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Trends in Expert System Development: A Practicum Content Analysis in Vocational Education for Over Grow Pandemic Learning Problems

*A Ana**

Faculty of Technology and Vocational Education, Universitas Pendidikan Indonesia, Jl. Dr. SetiaBudi no.229 Bandung, West Java, Indonesia
Correspondence: ana@upi.edu

ABSTRACT

The impact of the COVID-19 has emerged as a varied issue, ranging from the economy, society's social order, and education, especially when social and physical distancing have been introduced in various areas of community activities as one of the prevention. It has also affected the tertiary education institution where learning activities should be conducted from and at home, forcing the higher education communities to shift learning from conventional learning to online learning. Needless to say, learning that does not require practicum is easier compared to learning that needs it. Consequently, it is a new task for lecturers to ensure the meaningful practicum learning implementation is conducted as it should be. Therefore, the creation of expert systems for practicum learning in vocational education is urgently required in online learning. The aim of this literature review was to examine the development of an expert system used at practicum learning in tertiary institutions and how the design of learning systems could be integrated into vocational education in facing the COVID-19 pandemic. The method used was the literature study, through research stages starting from the finding and selection of articles and journals with relevant topics, and then analysing the data. The findings of this study was to identify the development of an expert program in an attempt to promote practicum learning using e-learning in the midst of the COVID-19 pandemic outbreak.

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1. INTRODUCTION

The learning system implemented in several universities and colleges has internationally changed due to the situation and condition in facing the corona virus (COVID-19), almost all university and college use online learning systems (https://en.unesco.org/covid19/educationresponse). The current corona virus 2019 (COVID-19) pneumonia pandemic caused by the severe acute respiratory syndrome corona virus 2 (SARS-CoV-2) is spreading globally at an accelerated rate, with a basic reproduction number (R0) of 2–2.5, indicating that 2–3 persons will be infected from an index patient (https://www.who.int/emergencies/diseases/novel-Coronavirus-2019/advice-for-public/ when-and-how-to-use-masks?gclid=EAIaIQo bChMI88ft4Iyr6QIVSwVgCh3I1QlGEAAYASAAEgK6EvD_BwE). It is a serious public health emergency and particularly deadly in vulnerable populations and communities in which healthcare providers are insufficiently prepared to manage the infection (Dashraath *et al.*, 2020).

Based on the data update in May 2020, there are more than 3.73 million people confirmed with positive COVID-19 worldwide, with a death toll of 258,344 people (https://www.worldometers.info/coronavirus/). The SARS-CoV-2 virus has spread easily from one individual to another. This virus can spread from people without symptoms, and patients who are infected continue to transmit it two weeks after the cessation of symptoms (Cascella *et al.*, 2020). The most common symptoms of COVID-19 are fever, fatigue, and dry cough. Some patients may experience aches and pains, nasal congestion, runny nose, sore throat, or diarrhoea. These symptoms are mild and occur gradually. However, some people are infected but do not show any symptoms and do not feel ill. Most people (about 80%) recover from the disease without the need for special treatment. Around 1 in 6 people who get COVID-19 are severely ill and have difficulties in breathing (https://www.who.int/emergencies/diseases/novel-Coronavirus-2019/advice-for-public/when-and-how-to-use-masks?gclid =EAIaIQobChMI88ft4Iyr6QIVSwVgCh3I1QlGEAAYASAAEgK6EvD_BwE).

The development of COVID-19 began in December 2019, and this virus originally appeared in Wuhan city with the name 2019-nCoV or Novel Coronavirus, but as the virus develops, WHO has finally officially named it as COVID-19. COVID-19 stands for 'corona', 'virus', and 'disease', whereas 19 is the beginning year of the virus spreads. The naming is a way to standardize the perception for the whole state spectrum of the virus both mild and severe. The official name given for the virus that causes COVID-19 by the International Virus Taxonomy Committee for the Wuhan corona virus is SARS-CoV-2, which stands for Severe Acute Respiratory Syndrome Coronavirus 2. Broadly speaking, the COVID-19 is the name used by the WHO to describe the disease caused by the new corona virus, while SARS-CoV-2 is a corona virus that causes infection in the respiratory tract.

