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THE USE OF EXPERT SYSTEMS HAS IMPROVED STUDENTS LEARNING IN ZIMBABWE

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ABSTRACT

The introduction of the e-learning, both multimedia and conventional, has resulted in drastic and inevitable improvements in the learning environment for both learners and tutors. This has been facilitated by the use of internet and has attracted more organizations and among them, academic institutions for communication as well as to share crucial information, such as research works and new knowledge discovered. All these efforts created the learning environment for students favorable, as learning resources becomes abundant in addition to the books and the tutors they already have. The current economic hardships have affected Zimbabwean education system having negative repercussions to the attraction of both local and foreign professionals. The current experienced professionally qualified tutors and technicians are being drained out in search of greener pastures leaving the Universities with only senior faculty heads and a pool of junior staff. However, this is resulting in inevitable deterioration of educational standards as semi-qualified staff is dominating throughout the whole industry and thus paving way for this paper to explore the need for an expert system to create an enjoyable student learning environment that has positive impact to their learning outcome. The study done in 2010 with students at Bindura University of Science Education doing a module-***Introduction to Computer Science*** showed that expert systems clearly plays a major role to help universities, lecturers and students in Zimbabwe where brain drain has affected the quality of teaching and learning.

Key Words: expert system, knowledge base, e-learning

INTRODUCTION

In spite of the Internet and the World Wide Web, which provides abundant educational resources, various computer application packages, e-portfolios and the cropping of open systems, proceeded further to enhanced student work through powerful documentations, presentations, calculations, publications, as well as formalized, integrated and logical storage of student information. All these efforts proved effective but left the tutoring side unabated.

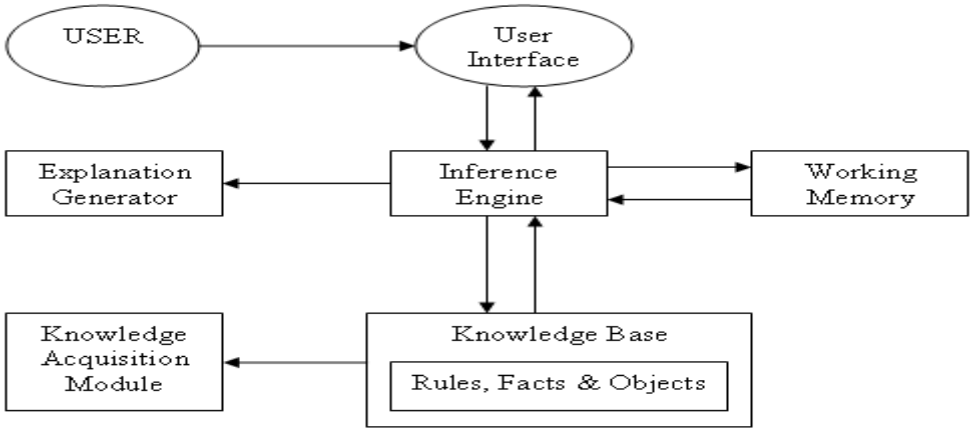
Only human intellectuals are domination the whole scene. Therefore this gives room for attitudes like biasness, favoritism, negligence, laziness and incompetence, which all deteriorates the quality of professional work delivered to the students in context. In spite of all these human weaknesses, the Zimbabwean education system is currently suffering in adequacy of professionally qualified staff to execute the lecturing and examining duties as the existing ones are leaving in search of greener pastures in neighboring nations.

Bulks of semi-qualified staff have been inevitably considered to fill the gap by the ministry of higher and tertiary education. The efforts rendered by these staff are definitely below the expected professional level and hence there is absolute need to have expert system in brain drained sections of profession such as medical and information technology so that the systems can assume much of duties of tutors through provision of expert advice and decisions while lecturing.

Expert systems

Expert systems involves the study and design of systems or computer systems that represents, behaves and reasons with expert knowledge in some specialist subject with a view to solving problems or giving advice in areas where human expertise is falling short (Ignizio and James, 1991). These systems are centralized on the use of the knowledge base (collection of reliable expertly gathered facts; pertaining to a particular subject, which can be formally represented if form of cases, frames, patterns, rules and semantic networks) (Jackson and Peter, 1998). Fig 1 illustrates and depicts its components.

