FUZZY EXPERT ADVISORY FOR E-COUNSELLING

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ABSTRAK

Logik Kabur dan Sistem Pakar di rekabentuk untuk meniru proses membuat keputusan dalam sistem bermodul, menetapkan nilai berasaskan syarat dan menggunakan kawalan logik kabur untuk menerangkan sistem yang ketidakpastian, dan menggunakan pengaruh sistem pakar untuk mewakili dan mengawal pengetahuan (Medeiros et al., 1998). Kertas kerja ini membentangkan pembangunan Logik Kabur dan Sistem Pakar penasihat untuk Sistem e-Kaunseling. Model penasihat dalam kaunseling ini menggunakan sistem bermodul yang digunakan untuk proses ujian psikologi bagi Tingkahlaku Kendiri terhadap Akademik (TKA). Sistem ini dibangunkan dengan menggunakan pendekatan struktur berhirarki. Sistem ini telah dibangunkan dengan menggunakan bahasa applikasi berasaskan web iaitu Halaman Pelayan Aktif Microsoft (ASP) iaitu tapak pelayan penulisan web. Sistem ini mengandungi lima modul, iaitu Inisiatif Pelajar bagi TKA faktor pertama, Perhatian Sosial bagi TKA faktor kedua, Kejayaan/Kegagalan bagi TKA faktor ketiga, Daya Tarikan Sosial bagi TKA faktor keempat, dan Keyakinan Diri bagi TKA faktor kelima. Ujian TKA ini mengandungi enam belas item, dikategorikan kepada lima (5) faktor utama TKA. Input yang dimasukkan ke dalam sistem akan dikaburkan (fuzzified) dan di proses melalui Memori Kesatuan Kabur (FAM) yang dibangunkan untuk mengendalikan syarat-syarat kabur berdasarkan kepada kelima-lima faktor kajian kes ke atas TKA. Pengkaburan Semula (Defuzzification) yang dikenali sebagai kawasan berpusat digunakan untuk membuat anggaran kepada faktor TKA dan menentukan tahap-tahap kendiri terhadap akademik seseorang pelajar samada ia berada pada tahap rendah, pertengahan atau tinggi. Tambahan pula, penasihat yang menggunakan Logik Kabur dan Sistem Pakar menyediakan penerangan dan juga menerangkan bagaimana sesuatu diagnosis dicapai bagi sesuatu kes. Keputusan-keputusan menunjukkan sistem prototaip Logik Kabur dan Sistem Pakar yang dibentangkan dalam kertas kerja ini telah menghasilkan keputusan yang boleh percaya dan tepat setelah beberapa pengujian kes telah dilakukan. Pencapaian keseluruhan bagi sistem ini telah berjaya diuji dan menghasilkan keputusan yang sama dengan keputusan pakar, justeru mencapai matlamat. Sistem ini telah disahkan oleh kaunselor-kaunselor dan keputusan-keputusan yang dihasilkan oleh sistem bertepatan dengan skala yang ditetapkan dan sub skor dalam TKA.

ABSTRACT

Fuzzy Expert is designed to mimic the human decision process of the modular system, maintains the value of based rules and using fuzzy logic control to describe uncertainty systems, and utilizes the predominance of using expert systems to denote and control knowledge (Medeiros et al., 1998). This paper presents the development of Fuzzy Expert Advisory for e-Counselling. The advisory model in counselling using a modular system for the psychology testing process for Behavioural Academic Self-Esteem (BASE) is used to test the prototype developed in this study. The system was constructed using hierarchical structural approach. The system was developed using web-based application language that is Microsoft's Active Server Pages (ASP) the server-side web scripting. The system comprises of five modules, namely Student Initiative of BASE Factor 1, Social Attention of BASE Factor 2, Success / Failure of BASE Factor 3, Social Attraction of BASE Factor 4, and Self-Confidence of BASE Factor 5. BASE test consists of sixteen items, categorized into the five main BASE factors. The input to the system was first fuzzified and Fuzzy Associative Memory (FAM) table were constructed to handle the fuzzy rules of the five factors of BASE case study. The defuzzification known as Centre of Area (COA) is used to estimate the BASE factor and determine the levels of academic self-esteem such as low self-esteem, moderate self-esteem, and high self-esteem. In addition, fuzzy expert advisory provides explanation and also explain how a diagnosis is reached for a particular case. The results showed that the fuzzy expert prototype system presented in this paper provided a reliable and accurate outcome after several test cases have been performed. Overall performance of this system was successfully tested and produced the results that were equal to an expert's judgment, thus accomplishing the set goals. The system has been verified by the counsellors and the results produced by the system conform to the BASE factor rating scale and sub-scores.

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CHAPTER 1

INTRODUCTION

This section presents the background of the project that focuses on the hybrid approach using fuzzy logic and expert system. The main idea of the study is to develop the prototype system using the integration of both approaches in e-counselling domain. The section also presents the problem statement, objectives, significance and scopes of the project.

1.1 Background

Fuzzy logic deals with the kind of uncertainty that is inherently human in nature. Fuzzy logic is a computational paradigm that provides a mathematical tool for representing and manipulating information in a way that resembles human communication and reasoning processes (Yager *et al.*, 1994). The concept of the fuzzy set was first introduced by Zadeh (1965). Fuzzy logic offers a better way of representing reality with a statement is true to various degrees, ranging from completely true through half-truth to completely false. The fuzzy system is a popular computing framework based on the concepts of fuzzy set theory, fuzzy if then rules and fuzzy reasoning.

An expert system is a system that employs human knowledge captured in a computer to solve problems that ordinarily require human expertise (Turban, 2001). An expert system is a narrow slice of computer intelligence and knowledge-based application. Its programs are designed to emulate human decision-making expertise in a particular domain. Expert systems belong to a group of systems known as knowledge-based systems. Knowledge-based systems contain the facts and procedures representing the rule of thumb (heuristic) decision-making processes of an expert. That collection is kept in a knowledge base that is separate from a control program. According to Bishop (1986), ES also matches capabilities of a competent level of human expertise in a particular field, and allows a user to access this expertise in a way similar to that in which he might consult a human expert, with a similar result.

Expert systems based conventional logics are not efficient in handling inaccurate and inexact information. This study focuses on the application of hybrid AI techniques on counselling. Counselling information and knowledge are often uncertain, ambiguous, or vaguely defined. Therefore, in an attempt to replace the human expert with a computer, fuzzy logic is integrated with the expert systems to mimic the human decision process of the psychology testing process for Behavioural Academic Self Esteem (BASE). Since both technologies have their own significance and advantages, this hybrid system could provide and increase the better systems performance especially in e-counselling.

A Hybrid Intelligent System (HIS) is one that combines at least two intelligent technologies (Negnevitsky, 2002). For example, combining a fuzzy logic with neural network results in a hybrid neuro-fuzzy system, fuzzy logic and expert system (fuzzy-expert), neural networks and expert system (neural-expert), neural networks, genetic algorithm and expert system (neuro-ga-expert), neural networks, fuzzy logic and expert system (neuro-fuzzy-expert) and hybrid modular system integrating fuzzy logic, neural networks and algorithmic optimization. The selection of the hybrid system is depending upon the applications to be solved. An emerging approach to building hybrid intelligent system capable of reasoning and learning in an uncertain and imprecise environment.

Psychology is the study of the mind and the behaviour of humans and animals. Some of the areas psychologists study is thinking, learning, cognition, emotions, personality, and abnormal behaviour. In order to study these, psychologists use a variety of methods to observe people including laboratory experiments, field experiments, observational studies, case studies, and questionnaires (Questia Online Library, 2004). According to Richmond (2004), psychological tests assess and evaluate information that client give to the examiner. This information either in the form of answers to interview questions or as answers on paper or on a computer to specific questions. Ultimately, a test's accuracy depends on how carefully and seriously the user answers the questions being asked. Psychological tests are usually administered and interpreted by a psychologist. A counsellor who has had the appropriate academic courses and supervision may administer occupational tests or achievement and aptitude tests. Some available tests are BASE (Coopersmith and Gilberts, 1981), Behavioural Indicators of Self-Esteem (BIOS), Body Esteem Scale, Coopersmith Self-Esteem Inventory, Personal Evaluation Inventory, Rosenberg Self-Esteem Scale (RSE), Self-Esteem Inventory and etc.

BASE measures children's academic self-esteem by using direct observation of their classroom behaviours. Teachers, parents, or other observers draw on their first-hand experience with a specific child to rate how often the child behaved in particular ways. BASE has been used with children of preschool, elementary, and junior high school, both individually or in groups. The BASE factor structure are divided into five factors: Student Initiative, Social Attention, Success/Failure, Social Attention, Social Attraction, and Self-Confidence and the rating scale consists of 16 items. BASE items are rated to the frequencies of behaviours as Never, Seldom, Sometimes, Usually, and Always. The BASE levels of academic self-esteem for each factor are classified as high self-esteem, moderate self-esteem, and low self-esteem (Coopersmith *et al.*, 1981).

BASE is used in this study to estimate the factor structures and determine the levels of academic self-esteem of the student. Since BASE requires the ability for estimating the factor structure and also the ability to explain how the conclusion is derived, therefore artificial intelligent techniques that are required to perform BASE must be able to estimate and provide reasoning. Artificial Intelligence (AI) techniques that are suitable for prediction are neural network, fuzzy logic and case based reasoning. On the other hand, expert system and case based reasoning are good at providing explanation to intelligent system. The techniques that provide the estimation and explanation abilities are necessary in this study. For this purpose, fuzzy logic and expert system have been integrated in a web-based environment to demonstrate the use of hybrid system, on BASE factor structure and levels of academic self-esteem.

The term *counselling* may have different connotations for different people. By counselling it is understand all other interactions between student and institute which are not directly subject related (Rekkedal, 1991). The counselling function thus embraces advice on general problems related student support services (Tait and Sewart, 1983). According to Watt (1998), the term counselling was used to include all the following processes: information provision on training and job opportunities, welfare support; guidance or direction on career and vocational options; advice by offering a possible solution or course of action, and counselling for empowering the individual to make decisions.

Increasing the automation level of counselling systems has led to more attention being paid to human control roles and the dependability of systems that comprise users and machines When humans build mental models of complex automated systems, they can be faced with problems regarding situation awareness. Moreover, these complex systems may lead to knowledge-based errors in situations where decision-making has to be performed (Norman, 1988). To cope with such situations, one may wish to consider advisory systems. An advisory system is a type of decision support system that tackles the complexity of systems with regard to human judgement for decision-making. Advisory systems are in the fields of expert systems and artificial intelligence (human cognitive science). However expert systems can be developed for two purposes: either to replace a human decision-maker or to support a human decision-maker (Oliveras, 2002). In this case, an expert system is designed to obtain advice with the aim to support and improve decision-making effectiveness for human users.

An expert system allows for easy encoding of expert knowledge as a set of rules and provides counselling advisory services through web. Fuzziness of the expert system allows better treatment of the uncertainties of the problem and to simplify the expert system itself. Fuzzy logic and expert system have their own significance, therefore the integration of both technologies that forms a fuzzy-expert system or a hybrid system could provide and increase the systems performance in counselling system. Thus, a fuzzy expert system should provide a convenient tool of providing an automated system for e-counselling.

1.2 Problem Statement

Based on the literature review, the advance computing techniques were not being applied much to counselling services. The current practice of the existing system using BASE scale may be scored by hand or by computer based on the rigid crisp values to represent rating number one through five. For each BASE factor, the sub score is provided based on the classifications of Academic Self-Esteem and their respective ranges. The computer scoring service provides a class profile, based on the class norms, which reports percentiles and self-esteem classifications for the total scores and factor scores. When BASE is scored by computer, the error of measurement is reduced and the predictive validity of the scale is improved (Coopersmith *et al.*, 1979).

In an attempt to replace the human expert with a computer and as knowledge involved in counselling is imperfect, vague and not completely reliable, then fuzzy logic is integrated with the expert systems is designed to mimic the human decision process of the modular system for the psychology testing process for BASE. In e-counselling, it is important to allow the user to choose their option in flexible manner and human nature in order to estimate the BASE factor score, and as well as to determine their levels of academic self-esteem. Furthermore, the result obtained will provide the information of measuring student's self-esteem at early ages. Therefore this project attempts to explore the possibility of using hybrid intelligent system in order to promote the use of imprecise information in e-counselling.

1.3 Objectives

The main objective of this project is to develop the fuzzy expert system for providing counselling advisory through web. The objectives of this system specifically are:

i. To identify the behavioural academic self-esteem of the student using fuzzy logic.

ii. To provide counselling advisory services using expert system approach.

iii. To integrate (i) and (ii) as hybrid system.

1.4 Significance of the Study

Emerging of AI techniques i.e. fuzzy logic and expert systems to permit the user interface is an essential link between the client and the counselling advisory services in Web-based counselling environments. This Fuzzy Expert Advisory for e-counselling which fuzzy logic is useful in handling uncertain systems for the case study, and expert system is providing the advantage of handling rule based knowledge system and advisory services. The system allows the users to slide the input in percentage of BASE items that are rated according to the frequencies of behaviours in uncertainty forms labeled as never, seldom, sometimes, usually, and always rather than the common form of 1, 2, 3, 4, and 5.

The proposed system provides the users particularly teachers, counselors, or parents to measure students' self-esteem at early ages, evaluate factors that affect academic self-esteem, encouraging discussions about self-esteem in parent-teacher conferences, and to establish construct and predictive validity related to common measures of school success. The strategy of incorporating e-counselling capabilities is tends to provide the schools in the development of information systems that will establish effective linkages with the parents (users) or other channel partners involved in counselling activities. As a result, the proposed system allows the users especially the teachers, counselors, parents, or other observers to obtain the counselling advisory services through web. Apart from estimating the BASE structure and identifying the academic self-esteem, the system can be used as part of portal development for schools and community as a whole.

1.5 Project Scope

The scope of this project is to develop a prototype of the fuzzy expert advisory system for BASE in e-counselling. Fuzzy logic system is used in handling the uncertainty type of rules of the BASE case study, on the other hand, the expert system acts as counselling advisor by providing the advices with respect to the case study of the BASE factors. The combination of both technologies that forms a fuzzy-expert system or a hybrid system could provide efficiency and a convenient tool in advisory system for e-counselling. The main target users are counsellors, teachers, parents, or other observers.

1.6 Thesis Overview

In this paper, the study is mainly focus on presenting the design, the knowledge representations, and the development of hybrid fuzzy expert advisory for e-counselling. This thesis report comprises five chapters and it is organized as follows: Chapter 1 is an introduction chapter that discusses the background of the study, problem statements, objectives, significance and scope of the study. Chapter 2 presents the relevant literature review including the approaches applied and e-counselling. Chapter 3 presents a system design, development and implementation and followed by Chapter 4 that presents the system results, system experiments and system explanation. Finally, Chapter 5 brings the conclusion and future direction.

CHAPTER 2

LITERATURE REVIEW

This section presents the introduction to the studies, related areas including an artificial intelligence, and the applications of fuzzy logic, expert systems, and hybrid intelligent system using fuzzy expert systems. This section is then further discussed on the literature of the e-counselling, psychology and psychological testing, self-esteem, and BASE.

2.1 Introduction

Fuzzy Expert Advisory for e-Counselling has been developed using hybrid intelligent system that integrates fuzzy logic and expert system. Due to their capabilities and advantages, this system offers an automated fuzzy expert system in dealing with uncertainty and vague information for BASE. The purpose is to estimate the BASE factor structure and determine the levels of academic self-esteem which obtained from the inputs given by the users. The system facilitates the user by handling the consultation session in order to determine the levels of academic self-esteem. A set of questions will be asked through graphical user interface and assists the user in diagnosing stage based on the given inputs to infer such a conclusion. The consultation and explanation performed by the fuzzy logic and expert system also involved in dealing with the natural and uncertainty data. This study focuses on the system design and development of using hybrid technology and the employment of fuzzy expert system in counselling domain.

Artificial Intelligence (AI) is the area of computer science focusing on creating machines that can engage on behaviours that humans consider intelligent and it is concerned with the simulation of human thinking and emotions in information technology (Luger, 2002). AI attempts to understand and model those faculties that characterize intelligent behaviour. As an applied science, it seeks to enhance the functionality of computer systems (Rich *et al.*, 1991). Much of the initial enthusiasm in AI centered on imitating everyday activities such as language and visual perception (Charles *et al.*, 1993). AI develops the intelligent systems capable, for example, of learning and logical deduction. AI systems are used for creatively handling large amounts of data (as in data mining), as well as in natural speech processing and image recognition. It is a collection of concepts and ideas that are appropriate for research and provide scientific foundation for several commercial technologies (Turban, 2001).

The major disciplines of AI are genetic algorithms, expert systems, robotics, fuzzy logic, neural networks, robotics, and so forth. AI is also used as to support decision taking in highly complex environments. AI is generally associated with Computer Science, but it has many important links with other fields such as Psychology, Cognition, Biology, Anthropology, Mathematics and Philosophy, and other subjects that study humans and other animals. The ability to combine knowledge from all these fields will ultimately benefit the progress in the quest of creating an intelligent artificial being (Champandard, 2002).

2.2 Fuzzy Logic

Fuzzy logic is an enhancement of classical AI approaches (Steimann, 1997). Instead of assigning an attribute a single value, several values can be assigned each with its own degree or grade. The notion of partial truth makes fuzzy logic a very good means to model the natural uncertainty of language, and consequently, expert knowledge that can be expressed in natural language. The apparatus of fuzzy logic has been accommodated to allow easy manipulation with verbal descriptions of numeric variables (Eberhart *et al.*, 1996). In other words, in fuzzy logic each value has a membership degree for each set. This membership degree [0,1] is in the interval of close. That is, a value can be a member of a set partially. With this characteristic, fuzzy logic can model the human thinking system in a better way than the classical available, and it can transform the experiences of the man to mathematical expressions in a quite better manner (Semerci *et al.*, 2003).

Fuzzy logic is an attempt to escape the perceived inadequacy of binary logic (Walter, 1988). Zadeh (1965) introduced the concept of the fuzzy set to provide a formal way of speaking about imprecise concepts, such as "large" and "small". Rather than requiring precise values to be attached to particular characteristics, a spectrum of values, broken into categories, is used to match concepts, analogous to concepts in cognitive psychology (Rosch *et al.*,1975). The object of fuzzy logic is to convert continuous measurements into approximate discrete values. A linguistic variable is a variable whose values are words or sentences in a natural or artificial language. Each linguistic variable may be assigned one or more linguistic values, which are in turn connected to a numeric value through the mechanism of membership functions. Each value in a fuzzy set has a corresponding membership function that determines how the degree is computed from the actual continuous value of an attribute. Human experts do not usually think in probability values, but in such terms as *often*, *generally*, *sometimes*, *occasionally* and *rarely*. Fuzzy logic is concerned with capturing the meaning of words, human reasoning and decision making. Fuzzy logic provides the way to break through the computational bottlenecks of traditional expert systems.

Fig. 2.1 shows the example of reading from a measuring device that may be connected to a linguistic variable "width" through membership functions "narrow", "normal" and "wide". For the sensor reading of 2.75 cm, the linguistic variable width Fuzzy reasoning is conducted by utilizing linguistic variables and fuzzy sets represented by their membership functions in rules, usually having the form of expression "if . . . then . . ." For the given example, a rule may be something like: "if beam's width is narrow then maximum load is low."

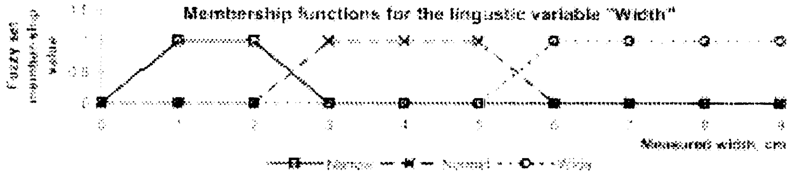

Figure 2.1: Membership Functions of the Linguistic Variable "Width"

According to Karady (2001), the fuzzy system is a popular computing framework based on the concepts of fuzzy set theory, fuzzy if then rules and fuzzy reasoning. The structure of fuzzy inference consists of three conceptual components, namely: rule base containing a selection of fuzzy rules, database defining the membership functions and these are used in the fuzzy rules, and reasoning mechanism that performs the inference procedure upon the rules and given facts and derives a reasonable output or conclusion. Some of successful fuzzy logic applications in manufacturing include the development of a model to predict the running time of a steam cracking process (Meier *et al.*, 1994). Matshushita developed a washing machine that uses fuzzy logic to select machine settings such as length of wash, rinse, and spin cycles, water temperature, and others based on an examination of the laundry itself such as dirt level, size of load, and etc. (Dutta *et al.*, 1993). King and

Marsolan (1988) used fuzzy logic to model time-variant dynamic changes in a thermal process unit.

As applied in psychology, several studies have been done. Fuzzy logic and methods of AI are also used to define and recognise sequences of virtual sources in real-time. The physician can click on a significant EEG pattern, this makes it a further recognisable phenomena through fuzzy logic and correlate it with his own observations. The multi-processor system recognises EEG activity, i.e. it interprets this as a possible description of the state of the brain, sets a defined stimulus and recognises and evaluates the Event Related Potential (ERP) immediately (Roscher, 1996). With a better understanding of EEG activity we can begin to understand the link between psychological disorders and physical illnesses and therefore create more effective diagnostic and corrective therapeutic strategies.

Warren *et al.* (2000) described the sources of fuzziness in clinical practice guidelines, by considering how fuzzy logic can be applied and give a set of heuristics for the clinical guideline knowledge engineer for addressing uncertainty in practice guidelines and describe the specific applicability of fuzzy logic to the decision support behaviour of Care Plan On-Line, an intranet-based chronic care planning system for General Practitioners. Semerci *et al.* (2003) proposed the use of fuzzy logic to give concise information in distance education especially, in taking tests.

Recently, Zadeh demonstrated that the main contribution of fuzzy logic is a methodology for computing with words, which cannot be done equally well with other methods (Zadeh 1996). Therefore, fuzzy-set technologies, with their ability to naturally represent human conceptualizations, can make many useful applications in the modelling of human-like intelligent system. Alastair presented a fuzzy model that combines the essence of Personal Construct Psychology with Fuzzy set theory (Alastair, 1998). This model can be used to generate structural measure for construct system in terms of the complexity of that system. Yager gave an interesting example of how to using fuzzy modeling for building intelligent agents. There are two steps in his fuzzy modeling process (Yager, 2000). The first step is to partition the variables in terms of natural language linguistic terms. This linguistic portioning, an inherent feature of what Lotfi Zadeh just calls computing with worlds, greatly simplifies model building. A next step in this process is to represent these linguistic concepts in terms of fuzzy subsets.

According to Xexeo (2000), fuzzy systems have been used to accomplish several different tasks, such as monitoring, controlling, diagnosing, querying, and optimizing. Broadly, they can be divided in 4 categories such as prescriptive systems, which require specific decisions (output) for a problem (input); descriptive systems, which only try to identify a problem, for instance by classification or pattern recognition; optimization systems, which try to establish conditions and actions to achieve some set of performance criteria, and predictive systems, which try to predict future outcomes.

The advantages and positive aspects of the fuzzy logic (Semerci, 2000) can be explained as the fuzzy logic is close to the functioning of the human thought, applications of the fuzzy logic are rapid and cost effective, the application process does not require a mathematical model, application of the fuzzy logic is quite easy, the case of "learning by experience which is peculiar to humans" can easily be modeled, uncertain and indefinite information can be used, and it allows the definition of concepts or correctness values in a graded way.

2.3 Expert System

Another important branch of artificial intelligence is known as expert systems, which are designed to represent and employ the knowledge of specific fields in problem solving. Expert systems are computer programs that use knowledge, facts, and reasoning techniques to solve problems that normally require the abilities of human experts. Some expert systems goals are helping human experts, training new experts, assimilating the knowledge and experience of several human experts, and providing requisite expertise to projects that cannot afford scarce expertise on site (Morsy, 1992). Expert system imitates the expert's reasoning processes to solve specific problems or narrow problem area efficiently and effectively (Waterman, 1986), and typically, pertains to problems that can be symbolically represented (Liebowitz, 1988). Expert systems are distinguished from conventional computer programs in two essential ways (Barr, Cohen et al. 1989); expert systems reason with domain-specific knowledge that is symbolic as well as numerical; and expert systems use domain-specific methods that are heuristic i.e., plausible as well as algorithmic i.e., certain.

Every expert system consists of two principal parts: the knowledge base; and the reasoning, or inference, engine. The knowledge base of expert systems contains both factual and heuristic knowledge. Factual knowledge is that knowledge of the task domain that is widely shared, typically found in textbooks or journals, and commonly agreed upon by those knowledgeable in the particular field. *Heuristic knowledge* is the less rigorous, more experiential, more judgmental knowledge of performance. In contrast to factual knowledge, heuristic knowledge is rarely discussed, and is largely individualistic. *Knowledge representation* formalizes and organizes the knowledge. One widely used representation is the *production rule*, or simply *rule* (Engelmore, 1993).

The typical approach to representing human decision making in simulation models is to try to elicit the decision rules from the decision maker. In some cases this amounts to little more than a guess on the behalf of the modeller. The rules are then included in the model using the constructs of the simulation language or simulator. This normally requires the use of a series of 'if', 'then', 'else' statements. Medeiros *et al.*, (1998) have developed one approach to overcoming the problems of handling large amounts of code that is difficult to interpret and even harder to change might be to use an expert system to represent the human decision maker, and link it with a simulation model. These problems might be to use an expert system to represent the human decision maker, and link it with a simulation model. This could be implemented in two ways: elicit the decision rules from the expert and represent them within an expert system, and use the simulation model to prompt the expert to make decisions, building up a set of examples from which an expert system could learn.

Morsy (1992) explained that with the development and widespread use of shells the range of expert systems applications has tremendously increased globally. The introduction of the experts system shells has played a major role in expanding expert system applications into areas such as psychology, management, finance, office automation, computer selection and networking, legal processes, manufacturing, equipment training, personnel training, education, transportation, oil and geology, science and medicine, and agriculture. Expert systems are computer programs that use expertise to assist people in performing a wide variety of functions, including programs that mimic the advice-giving human experts (Brule, 1986) and it can offer intelligent advice or make an intelligent decision about a processing function.

According to Bishop (1986), ES also matches capabilities of a competent level of human expertise in a particular field, and allows a user to access this expertise in a way similar to that in which he might consult a human expert, with a similar result (Edwards and Connell, 1989). Expert systems are artificial intelligence application programs that apply substantial knowledge of specific areas of expertise to solve a problem. NeXPert was developed by Morales *et al.* (1998), a WWW-based expert system advisor with the intention of providing access to expert knowledge to a broad user community. NeXPert provides advisory knowledge to help users solve these problems. The development of a WWW-based expert system which exhibits an ability compared to the human domain experts giving advise as to the cause or probable cause of network communication problems.

White and Bieszczad (1992), developed the Expert Advisor, a real-time expert system used in the monitoring of packet switching networks and it has been completely integrated into a conventional network surveillance system. The primary functions of the expert system as being the identification of service-affecting conditions in the network and the presentation of all information pertinent to the problem to the network operator in a single entity and based upon the concept of a network problem, defined in terms of network events and information from conventional databases

Some of successful expert system applications in counselling include the development of ExSport II, an expert systems model of artificial intelligence that simulates the career counselling process. Users answer 18 questions about their professional interests. Decision rules embedded in the system lead users into knowledge bases describing sport management careers that appear to be compatible with those expressed interests (Parks *et al.*, 1992). The system can be used in remote locations; there is no need for the presence of an expert e.g., counsellor or academic advisor. The system collects only relevant information, no idle chat and can be easily up-dated. Sciamanna *et al.* (1997) has developed an expert system for counseling patients to stop smoking and it is designed to be part of the routine clinical care of the office and used just prior to the physician visit. The symptoms and medical history are incorporated into counselling, the physician receives a report to assist in counselling the patient. Reports are based on a review of current medical and psychological literature, contain tailored messages and self-cessation techniques.

Druzdzel (1996), has suggested that computer-based decision support aids to decision making have a great potential in genetic counselling. The approach used expert systems that imitate human experts, model building and explanation of the results of its reasoning based on decision-theoretic principles for the increasing incidence of genetic testing. Acquired Intelligence (2004) was involved in developing the employment counselling applications for Human Resources Development Canada such as the Expert Counselling System (ECS) helps clients to solve their own employment problems at a publicly accessible kiosk. It lists job tips and local resources that can help clients find suitable work.

Another application by Spiegel *et al.* (2004) of an expert system prototype that is meant to support psychologists in finding out what disorders their clients might have. The expert system provides a user interface that permits the psychologist to enter a large variety of symptoms. The symptoms are linked to a database where records of these symptoms/symptom combinations as well as their underlying disorders are stored. The system provides fuzzy rather than deterministic feedback, i.e. instead of suggesting only one diagnosis it indicates all possible diagnoses and estimates the risk for each possible diagnosis individually. The system is not meant to replace psychologists, but rather to support them in generating hypotheses at an early stage of diagnosis.

An expert system is the methods and techniques used for constructing human-machine systems with specialized problem solving expertise. The pursuit of this area of artificial intelligence has emphasized the knowledge that underlies human expertise and has simultaneously decreased the apparent significance of domain-independent problem solving theory. Ultimately an expert system in counselling assists or replaces an expert in order to solve problems or recommend a set of alternative solutions.

2.4 Fuzzy Expert System

A fuzzy expert system is an expert system which incorporates fuzzy sets and /or fuzzy logic into its reasoning process and/or knowledge representation scheme. A fuzzy expert system can also described as an expert system that uses fuzzy logic instead of Boolean logic, or expert system that operates on a collection of fuzzy variables and rules, according to the principles of fuzzy logic (Kandel, 1991). Fuzzy rule-based systems perform faster than conventional expert systems and require fewer rules. A fuzzy expert system merges the rules, making them more powerful. Fuzzy systems allow the encoding of knowledge in a form that reflects the way experts think about a complex problem. They usually think in such imprecise terms as *high* and *low*, *fast* and *slow*, *heavy* and *light*. In order to build conventional rules, we need to define the crisp boundaries for these terms by breaking down the expertise into fragments. This fragmentation leads to the poor performance of conventional expert systems when they deal with complex problems. In contrast, fuzzy expert systems model imprecise information, capturing expertise similar to the way it is represented in the expert mind, and thus improve cognitive modelling of the problem.

Despite its successful application and proven effectiveness, the expert system approach is a difficult and time-consuming way to construct knowledge bases. In light the above, this work developed a novel expert system environment by applying advanced techniques, such as multimedia interfaces, fuzzy concepts, and knowledge acquisition methodologies. With application of the proposed approach, the environment not only helps knowledge engineers elicit and represent expertise with multimedia types, but also facilitates fuzzy reasoning. This work presents a grid-based fuzzy expert system environment, which employs a repertory grid, fuzzy theory and case-based reasoning. The proposed environment provides friendly user interfaces, abundant data types, intelligent knowledge acquisition facilities and an efficient inference engine. To help users make precise decisions, three factors (i.e., feasibility, reliability and certainty) are used during inference. Moreover, several tools are provided to help experts define membership functions and the knowledge of multimedia data types. Furthermore, the proposed approach is evaluated by implementing an expert system for the diagnosis of animal diseases and by performing several tests.

Some practical implementations of such integration can be found in the literature. Holden *et al.* (1999) built the Hand Motion Understanding (HMU) system recognizes static and dynamic hand signs in Australian Sign Language (Auslan) by dealing with "fine grain" hand motion, such as configuration changes of fingers. The system successfully recognized various 'fine-grain' hand movement. Lam *et al.* (1999) recommends the fuzzy logic expert system in the processing time customized to a production line given the localized ambient state and the condition of the plaster molds. The system also includes a data repository to store and analyze daily process records, an automatic control charting feature, and a training module to expedite the learning curve of new workers.

Another applications are an analysis of the fuzzy expert systems architecture for multispectral image classification using mathematical morphology operators (Marcos, 2004), whose rules are implemented through translation invariant mathematical morphology operators and uses the expert systems for image classification. Hayo *et al.* (1997), Pesticide use options available to farmers differ strongly with respect to the risks they pose to the environment. It uses a fuzzy expert system to calculate an indicator "Ipest" which reflects an expert perception of the potential environmental impact of the application of a pesticide in a field crop.

The finding by Fahmy *et al.*, (1999), fuzzy expert systems have proved to be very successful in formalizing the practical rules used by the design experts for computer networks design, formalizing the logic of solving computer network design problems, and initially choosing the most suitable solutions for a certain networking requirement. By using fuzzy expert systems to generate the network models/simulations the user is not required to have any kind of background of the simulation package operation. Neither is the user required to be an expert in networks design. Hansen (1997), in his study on A Fuzzy Expert System for Critiquing Marine Forecasts (SIGMAR) has been designed which uses fuzzy methods to interpret meteorological data. The system automatically evaluates the significance of actual wind reports. The system continuously monitors wind data, and alerts a forecaster if wind data indicate that a marine forecast is tending to become inaccurate.

Moraes (2004), analyze the architecture of a general expert systems architecture for image classification that uses fuzzy set theory as knowledge representation model by an expert system that classifies an area of the Tapaj'os National Forest, in Brazil. Jiajun *et al.* (1999) presents an architecture which is developed using rules-based fuzzy expert system. Fuzzy expert systems not only maintains the value of based rules and the merit of using fuzzy logic control to describe uncertainty systems, and utilizes the predominance of using expert systems to denote and control knowledge. In order to adapt the requirement of onboard operation, the resource restrain is considered in the architecture, such as processing speed of central processing unit, the capacity of storage and the real-time requirement. Whalen and Schott (1985) use a fuzzy linguistic logic system with production rules to suggest appropriate forecasting techniques for sales predictions in their expert system. They use possibilities and work in a backward chaining manner. They start with the possibilities of all conclusions equal to one and attempt to reduce the possibilities until they find an irreducible set. SPERILL II was developed by Ogawa *et al.* (1984), an expert system for damage assessment of existing structures, uses fuzzy sets to represent imprecise data. Another development by Buckley (1986), FLOPS is a fuzzy rule-based production expert system. Input to the system is a vector all of whose components are fuzzy sets. As output it produces a fuzzy sets of conclusions. Incoming information is pattern matched against rules to provide a fuzzy sets of fireable rules.

Expert system and fuzzy systems have now matured and been applied to a broad range of different problems, mainly in engineering, medicine, finance, business and management. Each technology handles the uncertainty and ambiguity of human knowledge differently, and each technology has found its place in knowledge engineering. They no longer compete; rather they complement each other. A synergy of expert systems with fuzzy logic improves adaptability, robustness, fault-tolerance and speed of knowledge-based systems. Besides, computing with words makes them more "human". It is now common practice to build intelligent systems using existing theories rather than to propose new ones, and to apply these systems to real-world problems rather than to toy problems.

2.5 E-Counselling

This subsection of literature review discusses the introduction to e-Counselling, available resources and websites related to this area, psychology and psychological test, self-esteem and BASE.

2.5.1 Introduction

E-Counselling is an alternative way of having one to one contact with a Counsellor by exchanging e-mail messages, discussion groups, or access to information sources and interaction through video-conferencing. According to Sampson (2002), the current use of world wide web (www) are counselling via e-mail, bulletin board systems and list servers for specific client concerns, chat for specific topics and career applications. Self-Help Resources Links could provide access to data, services, and referral sources such as the directory of National Certified Counsellors, psycho educational resources for prevention or self-diagnosed problems, supervision and conferencing transfer of client data, meetings via videoconferencing, crisis intervention support, and parent conferencing.

