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## UTILIZATION OF EXPERT SYSTEM IN LEARNING INVERTEBRATE ZOOLOGY

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**Abstract.** The great number of distributions from invertebrate animals will significantly challenge students to study each phylum primarily related to its general characteristics, anatomical structures of the body, physiological processes, habitats and habitus as well as ecological aspects, diversity, and its benefits. Instructional innovation using advances in technology and information is highly needed as an effective educational mediato improve the quality of education in this modern era. The application of expert system in the form of computer software as a system for learning invertebrate zoology by incorporating expert knowledge into computer system is expected to solve the assuming problem faced by the students. This study aims to review and evaluate the results of empirical research on expert systems, the importance of expert systems in terms of research results, and how to use expert system in learning. This study uses a critical literature review approach on primary scientific reports as a source of data. This article is intended to discuss the expert system on the learning process of computerized invertebrate zoology so that it can be used to provide useful information in identifying invertebrates in Modern Learning, Expert System Technology, Expert System Technology Design, and the Use of Expert System Technology in Biology Learning. After reading this article, all people associated with the educational process are expected to make improvements in the quality of their teaching and learning using educational technology since technology develops rapidly especially in Indonesia.

**Key words:** *expert system*, modern learning, zoology, invertebrate

### INTRODUCTION

Expert System is one branch of artificial intelligence realized in the form of a computerized application that attempts to mimic the reasoning process of an expert in solving a specific problem and in making a decision or conclusion because their knowledge is stored in a knowledge database to be processed as problem solving (Ongko, 2013). Sutojo et al (2001) explains that the expert system is a system designed to imitate an expert's expertise in answering questions and solving a problem. Expert systems will provide problem solving gained from dialogue with users. With the help of an expert system, someone who is not an expert can answer questions, solve problems and take decisions as normally done by an expert.

The use of expert system as a software application that serves as a tool in learning process is an effort in improving the quality of education oriented in the use of technology and information which rapidly developed over the times. This software can be utilized to update the conventional learning system into a learning system that is interesting, informative and more stimulating (Sari, 2006). Some research asserts that expert systems are applicable and suitable for interactive learning in which it can develop active and independent

attitudes (Hermawan&Sidiq, 2016; Khana, Kaushik&Barnela, 2010; Asabere&Enguah, 2012).

The integration of Expert system in education is an alternative innovation to enter the era of modern education in the 21st century. Modern learning requires students to be more independent and active in processing information and positioning teachers as mentors. Modern learning evolves with the development of science and technology. These changes aim to improve the quality of education in the form of great quality of human resources. Improving the quality of education is an integrated process with the improvement of human resources itself (Sari, 2006).

Plenty number of distributions from invertebrate animals will be of great challenge for students to learn particularly related to its general characteristics, anatomical structures of the body, physiological processes, habitats and habitus as well as ecological, diversity, and benefit aspects. Therefore, new methods are needed so that students can identify the target easily, quickly, accurately and efficiently without the direct presence of an expert. To this end, the expert system is presented as the second alternative in solving the problem of learning invertebrate zoology beside a teacher or lecturer.

## METHOD

This study is a literature study. Syaodih (2009) explains that literature study is a series of research related to library data collection method, or research whose research object is explored through various library information (books, encyclopedias, scientific journals, newspapers, magazines, and documents). Furthermore, some experts (Cooper, 1998, Taylor, 2012, The UCSC University Library, 2012) describes literature research as a study that examines or critically reviews the knowledge, ideas, or findings found in the body of academic oriented literature, as well as formulating its theoretical and methodological contributions to a particular topic.

Sources of data in this study come from primary scientific reports found in the thesis, dissertation as well as local, national, and international journals which were printed or non-printed with respect to the expert system. Data selection is based on aspects of the author's credentials and evidence support, objectivity, degree of conviction, the contributive value contained in the body of the literature and the content or substance studied (The UCSC University Library, 2012) related to the use of expert systems in learning.

Data were analyzed using annotated bibliography technique (Pharisa, 2012). The procedure of data analysis is as follows: 1) organizing the literature to be reviewed according to the topic; 2) synthesizing the link of the reviewed literature; 3) identifying controversial issues; 4) formulating questions for further research purposes (Mongan-Rallis, 2006; Galvan, 2006; Taylor, 2012; The UCSC University Library, 2012).