The SARS-CoV-2 virus looks similar to the one that caused SARS corona virus (SARS-CoV), but both have significant differences. SARS-CoV is a virus identified in 2003 that caused SARS (Severe Acute Respiratory Syndrome). This happened as the SARS outbreak spread to 26 affected countries in 2003, with a total of 8000 cases (https://www.who.int/emergencies/diseases/novel-coronavirus-2019). In addition, the name of the COVID-19 virus is given based on its genetic structure, which is consistent with diagnostic tests, vaccines, and drugs. The naming of this virus is related to the type of prevention, transmission spread, and its severity and treatment.

Figure 1 explains the impact when the corona virus attacks the human immune system. This virus is similar but different

from the severe acute respiratory syndrome (SARS). Symptoms of this virus are almost the same as flu. However, COVID-19 starts in the lungs and spreads through water droplets when someone sneezes or coughs (Zhao *et al.*, 2020). COVID-19 attacks the body in three phases, namely viral replication, immune hyperactivity, and lung damage. This virus replicates efficiently in the upper respiratory tract. Infected people produce large amounts of the virus at the onset of infection and the incubation period of infection happens in 5 days. Besides, COVID-19 happens in three patterns of infection, starting from mild illness and symptoms of the upper respiratory tract, followed by pneumonia. After about a week, severe pneumonia with acute respiratory distress syndrome can develop quickly and sometimes requires a breathing apparatus (https://www.who.int/ emergencies/diseases/novel-Coronavirus-2019/advice-for-public/when-and-how-to-use-masks?gclid=EAIaIQobChMI88ft4Iyr6QIVSwVgCh3I1QlGEAAYASAAEgK6EvD_BwE).

This virus attacks the immune system. Therefore, when the virus attacks through cells and air sacs causing a lack of oxygen absorbance in the body and at that time the body will experience cough, high fever, and finally difficulty in breathing. When the virus has spread to blood vessel cells that bind and convert the Angiotensin-converting enzyme 2 (ACE2), it will cause an infection in the blood vessels that can cause heart attacks and heart inflammation. Some people who get this virus can experience strokes, seizures, and inflammation of the brain because this virus has spread to the brain system. The spread of this virus can be so fast depending on the person immune system, the more the range of the person