WS E-Counselling is a professional counselling service available over the Internet at http://www.warrenshepell.com/ecounselling.asp, delivered by experienced, professional WarrenShepell counsellors. The main option is called WS InnerView, a one-to-one, short-term counselling relationship providing therapeutic consultation and support. WS E-Counselling is a viable, alternative source of help when in-person sessions or telephone contacts are not convenient, accessible or preferred. It is a trustworthy service that is conducted by skilled, ethical professionals. For some people, it's the only way they can get help or want to get help from a professional counsellor. Online counselling can be especially helpful for those who, for whatever reason, find it difficult or impossible to go to a counsellor's (Shepell, 2004).

EDotCounsellor was developed by James (1998), a web-based system that provides the online counsellors and online counselling, e-mail counselling, telephone counselling, and chat counselling. This site is a professional online counselling service from accredited counsellors. The use of email, or secure chat, or the telephone to counsel people online around the world and help them find options for change and solutions to problems such as relationship and marriage difficulties, divorce, assertiveness issues, grief, abuse, and others. For a growing number of people, the convenience and anonymity of email, secure chat, or phone counselling. The site is available at http://www.edotcounsellor.com

Wagner *et al.* (1995) concluded that "a more optimal approach may be to explore better ways of integrating minimal interventions with existing face-to-face contacts in such settings as a health care delivery system". Among the wide range of counselling services that is nowadays offered, web-counselling is evolving as an alternative or supplementary medium of distance counselling for parents of deaf children. The Internet provides the means for effective communication between parents and professionals as well as between parents themselves. Services may vary from e-mail and discussion groups, access to information sources and interaction through video-conferencing. The primary objective is to describe the role of web-counselling and the numerous ways through which it can support, inform and ultimately empower parents of deaf children. In addition, a proposal is made regarding the development of a web-counselling centre, the role of the participants who contribute in the centre operation as well as the level of collaboration among them, and also a number of possible difficulties are taken into consideration, ensuring that web-counselling will become an effective medium of distance counselling with forthcoming benefits for the parents of deaf children (Nikolaraizi *et al.*, 2000).

Acquired Intelligence (2004) was involved in developing the following employment counselling applications for Human Resources Development Canada such as the Employment Counsellor's Assistant is a Windows application that helps employment counsellors assist clients by providing recommendations and automatic documentation of a ten-step assessment process. The Expert Counselling System (ECS) helps clients solve their own employment problems at a publicly accessible kiosk. It sites at http://www.aiinc.ca lists job tips and local resources that can help clients find suitable work. While the Employment Coach is a version of the ECS developed for use on a desktop computer rather than at a kiosk. It provides useful employment information, tips, and resources and it clarifies issues underlying trouble spots that people may experience while trying to get work. The information is presented in Internet format which is easily changed to update tips, resources, and advice.

Counselling is available for supportive or problem-solving assistance for *academic*, *vocational*, *emotional*, *personal* or *social* concerns. Counsellors help explore these issues and assist students to work toward achieving the goals they have set for themselves. The Centre provides Acadia students the opportunity to discuss, in a private and relaxed atmosphere, *any personal, career, or academic concern* (Acadia, 2004). Other on-line counselling and interactive resources available at http://www.support4learning.org.uk provides some useful facilities such as ELIZA is an online counsellor to talk to. An Emotional Intelligence is on-line emotional IQ test and resources, while IQ Tests On-line with links to personality and entrepreneurial tests. On the other hand, some universities such as University of Toronto provide links to learning style theories, assessments, inventories, and tests. The Mind Tools provide major resources site on practical techniques for planning, thinking, stress, psychology and much more, mainly for people in work. Other useful resources available are Counselling organisations and standards, finding advice and guidance, health information, jobsearch, learning and work, related assessment tools and tests, Internet addiction, human rights, and civil liberties.

In Malaysia, e-counselling has been widely implemented and various services provided to the specific users or nation as a whole. Majlis Kaunseling dan Kerjaya Institusi Pengajian Tinggi Awam (MAKKUMA) has developed by the team of Counselling Centre at Universiti Utara Malaysia (UUM). The web site address is at http://portal.uum.edu.my/portalbm/ekaunseling/. This site provides list of resources such as updated news of MAKKUMA, counselling services from counsellors of any IPTA in Malaysia, discussion groups and access to counselling information sources. E-Counselling at Dewan Bandaraya Kuala Lumpur (DBKL) at http://www.dbkl.gov.my/kaunseling/index.htm provides online services such as e-mail discussion groups, on-line chat, and others.

2.5.2 Psychology and Psychological Test

Psychology is the science of the mind. The human mind is the most complex machine on earth. It is the source of all thought and behaviour. Psychologists use human behaviour as a clue to the workings of the mind. Although people cannot observe the mind directly, everything they do, think, feel and say is determined by the functioning of the mind. So psychologists take human behaviour as the raw data for testing their theories about how the mind works (BBC, 2004).

Referring to the BBC (2004), psychology lies at the intersection of many other different disciplines, including biology, medicine, linguistics, philosophy, anthropology, sociology, and artificial intelligence (AI). For example, neuropsychology is allied with biology, since the aim is to map different areas of the brain and explain how each underpins different brain functions like memory or language. Other branches of psychology are more closely connected with medicine. Health psychologists help people manage disease and pain. Similarly, clinical psychologists help alleviate the suffering caused by mental disorders.

Any attempt to explain why humans think and behave in the way that they do will inevitably be linked to one or another branch of psychology. The different disciplines of psychology are extremely wide-ranging. They include clinical psychology, cognitive psychology: memory, cognitive psychology: intelligence, developmental psychology, evolutionary psychology, forensic psychology, health psychology, neuropsychology, occupational psychology, and social psychology. What all these different approaches to psychology have in common is a desire to explain the behaviour of individuals based on the workings of the mind. In every area, psychologists apply scientific methodology. They formulate theories, test hypotheses through observation and experiment, and analyse the findings with statistical techniques that help them identify important findings (BBC, 2004).

Psychological tests assess and evaluate information that clients give to the examiner, which is why the formal name of psychological testing is *psychological assessment* (Richmond, 2004). The information given is either in the form of answers to interview questions or as answers on paper or on a computer to specific questions. A test's accuracy depends on how carefully and seriously the client answers the questions being asked. Psychological tests fall into several categories such as Achievement and Aptitude Tests, Intelligence Tests, Neuropsychological Tests, Occupational Tests, Personality Tests, and others.

Psychological tests were created for three main reasons, all of which are interconnected: It's easier to get information from tests than by clinical interview. The information from tests is more scientifically consistent than the information from a clinical interview. If a psychologist is simply trying to arrive at a diagnosis to help determine the course of psychotherapy, an interview is just fine. But when decisions have to be made about legal matters, disability issues, and so on, then the standardized information from tests allows one person to be directly compared with others, and it makes things more fair (Richmond, 2004). Some available psychological tests and their descriptions are tabulated as shown in Table 2.1.

2.5.3 Self-Esteem

Definition and Background

Self-esteem is a widely used concept both in popular language and in psychology. It refers to an individual's sense of his or her value or worth, or the extent to which a person values, approves of, appreciates, prizes, or likes him or herself (Blascovich and Tomaka, 1991). The most broad and frequently cited definition of self-esteem within psychology is Rosenberg's (1965), who described it as a favorable or unfavorable attitude toward the self. Self-esteem also can be defined as a generalized positive-negative attitude toward oneself; that is, how positively or negatively, in general, an individual thinks and feels about himself. Personality scales of self-esteem often include the word "confidence" in positively worded items such as feeling confident about one's own mental and physical abilities or about being accepted, liked, and admired by others and words relating to positive-negative affect, for example, feeling pleased or satisfied with one's appearance or one's abilities versus feeling ashamed, worried, anxious, or depressed (Mehrabian, 2003).

It is difficult to get consensus on a definition of self -esteem but Coopersmith's (1967) statement that self-esteem was "the evaluation which the individual makes and customarily maintains with regard to himself / herself" incorporates the ideas of many writers. Frequently self-esteem is seen as a component of a more inclusive construct, typically labeled self-concept or self-perception (Rosenberg, 1979). Self-esteem is generally considered the evaluative component of the self-concept, a broader representation of the self that includes cognitive and behavioural aspects as well as evaluative or affective ones (Blascovich and Tomaka, 1991). While the construct is most often used to refer to a global sense of self-worth, narrower concepts such as self-confidence or body-esteem are used to imply a sense of self-esteem in more specific domains. It is also widely assumed that self-esteem functions as a trait, that is, it is stable across time within individuals.

Table 2.1: Examples of Psychological Tests and Descriptions

Psychological Test	**Descriptions**
Personality Assessment	This assessment identifies the personality type and the true nature of the person such as an introvert or an extrovert, sensate or intuitive, thinking or feeling type and perception versus judgement.
Aptitude Tests	There are several different tests, which uniquely identify the aptitude ability: numerical reasoning, mechanical reasoning, abstract reasoning, spatial relations, verbal reasoning, language usage and spelling.
Entrepreneurship Index (EI)	The EI index has been devised by Dr. Cormac Lankford, Phd in Entrepreneurship, the use to analyzes entrepreneurial qualities by building a Career Profile and a Psychological Profile of the candidate.
Self-Esteem Test (10 questions, 3-7 min)	Self-esteem is an integral part of personal happiness, fulfilling relationships and achievement. This test is designed to evaluate the general level of self-esteem.
Honesty Test (60 questions, 30 min)	Honesty questionnaires usually intended to identify the most dishonest candidates. Employers are using honesty testing for positions where employees have access to cash or merchandise, where people need to be trusted to work with little supervision, and in other situations where there is temptation to act dishonestly.
Patience Test (15 questions, 10 min)	Patience, defined as calmness, self-control, and willingness or ability to tolerate delay, has recently received a lot of attention in psychological research. The test will determine whether the clients have the ability to calmly endure delay and inconvenience.
Management Skills Test (165 questions, 45-60 min)	The Management Skills Test assesses the capabilities as a supervisor, in seven different areas including the planning, organizing, staffing, leading, and controlling functions of management, along with relevant interpersonal and intrapersonal skills.
Creative Problem-Solving Test (30 questions, 10-15 min)	Creativity is linked to fundamental qualities of thinking, such as flexibility, tolerance of ambiguity or unpredictability, and the enjoyment of things heretofore unknown. The test was developed to evaluate whether you have these fundamental qualities of thinking.

Briere (2000) has constructed the 40-item Cognitive Distortion Scale (CDS) test. CDS was engineered to be brief, easily understandable to the average mental health client, to have modern psychometric properties, and to be applicable to a variety of clinical problems and etiologies. It measures five types of cognitive symptoms or distortions found among mental health clients and/or those who have experienced interpersonal victimization: Self-criticism, Self-blame, Helplessness, Hopelessness, and Preoccupation with Danger. CDS scales are psychometrically reliable and have construct, predictive, and convergent validity in the standardization and validity samples. Scales are normed separately for males and females (total standardization N = 620), and can be expressed as T-scores. Results of readability analysis (Flesch-Kincaid method) indicate that a minimal (fifth-grade) reading ability is required for respondents to understand and complete the CDS. This test is available from Psychological Assessment Resources (PAR). Table 2.2 shows the apart of questions of CDS.

Table 2.2: Apart of Questions of Cognitive Distortion Scale Test

Make how often you have had this thought or feeling *in the last month*.

	Never	Once Or Twice	Some-times	Often	Very Often
1. Putting yourself down	1	2	3	4	5
2. Blaming yourself for something that happened to you	1	2	3	4	5
3. Feeling helpless to improve your situation	1	2	3	4	5
4. Feeling hopeless	1	2	3	4	5
5. Expecting people to treat you badly	1	2	3	4	5
6. Hating yourself	1	2	3	4	5
7. Telling yourself that you got what you deserved when something bad happened	1	2	3	4	5
8. Feeling like you don't have much control over what happens to you	1	2	3	4	5
9. Thinking that things will never be very good for you	1	2	3	4	5
10. The world seeming dangerous	1	2	3	4	5

2.5.3 Self-Esteem

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It is difficult to get consensus on a definition of self -esteem but Coopersmith's (1967) statement that self-esteem was "the evaluation which the individual makes and customarily maintains with regard to himself / herself" incorporates the ideas of many writers. Frequently self-esteem is seen as a component of a more inclusive construct, typically labeled self-concept or self-perception (Rosenberg, 1979). Self-esteem is generally considered the evaluative component of the self-concept, a broader representation of the self that includes cognitive and behavioural aspects as well as evaluative or affective ones (Blascovich and Tomaka, 1991). While the construct is most often used to refer to a global sense of self-worth, narrower concepts such as self-confidence or body-esteem are used to imply a sense of self-esteem in more specific domains. It is also widely assumed that self-esteem functions as a trait, that is, it is stable across time within individuals.

According to Reasoner (2004), general agreement of the term self-esteem includes cognitive, affective, and behavioural elements. It is cognitive as one consciously thinks about oneself as one considers the discrepancy between ones ideal self, the person one wishes to be, and the perceived self or the realistic appraisal of how one sees oneself. The affective element refers to the feelings or emotions that one has when considering that discrepancy. The behavioural aspects of self-esteem are manifested in such behaviours as assertiveness, resilience, being decisive and respectful of others. Thus, self-esteem is difficult to define because of these multiple dimensions. Self-esteem is an extremely popular construct within psychology, and has been related to virtually every other psychological concept or domain, including personality (e.g., shyness), behavioural (e.g., task performance), cognitive (e.g., attributional bias), and clinical concepts (e.g., anxiety and depression). While some researchers have been particularly concerned with understanding the nuances of the self-esteem construct, others have focussed on the adaptive and self-protective functions of self-esteem.

Measurement

Among the most popular and well-utilized measures of self-esteem are the Rosenberg Self-Esteem Scale (1965) and the Coopersmith Self-Esteem Inventory (1967/1981). Rosenberg's scale was originally developed to measure adolescents' global feelings of self-worth or self-acceptance, and is generally considered the standard against which other measures of self-esteem are compared. It includes 10 items that are usually scored using a four-point response ranging from strongly disagree to strongly agree. The items are face valid, and the scale is short and easy and fast to administer. Extensive and acceptable reliability (internal consistency and test-retest) and validity (convergent and discriminant) information exists for the Rosenberg Self-Esteem Scale (Blascovich and Tomaka, 1991).

The Coopersmith Self-Esteem Inventory was developed through research to assess attitude toward oneself in general, and in specific contexts: peers, parents, school, and personal interests. It was originally designed for use with children, drawing on items from scales that were previously used by Carl Rogers. Respondents state whether a set of 50 generally favorable or unfavorable aspects of a person are "like me" or "not like me." There are two forms, a School Form at ages 8-15 and an Adult form with ages 16 and older (Blascovich and Tomaka, 1991; Pervin, 1993). Acceptable reliability including the internal consistency and test-retest, and validity such as convergent and discriminant information exists for the Self-Esteem Inventory (Blascovich and Tomaka, 1991). In order to measure self-esteem of different level of ages, many tests have been developed and constructed in such a way and the available tests were accessed at http://www.psy.mq.au/testlibrary/test_cat_alpha. Table 2.3 shows some of the psychological tests and the year they were constructed.

Table 2.3: Measures of Self-Esteem

Psychological Tests	Year
Rosenberg's Self Esteem Scale	1965
Self Perception Inventory	1969
Performance Self-Esteem Scale (PSES)	1979
Coopersmith Self-Esteem Inventories (CSEI)	1981
Behavioural Academic Self-Esteem (BASE)	1982
Piers-Harris Children's Self Concept Scale; 2nd edition	1984 2002
Self Perception Profile for Children	1985
Self Perception Profile for Adults	1986
Self Perception Profile for College Students	1986
Self Description Questionnaire - I (SDQ-I)	1987
Self Perception Profile for Adolescents	1988
Self Perception Profile for Learning Disabled Students	1988
Offer Self-Image Questionnaire for Adolescents (OSIQ) 4th Edition; Revised (OSIQ-R)	1989 1992
Self Description Questionnaire - III (SDQ-III)	1989
Self Description Questionnaire - II (SDQ-II)	1990
Self Esteem Index (SEI)	1991
Tennessee Self Concept Scale (TSCS) (Revised Manual); 2nd edition (TSCS: 2)	1991 1996
Visual Analogue Self-Esteem Scale (VASES)	1999
The Self Image Profiles (SIP)	2001

Relationship to Health

Much of the research about the relationship between self-esteem and health appears to have been done in terms of the influence of self-esteem on health-related behaviours. Self-esteem has been related to such health practices as the use of birth control, and exercise. At least one study did not find a linear relationship between self-esteem and health behaviours. Abood and Conway (1992) found a relationship between self-esteem and health values, and between self-esteem and general wellness behaviour, but not between self-esteem and tobacco. They found a significant relationship between self-esteem and general health behaviour for both younger and older adolescents, and that self-esteem accounted for a significant percent of the variance in mental health behaviour, social health behaviour, and total health behaviour.

Twenge and Campbell (2001) in a cross-temporal meta-analytic review describe age and birth cohort differences in self-esteem among college students and school-age children. Self-esteem in college students increased substantially during 1968-1994 as measured using the Rosenberg Self-Esteem Scale while children's scores on the Coopersmith Self-Esteem Inventory showed a curvilinear pattern, decreasing from 1965 to 1979 and increasing from 1980 to 1993. They conclude that during this period of rising self-esteem few positive changes occurred in children and young adults' behaviour, noting most of the relevant behavioural indicators worsened, for example, increases in adolescent crime rates, and increases in teen suicide rates and in anxiety and depression. Baumeister *et al.* (2003) in a review of the self-esteem literature conclude that the benefits of high self-esteem fall into two categories, enhanced initiative and pleasant feelings. They conclude that self-esteem has little association with health behaviour. High self-esteem does not appear to prevent children from drinking, taking drugs, smoking or engaging in early sex. The well-established relationship between self-esteem and psychological well-being such as depression, social anxiety, and loneliness may be an important factor in understanding the self-esteem and health relationship.

2.5.4 BASE

Behavioural Academic Self-Esteem (BASE) measures children's academic self-esteem by using direct observation of their classroom behaviours. Teachers, parents, or other observers draw on their first-hand experience with a specific child to rate how often the child behaved in particular ways. BASE has been used with children of preschool, elementary, and junior high school classes, both individually and in groups. BASE may be used for identifying students' levels of academic self-esteem, evaluating factors that affect the academic self-esteem, providing a rationale for intervening in the academic lives of students who need motivational stimulation, assessing how programs affect student motivation, supplementing information from clinical psycho-educational studies of children, and encouraging discussions about self-esteem in parent-teacher conferences (Coopersmith and Gilberts, 1982).

BASE is founded on Stanley Coopersmith's (1967) theory and research. Coopersmith demonstrated that children with high levels of self-esteem were active, exploratory, and persistent. He found that these children had usually experienced a great deal of care and affection in their early lives, and their parents' rule setting and disciplinary practices provided a clear social structure. The children displayed traits of self-confidence and social attractiveness, usually succeeded in their efforts yet coped well with failure, and demonstrated verbal behaviour appropriate to that social setting. BASE was developed to infer self-esteem from observations of behaviour; to validly and reliably measure self-esteem at early ages; to establish measures situationally specific to the classroom; and to establish construct and predictive validity related to common measures of school success.
(Coopersmith and Gilberts, 1982).

A number of researches have designed rating scales to assess self-esteem of children in the classroom setting. Some of the published devices include the Florida Key, developed by Purkey *et al.* (1973), which identifies four factors of self-esteem, such as relating, asserting, investing, and coping; and the Behavioural Rating Form (RBF) by Coopersmith (1967), which is used to infer the self-esteem of subjects from observer ratings.

Table 2.4 shows the detail of modified version of BASE Rating Scale. The information was accessed from http://www.stopyouthviolence.ucr.edu/measures

Table 2.4: Modified Version of BASE Rating Scale

Self-Esteem
Measure : The Behaviour Rating Form- Revised
Assesses : Self-esteem
Age Group : 4 to 6 years old
Respondent : Parent
Measure Description: 13 items, 5 pt scale (1=always, 5=never). This is a modified version of the Behavioural Academic Self-Esteem Scale (BASE)
Psychometric Information: Coefficient alpha .81 (N=38)
Primary Reference: Hughes, H. M., & Pugh, R. (1984). The behaviour rating form- Revised: A parent-report measure of children's self-esteem. *Journal of Clinical Psychology, 40* (4), 1001-1005.

BASE Rating Scale Results

Several studies have been done using BASE and the following discuss the BASE Rating Scale results. BASE, a self-esteem rating scale that measures academic self-esteem by using direct observation of students' classroom behaviours, was completed on each student four weeks after initial program implementation by each student's respective homeroom teacher and again seven months following program implementation. The instrument addresses five factors found most revealing of children's self-esteem as seen in their academic performance, and identifies low-self-esteem students by using the total BASE score. In addition, 16 student academic self-esteem behaviours determined to be most indicative of students with high academic self-esteem are rated by an observer according to behaviour frequency. The protocols of 1040 students from all three elementary study sites were analysed by Wright State University.

Students at all sites exposed to the self-esteem treatment for eight months showed significant gains in academic self-esteem at the <0.0001 level. No significant differences between scores in different grade levels were noted. Improvement was noted to be consistent throughout grade levels. Results indicated that students "lowest in self-esteem" (as identified by pre-BASE scores) at all sites and potentially highest at-risk for school failure showed significantly greater improvement in academic self-esteem gains than did those students categorized as not "lowest-self-esteem" (p-value <0.0001). Results also showed that 68% of the students categorized as "lowest-self-esteem" prior to program implementation no longer scored in the lowest category at the completion of the study.

Of the 16 academic self-esteem behaviours measured, 11 items showed significant improvement in all students: (a) willing to undertake new tasks, (b) able to make decisions and establish goals, (c) shows self-direction and independence in activities, (d) initiates new ideas relative to classroom activities, (e) asks questions when doesn't understand, (f) deals with mistakes or failures easily and comfortably, (h) takes criticism or corrections in stride without overreacting, (i) company is sought by peers, (j) acts as leader in group situations, (k) refers to self in genuinely positive terms, and (l) readily expresses opinions. For "lowest-self-esteem" students, six behaviours showed the most significant gains: (a) initiating new ideas, (b) asking questions, (c) peers seek company, (d) leader in group situations, (e) refers to self positively, and (f) readily expresses opinions.

Another study by Johnson *et al.* (1983), the Coopersmith Self-Esteem Inventory (SEI) was examined using a modified version of the Sabers and Whitney model for construct validation. The SEI, Piers-Harris Children's Self-Concept Scale (CSCS), and Children's Social Desirability Scale (CSDS) were administered to 55 males and

50 females enrolled in six intact fifth-grade classes. Each student also received a teacher rating of self-concept using the Coopersmith Behavioural Academic Assessment Scale (BASE). Regression analyses indicated that the SEI has convergent validity with regard to the CSCS ($p<.01$) and BASE ($p<.01$), has discriminant validity with regard to the CSDS ($p>.05$), is sensitive to differences in achievement level ($p <.01$), and is internally consistent (coefficient alpha = .86). Intra-rater stability for the BASE ranged from .85 to .97; average inter-rater agreement was .86. Haugland (1992) assessed the effect of developmental and nondevelopmental software on children's cognition, creativity, and self-esteem. Three classrooms of four-year-old children were exposed to computers for one hour, three days weekly, during self-selected activity time. In a fourth classroom, children received no computer exposure. Of the three classrooms exposed to computers, one classroom was exposed to nondevelopmental software (drill and practice), another to developmental software, and the third to developmental software reinforced with supplemental activities. Children were assessed using the Behavioural Academic Self-Esteem, the Detroit Test of Learning Aptitude, Pre-Primary, and the Multidimensional Stimulus Frequency Measure.

From the literature review, the hybrid inteligent techniques have been successfully applied to various types of applications. However, the hybrid techniques have not been applied to counselling, therefore this study aims to explore the potential use of hybrid techniques in psychology domain. The fuzzy logic and expert system approach is applied in developing advisory system for e-counselling is attempted to provide the amenities to the user especially teachers, parents, counsellors, observers and researcher in this field and to identify the kind of BASE factor based on the questions answered and determine the level of academic self-esteem. This system would infer a decision on the BASE factor and level of academic self-esteem with the explanation facilities through the Internet. For study and reference purposes, a BASE has been chosen as case study to develop this system.

CHAPTER 3

SYSTEM DESIGN AND DEVELOPMENT

This section describes the system design and development of Fuzzy Expert Advisory for e-Counselling. Adopted from Durkin (1994), Knowledge Engineering Methodology, the system design and development that is integrated into a six phases namely problem assessment, knowledge acquisition and analysis, design and implementation, testing, documentation, integration and maintenance of the system are described.

3.1 Introduction

The hybrid system is applied using the two AI techniques, known as fuzzy logic and expert system. The fuzzy logic technique is used to estimate the BASE factor structure scores and to determine the levels of academic self-esteem of the student, while the expert system is used to provide an explanation to the users. The purpose of developing the web-based application system is to provide a comprehensive information and consultation in interactive and user-friendly manner to the users through the Internet. Since the advance computing techniques were not being applied much to e-counselling services, this factor contribute to the uniqueness of the system in terms of its features and approaches used.

The first phase of the system involves the estimation of the BASE factor structure score using fuzzy logic. The fuzzy logic deals with vagueness, uncertainty and to reduce the rigidness of the existing BASE factor rating scale and sub score system. The single and hierarchical inference structure are used in this project to handle the two attributes and more than two attributes to the system at a time respectively. The second phase of the system involves the expert system technique to deal with the explanation facility. Fuzzy logic and expert system are applied due to the ability of each technology in handling the uncertainty and ambiguity of human knowledge differently, and each technology has been placed in knowledge engineering. They are no longer compete, rather they are complemented each other. A synergy of expert systems with fuzzy logic improves adaptability, and the speed of knowledge-based systems.

The internal structure of the fuzzy expert advisory for e-counselling comprises of two main phases. There are input screen in entry phase, and solution recommendation phase. By clicking the "Counselling System" button on the main menu user interface for the system, the input screen in entry phase will appear. The system interface is organised based on the five BASE factor structure and interacts with the user through a user interface to obtain the inputs starting from Factor 1: Student Initiative to Factor 5: Self-Confidence. The questions will be asked based on the BASE rating scale standard question consists of sixteen items. The system questions are extracted from the factor analysis of the items reflected Coopersmith's (1981) theory of self-esteem. It emphasized the traits pertinent to children's self-esteem as revealed in their academic performance. This is the source of the term *academic self-esteem*.

Users may make ratings at their own convenience or may refer to 'Guide to Answer Question' for help. First, the user is required to give the input to the system by sliding the corresponding value using the slider bar or by inputting the value for Student Initiative BASE Factor 1 through Self-Confidence of BASE Factor 5. The input value of Question 1 through Question 16 is representing 5 rating scale of fuzzy labels or linguistic value such as *never*, *seldom*, *sometimes*, *usually*, and *always*.

These values are later used in fuzzy rules for the inferences. The numerical ranges are represented in a form of percentage. The system uses a fuzzy knowledge base consisting of a database of information necessary for providing expert advice. Figure 3.1 shows the design of web-based system of Fuzzy Expert Advisory for e-Counselling. This design was adopted from Saini *et al.* (2002).

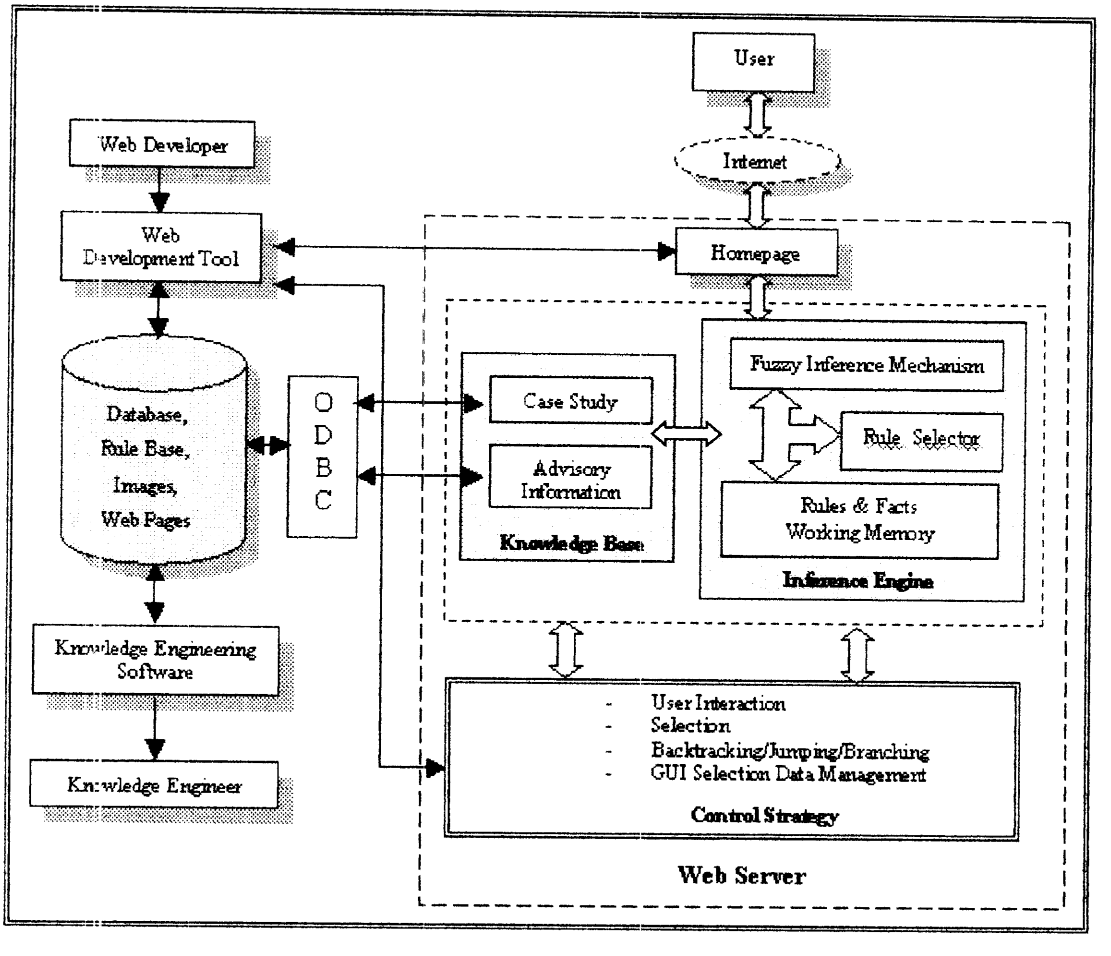


Figure 3.1: Design of Fuzzy Expert Advisory for e-Counselling

3.2 System Development

The process of developing fuzzy expert system involves the eliciting and constructing the knowledge base. Since the interest of expert system designers lies in the problem's knowledge, so to accomplish this task the knowledge from the expert is required to describe how the problem can be solved. To gain an understanding of the problem, the knowledge need to be acquired, organized and studied. The required knowledge also can be collected from other sources such as documented sources, journals databases, or observed human behaviour. The system is then built and tested to enhance the understanding. The system design and development of this system is integrated into a six phase process using Knowledge Engineering Methodology. This methodology was adopted from Durkin (1994). Fig. 3.2 shows the flow and sequence of the processes.

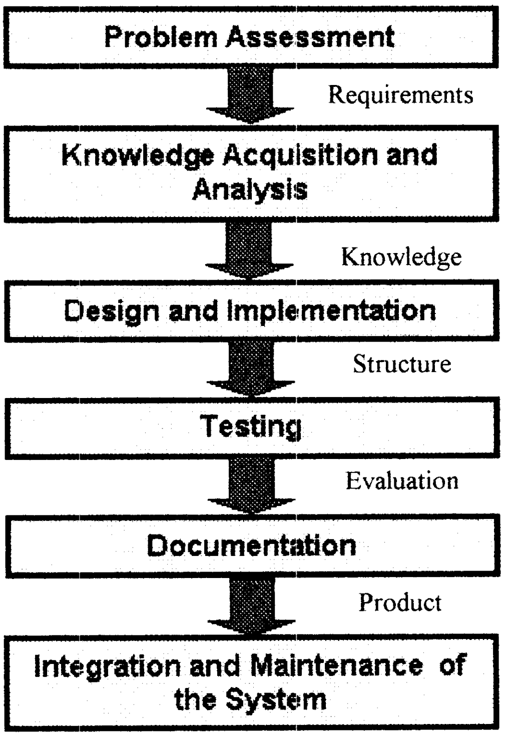


Figure 3.2: Knowledge Engineering Methodology

3.2.1 Problem Assessment

The problem assessment phase involved the studies to determine the important features and scope of the system, and establishes the needed resources. This phase also focuses on a methodology for accessing the applicability of an expert system to a domain problem. In this system the BASE factor structure for advisory system in e-counselling is chosen as a study domain. The BASE factor structure features, descriptions, scoring and interpretation are recognised and identified to produce a well-defined problem and offers a clear benefit for further system development. The sources of needed knowledge of BASE factors are identified such as experts, and various documentations.

3.2.2 Knowledge Acquisition and Analysis

Following the problem assessment phase, the next task is *knowledge acquisition*. This task is the most difficult challenge in the development of an expert system. Knowledge acquisition is a cyclical process. It follows the tasks of knowledge collection, its interpretation and analysis, and the methods for collecting additional knowledge. Collection is the process of acquiring knowledge from the expert. Interpretation of the collected information involves the identification of key pieces of knowledge, such as concepts, rules, and strategies (Durkin, 1994). According to Turban (2001), the knowledge acquisition is the accumulation, transfer, and transformation of problem solving expertise from experts or documented knowledge sources to a computer program for constructing or expanding the knowledge base.

Potential sources of knowledge include human experts, textbooks, journal databases, special, research reports, and information available on the web. Acquiring knowledge from experts is a complex task that often creates a bottleneck in ES construction. Knowledge engineer or knowledge elicitation expert needs to interact with one or more human experts in building the knowledge base. The acquisition via the Internet provides an "expert system" with a scope far greater than that possible with standard computer-based system and it is possible to access vast amounts of knowledge. Knowledge acquisition involves the acquisition of knowledge that may be specific to the problem domain or to problem solving procedures.

In this project, the counsellors in Pusat Kaunseling, Universiti Utara Malaysia (UUM) have been selected as the domain expert. The meetings held with the expert to discuss some aspects of the problem. These experts are posses the skill and knowledge to solve a specific problem related to counselling in a manner superior to others. They gain their expertise within certain period of time of solving similar problem. Through these experiences, they compile the knowledge and problem-solving skills into a compact form to enable them to solve problem efficiently. Besides of acquiring the knowledge from expert, the information related to e-counselling and psychology are also collected from other sources. As far as the project is concerned, the documented source of psychological testing has been used.

The process for BASE factor structure has been selected for easy construction in the domain problem. The information gathered from the expert are regarding the type of questions available in the psychological testing, the sequence of the questions whether the priority is taken into consideration, the significance of the test, and the scoring and interpretation. As BASE test is appeared and designed in standard form, the advanced studied has been done based on the documented sources. For this purpose also, the relevant knowledge has been obtained from numerous different sources such as expert interviews, literature references on psychology and counselling, existing models and references, and acquisition via the Internet.