## RESULTS AND DISCUSSION

### Modern Learning

Education is currently in the era of knowledge. All alternatives for life necessity in various contexts are more knowledge-based such as efforts to meet the needs of education, economic development, community development and empowerment, as well as industry development (Mukhadis, 2013). Everything requires an accelerated increase in knowledge. The accelerated increase in knowledge is supported by the application of media and digital technology better known as super highway information.

The development of technology significantly affects the world of education. Educational institutions that do not make use of technology will be less competitive. The use of technology in a school can improve the quality of the institution in terms of improving its access, accelerating the

learning process and reducing the conventional bureaucracy (Hardianto, 2005). The use of technology in learning influences students' motivation, interest, learning activities, learning outcomes and learning achievement. In addition, learning by using technology especially computer is also more effective, efficient, practical, and enticing (Supiandi & Lisa, 2018); (Higgins, Xiao, & Katsipataki, 2012). The role of technology in the education sector in Indonesia has covered 1) the improvement of skill and competence, 2) as learning infrastructure, 3) as a learning resource, 4) as a tool and educational facility, and 5) as education management (Sudibyo, 2011).

Generally the role of technology in learning is characterized by (Gros, 2002): 1) The use of student-centered technology, 2) Realistic assignments, 3) Technology is seen as learning tools and media 4) and Virtual learning environments must be analyzed in a social context and evolution. In modern learning, students must use information technology as a tool in the learning process so that learners should use technology actively to collect and process the data (Circay, 2014). Nowadays many modern learning environments effectively promote and support a variety of pedagogy including delivery, implementation, creation, communication, and decision making.

In particular, modern learning is a learning that follows the trend of the times. Therefore, modern learning requires the role of technological innovation in learning. This is done by developing and applying technology in learning, applying methods, techniques and tools to learn new programs, creating self-defining conditions during the learning process, changing the types of activities and thinking styles of teachers and students, changing relationships, as well as creating and developing creative and innovative teams (Stukalenko, Zhakhina, Kukubaeva, Smagulova, & Kazhibaeva, 2016).

### Expert System Technology

Expert system is a computerized system that mimics an expert in solving complicated problems in accordance with the knowledge it has. Expert system is one area covered in artificial intelligence. Artificial intelligence is one area of computer science that utilizes computers so that they can behave intelligently like humans. This field of computer science develops human activities that can be imitated such as reasoning, sight, learning, problem solving, understanding language and so on (Hartati and Iswanti, 2008: 1). With the application of artificial intelligence techniques, the Expert system mimics what an expert does in solving

complicated problems based on his knowledge. Expert knowledge system is not only obtained from an expert but can also come from books, magazines and people who have knowledge but not experts (Giarratano & Riley, 2005). The source of knowledge is commonly known as the source of expertise. Such knowledge is represented in a certain format, and collected in a knowledge base. This knowledge base is then used by Expert system to determine the reasoning of the problems it faces.

There are several components that must be owned to build a system that is capable of imitating an expert, including the user interface, knowledge base, and mechanism of inference (Inference). The basic concept of knowledge in the Expert system is the user and the Expert system itself which consists of knowledge base and inference engine. The knowledge base of an Expert system is illustrated in which the user provides facts or information to the Expert system, then the facts and information are stored in the knowledge base and processed by certain mechanisms in the inference engine, so the system can respond to the user in the form of skills or answers based on the knowledge it has (Kaur, 2014). The illustration of the basic concept of Expert system knowledge is shown in Figure 1.

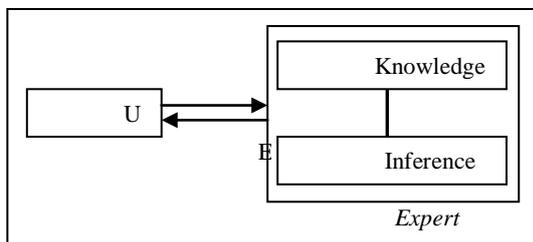


Figure 1. Basic Concept of Expert system Function

Expert systems can be defined as intelligent computer programs that use knowledge and inference procedures in solving difficult problems derived from human expertise as a solution. Knowledge acquisition facilities are needed in an Expert system. This facility is responsible for gaining knowledge from the knowledge base in a convenient and efficient way. The knowledge base stores all relevant information, data, rules, cases, and relationships used by the Expert system.

