33, "</X>");
             integer spaceIndexN33 = llSubStringIndex(result33, "<X>");
             string Yaw3 = llGetSubString(result33, spaceIndexN33+3, spaceIndex33-1);
          // llSay(0,Yaw3);

             string result11 = llGetSubString(body,194,250);//gets "abcd"
```

```
            integer spaceIndex11 = llSubStringIndex(result11, "</X>");
            integer spaceIndexN11 = llSubStringIndex(result11, "<X>");
            string hand11 = llGetSubString(result11, spaceIndexN11+3, spaceIndex11-1);
   // llSay(0,hand11);

           // string result4 = llGetSubString(body,116,136);//gets "abcd"
          //  integer spaceIndex4 = llSubStringIndex(result4, "</X>");
          //  integer spaceIndexN4 = llSubStringIndex(result4, "<X>");
          //  string hand1 = llGetSubString(result4, spaceIndexN4+3, spaceIndex4-1);
     //  llSay(0,hand1);

            string result22 = llGetSubString(body,218, 276);//ets "abcd"
           integer spaceIndex22 = llSubStringIndex(result22, "</X>");
           integer spaceIndexN22 = llSubStringIndex(result22, "<X>");
           string pitch2 = llGetSubString(result22, spaceIndexN22+3, spaceIndex22-1);
         // llSay(0,pitch2);

            string result44 = llGetSubString(body,244,368);//gets "abcd"
           integer spaceIndex44 = llSubStringIndex(result44, "</X>");
           integer spaceIndexN44 = llSubStringIndex(result44, "<X>");
           string direction44 = llGetSubString(result44, spaceIndexN44+3, spaceIndex44-1);
     //  llSay(0,direction44 );

          if ((Yaw==Yaw3 && hand==hand11 && pitch==pitch2 && direction=="0")) {
             //  llSay(0,direction44 );
              } else if ((direction==direction44 && direction !="0")) {
             // llSay(0,pitch2);
              } else
              llSleep(1);
              llMessageLinked(-4, 1,list_parameter, NULL_KEY);

        string result = llGetSubString(body, 42, 52); // gets "abcd"
          integer spaceIndex = llSubStringIndex(result, "</X>");
          integer spaceIndexN = llSubStringIndex(result, "<X>");
         firstName = llGetSubString(result, spaceIndexN+3, spaceIndex-1);
        //llSay(0, result );
           if(firstName=="0"){
         llSleep(1);
        llMessageLinked(LINK_ALL_OTHERS, 0, llGetScriptName(), "");
llSleep(0.5);
          }
llMessageLinked(-4, 1,list_parameter, NULL_KEY);
      // llSay(0, pitch);
       }
      }
}
////////////////////////////////////////////////////////////////////////////////////////////////////
integer vgIntDoorSwing = 0;
rotation gRotDoorSwing;
integer Open = 1;

default{
 state_entry(){
    llSetRot( llEuler2Rot( <0.03, 0.05, 1.4 > ) );
  gRotDoorSwing = llEuler2Rot( <0.0,  0.0, vgIntDoorSwing >* DEG_TO_RAD);
 // gRotDoorSwing =llEuler2Rot( <20.0,20.0,20.0> * DEG_TO_RAD );
       llSetLocalRot( (gRotDoorSwing = ZERO_ROTATION / gRotDoorSwing) * llGetLocalRot() );

       vector v1RadBase = llRot2Euler(llGetLocalRot() );
     // llSay(0, (string) v1RadBase);
        }
   link_message(integer Sender, integer Number, string list_argument, key ID){
   list re_list = llParseString2List(list_argument, ["|"], [""]);
   string direction;

direction = llList2String(re_list,4);
  // llOwnerSay( (string) direction );
integer Head_direction=(integer)direction;
```