3.2.3 Literature References on Psychology and Counselling

The initial study about the type of psychology testing and counselling as a whole have been conducted by referring to the measurement in psychology and counselling. These materials are compilation of Sidek's (1998), which consists of the introduction to testing and measurements, the validity and reliability, the process of forming the measurement tools, personality measurement tools issues and ethics in psychological testing measurement. The attachment of several psychological testing was also observed such as the Sidek's Personality Inventory, Junior Eysenck Personality Inventory (JEPI), Colour Personality Inventory, Tennessee Self-Concept Scale (TSCS), Vocational Preference Inventory (VPI), Self-Directed Search (SDS), Rothwell-Miller Interest Blank, and Sidek's Occupational Value Inventory. Other relevant materials also observed and reviewed including the Cognitive Distortion Scale (CDS) by Briere (2001) and BASE (Coopersmith and Gilberts, 1981).

The most important issues to be taken into consideration are the type of question, and the number of questions. According to Sidek (1998), psychological testing type of questions may be appeared in a form of unstuctured answer, fill in the blanks, tabular, category (e.g. yes or no), checklists, and rating scale (e.g. almost never, rarely, sometimes, quite often or most of the time). The information are necessary because the technique to be applied must have the ability of in handling the uncertainty and ambiguity of human knowledge. Other literature references includes books, compilation of psychology testing, research papers, surveys and reports, psychology databases, test library available on the web, and articles. Finally, BASE has been chosen due to its type of question in a form of rating scale that suit the technique to be used, and with a few number of questions for easier organization and implementation. Preliminary knowledge has been compiled from BASE compilation of the psychological testing, research papers published in journals and related materials on the web.

3.2.4 Expert Interviews

After several studies have been carried out, the acquisition of knowledge in this study is then followed by the face-to-face interview. This form of knowledge acquisition was used since it is the most commonly used method. The interview session was arranged with En. Muhammad Salleh b Ahmad, Pengarah, Pusat Kaunseling, Tn Hj Shahrin Hj. Ahmad, Unit Akademik, Jabatan Hal Ehwal Pelajar and Puan Faezah Binti Nayan, Pusat Kaunseling dan Kerjaya, from Universiti Utara Malaysia (UUM) to obtain detail information and knowledge. Based on the discussion, the knowledge provided in the BASE test is standard in terms of their description on self-esteem measurement. In order to form the system using fuzzy logic, it is necessary to know how the psychological test being constructed. Based on the information obtained, the questions are normally designed and constructed randomly. In other words, there is no priority given in organising the questions. On the explanation part, the scoring and interpretation of the BASE is also important. For each factor score or total score, there is an appropriate classification of academic self-esteem and their respective ranges for male and female students. For male and female students the score should appear differently. This is a normal practise in constructing and handling psychological testing.

3.2.5 Acquisition via the Internet

With the increase use of the Internet, it is possible to access vast amounts of knowledge. According to Turban and Aronson (2001), the acquisition, availability and management of knowledge via the Internet becoming the critical issues for the construction and maintenance of the knowledge-based system particularly because they allow the acquisition and dissemination of large quantities of knowledge in a short time across organizational and physical boundaries. Even though the Internet provides a lot of relevant information for psychology testing, but the detail information on the psychological testing especially BASE could not be obtained directly since there are procedures must be followed.

The information on e-counselling and psychology, the web-based application, and related information on the development in this domain is also gathered on the Internet. For the psychology testing there is number of websites that provide information and testing up to the results of the testing. The available websites can be accessed at http://ww.questia.com, http://www.queendom.com and others can be accessed by simply using the search engine such as Yahoo, Geocities, or Google. In Malaysia, UUM e-Kaunseling has been developed to provide on-line information and services on counselling. It is also provide searchable information link to other universities. The address is at http://portal.uum.edu.my/portalbm/e-kaunseling. The system developed has a potential to be introduced on the web to the educators or teachers, parents, or other observers to rate students' or child academic self-esteem. According to Coopersmith (1981), a rater's most important qualification is a minimum of five to six weeks' experience with the child on a daily basis in a setting associated with learning. The longer the educational exposure to the child, the more valid the ratings should be.

3.2.6 Knowledge Analysis

Following the collection of knowledge, the collected information must be interpreted, organized, analyzed, and documented. The key pieces of knowledge can be structured graphically such as using conceptual graphs, inference networks and flowcharts. The cognitive map is used to show the natural relationships between concepts or objects, inference networks provide a graphical representation of the system's rules with antecedents and consequences of the rules and flowcharts present a sequence of steps that will be performed. All these techniques provide visual perspectives of the important knowledges and its organization. They share the advantage of focusing on some issue and act as a resource for gathering additional information.

Another purpose of graphical approach is to improve the process of knowledge acquisition. This is also known as knowledge diagramming. In order to describe facts and reasoning strategies for problem solving, the hierarchical top-down descriptions of the major types of knowledge is applied. As knowledge is acquired, it supports the analysis and planning of subsequent acquisition. In this system, the key pieces of knowledge are interpreted and analysed. It describes the linkages and interactions among the knowledge. The current practice BASE scale may be scored by hand or by computer. If BASE is hand scored, the rater determines the factor scores simply by adding the item ratings for each factor. When BASE is scored by computer, the error of measurement is reduced and the predictive validity of the scale is improved. Based on the factor scores or the total score, there is an appropriate classification such as *high self-esteem*, *moderate self-esteem*, or *low self-esteem*.

As discussed before, the technique used in this system is to reduce the rigidness of the existing scoring system to BASE factors. It is more natural to the human to express their estimation of the academic self-esteem of the student in percentage to represent the specific behaviours. As stated, the sub score for Student Initiative (factor 1) using six attributes or inputs, the Social Attention (factor 2) and Social Attraction (factor 4) using three attributes and Social Attention (factor 3) and Self-Confidence (factor 5) with two attributes. This sub score and their ranges will contribute to the determination of the levels of academic self-esteem. The explanation part in the system may be used to evaluate factors that affect the academic self-esteem, encouraging discussions about self-esteem in parent-teacher conference, and to establish construct and predictive validity related to common measures of school success. The general flow of Fuzzy Expert Advisory for e-Counselling is as shown in Fig. 3.3.

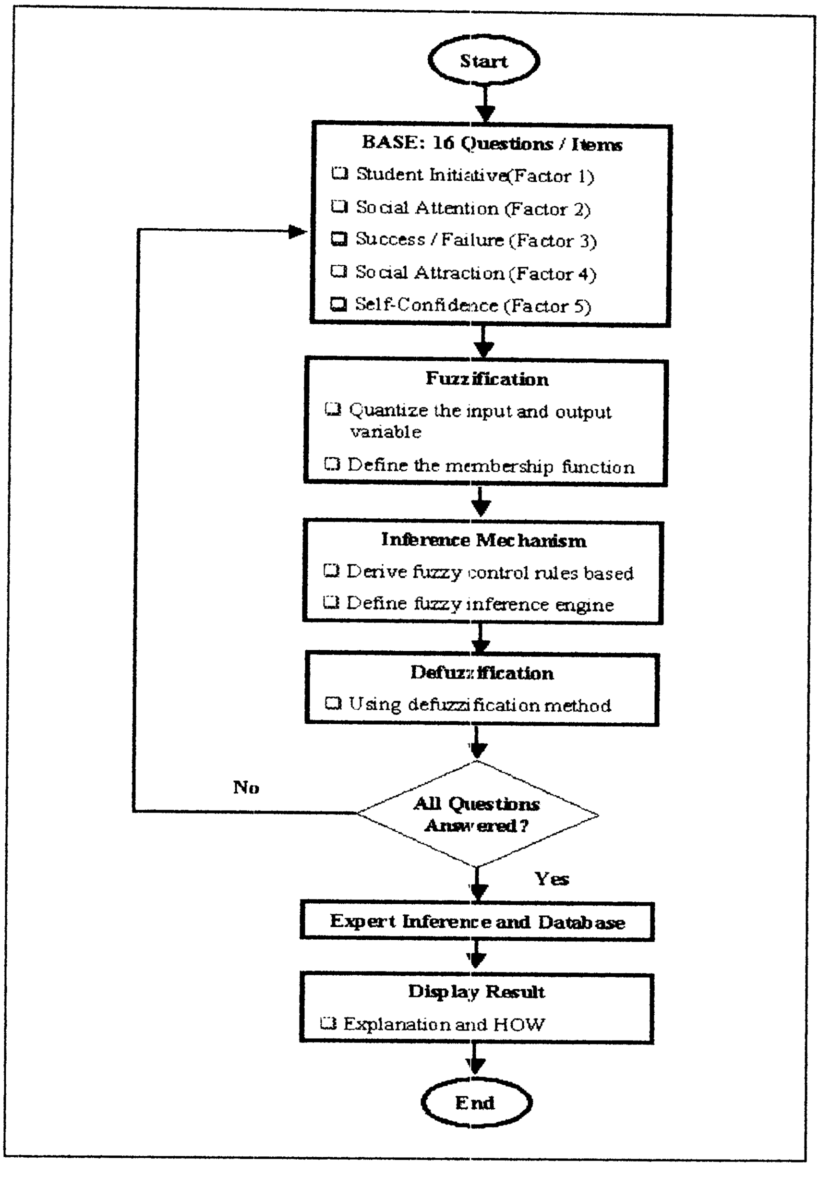


Figure 3.3: Flowchart of Fuzzy Expert Advisory for e-Counselling

The cognitive map is used to show the natural relationships between concepts or objects. The cognitive map also presents a concept or visual picture of the system to facilitate understanding and gaining clear picture of the system. Appendix B presents the cognitive map of Fuzzy Expert Advisory for e-Counselling, and Appendix C depicts the inference network to represent the nodes and branches relationship of BASE.

3.3 Design and Implementation

Following the knowledge acquisition task, the understanding of the problem should be sufficient to begin designing the system. Durkin (1994), explained that the knowledge representation technique need to be selected and as well as the software tool to develop the prototype system. This prototype system is then built to both validate the system and and provide guidance for future work. The system is then further developed including the interface and refined to meet the project objectives.

3.3.1 Knowledge Representation

Knowledge representation should support the tasks of acquiring and retrieving knowledge as well as subsequent reasoning (Turbon and Aronson, 2001). By taking the advantage of the production rules such as simple syntax, easy to understand, simple interpreter, highly modular, and flexible means easy to add or to modify, therefore this knowledge representation has been used. A rule is a form of procedural knowledge, or a knowledge structure that relates some known information to other information that can be concluded or inferred to be known. Choosing the correct representation produces a structure that supports effective problem solving. The processing of rules is managed by the inference engine and later used to make conclusions by providing the advice through the user interface.

Rule-Based Representation

Rule-based systems are currently the most popular choice in building an expert system. The basic structure of a production consists of an antecedent or IF part describing the situation and a consequent or THEN part describing some action to be taken in the event that the situation exists (Durkin, 1994). Rule-based expert system is involved in processing problem-specific information contained in the working memory with a set of rules contained in the knowledge base, using inference engine to infer new information. Rule-based expert systems often provide a reasonable model for replicating human problem solving behaviour with a computer.

3.3.2 Fuzzy Logic and Expert System

The fuzzy logic design can be divided into seven phases. It is used to provide the procedures in designing fuzzy logic system. The phases involves are system study, fuzzification, inference mechanism, defuzzification, simulation and testing and performance evaluation. Firstly, the study of the system involves the determining the objectives and identifying the input, process, and output. Thus, one should have a good knowledge on the system to be developed. The next phase involves the fuzzification where the input and output is quantized and membership functions for the input and output is defined. The fuzzy rule-base is derived and inference engine is defined. Finally, the right defuzzification method is chosen based on the application. The performance of the system can be analysed. If the results are not as desired, changes are made and the system can be tested again. The trial and error approach will continue until satisfactory results are obtained. However, this fuzzy logic design is widely employed and has been used successfully in many applications. Fig. 3.4 presents the Fuzzy Logic System Design Methodology.

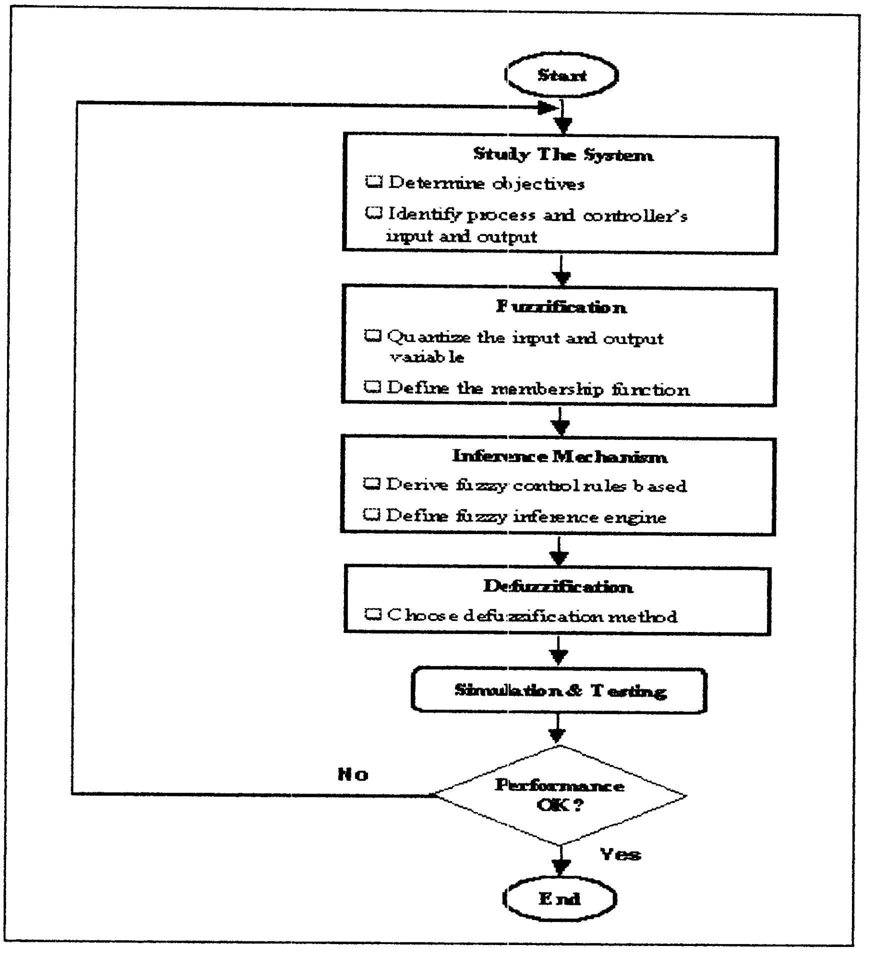


Figure 3.4: Fuzzy Logic System Design Methodology

The typical fuzzy logic architecture is generally comprises of four principle components: fuzzifier, knowledge base, inference engine, and defuzzifier. A fuzzy variable also called a linguistic variable is characterized by its name tag, a set of fuzzy values also known as linguistic values or labels, and the membership functions of these labels; these latter assign a membership value, label (μ) to a given real value R, within some predefined range. The basic components act as follows: a fuzzifier, which translates crisp or real-value inputs into fuzzy values; an inference engine that applies a fuzzy reasoning mechanism to obtain a fuzzy output; a defuzzifier, which translates this latter output into a crisp value; and a knowledge base, which contains both an ensemble of fuzzy rules, known as the rule base, and an ensemble of membership functions, known as the database. Fig. 3.5 illustrates the components of fuzzy logic.

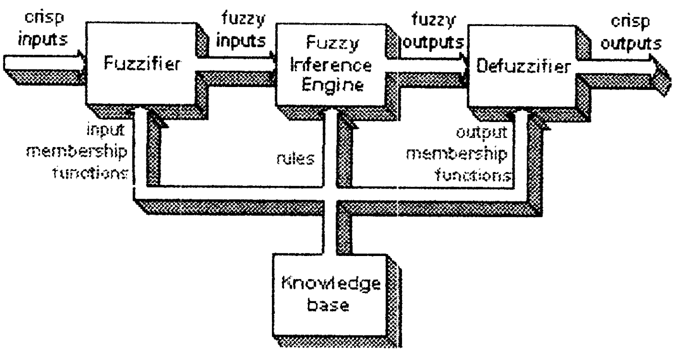


Figure 3.5: Components of Fuzzy Logic

The fuzzification is the first step in fuzzy system. It consists of converting the inputs from the crisp value to the fuzzy value, and identifies that there is an acceptance of uncertainty assigned to the input value. Every input value is associated with a linguistic variable. For each linguistic variable, it should be assigned a set of linguistic terms that subjectively describe the variable. Each linguistic term is a fuzzy set and has its own membership function. In constructing the membership function, it is expected that for a linguistic variable to be useful, the union of the support of the linguistic terms cover its entire domain. It is also expected there are some intersection between the support of linguistic terms that describe similar concepts. For instance, the fuzzy linguistic variable for temperature, the fuzzy set described as "warm" and "hot". Heuristically, adjacent linguistic terms should have 10 to 50% superposition (Xexeo, 2000). Some functions with specific shapes are highly preferred, such as triangular, trapezoidal, s-shaped, and gaussian functions. Given all the fuzzy sets which correspond to each linguistic variables, fuzzification means to calculate the membership value of each input value in each fuzzy set. Fig. 3.6 shows the two continuous membership functions describing the concepts of warm and hot temperature. The first function, warm, is a triangular function while the second, hot is a trapezoidal function.

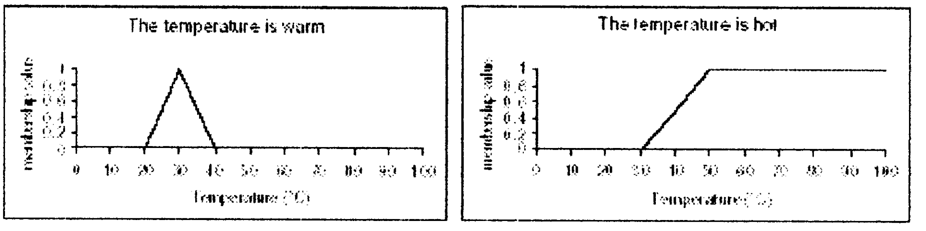


Figure 3.6: Two Continuous Membership Functions

The most common fuzzy system uses rules to formally represent knowledge. Although a single type of rule does not exist, if-then representation is a standard. A basic if- then rule can be written in the form

$$\textbf{\textit{IF}}\ a_1\ \textbf{\textit{AND}}\ a_2\ ...\ \textbf{\textit{AND}}\ a_n\ \textbf{\textit{THEN}}\ b$$

where a_i, $1 \leq i \leq n$, and b are fuzzy propositions. Similar to expert systems, each rule represents some reasonable assumption about the actions (output values) that should be taken in the case of that state of the system (input values), both input and output are described by fuzzy sets.

The structure of fuzzy inference consists of three conceptual components, rule base containing a selection of fuzzy rules, database defining the membership functions and these are used in the fuzzy rules, and reasoning mechanism that performs the inference procedure upon the rules and given facts and derives a reasonable output or conclusion. Every output value is a direct measure of input values. The rules had to be aggregated in order for decisions to be made. All the rule outputs were combined into a single fuzzy set via the aggregation process. The result was one fuzzy set for each output variable. After all rules were evaluated, the output of each rule was aggregated into a single fuzzy set whose membership function assigned a weighting for every output value.

Defuzzification or fuzzy decoding transforms a fuzzy set into a single crisp value. The aggregation process resulted in a range of output values that were defuzzified. There are many methods for defuzzification, such as max-membership principle (height method), which is limited to peaked functions, answers with the value for which the membership function is maximum; mean-max membership or mean of maxima (MOM), takes the mean of all the values generating maximum membership; first (or last) maxima, takes the smaller (or larger) value that generates a maximum; centroid or center of area/gravity (COA), calculates the centroid of a aggregating function, usually the maximum of all the original response functions, center of sums (COS) calculates the centroid over the sum of the output functions, instead of their maxima; center of largest area, which is useful for fuzzy sets with two convex sub-regions, answers with the centroid of the largest area, and weighted average method, uses the height of the functions to calculate a weighted average of the output. But the most common methods used are the COS, COA, and MOM.

An expert system is a narrow slice of computer intelligence and knowledge-based application. Expert systems program are designed to emulate human decision-making expertise in a particular domain. Expert systems belong to a group of systems known as knowledge-based systems. Knowledge-based systems contain the facts and procedures representing the heuristic decision-making processes of an expert. Fig. 3.7 illustrates the components of Expert System.

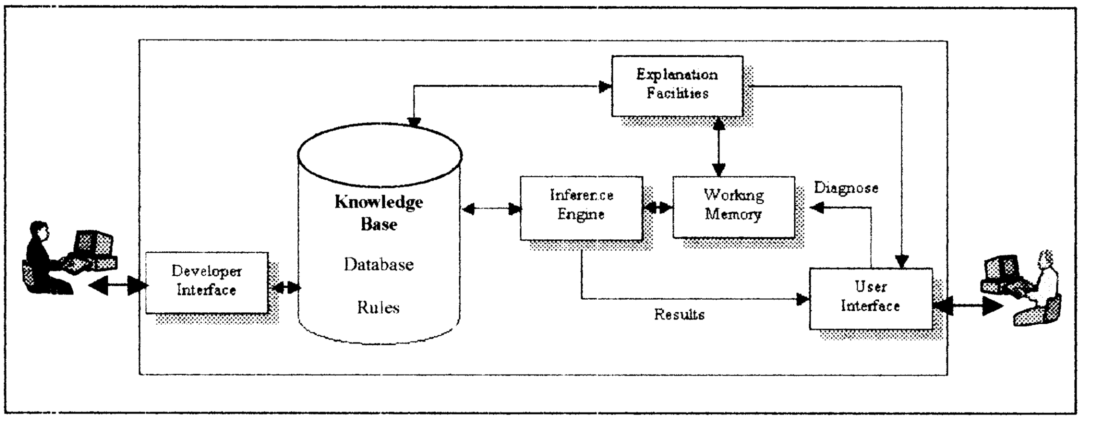


Figure 3.7: Components of Expert System

The components of expert systems are described as follow:

i. Knowledge Base

Knowledge base stores a factual and heuristic knowledge. An expert system tool provides one or more knowledge representation schemes for expressing knowledge about the application domain. It is normally constructed in the form of IF condition THEN action.

ii. Working Memory

The working memory contains the facts about a problem and it is a temporary storage.

iii. Inference Engine

An inference engine is processor for manipulating the symbolic information and knowledge in the knowledge base to form a line of reasoning in solving a problem. The inference mechanism can range from simple backward chaining of IF-THEN rules to case-based reasoning.

iv. User Interface

The means of communication with the user is user interface. Since user views the program through the system's interface, the acceptance of a system will depend on how well the interface accommodates the needs of the user.

3.3.3 Fuzzy Expert Advisory for e-Counselling Design

This system is constructed using four main components of an expert system. The components are knowledge base, inference engine, working memory and user interface. By integrating this expert system with fuzzy logic capability, the inference engine is modified in such a way to enable fuzzy inferencing. Therefore the fuzzy expert system inference engine are divided into three primary processes: fuzzification, fuzzy inference and defuzzification. Fig 3.8 depicts the Fuzzy Expert Advisory for e-Counselling System Components.

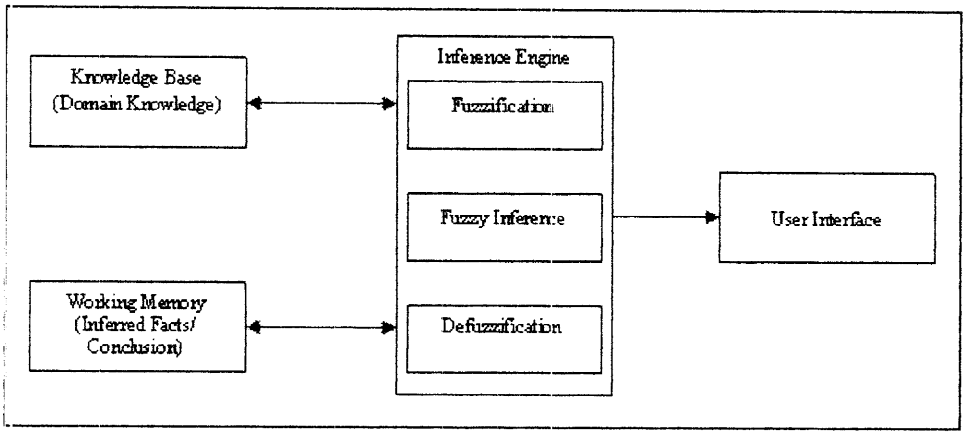


Figure 3.8: Fuzzy Expert Advisory for e-Counselling System Components

Knowledge Base

Knowledge base stores a factual and heuristic knowledge. An expert system tool provides one or more knowledge representation schemes for expressing knowledge about the application domain. Rule base containing a selection of fuzzy rules. It is normally constructed in the form of IF condition THEN action. The input of this estimating task is the questions base on the BASE factor structure. The output of this system is BASE factor sub score and their respective levels of academic self-esteem. In addition, based on the expert explanation, the advice is included with how the conclusion is derived. This knowledge base is stored in several DBExpert file using MS Access 2000 while the Active Server Pages (ASP) will invoke this file while the inference process is executed.

Working Memory

The working memory contains the facts about a problem that are discovered during consultation session. The Fuzzy Expert Advisory for e-Counselling needs to store these facts that gathered from users answers into a temporary storage and later used for inference tasks. The system would use this information to match with the knowledge contains in the knowledge base so that new facts can be inferred. This iterative process continues until the conclusion deduced.

Inference Engine

The module of inference engine involves the process of human reasoning. Inference engine is a processor in an expert system that matches the facts contained in the working memory with the domain knowledge contained in the knowledge base in order to derives a reasonable output or conclusion about the problem. Inference engine interact with working memory and knowledge base to find suitable matches in order to deduce solution. Fuzzy inference attempts to relate the fuzzified input facts to the premise patterns of fuzzy rules. It contains a knowledge base and intends to capture a given number of crisp inputs, apply fuzzy logic, and produce a given number of crisp outputs.

User Interface

Since user views the program through the system's interface, the acceptance of a system will depend on how well the interface accommodates the needs of the user. Therefore it is necessary to provide the best interface design with the explanation facility. The keys to effective design of interface development are consistency, clarity and control. The graphical user interface (GUI) has been applied for this system and the interfaces are supplemented with slider bar that acts as the input to the system. The screen direction is taken into consideration by providing the necessary button for user's further action. Finally, in the interface design, this system provides the conclusion and how the system derives a conclusion or recommendation.

Inputs of the System and Fuzzy Linguistic Variables

Input to the system is based on the five BASE factor structure questions or items. BASE factors involved are Student Initiative, Social Attention, Success/Failure, Social Attraction, and Self Confidence. Each item deals with a separate and represents different behaviours. Table 3.1 shows the item or question and its behaviours.

Table 3.1: Questions and its Behaviours

BASE Factor 1: Student Initiative
1. This child is willing to undertake new tasks.
2. This child is able to make decisions regarding things that affect him or her, e.g., establishing goals, making choices regarding "likes" and "dislikes" or academic interests.
3. This child shows self-direction and independence in activities.
4. This child initiates new ideas relative to classroom activities and projects.
5. This child asks questions when she or he does not understand.
6. This child adapts easily to changes in procedures.
BASE Factor 2: Social Attention
7. This child is quite in class, speaks in turn, and talks appropriately.
8. This child talks appropriately about his or her school accomplishments.
9. This child cooperates with other children.
BASE Factor 3: Success / Failure
10. This child deals with mistakes or failures easily and comfortably.
11. This child takes criticism or corrections in stride without overreacting.
BASE Factor 4: Social Attraction
12. This child's company is sought by peers.
13. This child acts as a leader in group situations with peers.
14. This child is quite in class, speaks in turn, and talks appropriately.
BASE Factor 5: Self-Confidence
15. This child refers to himself or herself in generally positive terms.
16. This child appreciates his or her work, work products, and activities.

As in fuzzy logic system, the crisp value of the items are fed into the system and then converted into fuzzy linguistic variables. Fuzzy linguistic variables are taken from the rating scale of BASE such as *never*, *seldom*, *sometimes*, *usually*, and *always*. The *Output 11*, *Output 12*, *Output 13*, and *Output 14* are in a form of crisp output values based on the calculated results after defuzzification have been performed for particular inputs. The linguistic variables for these outputs are assigned as *low self-esteem*, *moderate self-esteem*, and *high self-esteem*. Table 3.2 tabulates fuzzy input variables, calculated output variables and their linguistic variables of Student Initiative (BASE Factor 1).

Table 3.2: Fuzzy Input Variables and Linguistic Variable of Student Initiative

BASE Factor 1: Student Initiative	
Fuzzy Input Variables	Fuzzy Linguistic Variables
Question 1	{Never, Seldom, Sometimes, Usually, Always}
Question 2	{Never, Seldom, Sometimes, Usually, Always}
Question 3	{Never, Seldom, Sometimes, Usually, Always}
Question 4	{Never, Seldom, Sometimes, Usually, Always}
Question 5	{Never, Seldom, Sometimes, Usually, Always}
Question 6	{Never, Seldom, Sometimes, Usually, Always}
Output 11	{Low Self-Esteem, Moderate Self-Esteem}
Output 12	{Low Self-Esteem, Moderate Self-Esteem}
Output 13	{Low Self-Esteem, Moderate Self-Esteem, High Self-Esteem}
Output 14	{Low Self-Esteem, Moderate Self-Esteem, High Self-Esteem}

Following the same information as described in the Student Initiative BASE Factor 1, the fuzzy linguistic variables involve are *never*, *seldom*, *sometimes*, *usually*, and *always*. The *Output 21* is in a form of crisp output values based on the calculated results after defuzzification have been performed for particular inputs. The linguistic variables for these outputs are assigned as *low self-esteem*, and *moderate self-esteem*. Table 3.3 tabulates fuzzy input variables, calculated output variables and their linguistic variables of Social Attention (BASE Factor 2).

Table 3.3: Fuzzy Input Variables and Linguistic Variable of Social Attention

BASE Factor 2: Social Attention	
Fuzzy Input Variables	Fuzzy Linguistic Variables
Question 7	{Never, Seldom, Sometimes, Usually, Always}
Question 8	{Never, Seldom, Sometimes, Usually, Always}
Question 9	{Never, Seldom, Sometimes, Usually, Always}
Output 21	{Low Self-Esteem, Moderate Self-Esteem}

For the Success/Failure of BASE Factor 3, the fuzzy linguistic variables involve are *never*, *seldom*, *sometimes*, *usually*, and *always*. Table 3.4 tabulates fuzzy input variables and their linguistic variables.

Table 3.4: Fuzzy Input Variables and Linguistic Variable of Success/Failure

BASE Factor 3: Success / Failure	
Fuzzy Input Variables	Fuzzy Linguistic Variables
Question 10	{Never, Seldom, Sometimes, Usually, Always}
Question 11	{Never, Seldom, Sometimes, Usually, Always}

Using the similar information as described in the Social Attention BASE Factor 2, the fuzzy linguistic variables involve are *never*, *seldom*, *sometimes*, *usually*, and *always*. The *Output 41* is in a form of crisp output values based on the calculated results after defuzzification have been performed for particular inputs. The linguistic variables for these outputs are assigned as *low self-esteem*, and *moderate self-esteem*. Table 3.5 tabulates fuzzy input variables, calculated output variables and their linguistic variables of Social Attraction (BASE Factor 4).

Table 3.5: Fuzzy Input Variables and Linguistic Variable of Social Attraction

BASE Factor 4: Social Attraction	
Fuzzy Input Variables	Fuzzy Linguistic Variables
Question 12	{Never, Seldom, Sometimes, Usually, Always}
Question 13	{Never, Seldom, Sometimes, Usually, Always}
Question 14	{Never, Seldom, Sometimes, Usually, Always}
Output 41	{Low Self-Esteem, Moderate Self-Esteem}

Similar to the Success/Failure BASE Factor 3, the fuzzy linguistic variables involve for Self-Confidence BASE Factor 5 are *never*, *seldom*, *sometimes*, *usually*, and *always*. Table 3.6 tabulates fuzzy input variables and their linguistic variables of Self-Confidence (BASE Factor 5).

Table 3.6: Fuzzy Input Variables and Linguistic Variable of Self-Confidence

BASE Factor 5: Self-Confidence	
Fuzzy Input Variables	Fuzzy Linguistic Variables
Question 15	{Never, Seldom, Sometimes, Usually, Always}
Question 16	{Never, Seldom, Sometimes, Usually, Always}

In order to utilize the system, the user's system interface is equipped with the slider bar for input purpose. By sliding the bar, the corresponding value will be captured. The values of the input are then invoked by pressing the click button. Next, the system will display the label of the question and the confidence value for each item respectively. The label and confidence value is generated based on the value of range in the membership function.

Membership Function Graphs

A membership function graph can be constructed based on fuzzy linguistic variable definition. The membership function graph for a fuzzy input variable to represent such imprecision shows the degree of membership in each of the variable's fuzzy sets for each value in the range of interest. To determine each part of the function, two points on each straight line is expressed. All points on the line can then be easily identified. The membership functions defined on the input variables are applied to their actual values, to determine the degree of truth for each rule premise. Each fuzzy set has a corresponding membership function that returns the degree of membership, or belief, for a given value of the variable. Membership functions may be of any form, as for this system, the value return remains in the range [0, +1].

In developing this system, the membership functions for each input/item were developed through examining the actual academic self-esteem classifications for their respective ranges and the factor sub score. The x-axis represents the fuzzy variable and it ranges while the y-axis represents the confidence value ranges from 0.0 to 1.0. Each of the item containing Question 1 through Question 16 membership functions used five trapezoidal function fuzzy sets. The number and shape of the trapezoidal fuzzy sets for these questions were set in order to incorporate the full range of the linguistic variable. Each of these membership functions for the input was developed using five fuzzy sets each while the outputs of the hierarchical fuzzy logic was modelled using three fuzzy sets in order to facilitate the rule elicitation process.

The input for questions of BASE factors in the fuzzy set are labelled as *never*, *seldom*, *sometimes*, *usually* and *always*. For the defuzzified crisp output, in this case the Student Initiative involve five stages of obtaining crisp value and labelled as *Output 11*, *Output 12*, *Output 13*, and *Output 14* which are then treated as an input the next consecutive question, the fuzzy sets are labelled as *Low Self-Esteem*, *Moderate Self-Esteem*, and *High Self-Esteem*. The trapezoidal function was used to represent the linguistic variable which was applied to estimate the BASE factor. Real values entered by user through slider bar in system interface fall into corresponding membership function graph's zone. Table 3.7 shows the label of questions and label of defuzzified crisp output, and the ranges of the real values for Student Initiative of BASE factor 1.

Table 3.7: Label and Ranges of Student Initiative

BASE Factor 1: Student Initiative	
Label of Question	**Ranges**
Never	24 - 54
Seldom	84 - 114
Sometimes	144 - 174
Usually	204 - 234
Always	264 - 294
Label of Defuzzified Crisp Output	**Ranges**
Low Self-Esteem	54 - 144
Moderate Self-Esteem	154 - 244
High Self-Esteem	254 - 294

The input for questions of BASE factors in the fuzzy set are labelled as *never*, *seldom*, *sometimes*, *usually* and *always*. For the defuzzified crisp output, *Output 21*, which is then treated as an input the next consecutive question, the fuzzy sets are labelled as *Low Self-Esteem*, *Moderate Self-Esteem*, and *High Self-Esteem*. Table 3.8 shows label of questions and *Output 21*, and the ranges of the real values for Social Attention of BASE factor 2.