Fig 1. Expert System



User

Expert systems are applicable to various trades, professions and other sections that involve human ideas, deductions and reasoning which implies that any fields that require human expertise can use it to minimize risks associated with doing the business, or improve consistence of solutions, or improve completeness, or improve accuracy or all at once while appropriate documentation of the steps followed is compiled for reference and explanations (Darlington, 2000).In addition, today's weather forecasting is inevitably done by expert systems. These systems do the actual prediction of the weather accurately, quickly and consistently unlike the case of human beings whose reasoning is sometimes unpredictable, slow and inconsistent (Giarratano and Riley, 2005). In spite of these areas, expert systems are an essential useful tool for instructing or training which makes them ideal to aid academic tutors to deliver quality data to their resective students.

User Interface

In academic expert systems, the potential users are the tutors (trainers) and the tutees (students) (Darlington, 2000). Both interact with the system via an interactive interface where user queries pertaining to a particular subject are created and the system is then commanded to compute and decide on the solution or advice to the query. It is equipped with the unique features which allow users to ask question on how, why and what format. Student's tutorials and additional materials can be requested and passed on to the student easily over the interface.

In addition, revision and self assessment is expertly conducted between the system and the student and thus better preparation for student examinations. The tutor also uses the interface to the system to create queries on what to expertly deliver to students as well as setting parameters on computer aided student assessments, tests and marking. The actual training or instructing which is supposed to be done by the instructors can easily be conducted by the expert system on the student's pace and thus effective dissemination of data as the student interacts with the system.

Explanation Generator

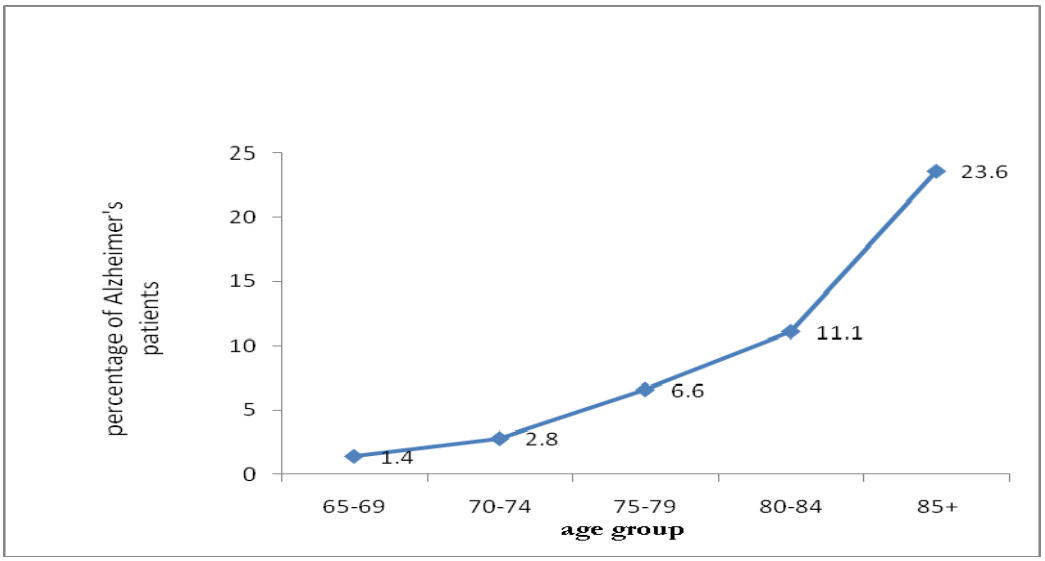
The explanation generator clearly explains all the procedures that the system used to reach a certain decision or advice which aids the system users to keep track of the strategies being applied to arrive at certain conclusion. During the implementation of forward or backward chaining reasoning strategies, expert systems produce permanent documentation of the decision process.

This enables the students and other users to understand better as the system documents the procedure as in an e-portfolio, unlike human explanations which can be affected by tone, vocabulary and the spellings used. Repeated

use of the system by the student helps in better understanding while not bothering with the information source since machines do not get tired or bored from repetitive work human explanations (Walker, Adrian et al. 1990). Till the late 19th century, negative human symptoms were considered as a "part of old age." (Chicot, 1999) It was only that Dr Alois Alzheimer vividly described a patient with manifestations of dementia and since then, this common cause of dementia has been called Alzheimer's disease.

Alzheimer's disease can occur at any age, even as young as 40 years, but its occurrence is much more common as the years go by. In fact, the rate of occurrence of the disease increases exponentially with age, which means that it occurs very rarely among those 40-50 years old, increases between 60–65 years, and is very common over 80 years. It has been estimated in USA (Shortliffe, 1976) that up to 50 per cent of Americans aged 85 years or more may have Alzheimer's disease. Combining the results of several studies, the following rates of occurrence of Alzheimer's disease are estimated in the general western population as shown by fig 2.