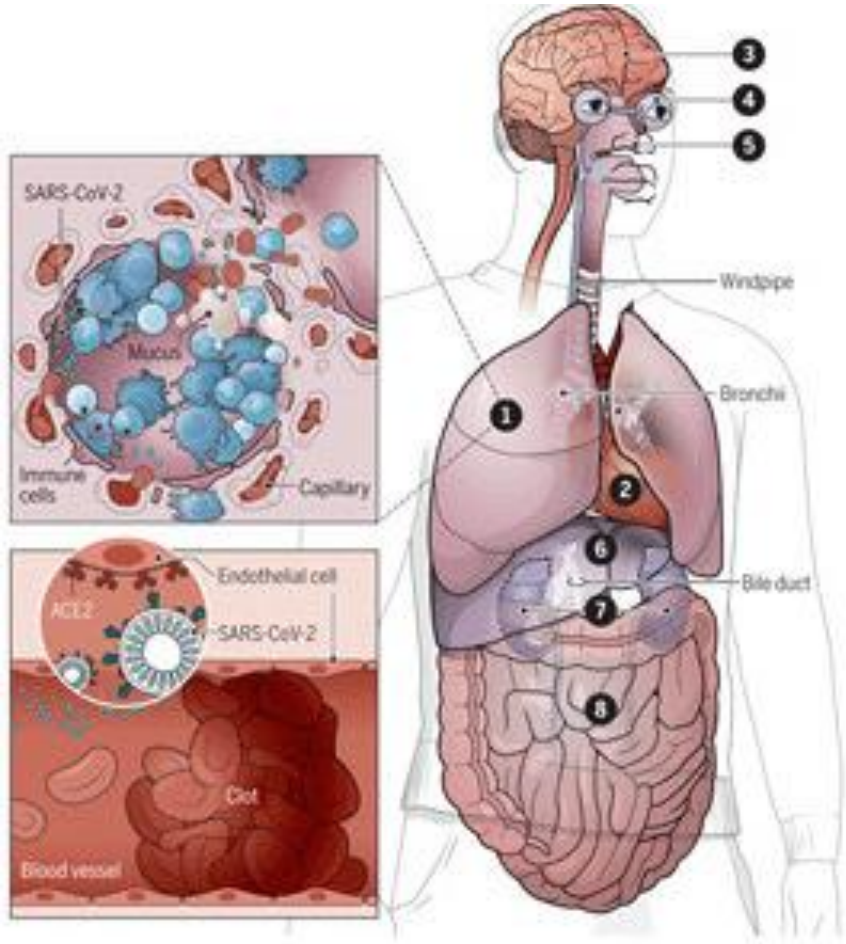

Figure 1. The spread of COVID-19 in the body (Wadman *et al.*, 2020)

immune system the faster the spread of this virus is (Wadman *et al.*, 2020). The body then triggers a cytokine reaction when infected, in which the immune cells fight the virus.

In certain cases, the virus can trigger an overly reactive response from the immune system which could further hamper efforts to recover. The most common symptoms of COVID-19 are fever, fatigue, and dry cough. Some patients may experience aches and pains, nasal congestion, runny nose, sore throat, or mild diarrhoea (https://www.who.int/emergencies/diseases/novel-Coronavirus-2019/advice-for-public/when-and-how-to-use-masks?gclid=EAIaIQobChMI88ft4Iyr6QIVSwVgCh3I1QlGEAAYASAAEgK6EvD_BwE). However, some infected people do not experience any symptoms and feel fine while around 80 percent of infected people recover from the disease without requiring special care (Vivian, 2020). Additionally, the COVID-19 pandemic is the first health crisis that affects all aspects. Many countries decided to close schools, colleges, and universities, and this requires a new pattern in the learning process (https://www.who.int/emergencies/diseases/novel-coronavirus-2019). The spread of COVID-19 is so fast in damaging the human immune system, demands that everybody do physical distancing as one of the solutions to the virus prevention. As a result, the implementation of physical distancing affects the learning process; it cannot be conducted face-to-face. The solution to the problem is conducting online learning (e-learning). E-learning as one of the digitalization and the global technology trends in education (Muktiarni *et al.*, 2019).

UNESCO supports countries in their efforts to reduce the direct impact of school closures, especially in the most vulnerable and deprived populations, and to promote continued education for all through distance learning, by developing special internet learning spaces that can be freely accessed. In the COVID-19 period, the online learning method has become a popular trend in the implementation of learning. It has also become a challenge for both students and lecturers to incorporate the learning process. Needless to say, the global locking of educational institutions will cause major disruptions in the learning process; interference with internal assessments; and achieving student qualifications and competencies (https://en.unesco.org/covid19/educationresponse).

It has also affected the vocational education. Vocational education has educational characteristics which can combine the functions of education and training (https://globalvaluechains.org/publication/global-value-chains-challenges-opportunities-and-implications-policy). Vocational education has the opportunity to develop skills with a sufficient theoretical foundation and academic base (Maknun *et al.*, 2019; Handayani *et al.*, 2020) and at the same time develop the competency to work in accordance with established competency standards (Lytvyn *et al.*, 2020). This condition requires vocational education to develop continuously and it also needs systematic efforts. However, vocational education requires students to learn more than just knowledge, but students are also required to have skills and competence (Grosch, 2017). This is definitely a challenge especially in deciding which learning system should be conducted and what should be applied in vocational education.

The learning method introduced during the COVID-19 pandemic so far focuses more on the knowledge aspect, therefore the existing online learning system needs a new approach in accommodating the psychomotor aspects of students. The solution to the problem is to integrate Artificial Intelligence (AI) in vocational education as a tool in supporting the learning system. One of the intelligences developed is by building an expert system.

As known, practicum implementation that cannot be carried out under the current

conditions inhibit the process of students mastering their skills and competences. Therefore, to solve this issue is an expert system that can provide information about deficiencies and solutions in making the products at the time of practicum implementation. This expert system will provide information that can help in taking corrective action, ranging from the types of failures, causes of failures, to how failures are resolved (Schmalhofer, 2001).