Table 3.8: Label and Ranges of Social Attention

BASE Factor 2: Social Attention	
Label of Question	**Ranges**
Never	12 - 27
Seldom	47 - 57
Sometimes	72 - 87
Usually	102 - 117
Always	132 - 147
Label of Output 21	**Ranges**
Low Self-Esteem	25 - 55
Moderate Self-Esteem	65 - 125
High Self-Esteem	135 - 145

Table 3.9 shows label of questions, and the ranges of the real values for Success/Failure of BASE factor.

Table 3.9: Label and Ranges of Success/Failure

BASE Factor 3: Success/Failure	
Label of Question	**Ranges**
Never	9 - 19
Seldom	29 - 39
Sometimes	49 - 59
Usually	69 - 79
Always	$\geq$ 89

Table 3.10 shows label of questions and Output 41, and the ranges of the real values for Social Attraction of BASE factor.

Table 3.10: Label and Ranges of Social Attraction

BASE Factor 4: Social Attraction	
Label of Question	**Ranges**
Never	12 - 27
Seldom	47 - 57
Sometimes	72 - 87
Usually	102 - 117
Always	132 - 147
Label of Output 41	**Ranges**
Low Self-Esteem	25 - 55
Moderate Self-Esteem	65 - 125
High Self-Esteem	135 - 145

Table 3.11 shows the label of questions, and the ranges of the real values for Self-Confidence of BASE factor.

Table 3.11: Label and Ranges of Self-Confidence

BASE Factor 5: Self-Confidence	
Label of Question	**Ranges**
Never	9 - 19
Seldom	29 - 39
Sometimes	49 - 59
Usually	69 - 79
Always	≥ 89

For the label Questions of the five BASE factors, there are five labels assigned to them namely *never*, *seldom*, *sometimes*, *usually*, and *always*. Membership function graph for questions of Social Attention and Social Attraction drawn for the input is illustrated in Fig. 3.9.

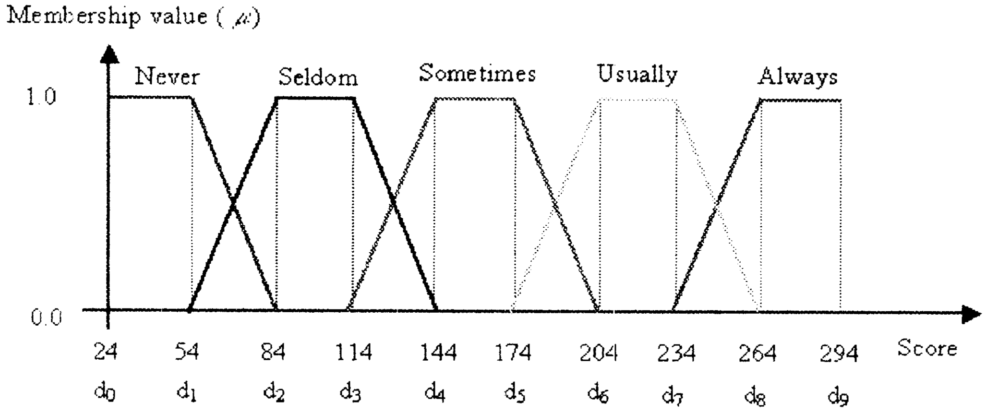


Figure 3.9: Membership Function for Questions of Student Initiative

The fuzzy membership function for questions of Social Attention and Social Attraction are as shown in Fig. 3.10.

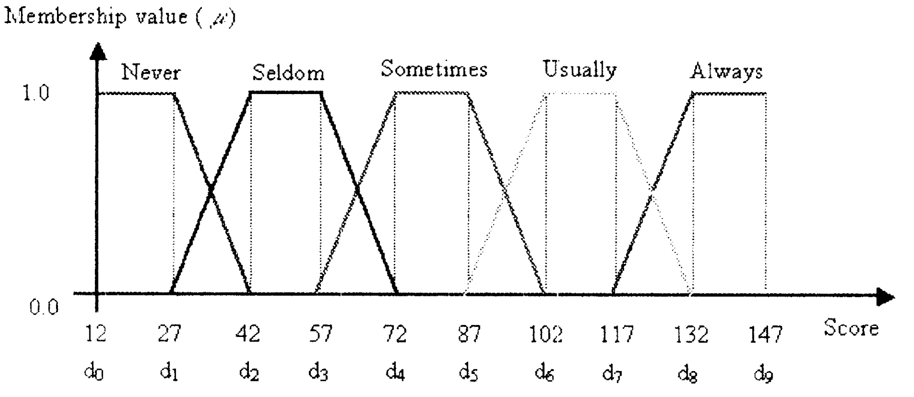


Figure 3.10: Membership Function for Questions of Social Attention and Social Attraction

The membership function for the hierarchical inference structure for Output 21 and Output 41 of Social Attention and Social Attraction is shown using the same graph as illustrated in Fig. 3.11. The label assigned to them namely *low self-esteem*, *moderate self-esteem*, and *high self-esteem.*

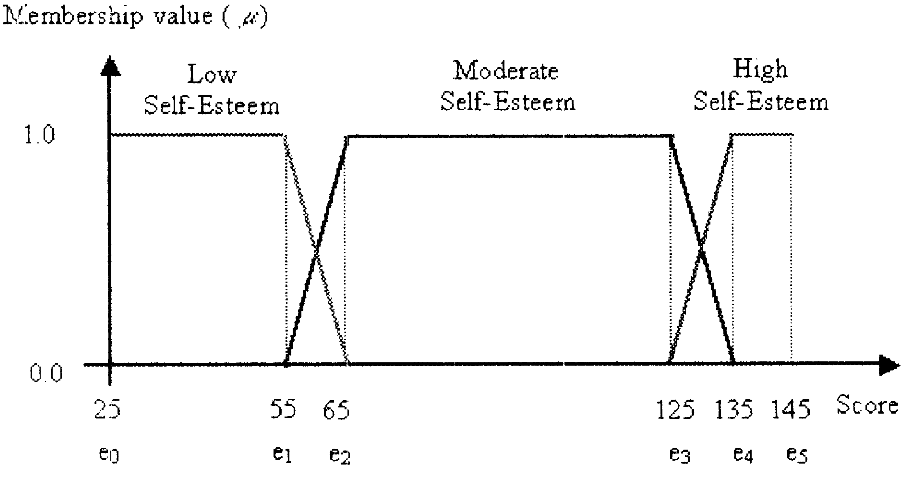


Figure 3.10: Membership Function for Output 21 and Output 41 of Social Attention and Social Attraction

The fuzzy membership function for questions of Success/Failure and Self-Confidence is illustrated as Fig. 3.11.

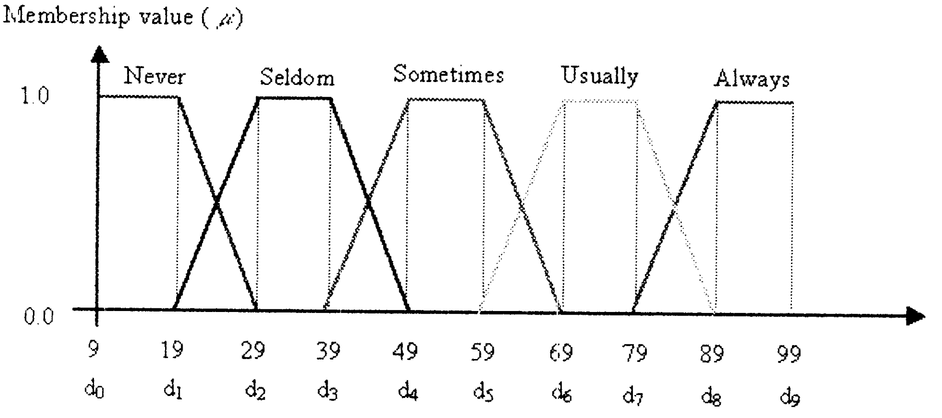


Figure 3.11: Membership Function for Questions of Success/Failure and Self-Confidence

To read the confidence value from the membership function graph, some calculations need to be performed. Let the value at x-axis denoted by d_0, d_1, d_2, d_3, d_4, d_5, d_6, d_7, d_8, and d_9. Assume that the membership function graph is splitting into nine zones. The graph with the zones are as illustrated in Fig. 3.12.

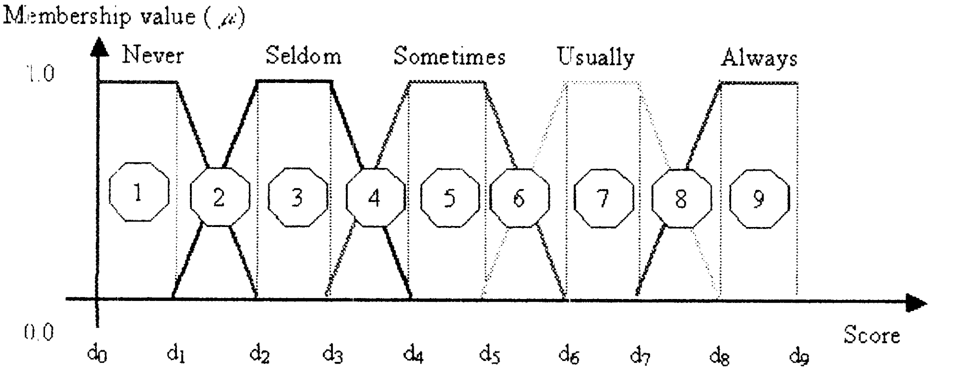


Figure 3.12: Membership Function Graph Zone

The computation for reading the confidence value from membership function graph is as formalized below.

Zone 1: $d_0 \le Score \le d_1$

Never	= 1.0
Seldom	= 0.0
Sometimes	= 0.0
Usually	= 0.0
Always	= 0.0

Zone 2: $d_1 \le Score \le d_2$

Never	$= (Score - d_1) / (d_0 - d_1)$
Seldom	$= (Score - d_0) / (d_1 - d_0)$
Sometimes	= 0.0
Usually	= 0.0
Always	= 0.0

Zone 3: $d_2 \le Score \le d_3$

Never	= 0.0
Seldom	= 1.0
Sometimes	= 0.0
Usually	= 0.0
Always	= 0.0

Zone 4: $d_3 \le Score \le d_4$

Never	= 0.0
Seldom	$= (Score - d_4) / (d_3 - d_4)$
Sometimes	$= (Score - d_3) / (d_4 - d_3)$
Usually	= 0.0
Always	= 0.0

Zone 5:	**$d_4 \leq$ Score $\leq d_5$**	
	Never	$= 0.0$
	Seldom	$= 0.0$
	Sometimes	$= 1.0$
	Usually	$= 0.0$
	Always	$= 0.0$
Zone 6:	**$d_5 \leq$ Score $\leq d_6$**	
	Never	$= 0.0$
	Seldom	$= 0.0$
	Sometimes	$= (\text{Score} - d_6) / (d_5 - d_6)$
	Usually	$= (\text{Score} - d_5) / (d_6 - d_5)$
	Always	$= 0.0$
Zone 7:	**$d_6 \leq$ Score $\leq d_7$**	
	Never	$= 0.0$
	Seldom	$= 0.0$
	Sometimes	$= 0.0$
	Usually	$= 1.0$
	Always	$= 0.0$
Zone 8:	**$d_7 \leq$ Score $\leq d_8$**	
	Never	$= 0.0$
	Seldom	$= 0.0$
	Sometimes	$= 0.0$
	Usually	$= (\text{Score} - d_8) / (d_7 - d_8)$
	Always	$= (\text{Score} - d_7) / (d_8 - d_7)$

Zone 9: $d_8 \leq$ **Score** $\leq d_9$

Never	= 0.0
Seldom	= 0.0
Sometimes	= 0.0
Usually	= 0.0
Always	= 1.0

Fuzzy Output Variables and Fuzzy Linguistic Variables

Fuzzy output variables for BASE factors are as stated in Table 3.12, and the fuzzy linguistic variables involved are low self-esteem, moderate self-esteem and high self-esteem. The crisp value for this stage is obtained after defuzzification phase has been performed. For output variable of Student Initiative, the crisp value is obtained after the fifth phase of the processes, while the Social Attention and Social Attraction, the value is obtained during the second phase of inferencing, and Success/Failure and Self-Confidence during the first phase of inferencing.

Table 3.12: Fuzzy Output Variables and Linguistic Variables for System Output

BASE Factors	
Fuzzy Output Variables	Fuzzy Linguistic Variables
Student Initiative	{Low Self-Esteem, Moderate Self-Esteem, High Self-Esteem}
Social Attention	{Low Self-Esteem, Moderate Self-Esteem, High Self-Esteem}
Success/Failure	{Low Self-Esteem, Moderate Self-Esteem, High Self-Esteem}
Social Attraction	{Low Self-Esteem, Moderate Self-Esteem, High Self-Esteem}
Self-Confidence	{Low Self-Esteem, Moderate Self-Esteem, High Self-Esteem}

Membership Function Graphs

Fig. 3.13 shows the membership function graph for output of Student Initiative.

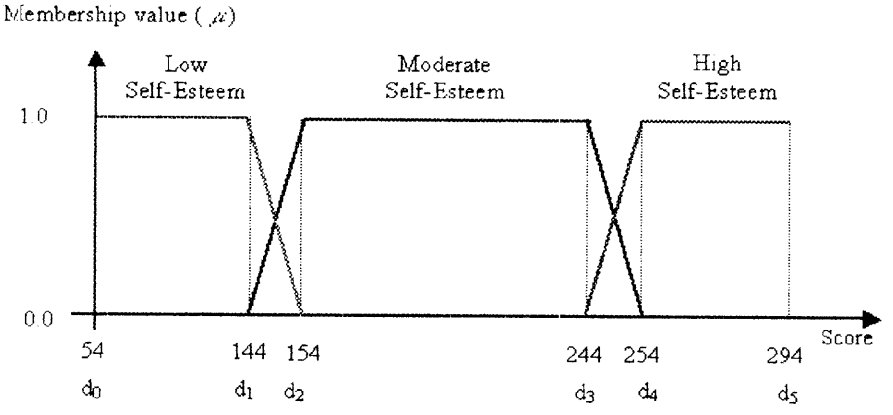


Figure 3.13: Fuzzy Membership Function for Output of Student Initiative

Fig. 3.14 shows the membership function graph for output of Social Attention and Social Attraction

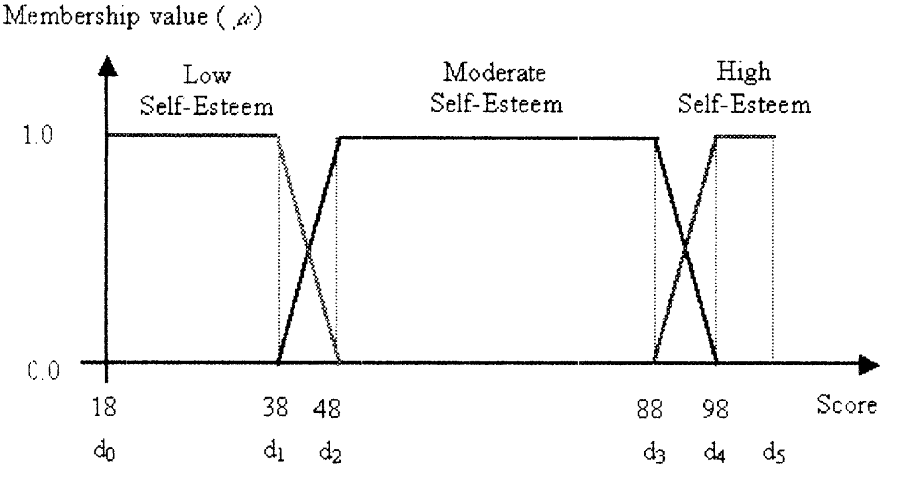


Figure 3.14: Fuzzy Membership Function for Output Social Attention and Social Attraction

Fig 3.15 shows the fuzzy membership function for Output of Success/Failure and Self-Confidence.

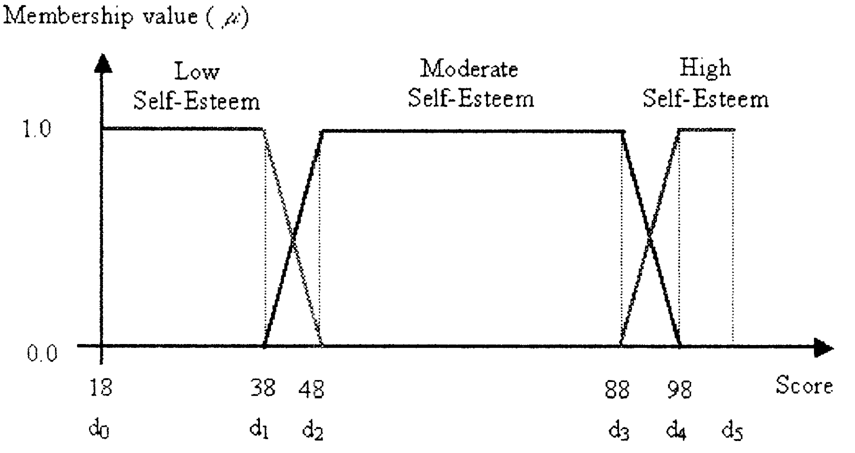


Figure 3.15: Fuzzy Membership Function for Output of Success/Failure and Self-Confidence

Fuzzification Phase

In psychology testing, the common practice for scoring is based on the total of rigid value of rating scale such as 1, 2, 3, 4 and 5. As applied in e-counselling using fuzzy logic technique, it is important to allow the user to choose their option in flexible manner and human nature in order to estimate the BASE factor score, and as well as their classifications. Therefore the use of fuzzy logic is useful and suitable in handling uncertain systems for the case study in order to promote the use of imprecise information to be represented in the knowledge base rules. The fuzzy linguistic values for Question 1 is given the range of 12 to 147. They are internally converted into rule membership value after the users have chosen their option in the percentage form. The fuzzification algorithm to perform this phase is as illustrated in Fig. 3.16. This algorithm is applied to the Question 1 through Question 16 but with different ranges as specified on the graphs of membership function of each BASE factor.

```
g0 = 12,  g1 = 27,  g2 = 42,  g3 = 57,  g4 = 72,
g5 = 87,  g6 = 102,  g7 = 117,  g8 = 132,  g9 = 147

If score>= cdbl(g0) and score< cdbl(g1) Then
        cnever = 1.0
        cseldom = 0.0
        csometimes = 0.0
        cusually= 0.0
        calways = 0.0
Else If score>= cdbl(g1) and score< cdbl(g2) Then
        cnever = (score - g2)/ (g1 - g2)
        cseldom = (score - g1) / (g2 - g1)
        csometimes = 0.0
        cusually= 0.0
        calways = 0.0
Else If score>= cdbl(g2) and score< cdbl(g3) Then
        cnever = 0.0
        cseldom = 1.0
        csometimes = 0.0
        cusually= 0.0
        calways = 0.0
Else If score>= cdbl(g3) and score< cdbl(g4) Then
        cnever = 0.0
        cseldom = (score - g4) / (g3 - g4)
        csometimes = (score - g3) / (g4 - g3)
        cusually= 0.0
        calways = 0.0
Else If score>= cdbl(g4) and score< cdbl(g5) Then
        cnever = 0.0
        cseldom= 0.0
        csometimes = 1.0
        cusually= 0.0
        calways = 0.0
Else If score>= cdbl(g5) and score< cdbl(g6) Then
        cnever = 0.0
        cseldom = 0.0
        csometimes = (score - g6) / (g5 - g6)
        cusually = (score - g5)/(g6 - g5)
        calways = 0.0
Else If score>= cdbl(g6) and score< cdbl(g7) Then
        cnever = 0.0
        cseldom= 0.0
        csometimes = 0.0
        cusually= 1.0
        calways = 0.0
Else If score>= cdbl(g7) and score< cdbl(g8) Then
        cnever = 0.0
        cseldom = 0.0
        csometimes = 0.0
        cusually = (score - g8) / (g7 - g8)
        calways = (score - g7) / (g8 - g7)
Else If score>= cdbl(g8) and score< cdbl(g9) Then
        cnever = 0.0
        cseldom = 0.0
        csometimes = 0.0
        cusually= 0.0
        calways = 1.0
End If
```

Figure 3.16: Fuzzification Algorithm

Inference Rules

The fuzzy inference consists of fuzzy rule bases for the system, knowledge base, and contains rules that can be stored as Fuzzy Associative Memory (FAM) table or in the form of if-then statements. The *if-then* statements are normally stored in the knowledge base rule base. The *if* part of the rule is called the antecedent, while the *then* part of the rule is called the consequent. The FAM table is constructed in such a way to perform the min or max function on two inputs and produces one output at each inference stage.

The single inference structure is used when there are only two attributes involved at a time, on the other hand if more than two attributes of input involves the hierarchical inference is applied. In the case of BASE factor structure, it involves both the single inference structure and hierarchical inference structure. The Student Initiative, Social Attention, and Social Attraction of BASE factor 1, 2 and 4 respectively use the single inference structure, while the Success/Failure and Self-Confidence of BASE factor 3 and 5 use the hierarchical inference structure.

A fuzzy logic model was developed for BASE factor structure in order to estimate the BASE factor. Fig. 3.17 shows the structure of the BASE factor 1 that is Student Initiative. Question 1, and Question 2 are presented as crisp, continuous inputs to a fuzzy rule base that predicts *Output 11*. *Output 11* is rated on an ordinal scale of 54 to 294, with 54 being the low self-esteem and 294 being the high self-esteem. This estimation of *Output 11* is then paired with a crisp, continuous estimation of the Question 3 in order to estimate the *Output 12* through the use of a second fuzzy rule base. This process is repeating until the last phase of *Output 14* is paired with a crisp value of Question 6 being performed. Finally the final output of Student Initiative is produced.

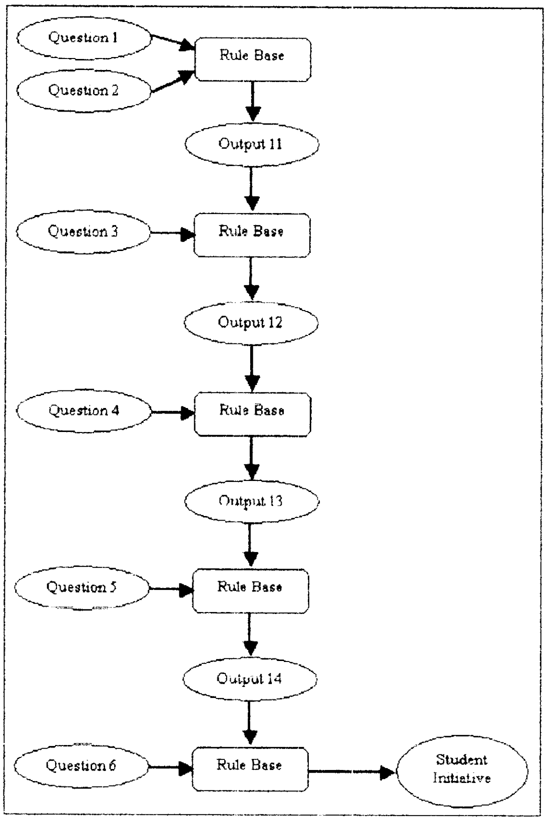


Figure 3.17: Student Initiative - Hierarchical Inference Structure

Fig. 3.18 shows the structure of the BASE factor 2 that is Social Attention. *Question 7*, and *Question 8* are presented as crisp, continuous inputs to a fuzzy rule base that estimates *Output 21*. *Output 21* is rated on an ordinal scale of 25 to 125, with 25 being the low self-esteem and 125 being the high self-esteem. This estimation of *Output 21* is then paired with a crisp, continuous estimation of the *Question 9* in order to estimate the final value of Social Attention through the use of a second fuzzy rule base.

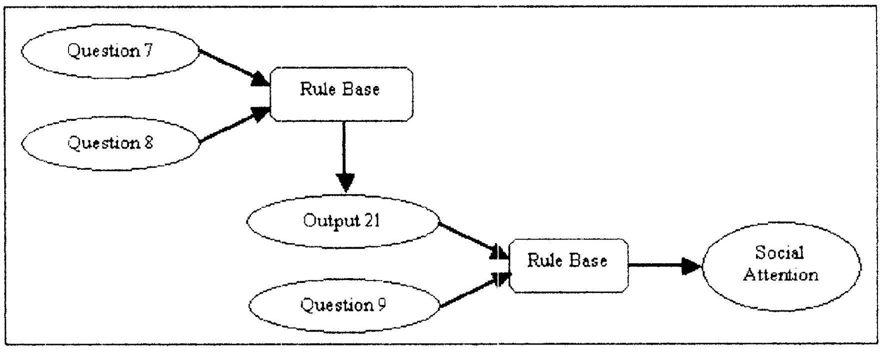


Figure 3.18: Social Attention - Hierarchical Inference Structure

Figure 3.19 illustrates the structure of the BASE factor 3 that is Success/Failure. *Question 10*, and *Question 11* are presented as crisp, continuous inputs to a fuzzy rule base that estimates Success/Failure sub score. Output of Success/Failure is rated on an ordinal scale of eighteen to ninety-eight, with eighteen being the low self-esteem and ninety-eight being the high self-esteem. The final output of Success/Failure is then produced.

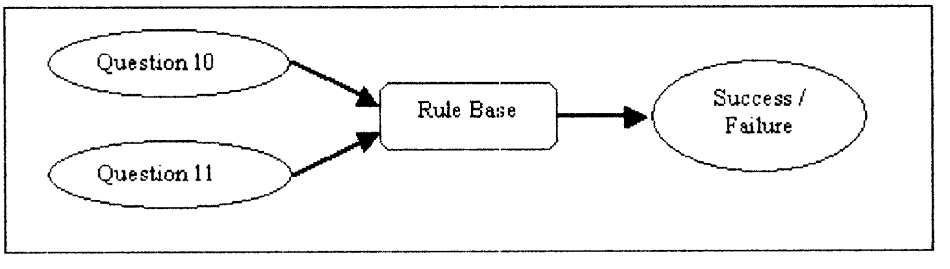


Figure 3.19: Success/Failure - Single Inference Structure

The structure of the BASE factor 4 is Social Attention. *Question 12*, and *Question 13* are presented as crisp, continuous inputs to a fuzzy rule base that estimates *Output 41*. *Output 41* is rated on an ordinal scale with the same range of BASE factor 2. This prediction of *Output 41* is then paired with a crisp, continuous prediction of the *Question 14* in order to estimate the Social Attraction through the use of a second fuzzy rule base. Figure 3.20 presents the Self-Confidence using hierarchical inference structure.

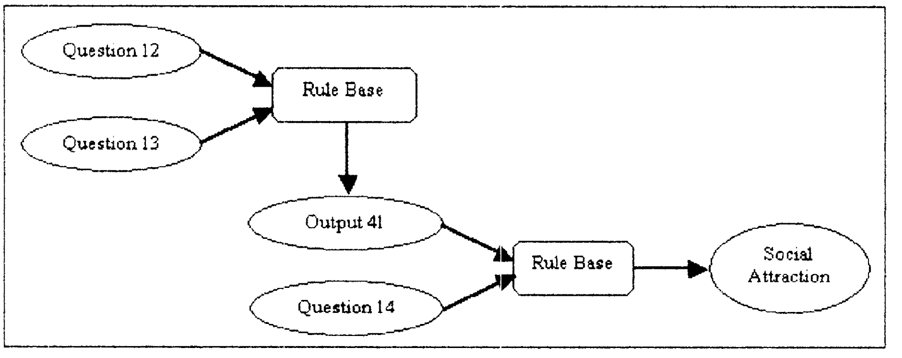


Figure 3.20: Social Attraction - Hierarchical Inference Structure

Final structure of the BASE factor 5 is Self-Confidence. *Question 15*, and *Question 16* are presented as crisp, continuous inputs to a fuzzy rule base that estimates Self-Confidence sub score. Output of Self-Confidence is rated on an ordinal scale with the same range of BASE factor 3. Fig. 3.21 illustrates the Self-Confidence using single inference structure.

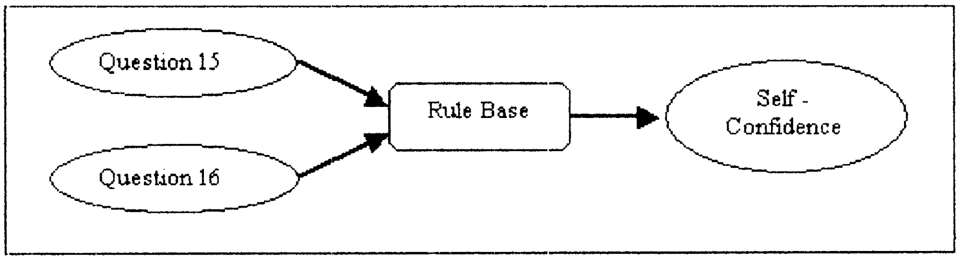


Figure 3.21: Self -Confidence - Single Inference Structure

In implementing fuzzy rules, fuzzy values are usually quantized and stored in memory in the form of a look-up table. The fuzzy algorithm that emulates a derivative mode is comprised of the *If / then* rules. The algorithm can be visualised in the form of table that such an arrangement is called FAM matrix. Since the

Student Initiative involves more than two attributes in estimating the BASE factor structure, then hierarchical fuzzy inference structure will be invoked. Thus, the inference process is divided into several stages. The output from first stage will become input for next stage and so forth. The FAM tables for Student Initiative can be divided into five phases. The first phase is by constructing FAM for the first two inputs. The two inputs are *Question 1* and *Question 2*. Table 3.13 below presents the first phase of FAM table for *Output 11* and the AND operation performed. This FAM table stores the confidence value that will be used in the next phase calculation until the final crisp value of Student Initiative is obtained. Null is labelled to represent the invalid score.

Table 3.13: Hierarchical FAM of Student Initiative (Phase 1)

FAM for Student Initiative (Phase 1)					
Question 1	Question 2				
	Never	Seldom	Sometimes	Usually	Always
Never	CF_{11}	CF_{12}	CF_{13}	CF_{14}	CF_{15}
	null	null	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem
Seldom	CF_{16}	CF_{17}	CF_{18}	CF_{19}	CF_{110}
	null	null	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem
Sometimes	CF_{111}	CF_{112}	CF_{113}	CF_{114}	CF_{115}
	null	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem
Usually	CF_{116}	CF_{117}	CF_{118}	CF_{119}	CF_{120}
	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem
Always	CF_{121}	CF_{122}	CF_{123}	CF_{124}	CF_{125}
	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem

For this system, the fuzzy rule is constructed with 25 statements and connected with the 'and' operator. Since the rules are stored and can be read directly from FAM table, the listed rules below show just apart of them. Referring to coloured cells, the rules can be interpreted as:

i. IF (Question 1 is *Never)*, AND (Question 2 is *Sometimes)* THEN (Output 21 is Low Self-Esteem)

ii. IF (Question 1 is *Never)*, AND (Question 2 is *Usually)* THEN (Output 11 is Low Self-Esteem)

iii. IF (Question 1 is *Never)*, AND (Question 2 is *Always*) THEN (Output 11 is Low Self-Esteem)

The second phase involves the constructing of FAM for the next two inputs. The two inputs are *Question 3* and *Output11*. Table 3.14 below presents the second phase of FAM table for *Output 12* and the AND operation performed. This FAM table stores the confidence value that will be used in the next phase calculation of the crisp value of *Output 12*.

Table 3.14: Hierarchical FAM of Student Initiative (Phase 2)

FAM for Social Attention (Phase 2)			
Question 3	Output 11		
	Low Self-Esteem	Moderate Self-Esteem	High Self-Esteem
Never	CF_{121}	CF_{122}	CF_{123}
	Low Self-Esteem	Null	Null
Seldom	CF_{124}	CF_{125}	CF_{126}
	Low Self-Esteem	Null	Null
Sometimes	CF_{127}	CF_{128}	CF_{129}
	Low Self-Esteem	Null	Null
Usually	CF_{1210}	CF_{1211}	CF_{1212}
	Low Self-Esteem	Null	Null
Always	CF_{1213}	CF_{1214}	CF_{1215}
	Low Self-Esteem	Null	Null

The third phase of constructing FAM involves the next two inputs and they are *Question 4* and *Output12*. Table 3.15 below presents the second phase of FAM table for *Output 13* and the AND operation performed. This FAM table stores the confidence value that will be used in the next phase calculation of the crisp value of *Output 13*.

Table 3.15: Hierarchical FAM of Student Initiative (Phase 3)

FAM for Social Attention (Phase 3)			
Question 4	Output 12		
	Low Self-Esteem	Moderate Self-Esteem	High Self-Esteem
Never	CF_{141}	CF_{142}	CF_{143}
	Low Self-Esteem	Null	Null
Seldom	CF_{144}	CF_{145}	CF_{146}
	Moderate Self-Esteem	Null	Null
Sometimes	CF_{147}	CF_{128}	CF_{149}
	Moderate Self-Esteem	Null	Null
Usually	CF_{1410}	CF_{1411}	CF_{1412}
	Moderate Self-Esteem	Null	Null
Always	CF_{1413}	CF_{1214}	CF_{1415}
	Moderate Self-Esteem	Null	Null

The fourth phase involves the two inputs of *Question 5* and *Output13*. Table 3.16 below presents the second phase of FAM table for *Output 14* and the AND operation performed. This FAM table stores the confidence value that will be used in the next phase calculation of the crisp value of *Output 14*.

Table 3.16: Hierarchical FAM of Student Initiative (Phase 4)

FAM for Social Attention (Phase 4)			
Question 5	Output 13		
	Low Self-Esteem	Moderate Self-Esteem	High Self-Esteem
Never	CF_{151}	CF_{152}	CF_{153}
	Moderate Self-Esteem	Moderate Self-Esteem	Null
Seldom	CF_{154}	CF_{155}	CF_{156}
	Moderate Self-Esteem	Moderate Self-Esteem	Null
Sometimes	CF_{157}	CF_{158}	CF_{159}
	Moderate Self-Esteem	Moderate Self-Esteem	Null
Usually	CF_{1510}	CF_{1511}	CF_{1512}
	Moderate Self-Esteem	High Self-Esteem	Null
Always	CF_{1513}	CF_{1514}	CF_{1515}
	Moderate Self-Esteem	High Self-Esteem	Null

The final phase involves the inputs of the last questions that is *Question 6* and *Output 14*. Table 3.17 below presents the second phase of FAM table for *Student Initiative* and the AND operation performed. This FAM table stores the confidence value that will be used in the next phase calculation of the crisp value of *Student Initiative*.

Table 3.17: Hierarchical FAM of Student Initiative (Phase 5)

FAM for Social Attention (Phase 5)			
Question 6	Output 14		
	Low Self-Esteem	Moderate Self-Esteem	High Self-Esteem
Never	CF_{161}	CF_{162}	CF_{163}
	Null	Moderate Self-Esteem	High Self-Esteem
Seldom	CF_{164}	CF_{165}	CF_{1614}
	Null	Moderate Self-Esteem	High Self-Esteem
Sometimes	CF_{167}	CF_{158}	CF_{1614}
	Null	High Self-Esteem	High Self-Esteem
Usually	CF_{1610}	CF_{1614}	CF_{1614}
	Null	High Self-Esteem	High Self-Esteem
Always	CF_{1613}	CF_{1614}	CF_{1614}
	Null	High Self-Esteem	Null

The FAM tables for Social Attention can be divided into two phases. The first phase is by constructing FAM for the first two inputs. The two inputs are *Question 7* and *Question 8*. Table 3.18 below represents the first phase of FAM table for *Output 21* and the AND operation performed. This FAM table stores the confidence value that will be used in the next phase calculation of the crisp value of *Output 21* is obtained.