Expert system is composed by two main parts namely development environment and consultation environment (Turban & Jay, 2001). The development environment is used to incorporate expert knowledge into the Expert system environment, while consulting environment is used by non-expert users to gain expert knowledge.

Some advantages from Expert system (Giarratano & Riley, 2005) are:

1. Increasing the availability of information
2. Reducing costs
3. Reducing hazards
4. Permanent
5. Improving reliability
6. Providing explanatory facilities
7. Responding more quickly
8. Providing a steady, non-emotional and complete response at all times
9. Being a smart guide
10. Accessing the database in a smart way.

The weaknesses and shortcomings of the Expert system (Arhami, 2005) include:

1. It is not easy to gain knowledge. Sometimes the expert of the problem we create does not exist, and if exists, sometimes the approach of the expert is different.
2. To create a truly high-quality Expert system is very difficult. It requires enormous expenses in its development and maintenance.
3. Sometimes the system cannot make a decision.
4. Expert systems need to be re-examined carefully before use. In this case, humans remain dominant.

Expert System design must meet the following quality criteria (Arhami, 2005):

1. Accuracy.  
The program must meet the specifications so that it can perform the task as expected.
2. Rigidity.  
The program should be less sensitive to errors in performing the tasks and presentations or in other words the program can resolve errors by changing them without making serious mistakes.
3. Readability.  
The coding must be written in such a way as to be understood by other programmers.
4. Maintability.  
The system is designed and implemented in such a way that by performing relative changes, it has been able to give effect without having to rewrite completely.

The steps to develop *Expert System* are (Arhami, 2005):

1. Choosing the correct problem

There are some types of problems that are suitable with *Expert System*, as indicated in Table 1:

**Table 1. Classifications of Expert System**

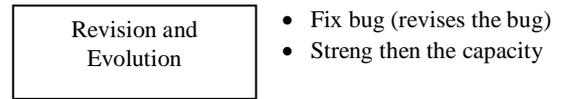
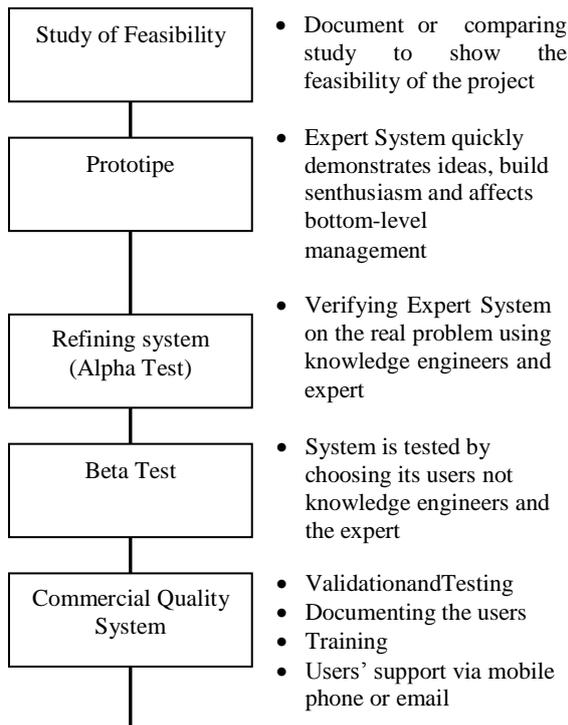
Class	General Area
Configuration	Assembling the system components properly
Diagnosis	Drawing conclusions from the observed facts.
Instruction	Smart teaching enabling the students to ask <i>why, how, and what if</i> as the normal teaching process human does.
Monitoring	Comparing the observed data with the expected data assessing its performance
Planning	Planning the action to achieve the expected target.
Prognosis	Predicting the result from the existing situation
Revision	Determining treatment for a certain problem
Control	Regulating the process which may need interpretation, diagnosis, monitoring, planning, prognosis, and revision.

Expert System can be applied in some fields such as: chemistry, electronics, medical, engineering, geology, computer system, teaching and training, data processing and so on.