Fig 2 Role of Alzheimer's disease with increasing age



Inference Engine

The inference engine is the central processing unit of an expert system whose main role is to infer rules and facts from the knowledge base to draw conclusions, solutions or give advice to particular situations as defined by the user with around 100% confidence (Shortliffe, 1976). It conducts dialogue with the user asking for information and applying it. The sequence of steps taken to reach a conclusion is dynamically synthesized with each new case and in the same time the system can process multiple values for any problem parameter to improve the breadth and depth of the goal(s) archived. In addition, these systems never "forgets" to ask questions as a human might,

while providing consistent answers for repetitive decisions, processes and tasks. This makes them useful in learning environment where correct and consistent answers are tolerated.

Knowledge Base

The knowledge base is independent from all other components of an expert system which makes it flexible to accept changes without affecting the whole system. It is the duty of the experts in a particular domain to research and compile data to fill into a knowledge base for use by an expert system to meet demand of expert ideas in areas where they are falling into short supply [8].

As the system matures, new rules maybe added and existing ones maybe amended or deleted from the knowledge base with the use of the knowledge acquisition module. All these are normally done to take into account inventions, innovations and discoveries as technology improves. In addition, some material may become obsolete and thus there will be need to update to standard material since education system is dynamic. In addition, expert knowledge is formally represented in a knowledge base which means that the system cannot forget unlike what humans do with the increase in time.

METHODOLOGY

Although so many expert systems have been developed, some are even being open systems; one can be designed these expert systems for the academic industry. In this case, a knowledge base is developed to capture all the fundamental aspects pertaining to each particular module. Various expert ideas are coaxed out of human experts and encoded for use by expert systems for forward or backward reasoning strategies in problem solving. All the course outlines, lecturing materials and tutorials are expertly formulated by professionals, analyzed and formally represented into rules or frames or cases depending on the method suggested by the knowledge engineer.

The author used an introductory course offered in nearly all the Universities and Colleges in Zimbabwe named *Introduction to computer science* which is designed to strategically introduce computer science concepts to all students in their first academic year. The course covers computer basics concepts, importance and applications as an aid to student learning, organizational and business operational needs for profit or non-profit reasons.

However, the author designed a sample expert system (*Binary Converter*) that performs number conversion from decimal to binary number system or vice-versa. Under normal circumstances, the conversion of any number from decimal number system to binary is done using the long division mathematical principle, noting down the remainders.

After implementing the binary converter and given to students doing Introduction to Computers, students used the tool covering the concept. The group of students was divided into two groups, one using the expert system and another using the textbooks and lecture based. Students were given a questionnaire to determine their satisfaction using the binary converter and the text books/lecture based through the control group. A final analysis on their final examinations performance for the sections where the questions emanated from the binary converter and text books/lecture based was done.

RESEARCH DESIGN/INSTRUMENTS AND ANALYSIS

The groups were analyzed using the designed questionnaire and the results obtained from the final examination. Each group consisted of equal number of students (15 apiece) i.e. the one using expert system, another using the textbooks and lecture based and a control group. The expert was designed and applied on building some certain concepts and the same concepts also covered on students who used textbooks and lecture based. The questionnaire consisted of eighteen questions grouped according to six set of variables, relevance of material given, students ability to remember concepts, student rate of understanding taught concepts, amount of work to do or read notes and textbooks, amount of effort put in by students to study and learning methods stimulate interest in the subject. The questions were accompanied by a five point Likert scale, 1 denoting disagreeable and 5 denoting the most agreeable. The performances of the students were then finally measured also using the final examination.

Design of the expert system

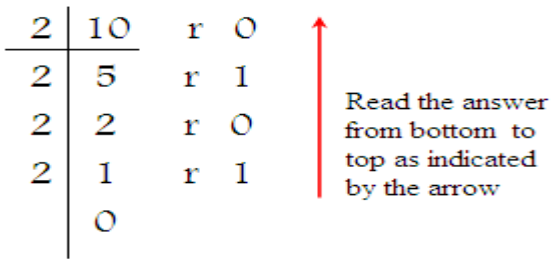
The expert system (*Binary Converter*) performed number conversion from decimal to binary number system or vice-versa. Under normal circumstances, the conversion of any number from decimal number system to binary is done using the long division mathematical principle, noting down the remainders.