Table 3.18: Hierarchical FAM of Social Attention (Phase 1)

FAM for Social Attention (Phase 1)					
Question 7	**Question 8**				
	Never	Seldom	Sometimes	Usually	Always
Never	CF_{21}	CF_{22}	CF_{23}	CF_{24}	CF_{25}
	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem
Seldom	CF_{26}	CF_{27}	CF_{28}	CF_{29}	CF_{210}
	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem
Sometimes	CF_{211}	CF_{212}	CF_{213}	CF_{214}	CF_{215}
	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Moderate Self-Esteem
Usually	CF_{216}	CF_{217}	CF_{218}	CF_{219}	CF_{220}
	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem
Always	CF_{221}	CF_{222}	CF_{223}	CF_{224}	CF_{225}
	Low Self-Esteem	Low Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem

Table 3.19 below depicts the second phase of FAM table for Social Attention. The following input is the applied, there are *Question 9 and Output 21* and the AND operation performed. This FAM table stores the confidence value that will be used in obtaining the final crisp value of Social Attention.

Table 3.19: Hierarchical FAM of Social Attention (Phase 2)

FAM for Social Attention			
Question 9	**Output 21**		
	Low Self-Esteem	Moderate Self-Esteem	High Self-Esteem
Never	CF_{221}	CF_{222}	CF_{223}
	Low Self-Esteem	Moderate Self-Esteem	High Self-Esteem
Seldom	CF_{224}	CF_{225}	CF_{226}
	Low Self-Esteem	Moderate Self-Esteem	Null
Sometimes	CF_{227}	CF_{228}	CF_{229}
	Low Self-Esteem	Moderate Self-Esteem	Null
Usually	CF_{2210}	CF_{2211}	CF_{2212}
	Moderate Self-Esteem	Moderate Self-Esteem	Null
Always	CF_{2213}	CF_{2214}	CF_{2215}
	Moderate Self-Esteem	High Self-Esteem	Null

For the Success/Failure, it uses the single fuzzy inference structure because only two attributes involves in estimating the BASE factor structure. The FAM tables for Success/Failure is as shown in Table 3.20. The two inputs are *Question 10* and

Question 11. This FAM table stores the confidence value that will be used in the calculation of final crisp value of Success/Failure.

Table 3.20: FAM of Success / Failure

FAM for Success / Failure					
Question 10	**Question 11**				
	Never	Seldom	Sometimes	Usually	Always
Never	CF_{31}	CF_{32}	CF_{33}	CF_{34}	CF_{35}
	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem
Seldom	CF_{36}	CF_{37}	CF_{38}	CF_{29}	CF_{310}
	Low Self-Esteem	Low Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem
Sometimes	CF_{311}	CF_{312}	CF_{313}	CF_{314}	CF_{315}
	Low Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem
Usually	CF_{316}	CF_{317}	CF_{318}	CF_{319}	CF_{320}
	Moderate Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem
Always	CF_{321}	CF_{322}	CF_{323}	CF_{324}	CF_{325}
	Moderate Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem

Similar to the Social Attention, the Social Attraction uses the hierarchical fuzzy inference structure. The FAM tables for Social Attraction can be divided into two phases. The first phase is by constructing FAM for the first two inputs. The two inputs are *Question 12* and *Question 13*. Table 3.21 below represents the first phase of FAM table for *Output 41* and the AND operation performed. This FAM table stores the confidence value that will be used in the next phase calculation until the final crisp value of Social Attraction is obtained.

Table 3.21: Hierarchical FAM of Social Attraction (Phase 1)

FAM for Social Attraction (Phase 1)					
Question 12	Question 13				
	Never	Seldom	Sometimes	Usually	Always
Never	CF_{41}	CF_{42}	CF_{43}	CF_{44}	CF_{45}
	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem
Seldom	CF_{46}	CF_{47}	CF_{48}	CF_{49}	CF_{410}
	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem
Sometimes	CF_{411}	CF_{412}	CF_{413}	CF_{414}	CF_{415}
	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Moderate Self-Esteem
Usually	CF_{416}	CF_{417}	CF_{418}	CF_{419}	CF_{420}
	Low Self-Esteem	Low Self-Esteem	Low Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem
Always	CF_{421}	CF_{422}	CF_{423}	CF_{424}	CF_{425}
	Low Self-Esteem	Low Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem	Moderate Self-Esteem

Table 3.22 below depicts the second phase of FAM table for Social Attention. The following input is then applied, there are *Question 14 and Output 41* and the AND operation performed. This FAM table stores the confidence value that will be used in obtaining the final crisp value of Social Attention.

Table 3.22: Hierarchical FAM of Social Attraction (Phase 2)

FAM for Social Attraction			
Question 14	Output 41		
	Low Self-Esteem	Moderate Self-Esteem	High Self-Esteem
Never	CF_{421}	CF_{422}	CF_{423}
	Low Self-Esteem	Moderate Self-Esteem	High Self-Esteem
Seldom	CF_{424}	CF_{425}	CF_{426}
	Low Self-Esteem	Moderate Self-Esteem	Null
Sometimes	CF_{427}	CF_{428}	CF_{429}
	Low Self-Esteem	Moderate Self-Esteem	Null
Usually	CF_{4210}	CF_{4211}	CF_{4212}
	Moderate Self-Esteem	Moderate Self-Esteem	Null
Always	CF_{4213}	CF_{4214}	CF_{4215}
	Moderate Self-Esteem	High Self-Esteem	Null

Similar to the Success/Failure, the Self-Confidence uses the single fuzzy inference structure. The FAM tables for Self-Confidence is as shown in Table 3.23. The two inputs are *Question 15* and *Question 16*. This FAM table stores the confidence value that will be used in the calculation of final crisp value of Self-Confidence.

Table 3.23: FAM of Self-Confidence

FAM for Self-Confidence					
Question 15	Question 16				
	Never	Seldom	Sometimes	Usually	Always
Never	CF_{51} Low Self-Esteem	CF_{52} Low Self-Esteem	CF_{53} Low Self-Esteem	CF_{54} Moderate Self-Esteem	CF_{55} Moderate Self-Esteem
Seldom	CF_{56} Low Self-Esteem	CF_{57} Low Self-Esteem	CF_{58} Moderate Self-Esteem	CF_{59} Moderate Self-Esteem	CF_{510} Moderate Self-Esteem
Sometimes	CF_{511} Low Self-Esteem	CF_{512} Moderate Self-Esteem	CF_{513} Moderate Self-Esteem	CF_{514} Moderate Self-Esteem	CF_{515} Moderate Self-Esteem
Usually	CF_{516} Moderate Self-Esteem	CF_{517} Moderate Self-Esteem	CF_{518} Moderate Self-Esteem	CF_{519} Moderate Self-Esteem	CF_{520} Moderate Self-Esteem
Always	CF_{521} Moderate Self-Esteem	CF_{522} Moderate Self-Esteem	CF_{523} Moderate Self-Esteem	CF_{524} Moderate Self-Esteem	CF_{525} Moderate Self-Esteem

The inference process involves the computing of the truth value for the premise of each rule, and then applied to the conclusion part of the rule. This result in one fuzzy subset is next to be assigned to each output variable for each rule. As for an example, the intersection between label never of *Question 7* and seldom of *Question 8*, value of *Output 21* produces a *low self-esteem*. The confidence values in the FAM table depend on the fuzzy operator used in the fuzzy rules. As far as the entire algorithm is concerned, the connective ELSE is analytically modelled as either OR ($\vee$) by taking the maximum value or AND ($\wedge$) taking the minimum value, depending on the implication operator used for the individual *if / then* rules. The AND (i.e. MIN) operator is being used in this project. A FAM is essentially a lookup table that shows the output value for each combination of inputs and provides fewer rules and much easier to deal. Based on Zadeh (1996), the computation using connectives operators are as follow:

$$a \wedge b = \min\{a, b\},\ a \vee b = \max\{a, b\}$$

Given two expressions a and b, the operators are defined as follows:

Table 3.24: Fuzzy Operators

a AND *b*	minimum(*a*, *b*)	Take minimum value of *a* and *b*
a OR *b*	maximum(*a*, *b*)	Take maximum value of *a* and *b*

Referring to the fuzzy rule stated above, the operator used in this case is the 'AND' operator. The minimum value of first and second input will be taken as a confidence value for FAM. The computation for producing the minimum value is as follows. Consider CF_{ij} as a cell of value in the FAM matrix. Table 3.25 shows the confidence value computation of FAM for Social Attention.

Table 3.25: Confidence Value Computation of FAM for Social Attention (Phase 1)

FAM for Social Attention (Phase 1)					
Question 7	Question 8				
	Never	Seldom	Sometimes	Usually	Always
Never	CF_{21} = min{cnever7,cnever8}	CF_{22} = min{cnever7,cseldom8}	CF_{23} = min{cnever7,cstimes8}	CF_{24} = min{cnever7,cusually8}	CF_{25} = min{cnever7,calways8}
Seldom	CF_{26} = min{cseldom7,cnever8}	CF_{27} = min{cseldom7,cseldom8}	CF_{28} = min{cseldom7,cstimes8}	CF_{29} = min{cseldom7,cusually8}	CF_{210} = min{cseldom7,calways8}
Sometimes	CF_{211} = min{cstimes7,cnever8}	CF_{212} = min{cstimes7,cseldom8}	CF_{213} = min{cstimes7,cstimes8}	CF_{214} = min{cstimes7,cusually8}	CF_{215} = min{cstimes7,calways8}
Usually	CF_{216} = min{cusually7,cnever8}	CF_{217} = min{cusually7,cseldom8}	CF_{218} = min{cusually7,cstimes8}	CF_{219} = min{cusually7,cusually8}	CF_{220} = min{cusually7,calways8}
Always	CF_{221} = min{calways7,cnever8}	CF_{222} = min{calways7,cseldom8}	CF_{223} = min{calways7,cstimes8}	CF_{224} = min{calways7,cusually8}	CF_{225} = min{calways7,calways8}

The algorithm used for this computation as shown as in Fig 3.22. This computation will take the minimum value from the two attributes being considered and applied to the remaining of this system.

CF_{21} = minimum(cnever7, cnever8)
CF_{22} = minimum(cnever7, cseldom8)
CF_{23} = minimum(cnever7, cstimes8)
CF_{24} = minimum(cnever7, cusually8)
CF_{25} = minimum(cnever7, calways8)

CF_{26} = minimum(cseldom7, cnever8)
CF_{27} = minimum(cseldom7, cseldom8)
CF_{28} = minimum(cseldom7, cstimes8)
CF_{29} = minimum(cseldom7, cusually8)
CF_{210} = minimum(cseldom7, calways8)

CF_{211} = minimum(cstimes7, cnever8)
CF_{212} = minimum(cstimes7, cseldom8)
CF_{213} = minimum(cstimes7, cstimes8)
CF_{214} = minimum(cstimes7, cusually8)
CF_{215} = minimum(cstimes7, calways8)

CF_{216} = minimum(cusually7, cnever8)
CF_{217} = minimum(cusually7, cseldom8)
CF_{218} = minimum(cusually7, cstimes8)
CF_{219} = minimum(cusually7, cusually8)
CF_{220} = minimum(cusually7, calways8)

CF_{221} = minimum(calways7, cnever8)
CF_{222} = minimum(calways7, cseldom8)
CF_{223} = minimum(calways7, cstimes8)
CF_{224} = minimum(calways7, cusually8)
CF_{225} = minimum(calways7, calways8)

Figure 3.22: Confidence Value Computation Algorithm

Table 3.26 shows the confidence value computation of FAM for Social Attention Phase 2 with the used of AND operator or MIN operation.

Table 3.26: Confidence Value Computation of FAM for Social Attention (Phase 2)

FAM for Social Attention			
Question 9	Output 21		
	Low Self-Esteem	Moderate Self-Esteem	High Self-Esteem
Never	CF_{221} = min{cnever9,clse2}	CF_{222} = min{cnever9, cmse2}	CF_{223} = min{cnever9, chse2}
Seldom	CF_{224} = min{cseldom9, clse2}	CF_{225} = min{ cseldom9, cmse2}	CF_{226} = min{ cseldom9, chse2}
Sometimes	CF_{227} = min{cstimes9, clse2}	CF_{228} = min{ cstimes9, cmse2}	CF_{229} = min{ cstimes9, chse2}
Usually	CF_{2210} = min{cusually9, clse2}	CF_{2211} = min{ cusually9, cmse2}	CF_{2212} = min{ cusually9, chse2}
Always	CF_{2213} = min{calways9, clse2}	CF_{2214} = min{ calways9, cmse2}	CF_{2215} = min{ calways9, chse2}

Table 3.27 shows the confidence value computation of FAM for Success/Failure with the use of AND operator or MIN operation.

Table 3.27: Confidence Value Computation of FAM for Success/Failure

FAM for Success / Failure					
Question 10	Question 11				
	Never	Seldom	Sometimes	Usually	Always
Never	CF_{31} = min{cnever10,cnever11}	CF_{32} = min{cnever10,cseldom11}	CF_{33} = min{cnever10,cstimes11}	CF_{34} = min{never10,cusually11}	CF_{35} = min{cnever10,calways11}
Seldom	CF_{36} = min{cseldom10, cnever11}	CF_{37} = min{ cseldom10, cseldom11}	CF_{38} = min{ cseldom10, cstimes11}	CF_{39} = min{ cseldom10, cusually11}	CF_{310} = min{ cseldom10, calways11}
Sometimes	CF_{311} = min{cstimes10, cnever11}	CF_{312} = min{ cstimes10, cseldom11}	CF_{313} = min{ cstimes10, cstimes11}	CF_{314} = min{ cstimes10, cusually11}	CF_{315} = min{ cstimes10, calways11}
Usually	CF_{316} = min{cusually10, cnever11}	CF_{317} = min{ cusually10, cseldom11}	CF_{318} = min{ cusually10, cstimes11}	CF_{319} = min{ cusually10, cusually11}	CF_{320} = min{ cusually10, calways11}
Always	CF_{321} = min{calways10, cnever11}	CF_{322} = min{ calways10, cseldom11}	CF_{323} = min{ calways10, cstimes11}	CF_{324} = min{ calways10, cusually11}	CF_{325} = min{ calways10, calways11}

Table 3.28 shows the confidence value computation of FAM for Social Attraction Phase 1 with the use of AND operator or MIN operation.

Table 3.28: Confidence Value Computation of FAM for Social Attraction (Phase 1)

FAM for Social Attraction (Phase I)					
Question 12	Question 13				
	Never	Seldom	Sometimes	Usually	Always
Never	CF_{41} = min{cnever12,cnever13}	CF_{42} = min{cnever12,cseldom13}	CF_{43} = min{cnever12,cstimes13}	CF_{44} = min{never12,cusually13}	CF_{45} = min{cnever12,calways13}
Seldom	CF_{46} = min{cseldom12, cnever13}	CF_{47} = min{ cseldom12, cseldom13}	CF_{48} = min{ cseldom12, cstimes13}	CF_{49} = min{ cseldom12, cusually13}	CF_{410} = min{ cseldom12, calways13}
Sometimes	CF_{411} = min{cstimes12, cnever13}	CF_{412} = min{ cstimes12, cseldom13}	CF_{413} = min{ cstimes12, cstimes13}	CF_{414} = min{ cstimes12, cusually13}	CF_{415} = min{ cstimes12, calways13}
Usually	CF_{416} = min{cusually12, cnever13}	CF_{417} = min{ cusually12, cseldom13}	CF_{418} = min{ cusually12, cstimes13}	CF_{419} = min{ cusually12, cusually13}	CF_{420} = min{ cusually12, calways13}
Always	CF_{421} = min{calways13, cnever13}	CF_{422} = min{ calways13, cseldom13}	CF_{423} = min{ calways13, cstimes13}	CF_{424} = min{ calways13, cusually13}	CF_{425} = min{ calways13, calways13}

Table 3.29 shows the confidence value computation of FAM for Social Attraction Phase 2 with the use of AND operator or MIN operation.

Table 3.29: Confidence Value Computation of FAM for Social Attraction (Phase 2)

FAM for Social Attraction			
Question 14	Output 41		
	Low Self-Esteem	Moderate Self-Esteem	High Self-Esteem
Never	CF_{421} = min{cneverl4, clse4}	CF_{422} = min{cneverl4, cmse4}	CF_{423} = min{cneverl4, chse4}
Seldom	CF_{424} = min{cseldoml4, clse4}	CF_{425} = min{ cseldoml4, cmse4}	CF_{426} = min{ cseldoml4, chse4}
Sometimes	CF_{427} = min{cstimesl4, clse4}	CF_{428} = min{ cstimesl4, cmse4}	CF_{429} = min{ cstimesl4, chse4}
Usually	CF_{4210} = min{cusuallyl4, clse4}	CF_{4211} = min{ cusuallyl4, cmse4}	CF_{4212} = min{ cusuallyl4, chse4}
Always	CF_{4213} = min{calwaysl4, clse4}	CF_{4214} = min{ calwaysl4, cmse4}	CF_{4215} = min{ calwaysl4, chse4}

Table 3.30 shows the confidence value computation of FAM for Self-Confidence with the use of AND operator or MIN operation.

Table 3.30: Confidence Value Computation of FAM for Self-Confidence

FAM for Self-Confidence					
Question 15	Question 16				
	Never	Seldom	Sometimes	Usually	Always
Never	CF_{51}= min{cneverl0,cneverl1}	CF_{52} = min{cneverl0,cseldoml1}	CF_{53} = min{cneverl0,cstimesl1}	CF_{54} = min{neverl0,cusuallyl1}	CF_{55} = min{cneverl0,calwaysl1}
Seldom	CFS_{56} = min{cseldoml0, cneverl1}	CF_{57} = min{ cseldoml0, cseldoml1}	CF_{58} = min{ cseldoml0, cstimesl1}	CF_{59} = min{ cseldoml0, cusuallyl1}	CF_{510} = min{ cseldoml0, calwaysl1}
Sometimes	CF_{511} = min{cstimesl0, cneverl1}	CF_{512} = min{ cstimesl0, cseldoml1}	CF_{513} = min{ cstimesl0, cstimesl1}	CF_{514} = min{ cstimesl0, cusuallyl1}	CF_{515} = min{ cstimesl0, calwaysl1}
Usually	CF_{516} = min{cusuallyl0, cneverl1}	CF_{517} = min{ cusuallyl0, cseldoml1}	CF_{518} = min{ cusuallyl0, cstimesl1}	CF_{519} = min{ cusuallyl0, cusuallyl1}	CF_{520} = min{ cusuallyl0, calwaysl1}
Always	CF_{521} = min{calwaysl0, cneverl1}	CF_{522} = min{ calwaysl0, cseldoml1}	CF_{523} = min{ calwaysl0, cstimesl1}	CF_{524} = min{ calwaysl0, cusuallyl1}	CF_{525} = min{ calwaysl0, calwaysl1}

Defuzzification Phase

Defuzzification combines all fuzzy outputs into a specific composite outcome. It involves the process of converting the linguistic variables into crisp variables or values. It uses some defuzzification techniques such as Centre of Area (COA), Centre of Sums (COS), and Mean of Maxima (MOM). This project uses COA defuzzification technique. In COA defuzzification the crisp value u^* is taken to be the geometrical centre of the output fuzzy value $\mu_{out}(u)$, where $\mu_{out}(u)$ is formed by taking the union of all the contributions of rules whose degree of fulfilment (DOF)>0. The centre is the point which splits the area under the $\mu_{out}(u)$ curve in two equals part. The defuzzified output is defined as

$$\text{Output} = u^* = \frac{\sum_{i=1}^{N} u_i \mu_{out}(u_i)}{\sum_{i=1}^{N} \mu_{out}(u_i)} \qquad \textbf{Equation (1)}$$

To illustrate the defuzzification phase, refer to Table 3.26 that shows the confidence value computation of FAM for Social Attention (Phase 2). The stored min value and its calculated labelled such as low self-esteem (L), moderate self-esteem (M), and high self-esteem (H), are used to obtain the crisp value through this defuzzification phase. The value of L, M and H are read from the membership function graph of Social Attention (refer Fig 3.15) along the x-axis. It is also observed that the M label involves two values while reading from the membership function graph. Using the Equation (1) above, the output produced is the crisp value of Social Attention. The output is calculated as

$$Output = \frac{\begin{array}{c} CF_{11}L + CF_{12}M_1 + CF_{12}M_2 + CF_{13}H_1 + CF_{13}L_2 + CF_{14}M_3 + CF_{14}M_4 + CF_{15}M_5 + CF_{15}M_6 + \\ CF_{17}L_3 + CF_{18}M_7 + CF_{18}M_8 + CF_{110}M_9 + CF_{110}M_{10} + CF_{113}M_{11} + CF_{13}M_{12} + CF_{14}H_2 \end{array}}{\sum_{CF_i}^{15} i = 1} \qquad \textbf{Equation (2)}$$

Figure 3.23 illustrates the defuzzification algorithm. The final output of crisp value for Social Attention is then produced. The defuzzified crisp value is used to identify and determine the levels of academic self-esteem whether it is *low self-esteem*, *moderate self-esteem*, or *high self-esteem*. Based on the expert's knowledge, the system is then match the value reside in the database DBExpert file to provide the explanation and how the conclusion is derived together with its confidence value.

'Social Attention - Defuzzification phase

'To calculate the value of Low Self Esteem for Social Attention
LSE221 = CF_{221} * (r1 - r2) + r2
LSE222 = CF_{224} * (r1 - r2) + r2
LSE223 = CF_{227} * (r1 - r2) + r2
'To calculate the value of Moderate Self Esteem for Social Attention
MSE2211 = CF_{222} * (r2 - r1) + r1
MSE2212 = CF_{222} * (r3 - r4) + r4
MSE2221 = CF_{225} * (r2 - r1) + r1
MSE2222 = CF_{225} * (r3 - r4) + r4
MSE2231 = CF_{228} * (r2 - r1) + r1
MSE2232 = CF_{228} * (r3 - r4) + r4
MSE2241 = CF_{2210} * (r2 - r1) + r1
MSE2242 = CF_{2210}* (r3 - r4) + r4
MSE2251 = CF_{2211}* (r2 - r1) + r1
MSE2252 = CF_{2211}* (r3 - r4) + r4
MSE2261 = CF_{2213}* (r2 - r1) + r1
MSE2262 = CF_{2213}* (r3 - r4) + r4
'To calculate the value of High Self Esteem for Social Attention
HSE221 = CF_{223}* (r4 - r3) + r3
HSE222 = CF_{2214}* (r4 - r3) + r3

num221 = (LSE221 * CF_{221}) + (MSE2211 * CF_{222}) + (MSE2212 * CF_{222})+ (HSE221 * CF_{223})+ (LSE222 * CF_{224}) + (MSE2221 * CF_{225}) + (MSE2222 * CF_{225}) + (LSE223 * CF_{227})+ (MSE2231 * CF_{228}) + (MSE2232 * CF_{228}) + (MSE2241 * CF_{2210})+ (MSE2242 * CF_{2210}) + (MSE2251 * CF_{2211}) + (MSE2252 * CF_{2211}) + (MSE2261 * CF_{2213}) + (MSE2262 * CF_{2213}) + (HSE222 * CF_{2214})

denom221 = CDbl(CF_{221}) + 2 * CDbl(CF_{222}) + CDbl(CF_{223})) + CDbl(CF_{224}) + 2*CDbl(CF_{225}) + CDbl(CF_{227}) + 2*CDbl(CF_{228}) + 2*CDbl(CF_{2210}) + 2*CDbl(CF_{2211}) + 2*CDbl(CF_{2213}) + CDbl(CF_{2214})

socatt2 = num221/denom221

Figure 3.23: Defuzzification Algorithm

System Design and Development Tools

The design and development of this web-based application project has been developed using the web application language that is Microsoft's Active Server Pages (ASP), a server-side web scripting; Microsoft Visual Basic Script, and Java Script. MS Access as a database and SQL. The Dreamweaver MX development environment supports the server technology, namely Microsoft Active Server Pages (ASP). Macromedia Dreamweaver MX has been used in this project since it is a professional HTML editor for designing, coding, and developing websites, web pages, and web applications. Dreamweaver provides helpful tools to enhance the web creation experience and also includes many coding-related tools and features, including code editing tools in the code view; reference material on HTML, JavaScript, ASP, and a JavaScript Debugger. Furthermore, the Dreamweaver is fully customizable.

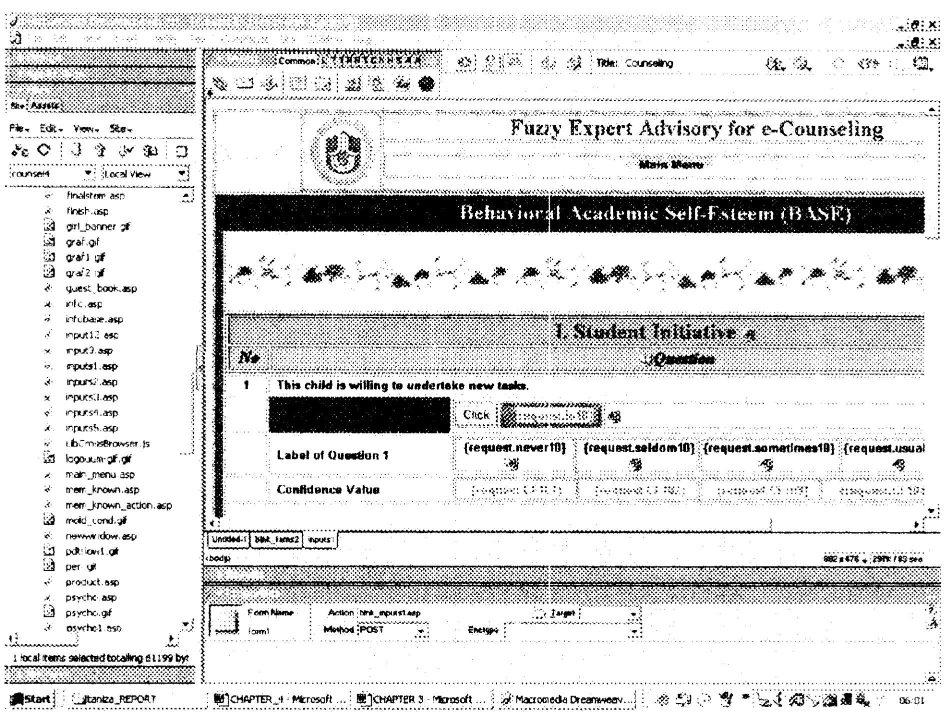


Figure 3.24: Macromedia Dreamweaver MX Design Tool

System Requirements

The following hardware and software is required to run the web-based system for fuzzy expert advisory for e-counselling using Dreamweaver. System requirements for Microsoft Windows are an Intel Pentium II Processor or equivalent, 300 MHz or faster; Windows 98, Windows 2000, Windows NT, Windows ME, or Windows XP; Version 4.0 or later of Netscape Navigator or Microsoft Internet Explorer (IE); 96 MB of available random-access memory (RAM) (128 MB recommended); 275 MB of available disk space; a 256-color monitor capable of 800 x 600 pixel resolution (millions of colors and 1024 x 768 pixel resolution recommended) and a CD-ROM drive.

Fuzzy Expert Advisory for e-Counselling Web-based Application

The final product of this fuzzy expert advisory for e-counselling system is a web application. A web application is a collection of web pages that interact with the user, with each other, and with various resources on a web server, including databases. The final content of the page varies from request to request based on the user's actions, this kind of page is called a dynamic page. A server technology is the technology that an application server uses to modify dynamic pages at runtime. In this case using ASP.

An application server let the user works with server-side resources such as databases, as for this project, Microsoft Access 2000. For example, a dynamic page may instruct the application server to extract data from a database such as DBExpert file and insert it into the page's HTML. The instruction to extract data from a database is called a database query. A query consists of search criteria expressed in a database language called SQL (Structured Query Language). The SQL query is written into the page's server-side scripts or tags. After the driver establishes communication, the query is executed against the database and a recordset is created. A recordset is a subset of data extracted from one or more tables in a database. The recordset is returned to the application server and the data used in the dynamic page. This processes mentioned above, shows the steps taken involving the web-based application that has been applied in this project development.

User Interface

Since user views the program through the system's interface, the acceptance of a system will depend on how well the interface accommodates the needs of the user. Fig 3.25 shows the user interface for Fuzzy Expert Advisory for e-Counselling web-based application.

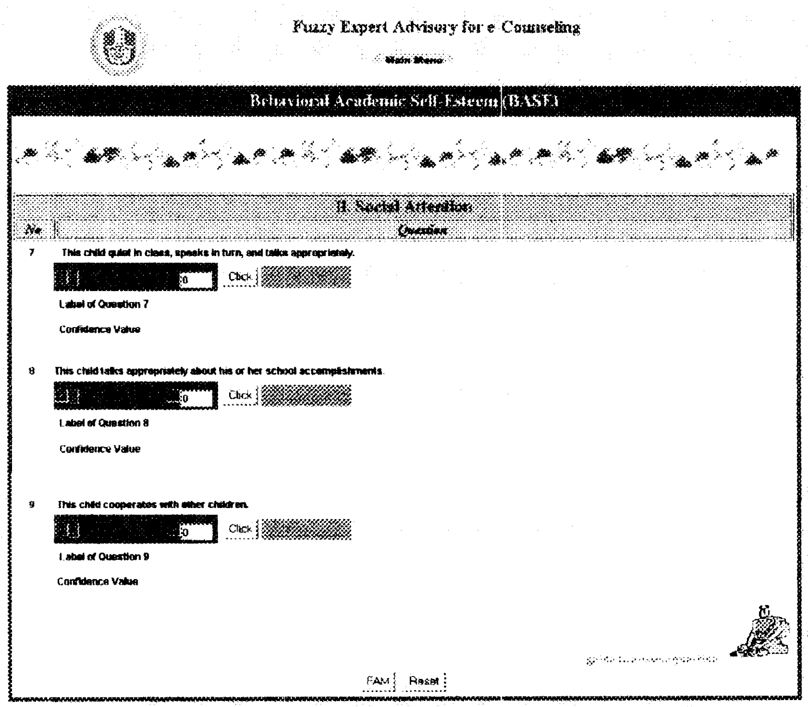


Figure 3.25: Fuzzy Expert Advisory for e-Counselling User Interface

3.4 Testing

Following the development of the prototype system is testing. The testing phase is a continual process throughout developing the system. The major purpose of testing is to validate the overall system results and its knowledge. The test also involved the evaluation of complete knowledge base by testing possible combinations of answers to the questions asked by the system. Acceptance depends on behavioural and psychological considerations, as well as on quality and ease of use.

3.5 Documentation

The documentation phase addresses the process of compiling the project's information into a document that can meet the requirements of the user and developer. It is also included the documentation of the operation of the system and system's user manual to explain the steps through the major operational features of the system. Other documents are the knowledge representation graphs, rules, and the source code. These documentations are essential for future references, maintenance and further enhancements.

3.6 Integration and Maintenance of the System

After the system is deployed to the users, it will need to be periodically maintained. Since knowledge is dynamic, so it grows, evolves, and matures. The system's knowledge needs to be refined, updated to meet currents needs and major changes on system requirements that occur would require a reformulation of system specifications. The maintenance of the system will be easier with the complete and well-organised system's documentation.

CHAPTER 4

RESULTS AND DISCUSSION

This chapter discusses the results of the study. The results were obtained during the systems testing phase. The study discusses the findings from the testing of fuzzification, fuzzy inference, and defuzzification. While the experimental results presents the results with several different combinations test cases of inputs and outputs displayed. The explanation facility is also explained as well as how the conclusion is derived.

4.1 Introduction

The common practice in handling psychological test with rating scale is in the form of such as never, seldom, sometimes, usually, and always with rigid values. The values are then added to obtain the score or sub score. Thus, this system is developed using the technique to reduce the rigidness of existing scoring system to BASE factors. This input phase allows the users to slide or inputting the value in percentage of BASE items that are rated according to the frequencies of behaviours in uncertainty forms labeled as never, seldom, sometimes, usually, and always rather than the common form of 1, 2, 3, 4, and 5. It is more natural to the human to express their estimation of the academic self-esteem of the student in percentage to represent the specific behaviours.

The results obtained will provide the information of measuring student's self-esteem at early ages. Fuzzy logic is useful in handling uncertain systems for the case study, and expert system is providing the advantage of handling rule based knowledge system and advisory services. This system provides a fuzzy logic in order to estimate the BASE factor with its level of academic self-esteem activity. Questions are provided and user is required to answer the question to let the system diagnose the suitable conclusion within its knowledge base. Questions are asked to represent a different behaviour and should be rated without regard or reference to other items. This system also provides the recommendation or result screen as an advisory to e-counselling system.

4.2 Experimental Results

The experimental results of the system were obtained from the testing phase. The objectives of performing the experiments are to test the functionality of the knowledge base constructed using FAM table. It also attempts to test whether the fuzzy inference engine perform correctly and concerning on the system results and reasoning capability. The purpose is to validate the systems as it should be able to infer in the same way as the human expert. The explanation facility act as advisory system that provides certain recommendations based on the result.

A snapshot of the fuzzy expert advisory for e-counselling system is as shown in the following figures to explain the processes involved. The standard questions of BASE have been provided and the user must answer the question accordingly. The system will then invoke the knowledge base to find the conclusion based on the given answer. A number of inputs have been tested based on different output of levels of academic self-esteem.

4.2.1 BASE Factor 1: Student Initiative

This experiment was performed to determine the flow of the system and performance of fuzzy expert inference engine. For the first experiment, it involves five stages since six inputs are used and it is executed using hierarchical inference structure (refer Chapter 3: Fig. 3.17). The information used for generating the first test case as shown in Fig 4.1. Because BASE requires observers to make sensitive judgements, its administration and use should be approached carefully and thoughtfully. The observer needs to be familiar with the child in a variety of situations in order to recognise and reliably report the child's typical responses. A minimum of five to six weeks of classroom experience with the youngsters who are to be rated is recommended. From the user interface, a user is required to give the input to the system by sliding the corresponding value using the slider bar or by inputting the value for Question 1 through Question 6 of Student Initiative. The appropriate rating selection based on the believe of the best estimate of the behaviour frequency noted in the classroom. It is best to the user not to debate or linger over the item. For guidance purpose, this system is providing the 'Guide to Answer Question' for a particular questions. Thus, it helps users to make ratings at their own convenience.

Experiment 1: Fuzzification

The first stage of the system involves the fuzzification phase. This fuzzification will be invoked where the real value, given by user, will be transformed into linguistic value. When dealing with hierarchical structure, the first two inputs will be generated first. Next, the output produced will become an input to the second AND operation with the third input. Once the output is produced from the second AND operation, similar processes will be repeated until the final stage is reached. Refer to table 3.2 on chapter three; the Question 1 to 6 will have five linguistic labels of *never*, *seldom*, *usually*, *sometimes* and *always*. The defuzzified crisp outputs are labelled as *low self-esteem, moderate self-esteem* and *high self-esteem*. The transformation process is then executed, and it is performed as illustrated in Fuzzification Algorithm (refer Chapter 3: Fig 3.16). The membership graph is also referred as shown in Fig 3.9. From the user interface, a user is required to give the input to the system by sliding the corresponding value using the slider bar or by inputting the value for Question 1 through Question 6 of Student Initiative. Fig 4.1 illustrates the fuzzification phase result after the transformation process has been performed.