2. Expert System Development

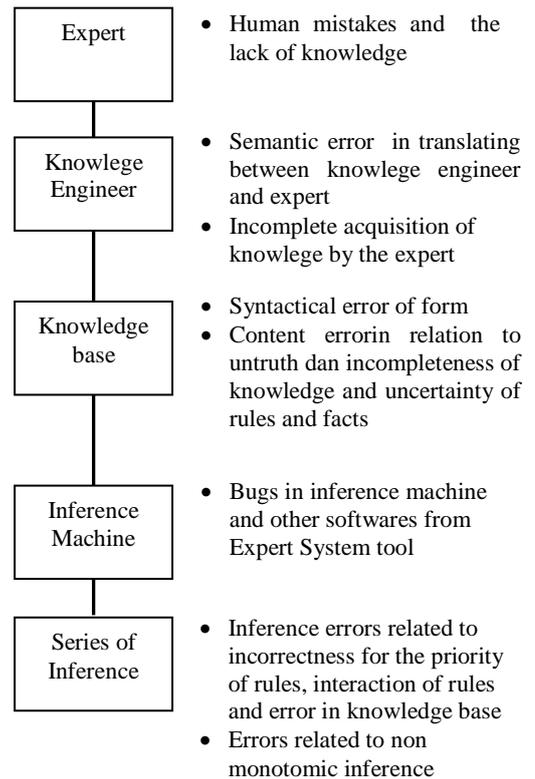
The development of an Expert System depends on the available resources and the way the process is organized and regulated.

Basic step in developing the Expert System is shown in Figure 2. :



**Figure 2. Basic Step in Developing the Expert System**

Possible errors that may happen in the basic step of developing the Expert System and thus need avoiding are shown in Figure 3.



**Figure 3. Errors in the Stage of developing the Expert system**

3. Choosing the development tools for Expert System

There are two kinds of development tools in developing the Expert system, such as (Giarratano & Riley, 2005):

- a. Programming language.
 

Some programming languages that can be used for both declarative and procedural artificial intelligence applications are LISP, CLIPS, Prolog, BASIC, FORTRAN, C, Pascal, Fort, Fox Pro, Delphi etc. All this requires a reliable programmer to use it.
- b. Shell.
 

Shell is a utility that can simplify and accelerate the development of Expert system. The one needed is the editor who

can insert knowledge into a predefined rule format and then edit it as needed.

### **The Importance of Expert System from the Results of the Study**

Some research done for the purpose of improving the quality of education and learning had made use of Expert system technology as a form of learning innovation adjusted to the modern learning in the 21st century. These research was conducted in the form of reviews of the Expert system literature orthrough research and development in supporting the learning process. Nwigbo and Madhu (2016) explained in their research that the Expert system was very important in the field of education. Expert systems provided a friendly and interactive environment for students to motivate them to learn with a more practical approach to learning. Students could learn independently and assess their own performance while the teacher acted as a mentor.

The research by Khanna, Kaushik, & Barnela (2010) suggested that the Expert System was useful as a teaching tool because it had features that allowed users to ask about what, why and how so that the system was considered to have great potential in advancing education. Some applications of the Expert System in education included Computer Aided Instruction (CAI), Intelligent Tutoring Systems (ITS), Intelligent Pascal Tutoring System (IPTS), and BiMOS.

Development research on Expert system as a learning tool proved to simplify the teaching process and could significantly reduce the workload of teachers / lecturers / tutors. Additionally, learners preferred the learning process using this system because they were able to develop an active and independent attitude (Hernawan&Sidiq, 2016; Salekhova, et al, 2013; K, et al, 2013; Sari, 2006). Other research as reference of Expert System usage in supporting education system in decision making showed that Expert System was successfully used on tasks given to it such as able to identify students' talent, able to diagnose students' failure in completing lecturing and able to diagnose students' learning difficulty in basic education ( Mousalli, 2015; Samsudin, 2016; Salisah, et al, 2015).

### **Utilization of Expert System as Supporting System of Invertebrate Zoology Learning**

Biology has significant role for human life (Shihusa&Keraro, 2009). Biology is one of the fundamental areas of science that serve as the basis for the development of other sciences in which one of them is zoology. Zoology is the branch of biology that concerns with animals and different aspects of animal's life (Sugiri, 1999). Zoological subjects are

divided into two parts: invertebrate and vertebrates. The vertebrate zoology studies the various vertebrate animals existing around students' life, making it possible to apply learning associated with phenomena in their everyday life (Fitriah, 2017). Invertebrate zoology describes specifically the ins and outs of animal life, especially those without spine (Haryanti, Ulfah, & Rahayu, 2013). Setyawan (2017) states that invertebrate zoology is closely related to the daily life of the students, such as the problems of animal life and human relationships.