The binary equivalent is the concatenation of the remainders starting with the last calculated as the highest unit as shown by the example below.

Question 1

Convert 10_{10} into Binary equivalent.

Answer



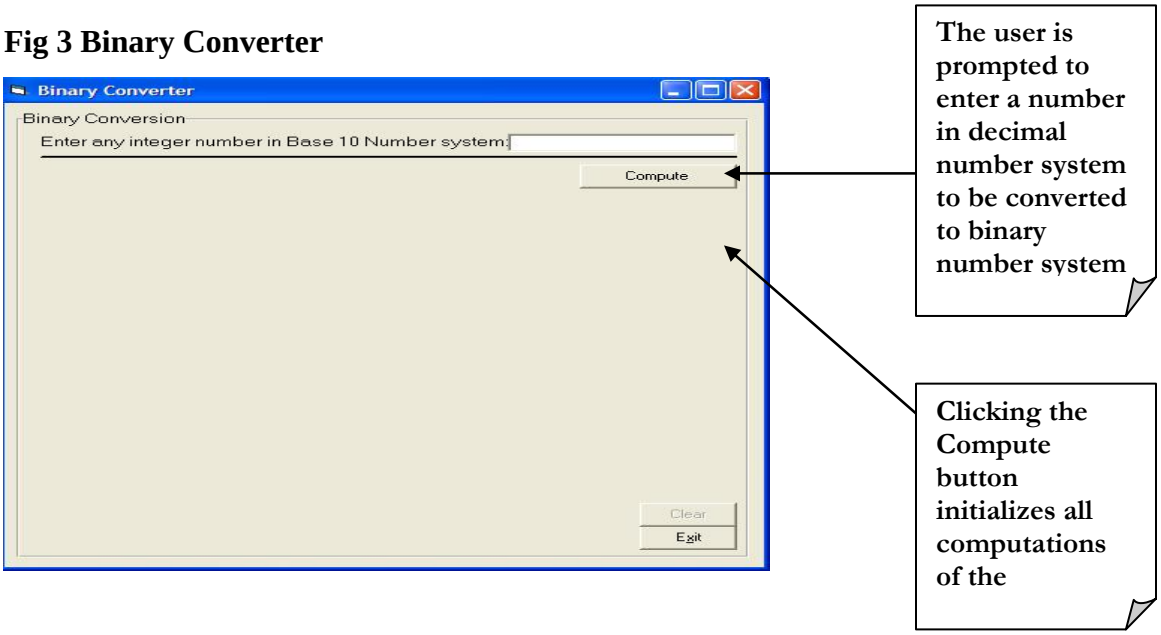
$$10_{10} = 1010_2$$

However, the concept of recursive long division while noting the remainder until the dividend is **0** has been considered and embedded in the design of Binary Converter Expert system. This system aids students in understanding the division process and how the actual binary equivalent value can be deduced from the results of the overall computations.

Binary Converter

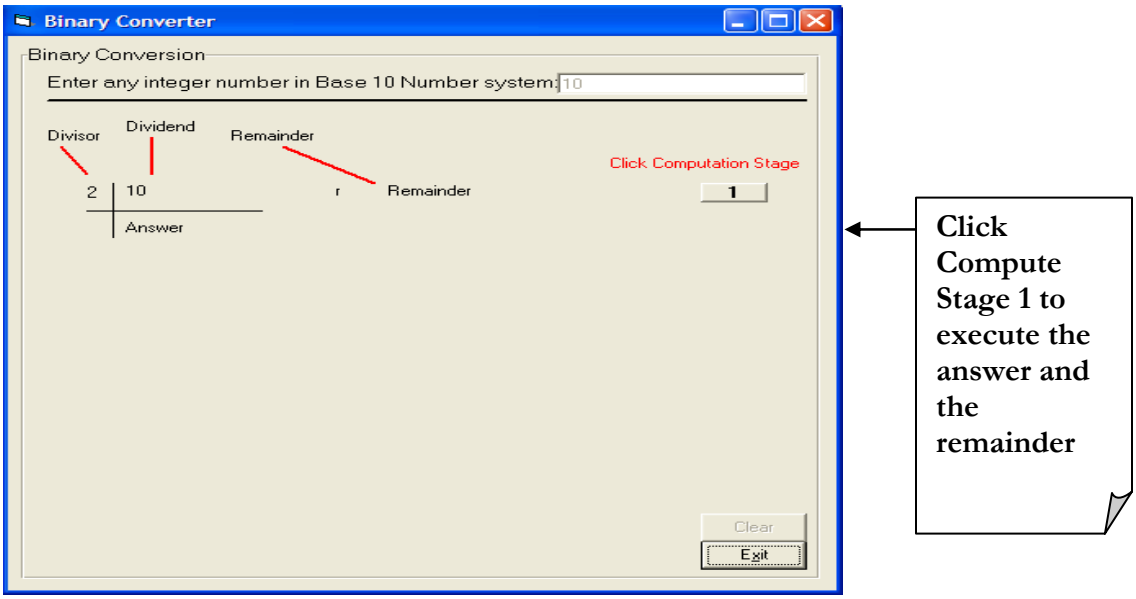
The system initially prompts the user to enter any valid number from decimal number system into the text area provided on the interface. The interface allow the user to enter any particular number in decimal number system as well as the command options for the computational stages the system uses to arrive at a particular solution which is the binary equivalent by clicking the compute button as shown by fig 3.