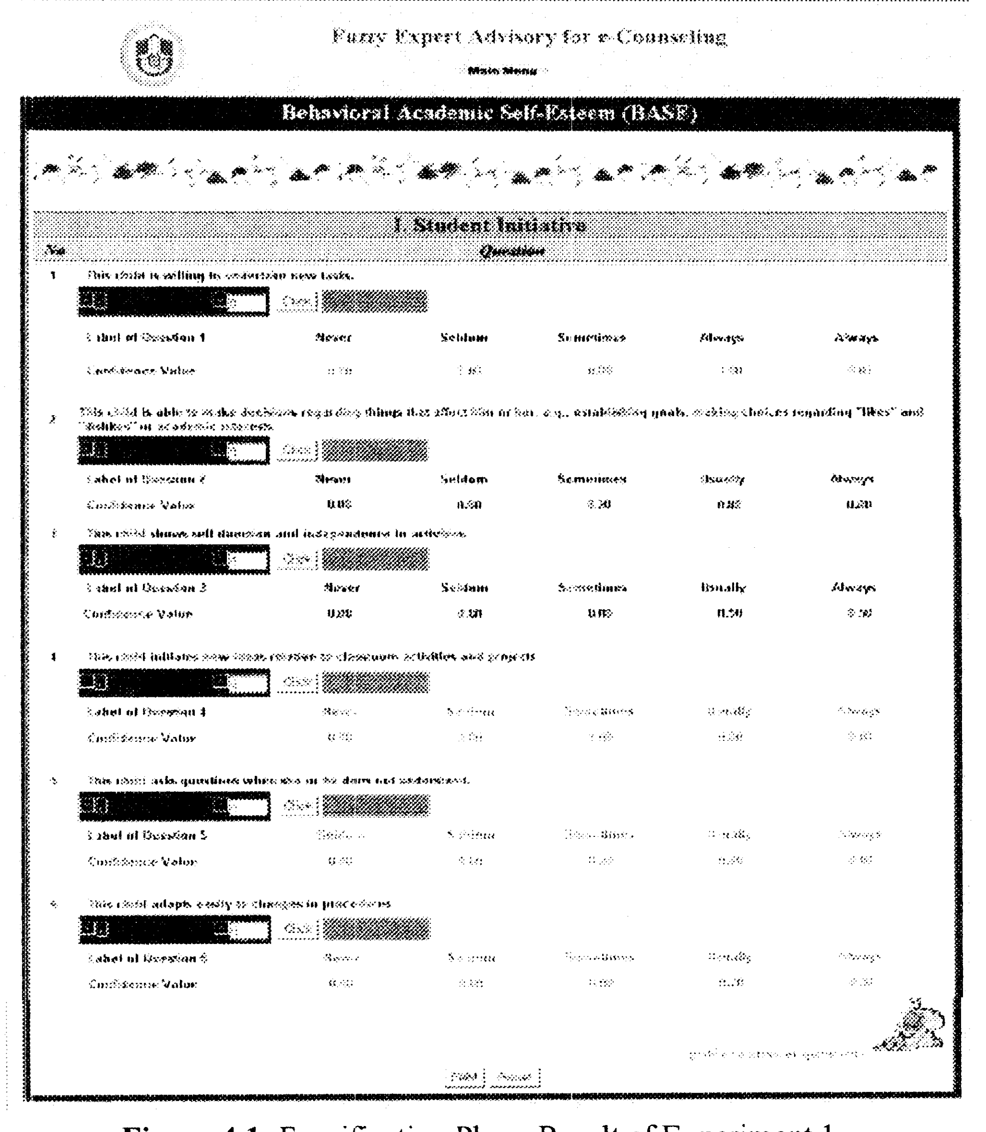


Figure 4.1: Fuzzification Phase Result of Experiment 1

Experiment 1: Fuzzy Inference

The Student Initiative involves more than two attributes in estimating the BASE factor structure, this will invoke the hierarchical fuzzy inference structure. The FAM table for Student Initiative can be divided into five phases. The first phase involves the first two inputs, *Question 1* and *Question 2*. This FAM table stores the confidence value that will be used further for calculating the level of *Output 11* that is the first phase of output for this factor. The fuzzy AND operator is, therefore the minimum value from the two inputs will be taken as confidence value for the output variable. Table 4.1 below shows the process of obtaining the min value through the first phase of inference.

Table 4.1: FAM of First Inference for Student Initiative

FAM for Student Initiative (Phase 1)					
Question 1	Question 2				
	Never	Seldom	Sometimes	Usually	Always
Never	CF_{11} = min{never1,never2} = min{0.00,0.00} = 0.00	C_{12} = min{never1,seldom2} = min{0.00,0.00} = 0.00	CF_{13} = min{never1, stimes2} = min{0.00,0.20} = 0.00	CF_{14} = min{never1,usually2} = min{0.00,0.80} = 0.00	CF_{15} = min{never1,always2} = min{0.00,0.00} = 0.00
Seldom	CF_{16} = min{seldom1,never2} = min{0.00,0.00} = 0.00	CF_{17} = min{seldom1,seldom2} = min{0.00,0.00} = 0.00	CF_{18} = min{seldom1,stimes2} = min{0.00,0.20} = 0.00	CF_{19} = min{seldom1,usually2} = min{0.00,0.80} = 0.00	CF_{110} =min{seldom1,always2} = min{0.00,0.00} = 0.00
Sometimes	CF_{111} = min{stimes1,never2} = min{0.00,0.00} = 0.00	CF_{112} = min{stimes1,seldom2} = min{0.00,0.00} = 0.00	CF_{113} = min{stimes1,stimes2} = min{0.00,0.20} = 0.00	CF_{114} = min{stimes1, usually2} = min{0.00,0.80} = 0.00	CF_{115} = min{stimes1,always2} = min{0.00,0.00} = 0.00
Usually	CF_{116} = min{cusually1,cnever2} = min{1.00,0.00} = 0.00	CF_{117} = min{usually1,seldom2} = min{1.00,0.00} = 0.00	CF_{118} = min{usually1,stimes2} = min{1.00,0.20} = 0.20	CF_{119} = min{usually1,usually2} = min{1.00,0.80} = 0.80	CF_{120} = min{usually1,always2} = min{1.00,0.00} = 0.00
Always	CF_{121} = min{always1,never2} = min{0.00,0.00} = 0.00	CF_{122} = min{always1,seldom2} = min{0.00,0.00} = 0.00	CF_{123} = min{always1,stimes2} = min{0.00,0.20} = 0.00	CF_{124} = min{always1,usually2} = min{0.00,0.80} = 0.00	CF_{125} = min{always1,always2} = min{0.00,0.00} = 0.00

The second phase in constructing the FAM of this factor involves variable of *Question 3* vertically and *Ouput 11* horizontally. This FAM table stores the confidence value that will be used further for calculating the level of *Output 21*. The fuzzy operator used is AND operator, therefore the minimum value from the two inputs will be taken as confidence value for the output variable. Table 4.2 below shows the process of obtaining the min value through the second phase of inference.

Table 4.2: FAM of Second Inference for Student Initiative

FAM for Student Initiative (Phase 2)			
Question 3	Output 11		
	Low Self-Esteem	Moderate Self-Esteem	High Self-Esteem
Never	$CF_{I11} = \min\{never3, lse1\}$ $= \min\{0.00, 0.68\}$ $= 0.00$	$CF_{I12} = \min\{never3, mse1\}$ $= \min\{0.00, 0.32\}$ $= 0.00$	$CF_{I13} = \min\{never3, hse1\}$ $= \min\{0.00, 0.00\}$ $= 0.00$
Seldom	$CF_{I14} = \min\{seldom3, lse1\}$ $= \min\{0.00, 0.68\}$ $= 0.00$	$CF_{I15} = \min\{seldom3, mse1\}$ $= \min\{0.00, 0.32\}$ $= 0.00$	$CF_{I16} = \min\{seldom3, hse1\}$ $= \min\{0.00, 0.00\}$ $= 0.00$
Sometimes	$CF_{I17} = \min\{stimes3, lse1\}$ $= \min\{0.00, 0.68\}$ $= 0.00$	$CF_{I18} = \min\{stimes3, mse1\}$ $= \min\{0.00, 0.32\}$ $= 0.00$	$CF_{I19} = \min\{stimes3, hse1\}$ $= \min\{0.00, 0.00\}$ $= 0.00$
Usually	$CF_{I110} = \min\{usually3, lse1\}$ $= \min\{0.50, 0.68\}$ $= 0.50$	$CF_{I111} = \min\{usually3, mse1\}$ $= \min\{0.50, 0.32\}$ $= 0.32$	$CF_{I112} = \min\{usually3, hse1\}$ $= \min\{0.50, 0.00\}$ $= 0.00$
Always	$CF_{I113} = \min\{always3, lse1\}$ $= \min\{0.50, 0.68\}$ $= 0.50$	$CF_{I114} = \min\{always3, mse1\}$ $= \min\{0.50, 0.32\}$ $= 0.32$	$CF_{I115} = \min\{always3, hse1\}$ $= \min\{0.50, 0.00\}$ $= 0.00$

This process will be repeated until final output of Student Initiative is obtained. The outputs of phase one to five are illustrated as shown in Fig 4.2 and Fig 4.3. Figure 4.2 illustrates the FAM of Inference of phase 1 to phase 3 for Student Initiative.

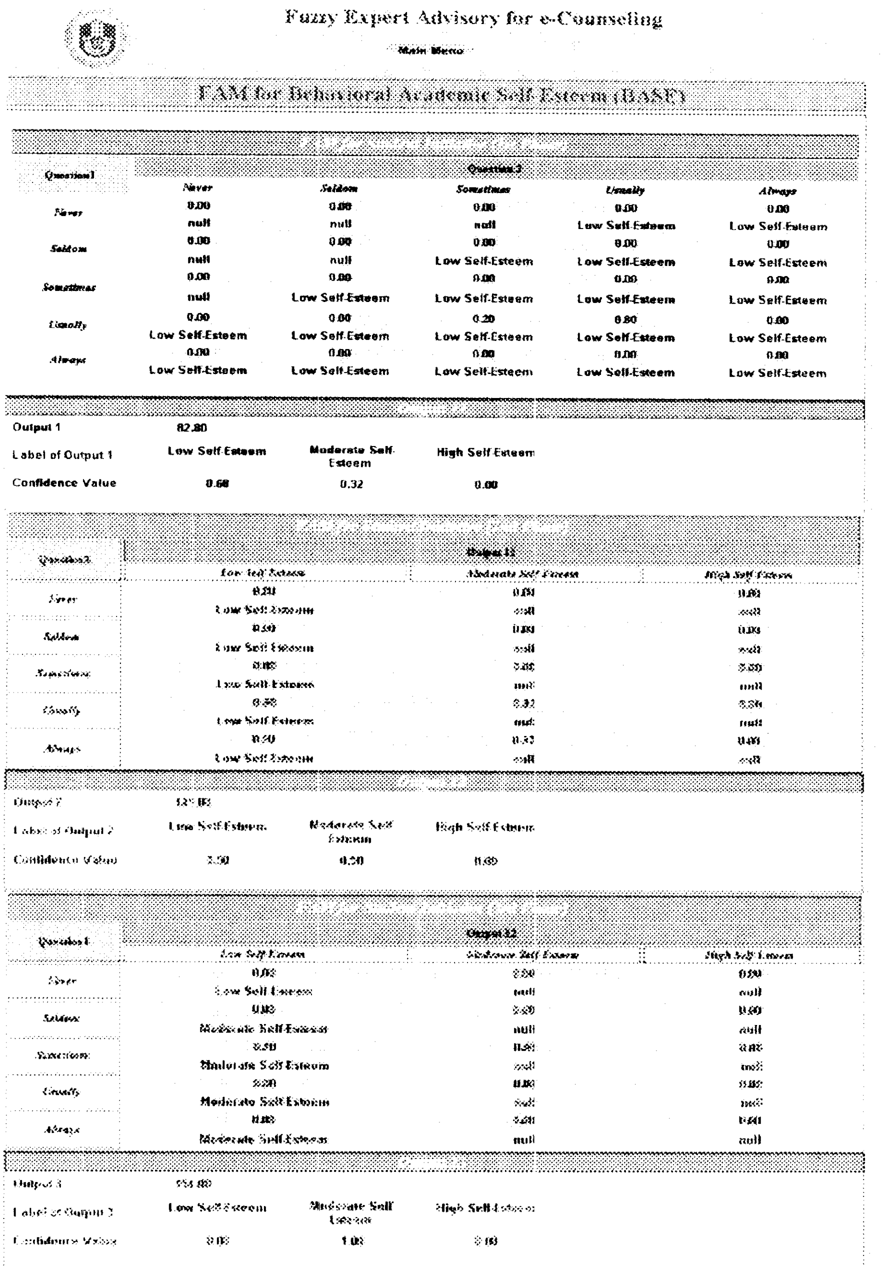


Figure 4.2: FAM of Inference (Phase 1 to 3) of Experiment 1

Figure 4.3 illustrates the FAM of Inference consisting of Phase 4 and Phase 5 for Student Initiative.

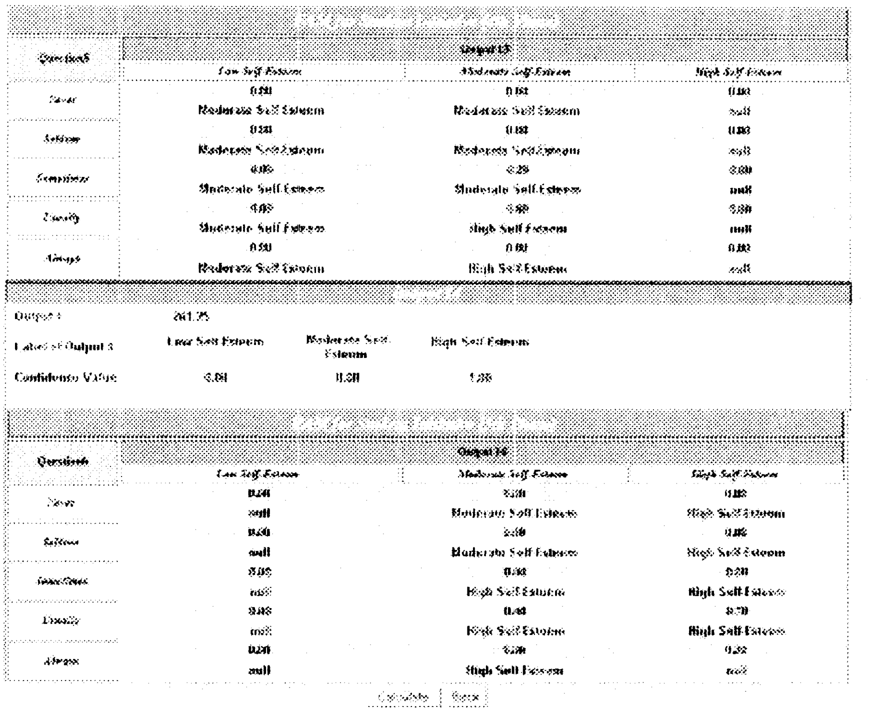


Figure 4.3: FAM of Inference (Phase 4 to 5) of Experiment 1

Experiment 1: Defuzzification

Defuzzification will transforms a fuzzy set into a single crisp value. The fuzzy value produces by fuzzy inference will be transformed again into real value. This computation is performed using COA and see Equation (1) and (2) in chapter 3. The value of μ_i is obtained from the FAM table while value of μ_{out} is calculated using algorithm 3.17. For this case, the defuzzification need to be done to calculate *Output 11*, *Output 12*, *Output 13*, *Output 14 and* final output of Student Initiative. The calculation of *Output 11* using COA as defuzzification function is as illustrated below.

$$\text{Output} = \frac{\begin{array}{c} m_1L_1 + m_2L_2 + m_3L_3 + m_4L_{11} + m_5L_{12} + m_6L_4 + m_7L_5 + m_8L_{13} + m_9L_{14} + \\ m_{10}L_4 + m_{11}L_5 + m_{12}L_{13} + m_{13}L_{14} + m_{14}L_4 + m_{15}L_5 + m_{16}L_{13} + m_{17}L_{14} + \\ m_{18}L_4 + m_{19}L_5 + m_{20}L_{13} + m_{21}L_{14} + m_{22}L_4 + m_{23}L_5 + m_{24}L_{13} + m_{25}L_{13} \end{array}}{\begin{array}{c} m_1 + m_2 + m_3 + m_4 + m_5 + m_6 + m_7 + m_8 + m_9 + m_{10} + m_{11} + m_{12} + m_{13} \\ m_{14} + m_{15} + m_{16} + m_{17} + m_{18} + m_{19} + m_{20} + m_{21} + m_{22} + m_{23} + m_{24} + m_{25} \end{array}}$$

$$\text{Output} = \frac{\begin{array}{c} 0.0L_1 + 0.0L_2 + 0.0L_3 + 0.0L_{11} + 0.0L_{12} + 0.0L_4 + 0.0L_5 + 0.0L_{13} + 0.0L_{14} + \\ 0.0_{10}L_4 + 0.0L_5 + 0.0L_{13} + 0.0L_{14} + 0.0L_4 + 0.0L_5 + 0.0L_{13} + 0.0L_{14} + \\ 0.20L_4 + 0.80L_5 + 0.0L_{13} + 0.0L_{14} + 0.0L_4 + 0.0L_5 + 0.0L_{13} + 0.0L_{13} \end{array}}{\begin{array}{c} 0.0 + 0.0 + 0.0 + 0.0 + 0.0 + 0.0 + 0.0 + 0.0 + 0.0 + 0.0 + 0.0 + 0.0 + 0.0 \\ 0.0 + 0.0 + 0.0 + 0.0 + 0.2 + 0.8 + 0.0 + 0.0 + 0.0 + 0.0 + 0.0 + 0.0 \end{array}}$$

$$= 82.80$$

Figure 4.4 depicts the FAM of final inference for Student Initiative. The defuzzified output is obtained after the final phase of defuzzification is performed. The rest of the system was using the same calculation to obtain the crisp value of defuzzification.

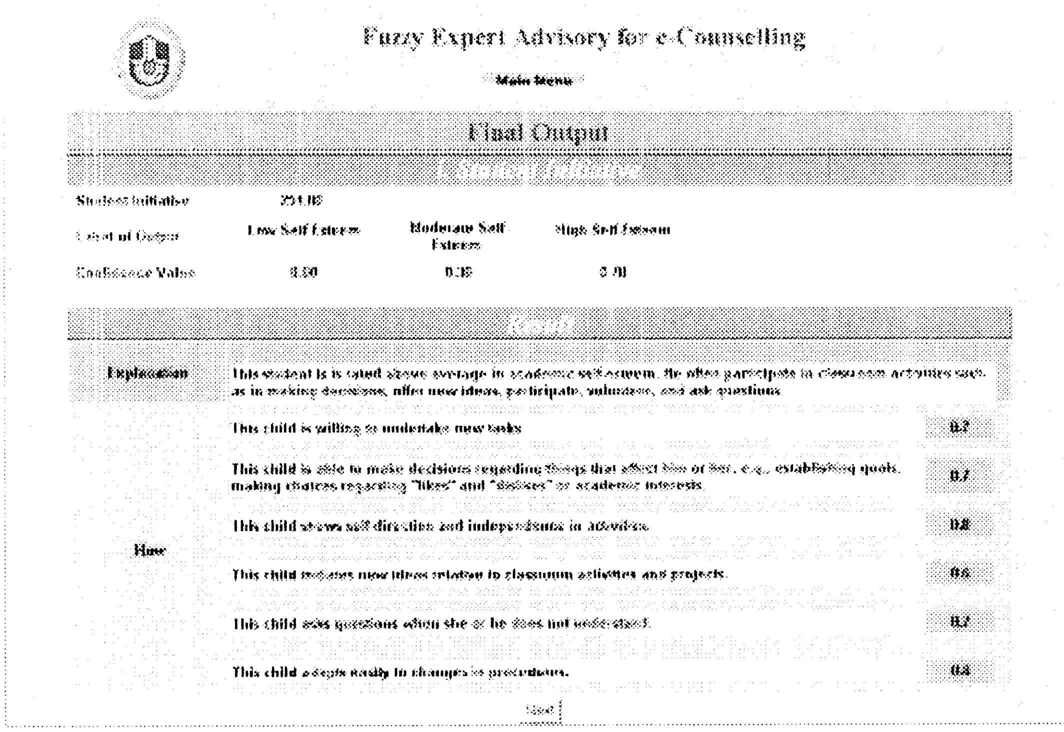


Figure 4.4: Final Inference Result of Experiment 1

4.2.2 BASE Factor 2: Social Attention

This next experiment was performed to BASE factor 2 that is Social Attention. For this factor, there are three inputs involves. The hierarchical inference structure (refer Fig. 3.13) is then executed to form the two phases of FAM. The information used for generating the second test case onward is as shown in the following figures. The experiments of several test cases have been performed to illustrate the different result for levels of academic self-esteem.

Experiment 2: Fuzzification

This fuzzification for Experiment 2 involved the tranformation of inputs of *Question 7*, *Question 8*, and *Question 9* into a linguistic value. Dealing with hierarchical structure, the first two inputs i.e. *Question 7* and *Question 8* will be activated first. Next, the output produced will become an input to the second AND operation with the third input (*Question 9*). Once the output is produced from the second AND operation, similar processes will be repeated until the Social Attention is reached. Similar to the Student Initiative, the Social Attention with three inputs used five linguistic labels of *never*, *seldom*, *usually*, *sometimes* and *always*. The defuzzified crisp outputs are labelled as *low self-esteem, moderate self-esteem* and *high self-esteem*.

The transformation process is then executed, and it is performed using the same fuzzification algorithm. The membership graph is as shown in Fig 3.10. From the user interface, by clicking the next button, a user is then required to give the input to the system for BASE factor 2. Sliding the corresponding value using the slider bar or by inputting the value for Question 7 through Question 9 of Social Attention, will transform the inputs to its corresponding linguistic value. Fig 4.5 illustrates the fuzzification phase result after the transformation process has been performed.

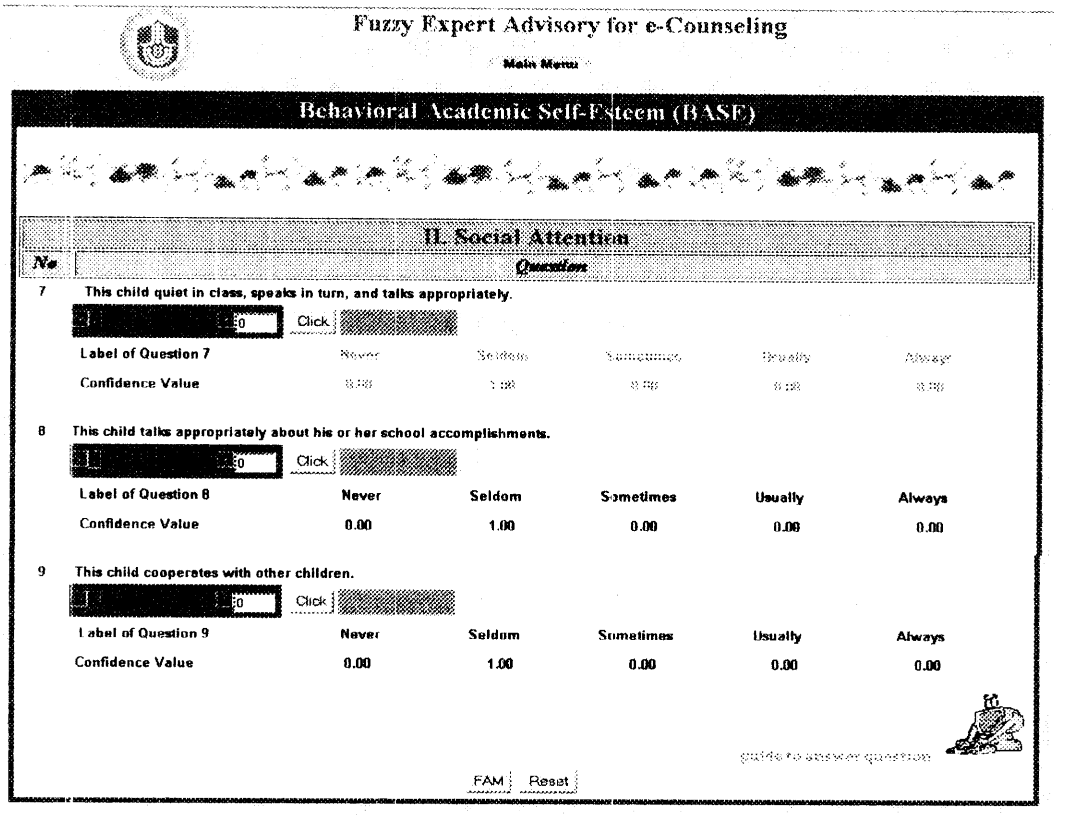
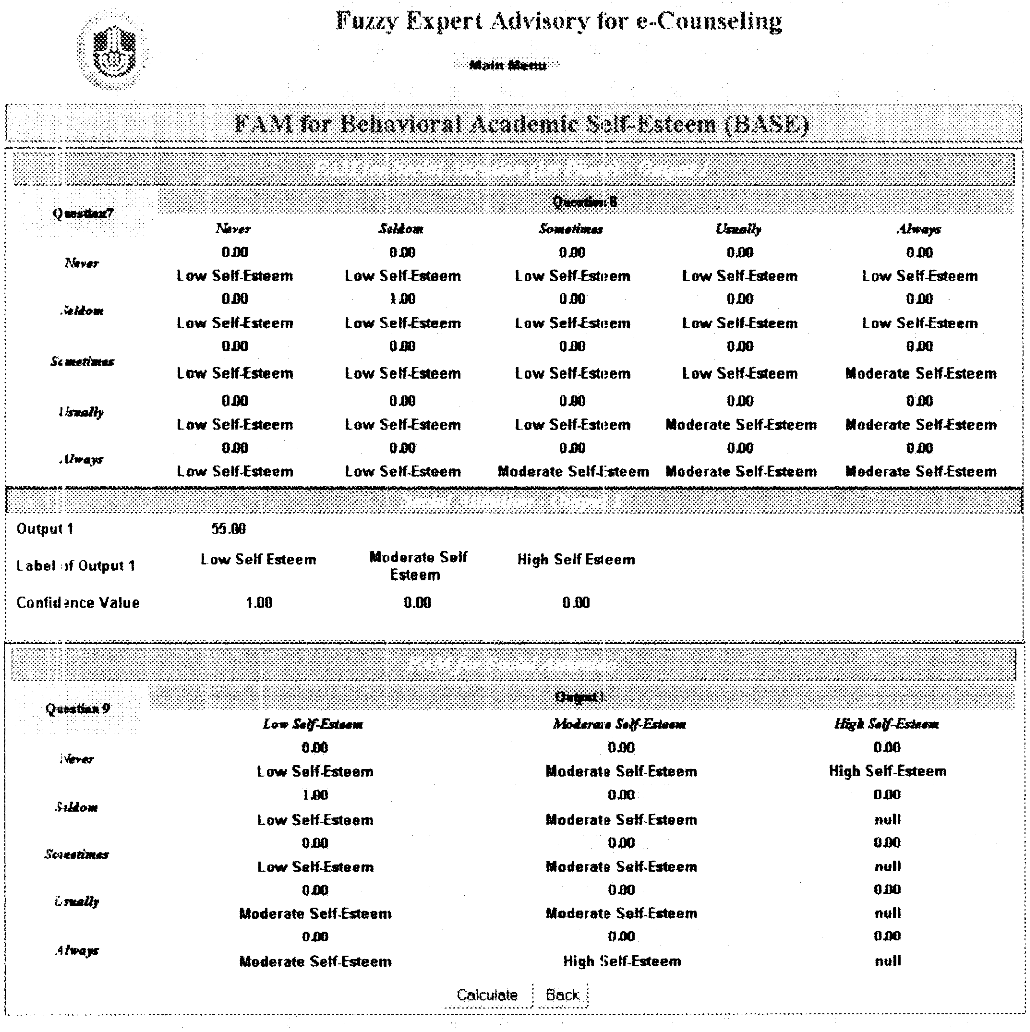


Figure 4.5: Fuzzification Phase Result of Experiment 2

Experiment 2: Fuzzy Inference

The Social Attention involves and using hierarchical fuzzy inference structure in estimating the BASE factor structure. The FAM table for Social Attention can be divided into two phases. This FAM table stores the confidence value that will be used further for calculating the level of *Output 21* that is the first phase of output for this factor. The fuzzy AND operator is, therefore the minimum value from the two inputs will be taken as confidence value for the output variable. Similar to process of obtaining the min value explained in Table 4.1 above, the first phase of inference is then performed. Figure 4.6 shows the FAM of first inference for Social Attention. The first defuzzified value for *Output 21* shows the label of low self-esteem.



Fuzzy Expert Advisory for e-Counseling

Main Menu

FAM for Behavioral Academic Self-Esteem (BASE)

Question7	Question 8				
	Never	*Seldom*	*Sometimes*	*Usually*	*Always*
Never	0.00 Low Self-Esteem	0.00 Low Self-Esteem	0.00 Low Self-Esteem	0.00 Low Self-Esteem	0.00 Low Self-Esteem
Seldom	0.00 Low Self-Esteem	1.00 Low Self-Esteem	0.00 Low Self-Esteem	0.00 Low Self-Esteem	0.00 Low Self-Esteem
Sometimes	0.00 Low Self-Esteem	0.00 Low Self-Esteem	0.00 Low Self-Esteem	0.00 Low Self-Esteem	0.00 Moderate Self-Esteem
Usually	0.00 Low Self-Esteem	0.00 Low Self-Esteem	0.00 Low Self-Esteem	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem
Always	0.00 Low Self-Esteem	0.00 Low Self-Esteem	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem

Output 1	55.00		
Label of Output 1	Low Self Esteem	Moderate Self Esteem	High Self Esteem
Confidence Value	1.00	0.00	0.00

Question 9	Output1		
	Low Self-Esteem	*Moderate Self-Esteem*	*High Self-Esteem*
Never	0.00 Low Self-Esteem	0.00 Moderate Self-Esteem	0.00 High Self-Esteem
Seldom	1.00 Low Self-Esteem	0.00 Moderate Self-Esteem	0.00 null
Sometimes	0.00 Low Self-Esteem	0.00 Moderate Self-Esteem	0.00 null
Usually	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem	0.00 null
Always	0.00 Moderate Self-Esteem	0.00 High Self-Esteem	0.00 null

Calculate Back

Figure 4.6: FAM of First and Second Inference of Experiment 2

Experiment 2: Defuzzification

As explained before in section 4.2.1, the defuzzification phase perform the same operations that transform a fuzzy set into a single crisp value. In this case, the defuzzification needs to be done to calculate *Output 21, and* final output of Social Attention. The calculation of *Output 21* using COA as defuzzification function is as illustrated below. As depicted in Figure 4.7, the final inference result shows the output of Social Attention crisp value and labelled as low self-esteem with appropriate explanation.

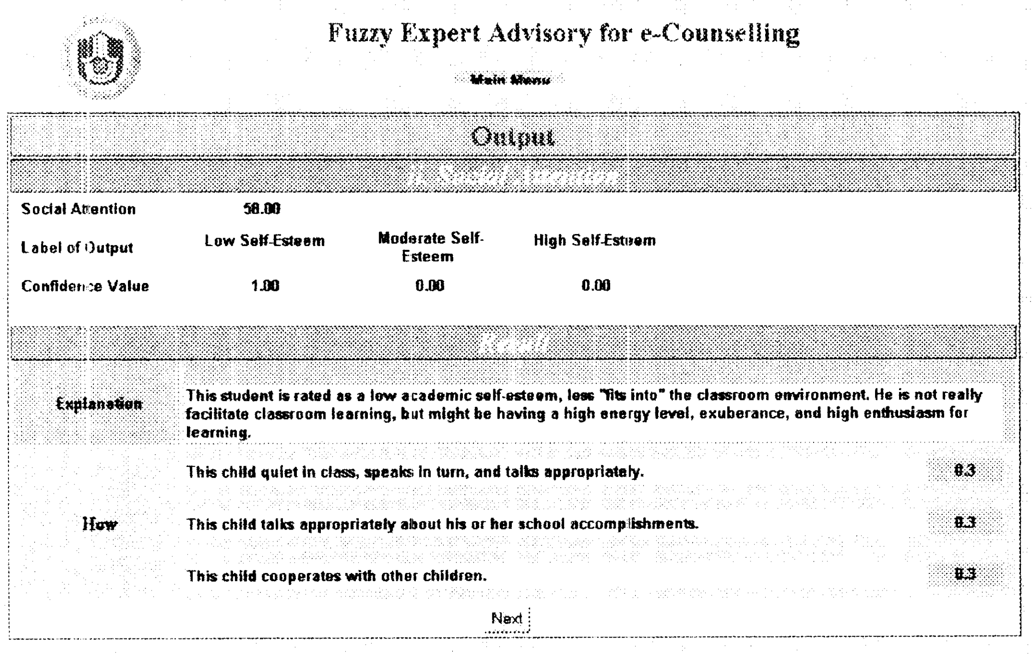


Figure 4.7: Final Inference Result of Experiment 2

Experiment 3: Fuzzification

This fuzzification for Experiment 3 involved the transformation of inputs for the same BASE factor for Social Attention. The next test case is applied with the same inputs that is sixty for *Question 7*, *Question 8*, and *Question 9*. The transformation process is then executed, and it is performed using the same fuzzification algorithm. The membership graph is as shown in Fig 3.10. Fig 4.8 illustrates the fuzzification phase result after the transformation process has been performed.

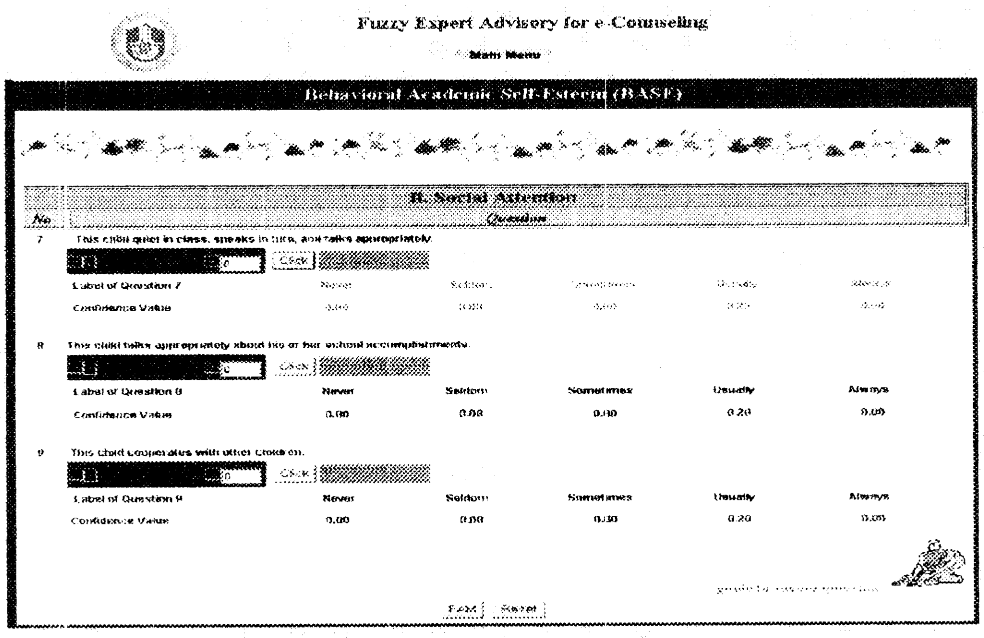


Figure 4.8: Fuzzification Phase Result of Experiment 3

Experiment 3: Fuzzy Inference

Based on the FAM table of Social Attention for Experiment 3, the *Output 21* shows the result after defuzzifictaion is 58.71 and its label based on the membership function graph specified. Figure 4.9 shows the phase one and the phase two of inference.