An expert system is a program which aims to transfer human knowledge to a computer to solve problems like what the experts do. Generally, an expert system is designed to interact directly with users in dialog format (Frenzel, 1987). Therefore, a user can save time and money with this sort of intelligence technology. In addition, the expert system provides simplified solutions for repeated, complex cases. Besides, the implementation can be built using either web-based or mobile based application (Merritt, 2000). It is expected that developing this expert system will support the aspects of the students' skills and competencies in order to achieve the learning process.

This article significantly discusses two main sections. Firstly, to help lecturers understand better how to design learning systems that can be integrated into vocational education during the COVID-19 pandemic. Secondly, this article summarizes and criticizes research topics relating to trends and the use of an expert system in education. The purpose of this study is to develop, explore and evaluate the use of an expert system in the context of the students' competencies. Educators and researchers may use this knowledge to identify unresolved issues or concerns in the literature, and to determine potential directions for research on methods to detect realistic effects of product failure results in practicum. Another analysis of this article will focus on the description of the expert system, method used, results and discussion, as well as conclusions.

2. LITERARURE REVIEW

An expert system is an attempt to imitate an expert. Typically, the expert system is in the form of decision-making software which is capable of achieving an expert's comparable performance levels in a specific and narrow problem area. Expertise is essentially transferred from an expert to a computer, and the current expertise is stored in a database which users then can search for information on that database. Sometimes the expert system is better at its performance than human experts (Copeland, 2015). The difference between expert systems and human experts can be seen in **Table 1.**

The most popular and most successful research in the field of AI for the last thirty years is the expert system (Wagner, 2017). Different methods, principles, and technologies have been built in several problem areas and domains. During its development, expert system has been widely adopted in the fields of accounting,

Table 1. The Comparison between expert and expert system

No	Factor	Expert	Expert System
1	Time availability	Work day	Always
2	Location	Local	Anywhere
3	Safety	Can't be replaced	Replaceable
4	The possibility of loss	Yes	No
5	Performance	Variable	Consistent
6	Speed	Variable	Consistent (usually faster)
7	Cost	High	Affordable

manufacturing, medicine, agriculture, automotive, banking, chemistry, government, logistics, oil and gas, transportation, education, and others (Wagner, 2017). By far, health is the most popular field that applies an expert system. The development of the expert system in education includes many aspects from curriculum development (Borges *et al.*, 2010), lesson planning (Reddy & Mahajan, 2016), learning process (Stella & Madhu, 2013), online learning evaluation (Simsek *et al.*, 2019), distant learning management (de la Peña Esteban *et al.*, 2019), to career guidance (Supriyanto *et al.*, 2019) have adopted this system.

However, the choice of the expert system as a substitute for experts is based on the advantages of its characteristics, so that more outcomes are generated. Time availability, location, safety, the possibility of loss, performance, speed, and cost are factors that compare the expert system to experts (Simsek *et al.*, 2019). The comparison between experts and the expert system is presented in **Table 1.**

Another important factor in the development of expert systems is the selection of the right framework with indicators of success based on the user perception (Tan *et al.*, 2016). The results of the literature study reveal that the expert system evaluation research only focuses on the parameters of the technical scale and ignores other factors that affect the scale of the impact (Wagner, 2017). As a result, researchers do not reach the normative conclusions about the overall strategy of the expert system.

Furthermore, the expert system is a program that is made based on a set of rules that analyze information about a specific problem class and mathematical analysis of the problem. Depending on the design, the expert system is also capable of recommending a series of user actions which enables user to do corrections. This system also utilizes the capability of reasoning to reach a conclusion. The expert system programs can be built by using programming languages, such as FORTRAN, BASIC, Pascal, FORTH, and Assembly Language. However, the Pascal programming language is more preferable. Besides building a programming language, the expert system can also be built using a shell. The expert system shell contains the inference engine, user interface, and explanation facilities. Most expert system shells use a unique format of product rules and knowledge base (Frenzel, 1987). An expert system can work faster with a shell and requires fewer programming skills. However, it loses its flexibility as it has to follow the requirements of the shell.