Fig 3 Binary Converter



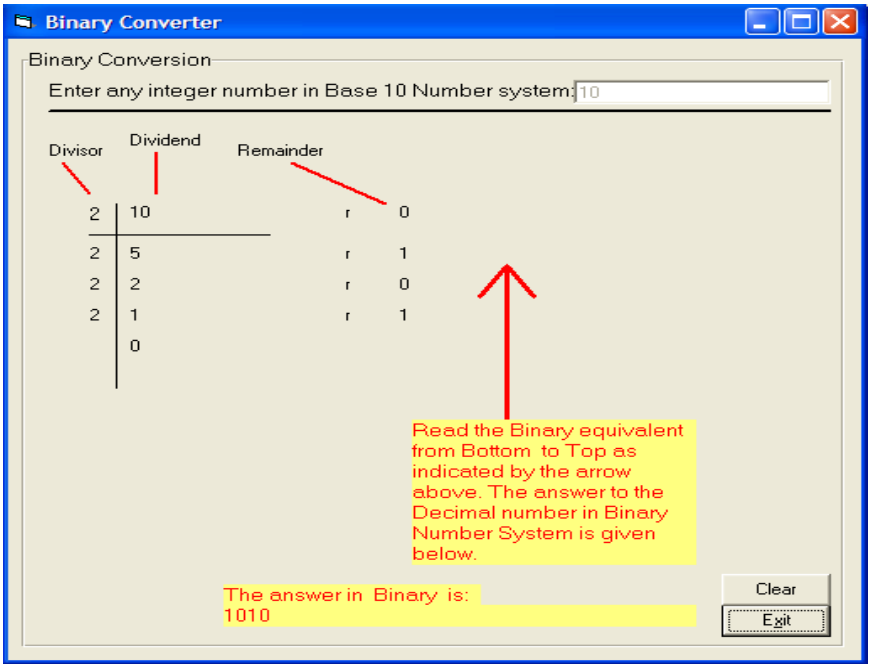
Entering a valid digit from decimal number system will be followed by clicking the "Compute" command which begins the conversion process by drawing the long-division horizontal and vertical lines as well as positioning the divisor , dividend, remainder and answer as illustrated by fig 4.

Fig 4 Binary Converter computation



By clicking the computational stages, the system performs the long division process until no more computations are required for the computation of the binary equivalent for 10_{10} as illustrated by fig 5.

Fig 5 Binary Converter solution



RESULTS AND ANALYSIS

The reliability of the tool was measured using Cronobach's Alpha at **0.7** and showed five variables having Alpha closer or greater than **0.7** to show that all variables were reliable. A set of assumptions and hypothesis were tested and analyzed using one way ANOVAs tests.

Although age and gender seems to be an important factor on expert systems as well as the lecture and textbooks students approach, they did not show any significance effect on the learning variables. The age group clustered into one common age group of between 19 to 25 years and this did not have any effect on the performance of students. However, gender, although it was normally distributed it sometimes can affect how students collaborate each other but does not have any significance difference to the learning of both the two groups.

Results, shows that the field of study and previous level of education had a significance effect to the learning ability of both the two group setups. Those from pure sciences had a major impact on the expert system tool than ones from social and communication sciences. The student to computer ratio and student to textbook ratio enhanced collaboration between students and the expert system tool well, although the ratio was too small.