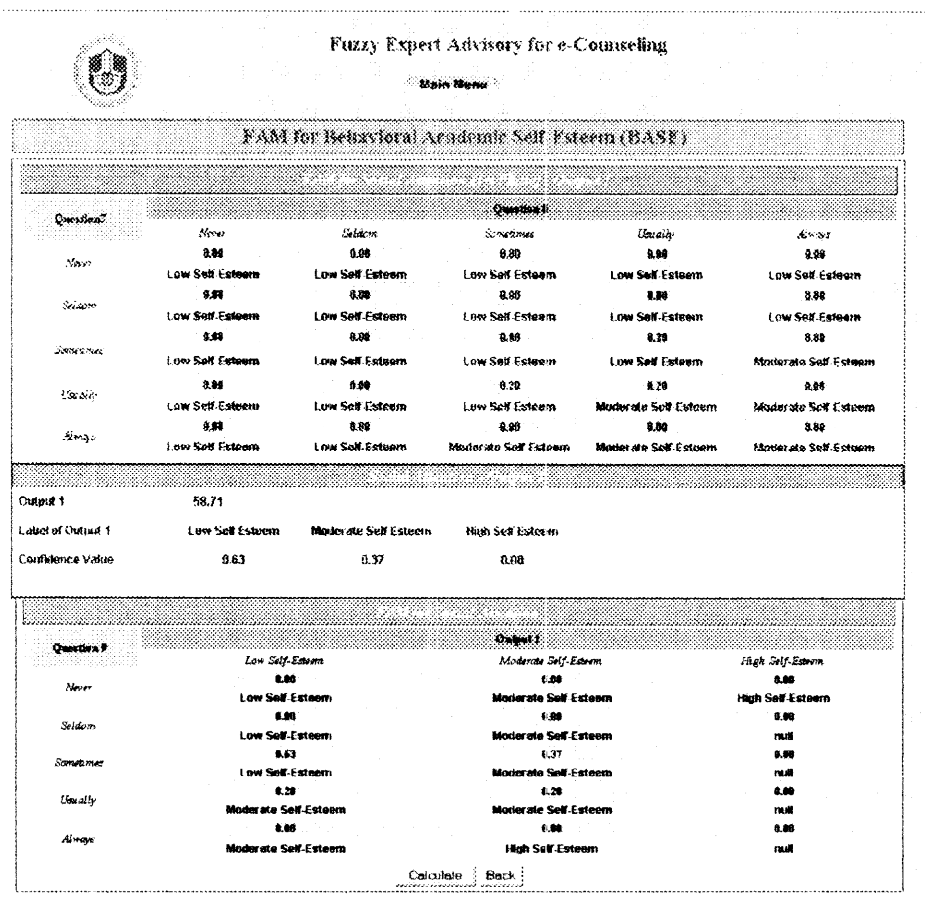


Figure 4.9: FAM of First and Second Inference of Experiment 3

Experiment 3: Defuzzification

Figure 4.10 presents the final inference result for the output of Social Attention crisp value and labelled as moderate self-esteem with appropriate explanation. The membership function graph can be referred at Fig 3.14.

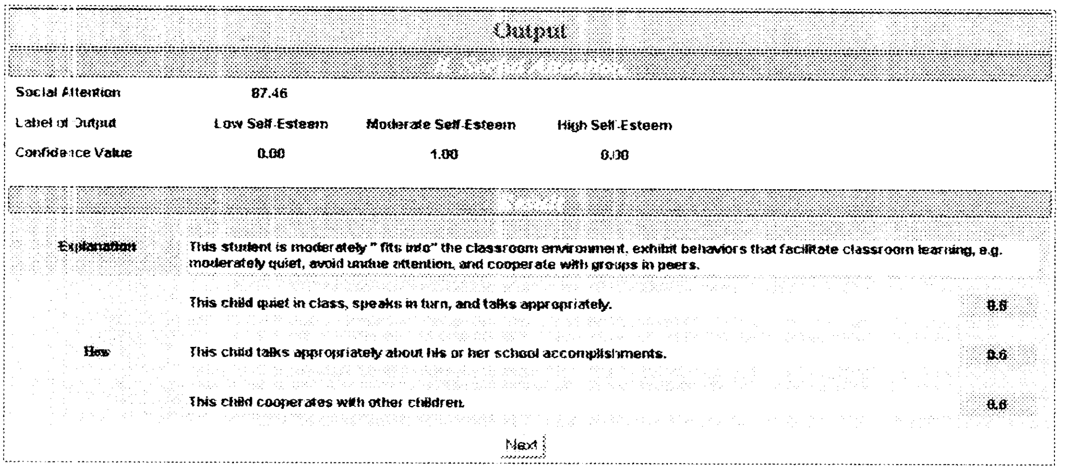


Figure 4.10: Final Inference Result of Experiment 3

4.2.3 BASE Factor 3: Success/Failure

The next experiment was performed to Success/Failure of BASE factor 3. For this factor, only two inputs involved. The single inference structure (refer Fig. 3.19) is then executed forming the FAM. The membership graph is also referred as shown in Fig 3.11 (Chapter 3).

Experiment 4: Fuzzification

From the user interface, a user is required to give the input to the system by sliding the corresponding value using the slider bar or by inputting the value for Question 10 and Question 11. Fig 4.11 illustrates the fuzzification phase result after the transformation process has been performed.

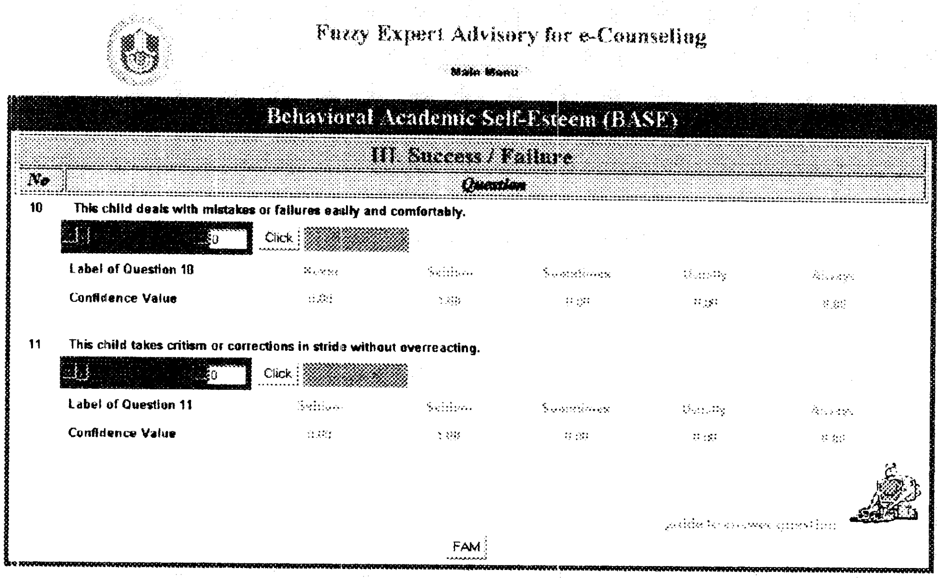


Figure 4.11: Fuzzification Phase Result of Experiment 4

Experiment 4: Fuzzy Inference

Figure 4.12 shows the FAM table of Success/Failure for Experiment 4.

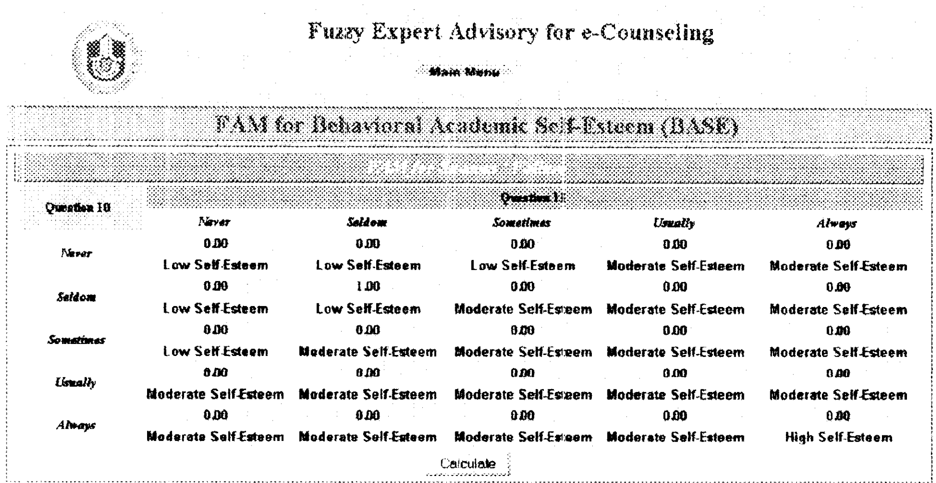


Figure 4.12: FAM of Experiment 4

Experiment 4: Defuzzification

Figure 4.13 presents the final inference result for the output of Success/Failure crisp value and labelled as low self-esteem with appropriate explanation. The membership function graph can be referred at Fig 3.15.

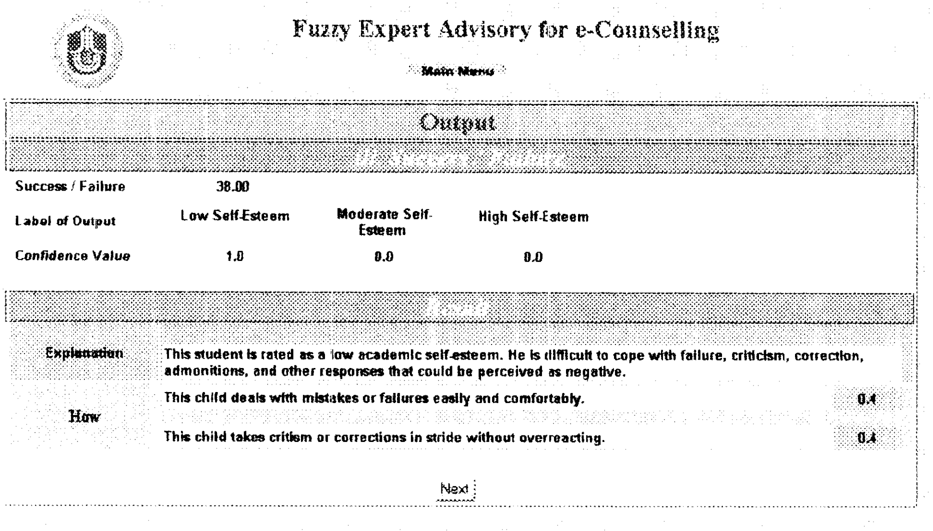


Figure 4.13: Final Inference Result of Experiment 4

4.2.4 BASE Factor 4: Social Attraction

Followed by BASE Factor 4, the experiment was performed to the Social Attraction. Similar to Social Attention, there are three inputs involves. The hierarchical inference structure (refer Fig. 3.20) is then executed to form the two phases of FAM. The experiments of test cases have been performed to illustrate the different results for levels of academic self-esteem.

Experiment 5: Fuzzification

This fuzzification for Experiment 5 involved the tranformation of inputs of *Question 12*, *Question 13*, and *Question 14* into a linguistic value. Dealing with hierarchical structure, the first two inputs i.e. *Question 12* and *Question 13* will be activated first. Next, the output produced will become an input to the second AND operation with the third input (*Question 14*). Once the output is produced from the second AND operation, similar processes will be repeated until the Social Attraction is obtained. The membership graph is as shown in Fig 3.10 and Figure 3.11. Sliding the corresponding value using the slider bar or by inputting the value for *Question 12* through *Question 14* of Social Attraction, will transform the inputs to its corresponding linguistic value. Fig 4.14 illustrates the fuzzification phase result after the transformation process has been performed.

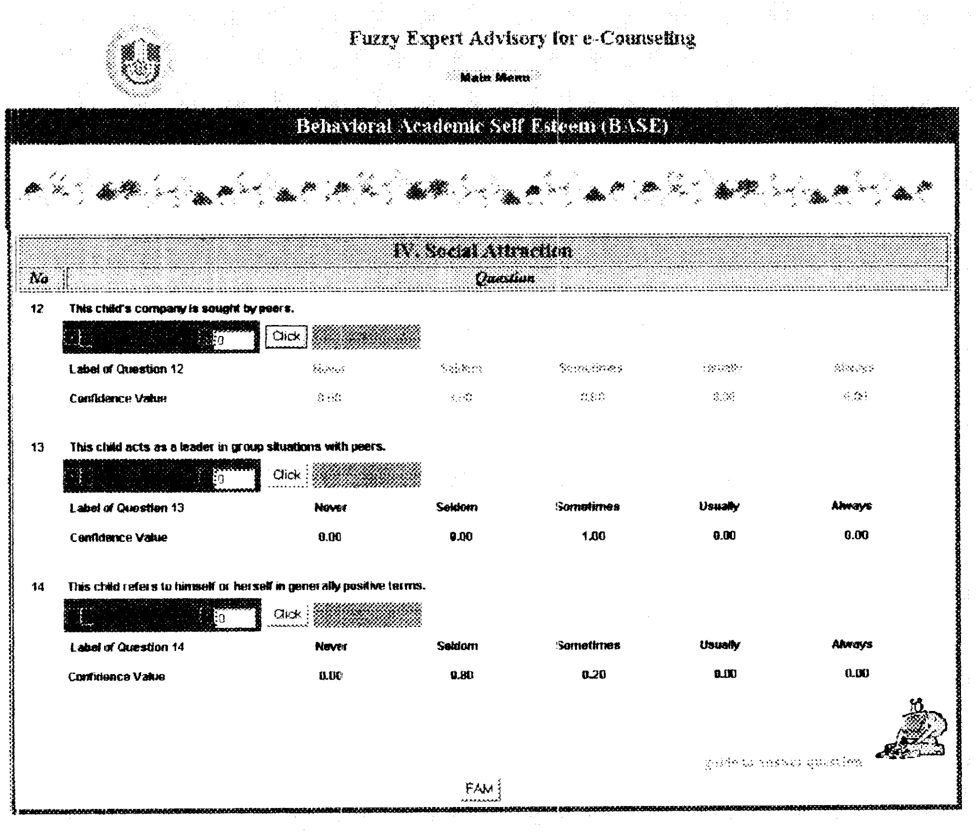


Figure 4.14: Fuzzification Phase Result of Experiment 5

Experiment 5: Fuzzy Inference

Similar to Social Attention, the FAM table for Social Attraction can be divided into two phases. This FAM table stores the confidence value that will be used further for calculating the level of *Output 41* that is the first phase of output for this factor. The fuzzy AND operator is, therefore the minimum value from the two inputs will be taken as confidence value for the output variable. Based on the process of obtaining the min value explained in Table 4.1 above, the first phase of inference is then performed. Figure 4.15 shows the FAM of first inference and second phase inference for Social Attraction. The first defuzzified value for *Output 41* shows the label of low self-esteem.

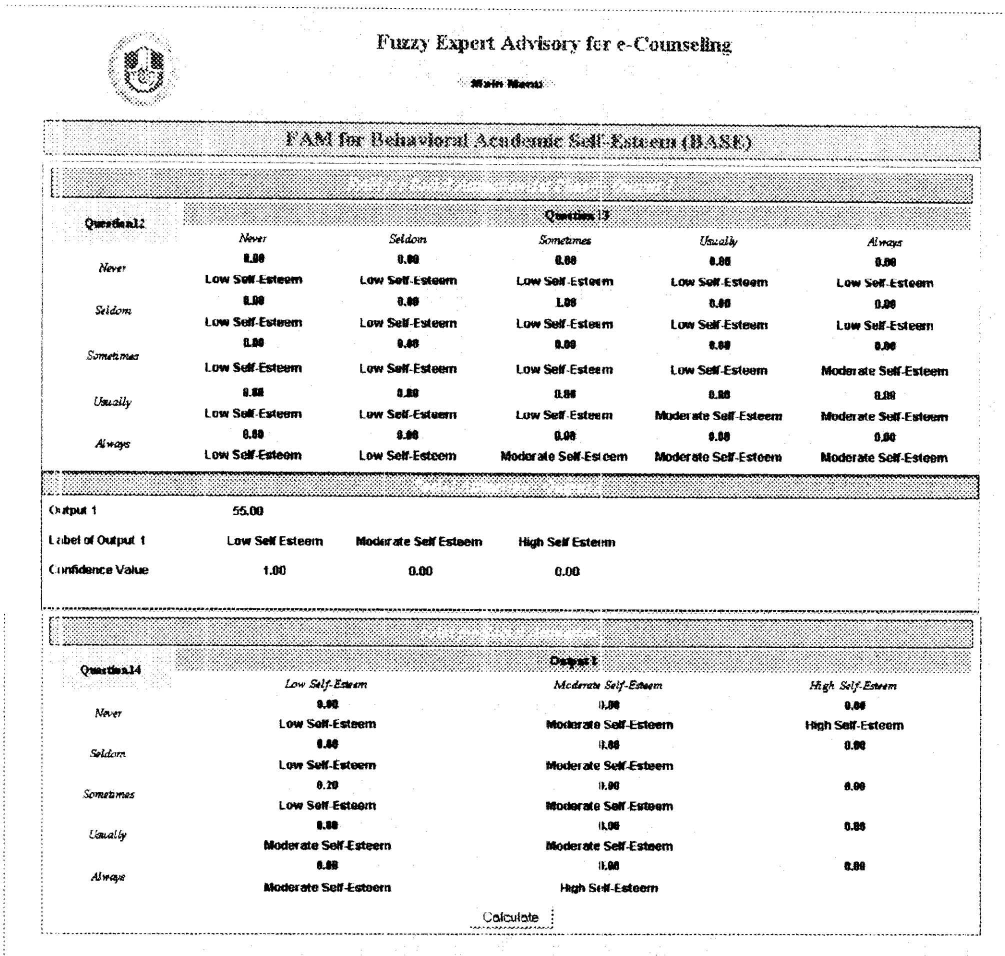


Figure 4.15: FAM of First and Second Inference of Experiment 5

Experiment 5: Defuzzification

Figure 4.16 presents the final inference result for the output of Social Attraction crisp value and labelled as low self-esteem and moderate self-esteem with appropriate explanation. The membership function graph can be referred at Fig 3.14.

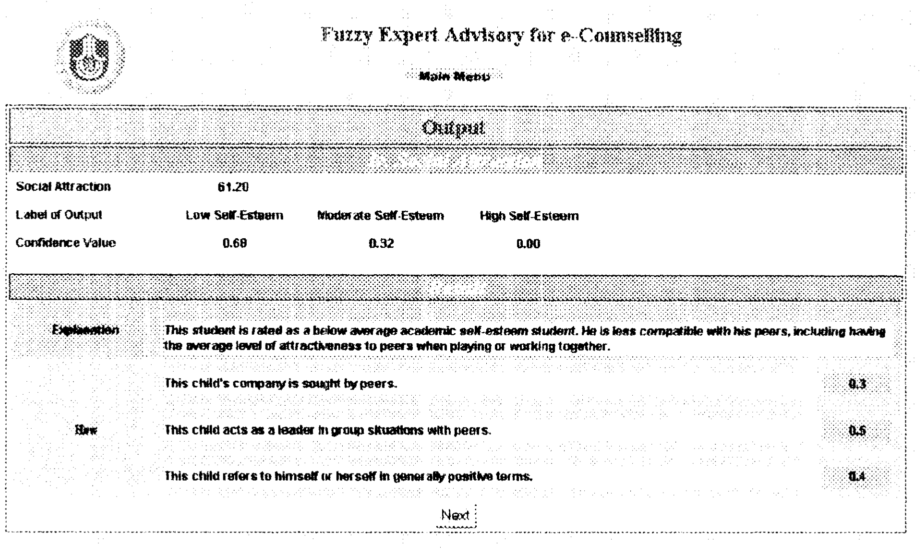


Figure 4.16: Final Inference Result of Experiment 5

4.2.5 BASE Factor 5: Self-Confidence

The next experiment was applied to Self-Confidence of BASE factor 5. For this factor, only two inputs involved. The single inference structure (refer Fig. 3.21) is then executed to form the FAM. The membership graph is also referred as shown in Fig 3.11 (Chapter 3).

Experiment 6: Fuzzification

From the user interface, a user is required to give the input to the system by sliding the corresponding value using the slider bar or by inputting the value for Question 15 and Question 16. Fig 4.17 illustrates the fuzzification phase result after the transformation process has been performed.

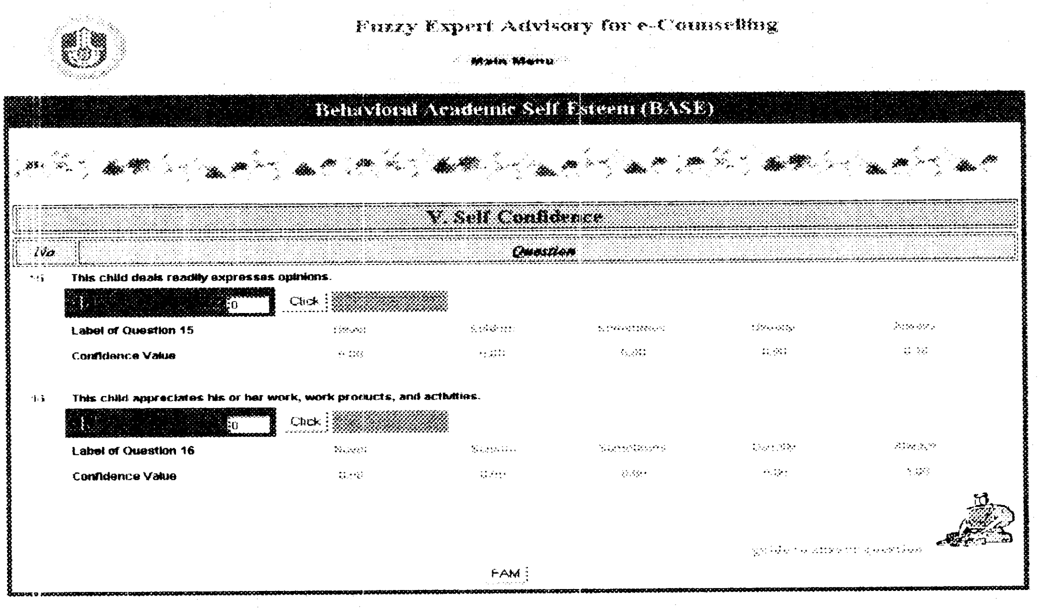
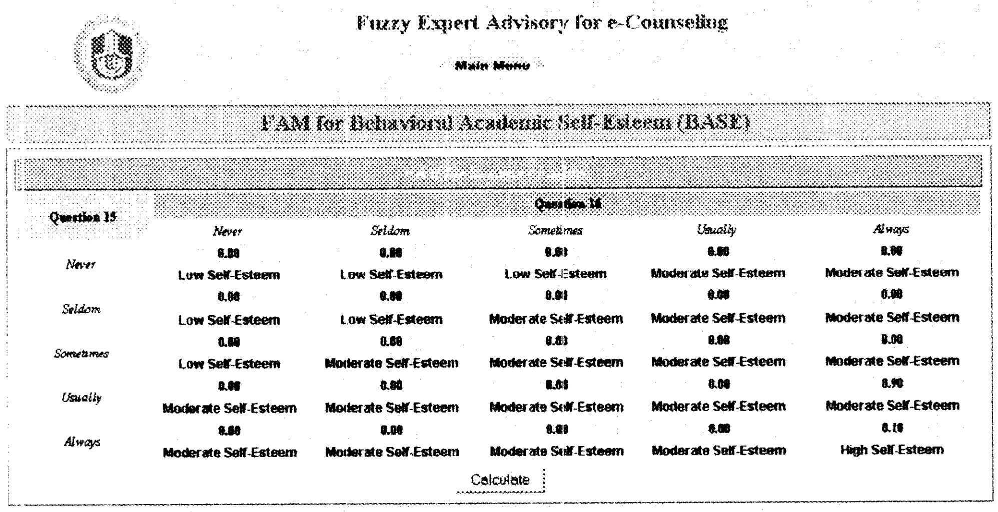


Figure 4.17: Fuzzification Phase Result of Experiment 6

Experiment 6: Fuzzy Inference

Figure 4.18 shows the FAM table that stores the confidence value to be used for calculating the level of output of Self-Confidence. The defuzzified value for *output of Self-Confidence* is illustrated in the next figure.



Question 15	Never	Seldom	Sometimes	Usually	Always
Never	0.00 Low Self-Esteem	0.00 Low Self-Esteem	0.00 Low Self-Esteem	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem
Seldom	0.00 Low Self-Esteem	0.00 Low Self-Esteem	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem
Sometimes	0.00 Low Self-Esteem	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem
Usually	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem	0.90 Moderate Self-Esteem
Always	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem	0.00 Moderate Self-Esteem	0.10 High Self-Esteem

Figure 4.18: FAM of Experiment 6

Experiment 6: Defuzzification

Figure 4.19 presents the final inference result for the output of Self-Confidence crisp value and labelled as moderate self-esteem with appropriate explanation. The membership function graph can be referred at Fig 3.15.

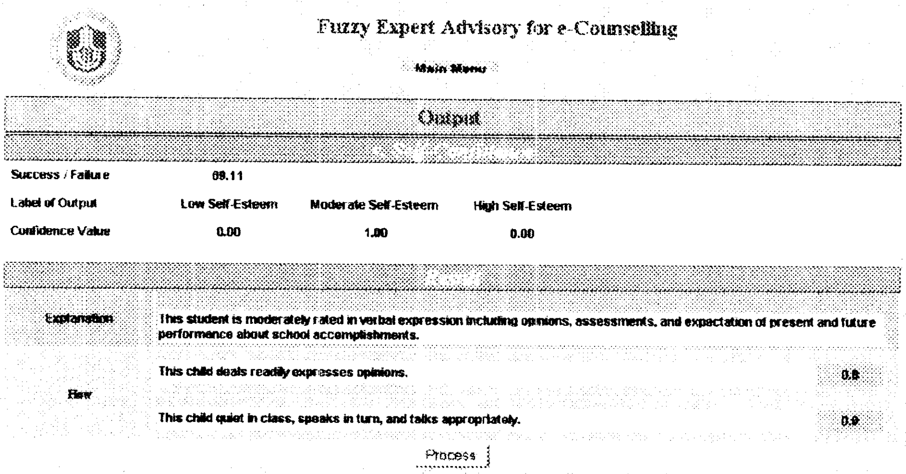


Figure 4.19: Final Inference Result of Experiment 6

By pressing the Process button, the final output will be displayed that combined all of the final inference results. Figure 4.20 presents the four BASE factor inference results. Except for BASE factor 1 it is not included. This output was displayed in such a way to assist the user in viewing the overall results based on the inputs or rating they have chosen.

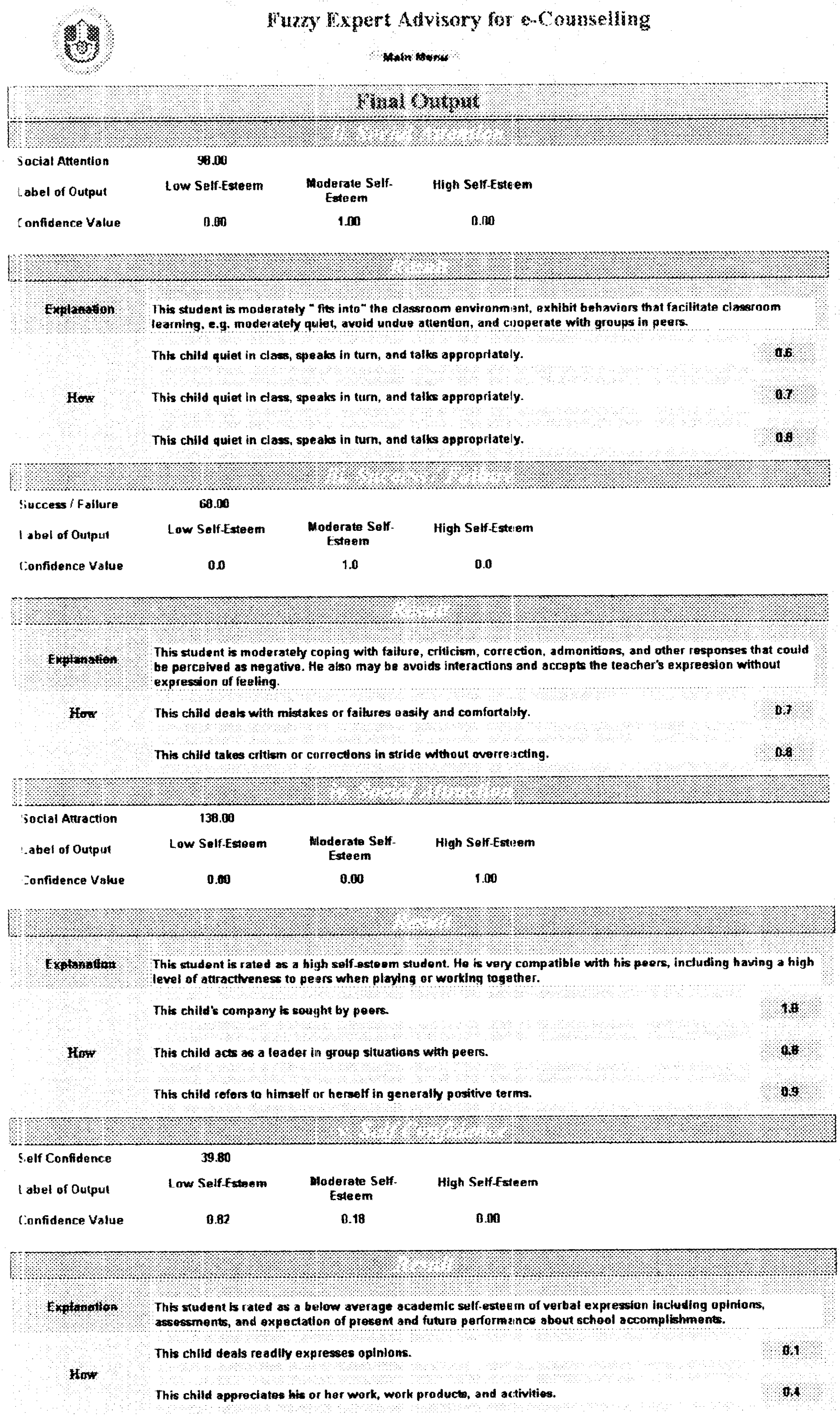


Figure 4.20: Final Output of Inference Results

4.3 Expert System Explanation

Expert systems use knowledge, facts, and reasoning techniques to solve problems that normally require the abilities of human experts. Expert system imitates the expert's reasoning processes to solve specific problems or narrow problem area efficiently and effectively. In this advisory system for e-counselling, the knowledge base consisting of a database of information necessary for providing expert advice and provide the how conclusion is derived and it is stored in DBExpert file. Fig 4.21 shows the fuzzy expert advisory for e-counselling explanation and how the conclusion is reached together with the CF value. The explanation is obtained based on the defuzzified crisp value as for this case the Social Attention.

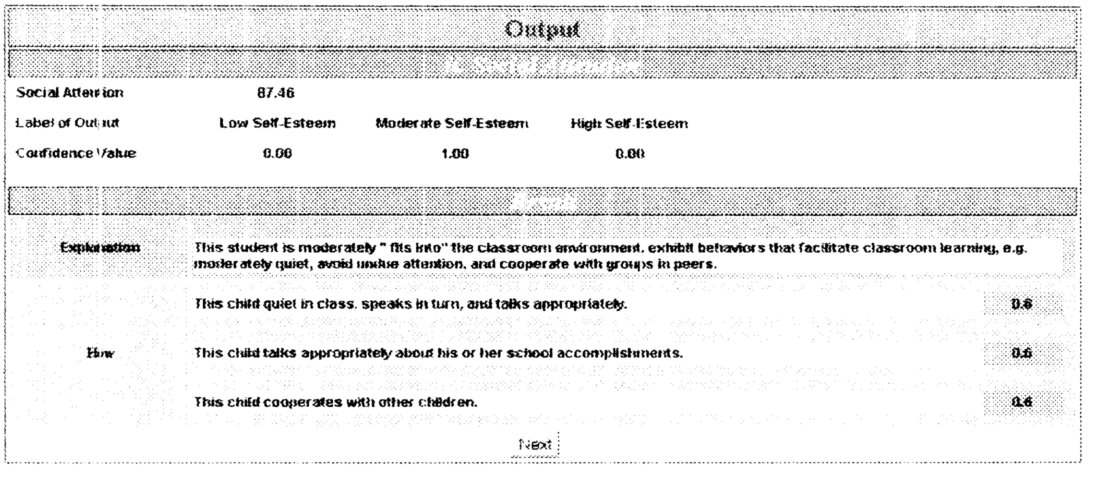


Figure 4.21: Result on Explanation and How

User Interface

In this system, the set of questions are provided and users are required to answer the questions to let the system diagnose the suitable conclusion within its knowledge base. The user is also required to give the input to the system by sliding the corresponding value using the slider bar or by inputting the value inside the text box. Figure 4.21 depicts the fuzzy expert advisory for e-counselling user interface.

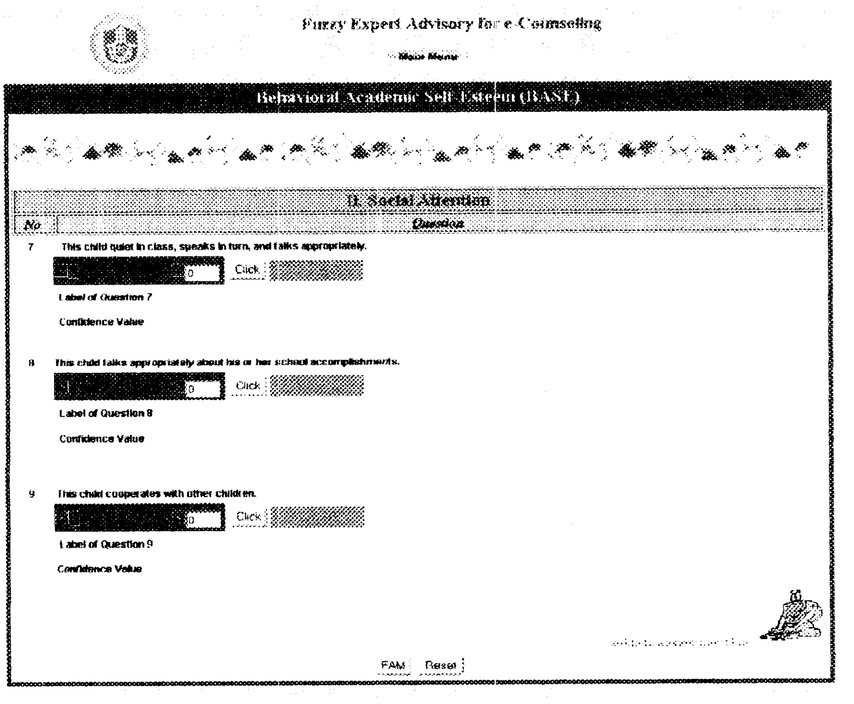


Figure 4.21: Fuzzy Expert Advisory for e-Counselling User Interface

'Guide to Answer Question' will assist the users in order to make ratings at their own convenience. Figure 4.22 shows the Guide to Answer Question screen.