One popular expert system shell used is CLIPS (C Language Integrated Production System). An expert system also has the function of transferring knowledge from an expert to a machine then to someone else. This process is covered in knowledge engineering. As the name implies, an expert system will depend on the knowledge obtained from the experts who contribute their expertise and experience (Sadly *et al.*, 2009).

Furthermore, an expert system has advantages in solving individual or specific problems. The strengths of expert system in solving problems include diagnosis, prediction, testing, and clarifing (Frenzel, 1987). A popular technique for explaining problems is the use of rules. All the rules in the expert system are called rule sets. Knowledge then is presented in rules in the form of action conditions pairs: "IF the situation is fulfilled or happens THEN an action will occur". An expert system on which knowledge base is only presented in the form of product rules is called rule-based systems (McLeod & Schell, 2007).

The expert system component consists of several components named a knowledge base which is a database to understand,

formulate and solve problems. The knowledge base is composed of two basic elements which are facts and rules. An inference engine is the brain of the expert system and it is often known as a rule interpreter. This component is a computer program which provides a reasoning methodology and formulates conclusions. There are two fundamental search strategies that the inference engine can use to find conclusions to solve problems encountered by the expert system, they are forward chaining and backward chaining (Yunanto, 2007). A blackboard or workplace is a memory or location for working and storing temporary results which is usually in database form. User interface is a system where communication between users and computers is regulated. This communication often performs better using natural language, specifically in question and answer and it is often shown in the form of pictures or graphs. Additionally, the explanation facility is the ability to track how to get at a conclusion which is very useful for information transfer and problem solving. The Knowledge Refining System is a refinement system of knowledge and it means users can analyze their own performance, learn from their experience and improve their knowledge for the next consultation. In the expert system, this evaluation is important so that it can analyze the reasons for the success or failure of conclusions, and improve its knowledge base (Borštnar & Pucihar, 2014).

Additionally, there are several reasons for an institution to use an expert system, especially during the current COVID-19 pandemic. First, an expert at the institute can resign or quit. Therefore, an expert system as an exceptional tool for maintaining important professional knowledge can be used. Second, certain knowledge needs to be documented or analyzed. Thus, an expert system is a great tool for documenting professional knowledge for analysis or improvement. Third, education and training are important but it is also difficult tasks. So, an expert system is a great tool that can be used for training new employees. Fourth, an expert system allows knowledge to be transferred more easily at lower costs (Borštnar & Pucihar, 2014).

In addition to advantages mentioned, an expert system has limitations. One of them is the lack of users trust in the system consequently it discourages the use of the system itself (Sadly *et al.*, 2009). There are four parties involve in the creation of expert system, they are the systems analysts, knowledge engineers, experts and users. These four parties will get involved in the each stage of an expert system development. Meanwhile, there are several stages in building an expert system. They are defining the problem, evaluating several alternative solutions, verifying the expert system solution, calculating the estimated cost in building an expert system, choosing an expert system tool, doing knowledge engineering, building a knowledge base, building expert system software, doing testing and validation of systems built, and maintenance systems that have been built so as not to be outdated (Frenzel, 1987). Therefore collaboration among these four parties are essential.

3. METHODOLOGY

Literature review on this study was identified by browsing the Web of Science database, followed by Scopus by entering the keyword "expert system." As a result, there were 50 articles in the last 10 years between 2010 and 2019. Those articles then read, analyzed and coded using a spreadsheet program. The coding scheme was adapted from a structured and systemic approach to the literature review.

4. FINDINGS AND DISCUSSION

4.1. The Expert System Trend

In education, the expert system plays an important role in transferring on both knowledge and learning experiences that make the teaching and learning process more effective. Learning media can be built using expert system to design concepts and strategies, as a result, learners will learn without having direct communication with the teachers, and information in educational media will certainly make it easier and simpler for the teachers to transform their knowledge and learning experiences towards students. Therefore, it can also be stated that the application of AI in education, one of which is an expert system, could act as a students' partner in studying a subject.