Student rate of understanding from the two groups differed with those using the expert system showing high rate of understanding and ability to remember concepts. They also showed a marked rise in the interest and stimulus to the subject from those students using expert system than textbooks and lecture materials. Students also revealed that they put in less effort and work where an expert system is used than where textbooks and lecture material are used. Finally, the material given to students using an expert system showed great relevance to the students than one given to students using lecture based and textbooks where some of the material can be of no essence to the concepts.

Finally the groups were tested on the final examination performance were a set of assumptions and hypothesis were set and tested using the T distribution and one way ANOVAs. Results shown using Levene's test of equality of variance and independent sample test showed that the two groups are 100% different on performance to the final examinations.

Both the two set of tests i.e. the tool and the use of final examination clearly showed and proved that expert systems are the best approach to students where there is a problem of shortage of experienced and expert tutors in a colleges and universities in a country like Zimbabwe. It clearly yields a positive impact and outcomes to the student performance.

DISCUSSION

If the expert system is applied where students' background is the same and the technology is available it is one of the best approaches. However, there is need to integrate and blend them together with the conversional approach. Proper monitoring and assistance is needed although most of the time is spend in designing and illustration of the expert system so that this will benefit students. This means that if the system is replicated among the students themselves, it will be easier to follow the actual computations at the student's pace as well as repeating the computations whenever the computations are not easy to understand. However, the student can learn through repeated execution of the same problem thus making it better for slow learners to understand. Designing expert system brings a lot of benefits to the students, trainers and the colleges or universities at large.

Benefits to the students (tutee)

The systems better performs simulations and aid practices better than the teaching side. However, the expert systems are normally used in support of other learning / teaching activities such as the problem based learning (PBL). The students learn by repeated use of the concept and they understand even the slow learner can visualize. Expert systems are reproducible and thus making them readily available for consultation by students at every

stage and permits (indeed always should permit) the student to interrogate and analyze the reasoning process. Finally, worked examples, and all forms of guidelines are readily available for revision purposes.

Benefits to the Trainer (tutor)

The expert system takes on the tutoring function that is, presenting a series of screens of information, test questions and feedback. Expert systems are also excellent in instructional design, decision making, planning, controlling, and collaboration with both the student and trainer. It reduces explanation where a trainer has difficulties in illustrating concepts.

Benefits to the college

Professional material is passed on to students by semi-professional staff without compromising standards. This means that the colleges and universities will be able to compete with regional institutions operating under normal economic environment with adequate resources. In spite of being expensive to develop, expert systems will reduce the quantity of human experts required to deliver teaching responsibilities. However expert systems must also check on the student skills and their background in computer usage as they will end up being a block to the learning of the student.

CONCLUSION

If implemented, expert systems can utilize their ability to adaptively adjust the training for each particular student on the bases of his/her own pace of learning which allows students to gain deep understanding of fundamentals to be able to follow the more advanced topics within the specified field. In addition, expert systems will provide the excellent alternative to the private tutorial and individual training. However, expert systems are the best in those situations where there is a structure that is noted as previously existing or can be elicited just like the academic environment. They also work perfectly depending on the technology used and need to be designed suiting the students background. The results show that they are suitable to the Zimbabwean educational needs and bring in high satisfaction and positive outcomes to students learning and results.

Most developing countries are faced with severe brain drain, which leads to loss of knowledgeable experts in various sectors like; education, medical, engineering, mining, agriculture etc. This leaves a country with absolutely minimum resources to support economic, social and manpower development since the remaining professional will definitely fail to meet the requirements. The training of the remaining manpower to meet the necessary knowledge will be inevitable. This means that relying on knowledgeable human experts is unsustainable for economic, social and human development in the country since more and more continue to trick

out with the need for greener pastures. This makes it difficult to the meet present needs without compromising the ability for future generations to meet their own needs hence no sustainable development.

Therefore, there is need to put in place a dependable system that sustains development, like an expert system. An expert system has the ability to represent multiple experts, their development and implementation in the developing economies will definitely aid in restoring the lost expertise and probably salvaging ravaging economies. This means that better professionals will be modeled without human professions to mentor but with the aid of expert systems in various fields. In addition, fuzzy expert system(instance of expert systems) also helps in representing the expertise in case where multiple experts participating in design have opposing or conflicting ideas (e.g. in areas, such as business and management), which means that a wealth of ideas are used in expert system development to promote the ultimate output quality.

In conclusion, expert systems in their various forms have the ability to meet current needs and future needs since they cannot be affected by fatigue, death etc like humans and they can be upgraded by adding new rules and facts into the knowledge base therefore it is too far a cry for human experts to achieve sustainable development without the interconnection with expert systems.

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