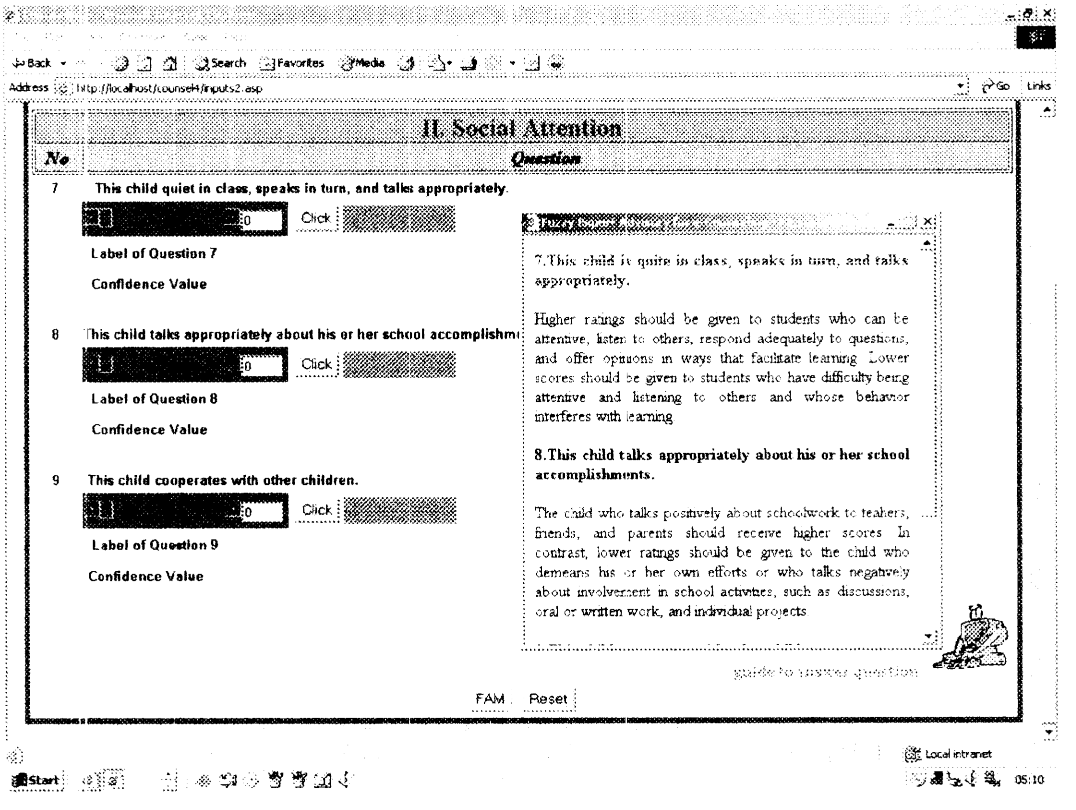


Figure 4.22: Guide to Answer Question Screen

The final product of this fuzzy expert advisory for e-counselling system is a web application. Using ASP as a web-based language, the user may interact with the system using the browser and the Internet.

CHAPTER 5

CONCLUSION

Artificial intelligence (AI) has received extensive attention in recent years. AI's scientific goal is to understand intelligence by building computer programs that exhibit intelligent behaviour. It is concerned with the concepts and methods of symbolic inference, or reasoning, by a computer, and how the knowledge used to make those inferences will be represented inside the machine. The term *intelligence* covers many cognitive skills, including the ability to solve problems, learn, and understand language; AI addresses all of those capabilities (Engelmore and Feigenbaum, 1993). Most progress to date in AI has been made in the area of problem solving, concepts and methods for building programs that *reason* about problems rather than calculate a solution.

This study focuses on the software development using hybrid AI technology and the employment of fuzzy expert system in counselling domain. Fuzzy expert systems model imprecise information, capturing expertise similar to the way it is represented in the expert mind, and thus improve cognitive modelling of the problem. Fuzzy Expert Advisory for e-Counselling offers computerized fuzzy expert system and in line with the developing technology, the web environment is preferred in implementing the artificial intelligence techniques in e-counselling and as well as in psychology domain. This web based application has been developed to estimate the BASE factor structures and determine the levels of academic self-esteem of the student.

The system helps the user by managing the consultation session in order to obtain the score for a particular factor. A set of questions will be asked through graphical user interface and helps user diagnose their given options to infer such a conclusion. The consultation performed by the expert system also involved fuzzy logic when dealing with the natural and uncertainty data. In addition, fuzzy expert advisory provides explanation and explain how a diagnosis is reached for a particular case. The results showed that the fuzzy expert prototype system presented in this paper provided a reliable and accurate results after several test cases have been run. The system performance was successfully tested and produced the results that were equal to an expert's judgment, thus accomplishing the objectives. The system that has been produced, conform to the BASE factor rating scale and sub-scores.

The results obtained provide the information of measuring student's academic self-esteem at early ages. The explanation part in the system may be used to evaluate factors that affect the academic self-esteem, encouraging discussions about self-esteem in parent-teacher conference, and to establish construct and predictive validity related to common measures of school success. Since this study focuses on the software development using hybrid AI technology and the employment of fuzzy expert system in counselling domain, therefore it emphasize on data acquisition, type of questions and mapping of uncertainty into fuzzy values, which consists of labels and confidence values. This involves the determination of membership function graph that requires the knowledge from counselling expert. This mapping process is very crucial in this study since if incorrect membership function graph was chosen, the final value yields from the fuzzy logic system is also incorrect.

After several testing has been done, it is realized the fuzzy logic drawbacks are in the aspects of the rules of the fuzzy logic, which apply in this counselling domain have to be determined by the expert experiences. It is difficult to make analysis of determination of a system designed according to the fuzzy logic. That is, it cannot be estimated how the system reacts beforehand. As the membership functions are determined according to the trial and error learning, they take a long time.

Future Direction

This project is focused on the development of fuzzy expert in e-counselling. Although the prototype developed met the objectives, many efforts have to be made to improve and enhance the system. For future research and development, it is beneficial to integrate the neural network and fuzzy logic, if more historical data can be captured. Other AI technique can be applied to this system such as an intelligent agent to provide explanation on expert systems as well as to support the web-based facilities. The statistical method also may be included as a basis for comparison purpose.

As referring to the domain, further enhancement can also be expanded to the other psychological testing system. The same platform still can be used, however the database for other tests need to be developed. In other words users, teachers, and parents will be able to benefits from the system. Further studies can focus on other psychology testing with the rating scale format, in other words with rigid score calculation. The merging of expert systems and fuzzy logic with neural networks utilizes the strength of all three disciplines to provide a better system than either can provide themselves. Expert systems have the problem that most experts don't exactly understand all of the nuances of an application and, therefore, are unable to clearly state rules which define the entire problem to someone else. But the neural network doesn't care that the rules are not exact, for neural networks can then learn, and then correct, the expert's rules. It can add nodes for concepts that the expert might not understand. It can tailor the fuzzy logic which defines states like tall, short, fast, or slow. It can twist itself until it can meet the user identified state of being a workable tool. In short, hybrid intelligent systems are the future.

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APPENDIX A

USER MANUAL

USER MANUAL

1.0 Development Tools

The Fuzzy Expert Advisory for e-Counselling system using a hybrid approach, the hierarchical fuzzy logic model and expert system. This web-based application project has been developed using the web application language that is Microsoft's Active Server Pages (ASP), a server-side web scripting; Microsoft Visual Basic Script, and Java Script. MS Access as a database and SQL. The Dreamweaver MX development environment supports the server technology, namely Microsoft Active Server Pages (ASP).

2.0 Copying Counsel System

- **Web server setup: Copy Counsel folder into root folder**

C:\Inetpub\wwwroot

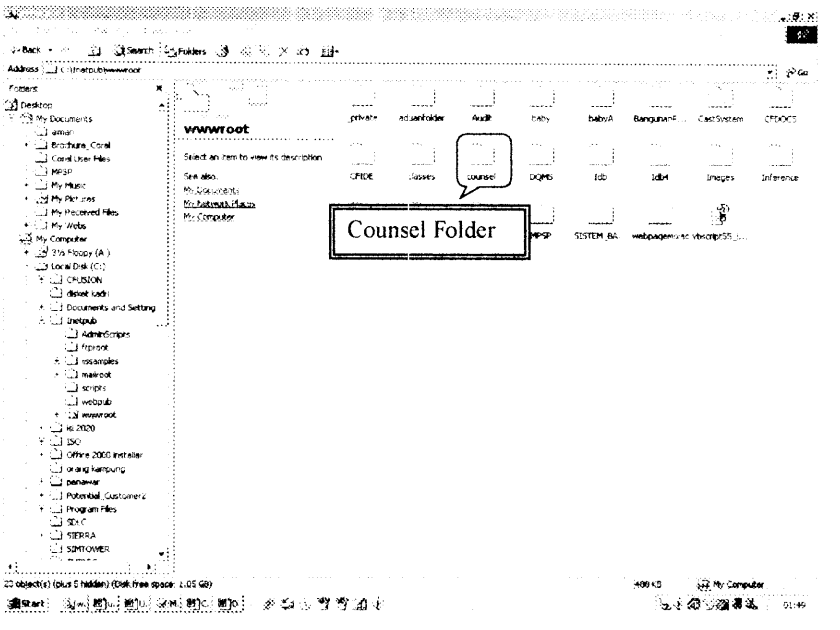


Figure 1: Copying Counsel Folder

3.0 Getting Started

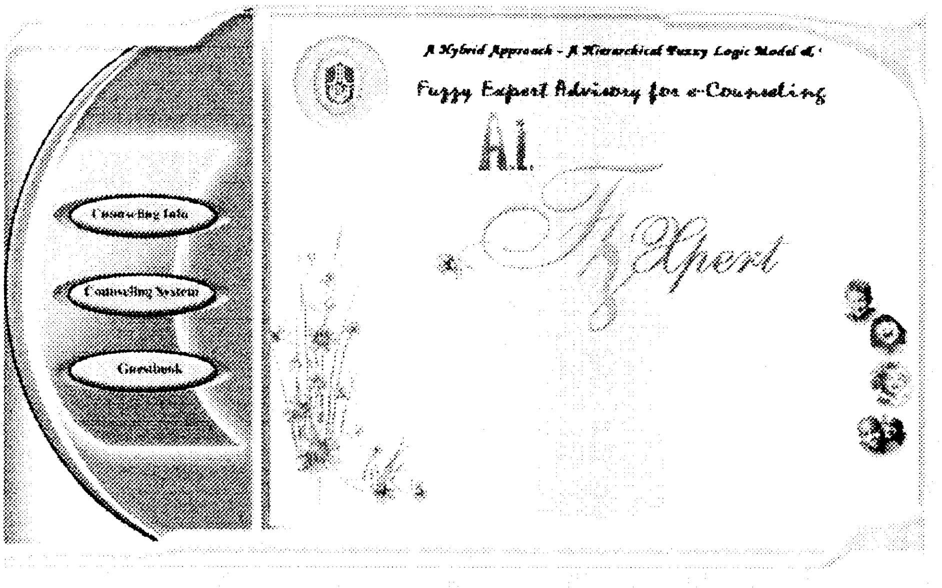


Figure 2: Main Menu Screen

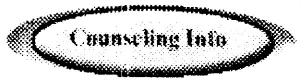
- To use this system, a user can launch it by log on to:

  http://localhost/Counsel/main_menu.asp

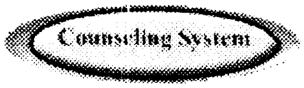
Note: The default name of the web server is the name of the computer. User can change the server name by changing the name of the computer. If the computer has no name, the server uses the word localhost. User can open any web page stored in the root folder by entering the following URL in a browser running on your computer:

*http://*myServerName/myFileName

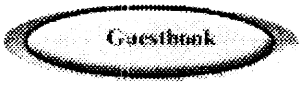
- The Main Menu screen will be displayed as shown in Figure 2. The Main Menu screen contains the title of the system, and the selection buttons.



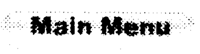
Click on the **Counselling Info** button to obtain the Counselling information about the Psychology, Testing, and BASE.



Click on the **Counselling System** button to use The Fuzzy Expert Counselling System - A Hierarchical Fuzzy Logic Model and Expert System Approach



Click on the **Guestbook** button to update personal details.



Click on the **Main Menu** button to go back to the Main Menu

3.1 Counselling Information

- Clicking on the **Counselling Info**, some information related to counselling will be displayed as shown in Figure 3. There are three major processes involved. User may click the labelled icon namely Psychology, Testing, and BASE in order to move from one screen to another screen.

Figure 3: Counseling Information Screen

- Clicking on the **Psychology** button, some information related to psychology testing will be displayed as shown in Figure 3.

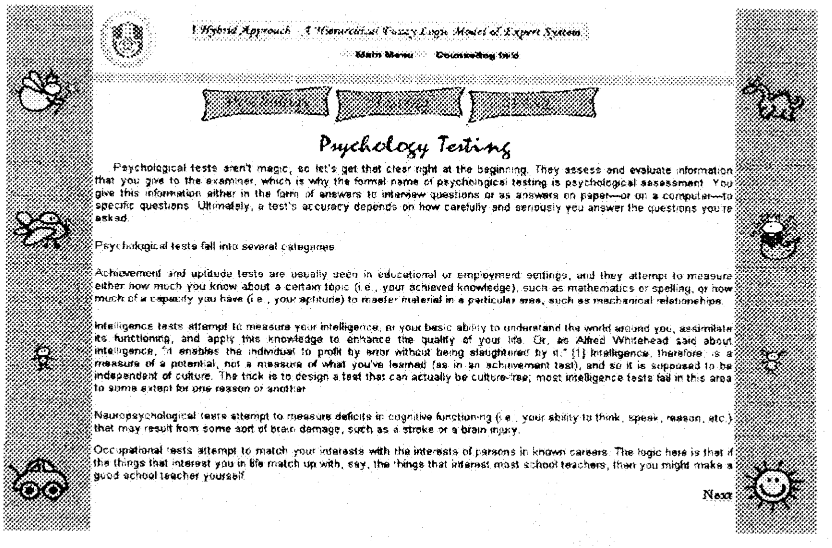


Figure 4: Counseling Information Screen

3.2 Fuzzy Expert Advisory for e-Counselling System

- Clicking on the **Counselling System** button, the Test Guide will be displayed as shown in Figure 5. This test guide is explained the procedure in answering the questions.

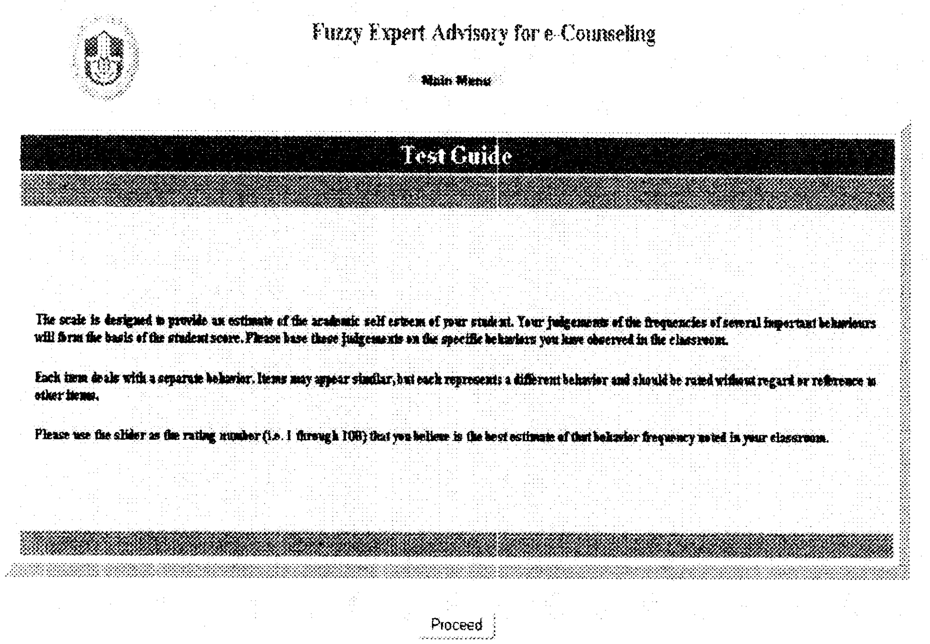


Figure 5: Test Guide Screen

- In order to use the system, click the **Proceed** button and the system will bring the user to the main function of the system.

- **Standard Button**

Click — Click on the **Click** button to activate the input.

FAM — Click on the **FAM** button to move to the FAM table on the next screen.

Reset — The **Reset** button will clear all the input fields or display fields available in the screen.

Back — Click on the **Back** button to go back to the previous screen.

Calculate — On clicking the **Calculate** button, it brings the user to the next screen which will perform the calculation of defuzzification.

Process — On clicking the **Process** button, the system the user will next display the overall results of BASE factors.

- The system interface is organised based on the five BASE factor structure and interacts with the user through a user interface to obtain the inputs starting from Factor 1: Student Initiative to Factor 5: Self-Confidence. The questions will be asked based on the BASE rating scale standard question consists of sixteen items.

- In each question the user will have to make ratings at their own convenience or may refer to 'Guide to Answer Question' for help.

- First, the user is required to give the input to the system by sliding the corresponding value using the slider bar or by inputting the value for Student Initiative BASE Factor 1 through Self-Confidence of BASE Factor 5. The input value of Question 1 through Question 16 is representing 5 rating scale of fuzzy labels or linguistic value such as *never*, *seldom*, *sometimes*, *usually*, and *always*.

- Upon completing the individual group of BASE factor, the system will process the input and establish the result or output accordingly.

- User will have to update the BASE in sequential process i.e from BASE 1 to BASE 5 and all the result will be produced in group based accordingly. Once the user completed inputing the BASE 5, system will provide a summary of all result.

The following is an example of how user can use the system by inputting the relevant data in the sample question of the input and output processing in BASE factor 2. The steps for the processing in BASE Factor 1, 3, 4 and 5 are the same as explained in BASE Factor 2.

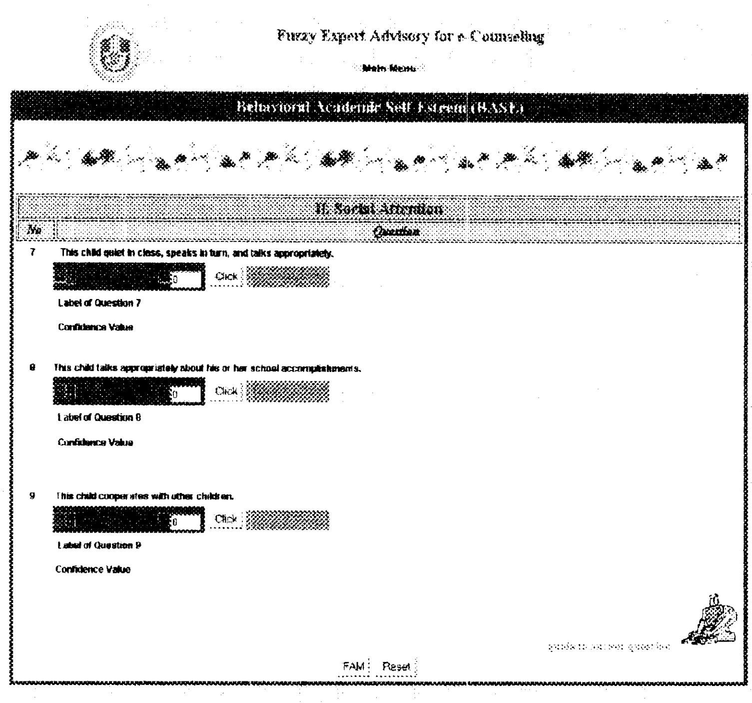


Figure 6: Input Screen for Social Attention

- Clicking on the **Proceed** button, the BASE factor of Social Attention will be displayed as shown in Figure 6. There are three questions that required user respond.

- The following presents the steps to use inputs screen of the Social Attention.

  a) For Question 7, after user have read the question, scroll the bar to determine percentage. Then press click button.
  b) Repeat the same steps for Question 8 and 9.
  c) Click **FAM** button.

- Clicking the **FAM** button will bring the user to the screen as shown in Figure 7 below.

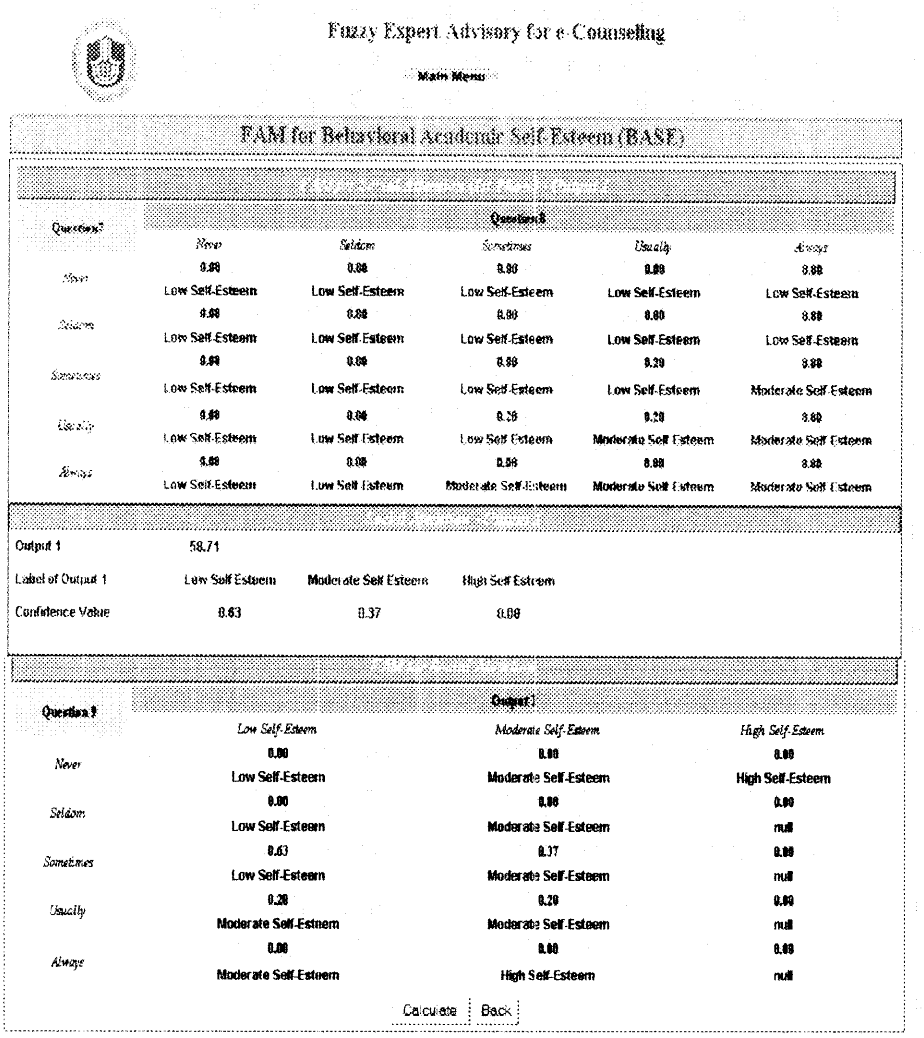


Figure 7: FAM for Social Attention

- The next step is to click the **Calculate** button and the system will calculate and produce the result as shown in Figure 8 below.

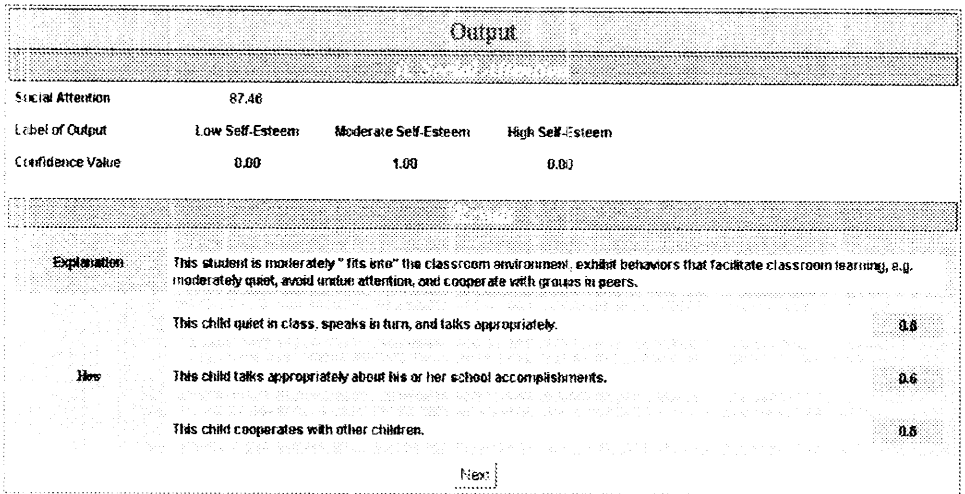


Figure 8: Result for Social Attention Screen

- Click the **Next** button to proceed to the following factor of question respectively.

- The same steps and process will be repeated for the following factor and question.

3.3 Guest Book

- Clicking on the **Guest Book** button, user will have to update personal details in order to utilize the system.

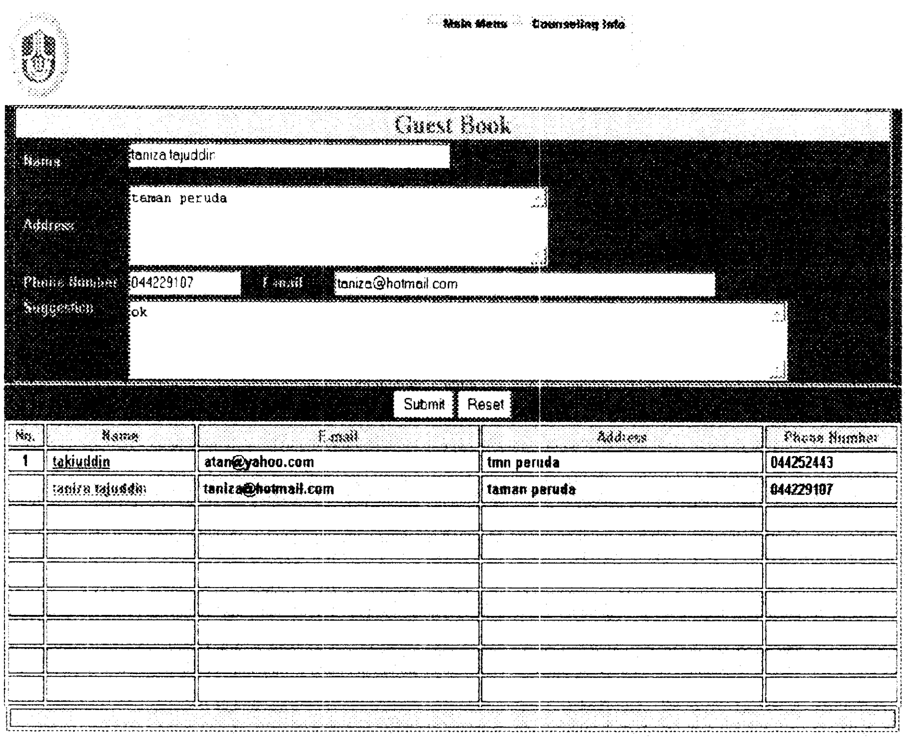


Figure 9: Guest Book Screen

- User needs to fill up the form following the request particulars. Upon completing the form, click the **Submit** button to save the information. The users' particulars will be displayed in the table shown below and save in the database.

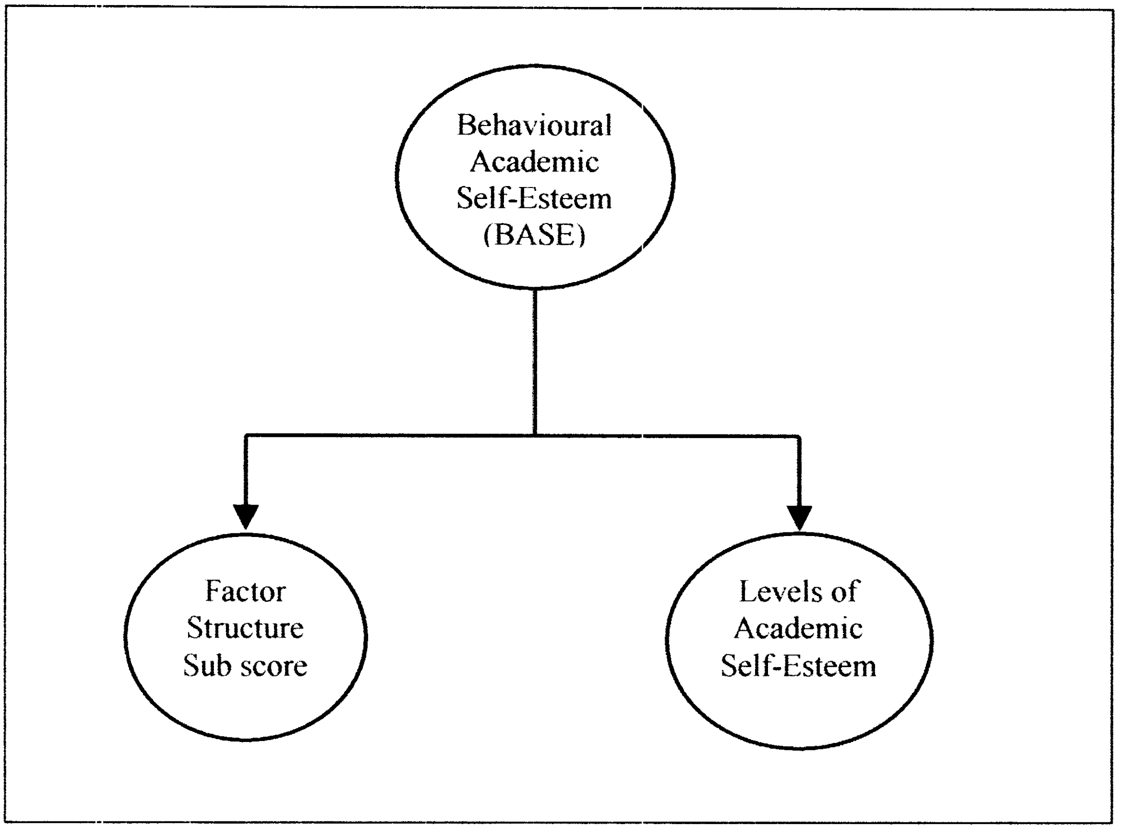
- Click on the **Reset** button to clear the screen.

- Click **Main Menu** button to go back to the Main Menu or **Counselling Info** button to access the information regarding counselling.

APPENDIX B

COGNITIVE MAP

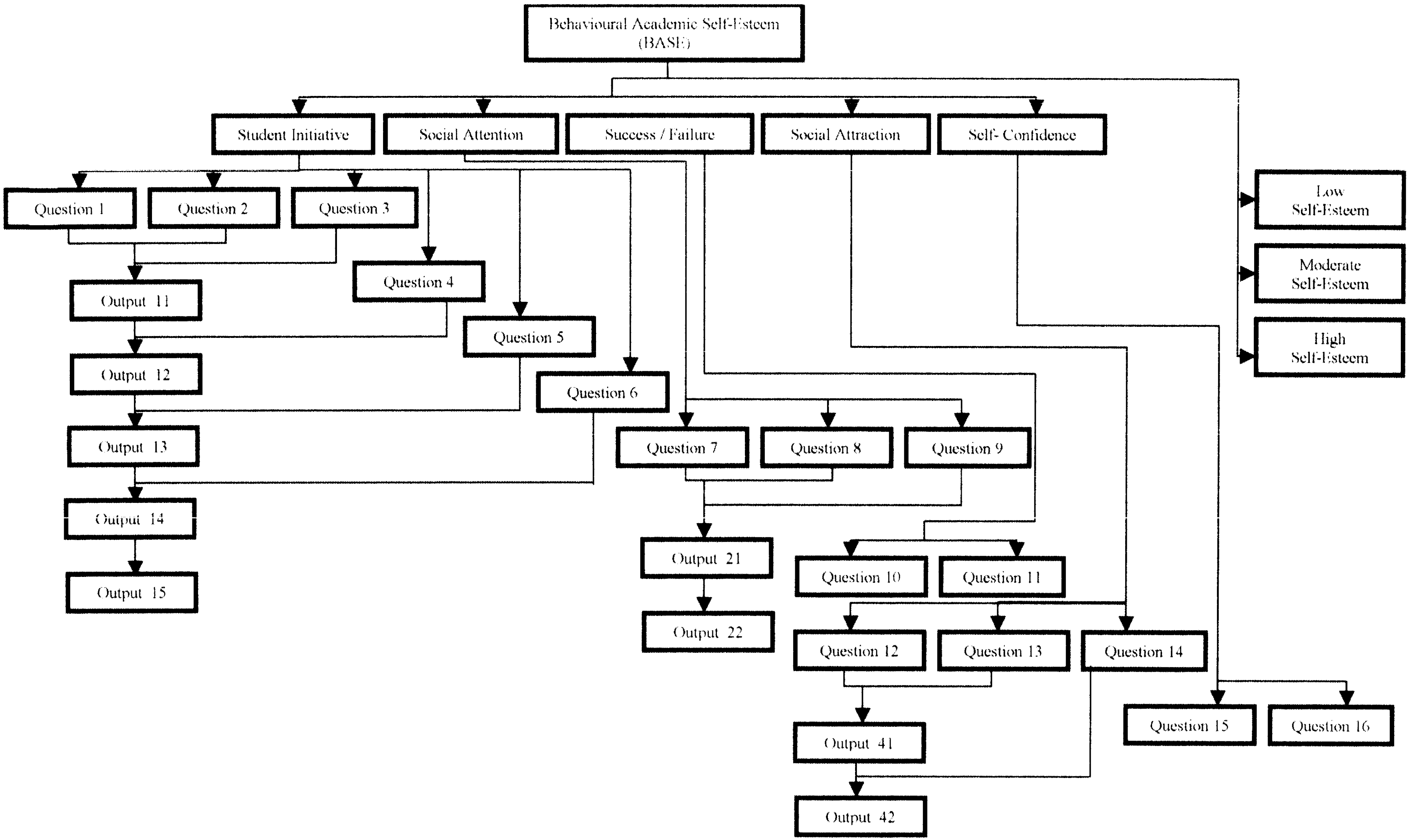
COGNITIVE MAP



APPENDIX C

INFERENCE NETWORK

INFERENCE NETWORK



APPENDIX D

DATA DESCRIPTION TABLE

DATA DESCRIPTION TABLE

1. Expert2

Field	Description	Data Type
ExpertSection	Expert Section	Text
ExpertCF	CF Value	Number
ExpertQuestion	List of Question	Text

2. Experts1

Field	Description	Data Type
Advicescore	Score of Factor 1	Number
Advice1	Advice	Text

3. Experts2

Field	Description	Data Type
Advicescore	Score of Factor 2	Number
Advice1	Advice	Text

4. Experts3

Field	Description	Data Type
Advicescore	Score of Factor 3	Number
Advice1	Advice	Text

5. Experts4

Field	Description	Data Type
Advicescore	Score of Factor 3	Number
Advice1	Advice	Text

6. Experts5

Field	Description	Data Type
Advicescore	Score of Factor 5	Number
Advice1	Advice	Text

7. guest_book

Field	Description	Data Type
name	Name of Guest	Text
address	Address	Text
phone	Telephone Number	Number
email	E-mail Address	Text
suggestion	Suggestion	Memo