Information technology has evidently modified the obsolete jobs and make a new discovery. In order to gain success, traditional education must be combined with computer training and communication. Additionally, we do need to consider what the key trends of a digital age are, then taking these patterns into account when designing computers and communications. An expert system is part of AI as well as a set of programs, routine computer, and data activities that have a broad knowledge base in a limited domain and use structured reasoning to perform the tasks or jobs that an expert can do. Generally, an expert system is developed with the help of professionals who seek to complement or compete with other experts in their field of practice. Expertise consists of knowledge of a specific domain that recognizes the domain problem, and the relative ability to solve all or some part of the problems.

An expert system itself is a software application or computer program software intended as a provider of advice and assistance in solving problems in specialist areas such as technology, engineering, mathematics, medicine, education and so on. Expert system is a subset of Artificial Intelligence (Arhami, 2005). Basically, an expert system is applied to support problem solving activities. Some of the problem-solving activities include Interpretation, Prediction, Diagnosis, Design, Planning, Monitoring, Debugging, Instruction and Control (Hastuti *et al.*, 2018)**.** The expert problem-solving control system is considered appropriate based on several studies performed on the use of an expert method in learning, which is focused on the needs during the COVID-19 pandemic in promoting realistic learning. In the problem solving or control system, the system manages the behavior of a complex environment. The system can control the interpretation, prediction, improvement and monitoring of system behavior.

Figure 2 shows the use of an expert systems in education. It can be seen that 47.6% of respondents used an expert system as a learning application. This learning application is used to support the learning process as learning media or tutorials, in order to help users understand the content and improve the quality of education further. Expert system as learning media can be a source of reference knowledge that users need, as the knowledge in this application system is collected from an expert. By using an expert system, the information will be obtained faster and more effectively without the need for a special expert (AlHamad *et al.*, 2014). Additionally, 26.8% of respondents used an expert system as a learning management system in the education process. An expert system as a Learning Management System (LMS) in a software application can help, plan, and implement a learning process (Radwan *et al.*, 2016). A small portion of respondents, 20.8%, used an expert system as an evaluation tool in learning. Evaluating students is a relatively complex method and task. There are several phases to be completed during the

evaluation process starting from the cognitive, affective, and psychomotor evaluation. Various techniques are used in the process of evaluating students, one of them is by using an expert system which is to make the process of evaluating in the learning process easier (Gupta & Raghuwanshi, 2019). A small percentage (9.5% of respondents) use the expert system as career guidance in vocational education. One of the problems which young adults sometimes experience is the ignorance of their interests and talents. This makes it difficult for them to make potential decisions about their study program and career. In the end, they appear to obey parents' wishes or choose the most preferred program based on their peers' interests. Being based on this, there is an incorporation of an expert system in the collection of preferences and skills and this system will show personality-type information and provide guidance on the study program according to the users' personalities (El Haji *et al.*, 2014).

Based on the study of an expert system in education, it is widely used as a medium for e-learning. It answers the research that the use of expert system in the learning process is a trend that has been implemented since a long time ago. The use of an expert system in the learning cycle practicum is therefore one approach that can be implemented in the implementation of e-learning in the during COVID-19 pandemic. Some research showns that an expert system gave flexibility for both educators and students by incorporating expert systems into the learning process. In implementing the learning, educators are facilitators, and students may learn independently. The advancement of the use of technology in the education world has been widely used including the assessment process. One of them is an expert system which is one part of the science of AI that is developing rapidly using knowledge and inference procedures to solve problems that are difficult enough to require an expert (Lindsay *et al.*, 1993). Through an expert system, a person can be supported on a need-by-need basis when it is difficult to meet the expert. An expert system can help solve problems and acts as representatives of experts (Chojnacki *et al.*, 2019).