```
 // integer Head_direction=2;
  if( Head_direction==1){
       llSetRot( llEuler2Rot( <0.03, 0.05, 1.4 > ) );
       gRotDoorSwing = llEuler2Rot( <35,  0, 0 > * DEG_TO_RAD );//up
       llSetLocalRot( (gRotDoorSwing = ZERO_ROTATION / gRotDoorSwing) *     llGetLocalRot() );
         }

       if( Head_direction==2){
       llSetRot( llEuler2Rot( <0.03, 0.05, 1.4 > ) );
       gRotDoorSwing = llEuler2Rot( <0,  0, -70 > * DEG_TO_RAD );//left
       llSetLocalRot( (gRotDoorSwing = ZERO_ROTATION / gRotDoorSwing) *    llGetLocalRot() );
         }

        if( Head_direction==3){
       llSetRot( llEuler2Rot( <0.03, 0.05, 1.4 > ) );
       gRotDoorSwing = llEuler2Rot( <0, 0, 70 > * DEG_TO_RAD );//right
       llSetLocalRot( (gRotDoorSwing = ZERO_ROTATION / gRotDoorSwing) *   llGetLocalRot() );
         }

        if( Head_direction==4){
       llSetRot( llEuler2Rot( <0.03, 0.05, 1.4 > ) );
       gRotDoorSwing = llEuler2Rot( <-35,  0, 0 > * DEG_TO_RAD );//down
       llSetLocalRot( (gRotDoorSwing = ZERO_ROTATION / gRotDoorSwing) *     llGetLocalRot() );
         }
else  if( Head_direction==0){
string element;
      element = llList2String(re_list,1);
      // llOwnerSay( (string) element );
      string element1;
      element1 = llList2String(re_list,2);
      string element2;
      element2 = llList2String(re_list,3);
     integer val=(integer)element/2;
      integer val1=(integer)element1/2;
     integer val2=(integer)element2/2;

     // llOwnerSay( (string) val );
     //   llOwnerSay( (string) val1);
      //   llOwnerSay( (string) val2);
        if(val2>25){
            val2=25;
        //llOwnerSay( (string) val2);
         }
          if(val2<-25){
            val2=-25;
        //llOwnerSay( (string) val2);
         }
         if( val>25){
            val=25;
// llSetPos(llGetLocalPos() + <0.05, 0.0, 0>);
        //llOwnerSay( (string) val2);
         }
         if(val<-25){
            val=-25;
        //llOwnerSay( (string) val2);
         }

         if(val1>30){
            val1=30;
        //llOwnerSay( (string) val2);
         }
          if(val1<-30){
            val1=-30;
        //llOwnerSay( (string) val2);
         }
        //llSay(0,(string) pos.x);
 //  llSetPos(llGetLocalPos() + <-0.05, 0.0, 0>);
       llSetRot( llEuler2Rot( <0.03, 0.05, 1.4 > ) );
```

```
          gRotDoorSwing = llEuler2Rot( <val,  val2, val1 > * DEG_TO_RAD );
    //  gRotDoorSwing = llEuler2Rot( <val,  0, 00 > * DEG_TO_RAD );
        // gRotDoorSwing =llEuler2Rot( <20.0,20.0,20.0> * DEG_TO_RAD );
        llSetLocalRot( (gRotDoorSwing = ZERO_ROTATION / gRotDoorSwing) *                llGetLocalRot() );

        vector v1RadBase = llRot2Euler(llGetLocalRot() );
        //  llSay(0, (string) v1RadBase);
         return;
    }
    }
}
////////////////////////////////////////////////////////////////////////////////////////////////////
key requestid;
string NUM;
float gap = 1.0;

default{
    state_entry(){
     // llSetTimerEvent(gap);
      llSay(0, "ok");
      }

    timer(){
          requestid = llHTTPRequest("http://oberon.nagaokaut.ac.jp/cgi-bin-
fz/setu/Eye_Blinking/Rajive/Rajive1.php?var=",[HTTP_METHOD,"POST"],"");
         }
    http_response(key request_id, integer status, list metadata, string body){
       if (request_id == requestid){
            string result = llGetSubString(body, 44, 47); // gets "abcd"
          // llSay(0, result);
            if(result=="Blin"){
            llSleep(0.5);
            llMessageLinked(LINK_ALL_OTHERS, 0, llGetScriptName(), "");
//llSleep(0.5);
            }
       }
       }
}
```