Campbell et al (2008) states that invertebrates account for 95% from known animal species. The diversity of invertebrate animals can be found in the sea (Faridah, 2014). Putra (2014) states that invertebrate animals occupy almost every habitat on earth, from boiling water at the hydrothermal pits of the deep sea to rocky and frozen Antarctic lands. Indonesia is a country which is rich in marine life. Sihasale (2013) states that the coastal and marine areas in Indonesia have a great diversity of invertebrate that is quite amazing and distinctive.

Indriwati et al (2016) states that invertebrate zoology studies the general characteristics, the anatomical structure of the body, physiological processes, habitats and habitus as well as ecological, diversity, and the benefit aspects of invertebrates. Putra (2014) explains that lecturing on invertebrate zoology leads the students to learn how to observe the species, identify the characteristics and properties of each phylum, classify the species based on the phylum, explain the different characteristics of each phyla, examine each livelihood of animal invertebrates, and know the role of invertebrate animals for life.

Invertebrate subjects consist of 8 phyla, namely porifera, coelenterate, Platyhelminthes, Nematelminthes, annelids, molluscs, arthropods, and echinoderms (Campbell, Reece, & Mitchell, 2003). Haryanti et al (2013) states that invertebrates consist of ten phyla: porifera, coelenterate, ctenophora, platyhelminthes, nematelminthes, bryozoa, molluscs, annelids, arthropods and echinoderms. Furthermore Rusyana (2014) states that invertebrate is divided into 11 phyla namely protozoa, porifera, coelenterata, ctenophora, platyhelminthes, aschelminthes, nematelminthes, annelids, molluscs, echinoderms and arthropods.

Expert System in learning invertebrate zoology played a significant role as an application software for invertebrate animal identification based on the characteristics of the phyla covering its general characteristics, anatomical structures of the body, physiological processes, habitats and habitus as well as ecological, diversity, and the

benefit aspects of invertebrate itself. The data used in the form of the characteristics of invertebrates are categorized by phylum. The knowledge representation of these invertebrates is presented through the Rule-Base Knowledge technique in terms of facts and rules. The preparation of these facts and rules follows the rules of IF ... THEN, for example:

IF:      1) the magnitude is between 3 microns-100 micron  
           2) Occupant of big places  
           3) generally single-celled  
           4) it has an oval-shaped body structure with anterior and posterior taper rounded  
           5) it has bright green body due to the presence of chloroplasts in its cell  
           6) has two flagella rooted in the basal body  
           7) there is a star-shaped structure called orange-contractile vacuoles  
           8) asexual and sexual reproduction  
 THEN:   The animal intended is *Euglena Viridis* from Protozoa Phylum

Forward Chaining is one of the inference techniques that can be used to make decisions based on the existing knowledge. The conclusion begins with data or facts that exist then move forward through the premises to the conclusion.

Multimedia-based teaching system in the form of application software will make the learning atmosphere seem more fun and the lesson is easily absorbed. In addition, the use of computer software in effective learning will increase students' motivation (Deni, 2008). The development of software based on Expert System for learning invertebrate biodiversity will be new and very interesting in comprehending the subjects. Concepts and theories can be found by the learners from experts and can be stored in a knowledge base. Learners can organize and evaluate their own learning speed. In addition, teachers / lecturers / tutors can provide more easily the case studies related to the problem of invertebrate animal identification to the students. Such kind of activities can stimulate the learner to be more active because learning activities is not only just accepting but also doing themselves.

The use of Expert System as a software application supporting learning makes the teaching staff work more efficient. It motivates the learner to be more successful. Learning support using Expert System-based software tools provide a new and unique learning experience for gaining new knowledge and enhancing creativity.

## CONCLUSION

Based on the result of the research, it could be concluded that 1) Expert System was an information and communication technology that could be applied as an innovative way in designing modern learning. 2) Applying Expert System as a software application supporting learning in terms of research results showed that it contributed optimally to improve the quality of learning process. Learners gained new experiences about the theory and the concepts of learning so as to increase interest, creativity and learning independence. Learners could also manage and evaluate their own ability more easily using this software. 3) The use of Expert System as a software supporting learning made the learning process become more practical and made the work of teaching staff / teacher / lecturer / mentor more efficient so as to have time to improve their professional skills.

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