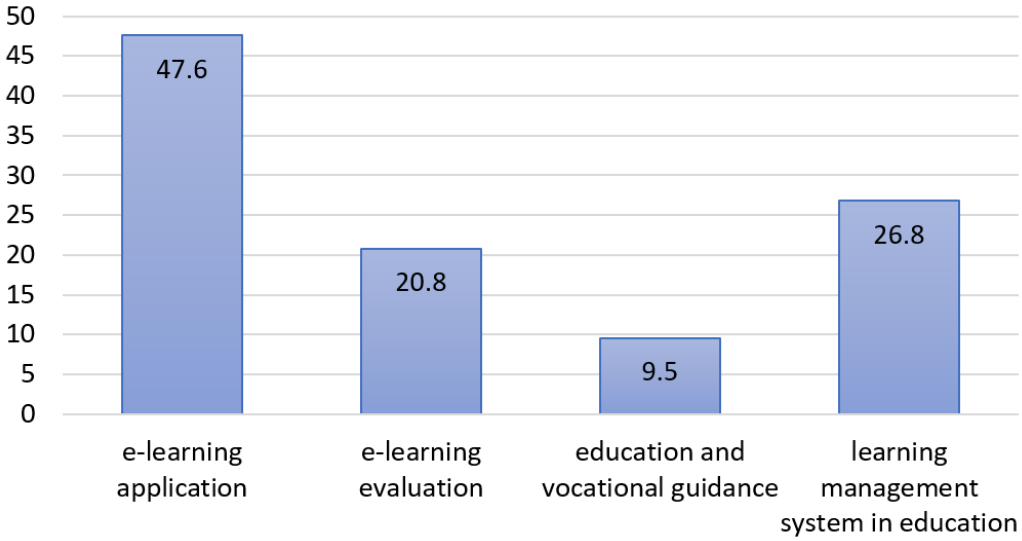

Figure 2. The use of expert system in education field

4.2. Best Practice of Expert System Development in Vocational Education

Furthermore, an expert system has been widely developed in vocational education, for example an expert system used in making digital electronic virtual laboratories by using mobile virtual reality technology (Dyrberg *et al.*, 2017; Triatmaja & Khairudin, 2018). Besides, the development of an expert system in learning is useful for developing student competencies and reducing costs (Triatmaja & Khairudin, 2018). The development of the expert system in learning can also increase self-confidence and motivation (Dyrberg *et al.*, 2017). Furthermore, an expert system may also provide convenience and it is also Saccessible anywhere, as stated by Zaimuddin *et al.*, (2019). One example, developing the expert system with a vehicle number plate identification system using the Android system that can provide solution to get a parking space when visiting a mall. It gives convenience while parking the vehicle, and shorten the time in finding a parking space. As a result, mall customers will find it easy to get a parking space.

Also, in the field of animal husbandry, an expert system can also be used for the development of Chicken Layer Disease Diagnosis (Aminudin *et al.*, 2019) to create a website application that can be used by ordinary people, either rural farmers or experts who want to add insight into the various symptoms and diseases that attack livestock. One example in education is in the service at the laboratory where the development of the expert system using the Largest of Maximum Mamdani method (Prasetya, 2019) can also be used to determine the final grade index of practicum activities. Recapitulating practicum values in the context of information systems using the help from AI in evaluating realistic values is certainly one of the valuable resources for educational service laboratories. Assessment in the education world continues to evolve dynamically according to theory, technology, social and political change, with several aspects that have remained stable over the years, such as classical test theory (Maosul et.al, 2019). Furthermore, an expert system is one assessment tool that can be used to diagnose product failures. During the practicum, failure to produce products needs to be evaluated and standardized so that students can understand and develop it. An expert system is designed to communicate directly with users in a dialog format, providing simpler solutions in complex, repetitive situations such as mistakes in making dessert products during the table-setting course. The expert system can also be built using either web-based or mobile-based application.

4.3. Designing an Expert System

Each person has different abilities, expertise, and knowledge. Therefore, computers can be programmed to act like experts in certain fields. These computers can be used as consultants or experts in certain fields that can answer questions and provide appropriate advice and such system is called an expert system.Thus, a knowledge base required for the application must be developed to build an expert system. A knowledge base consists of specific data for specific problems and guidelines on how to manipulate the stored data. Unlike ordinary databases, knowledge base may also be structured of assumptions, beliefs, estimates and heuristic methods. In order to create a knowledge base, the system planning needs to work together or receive input from the experts in their fields. Therefore, we need people who can create this expert system, and these people are called knowledge engineers.

In general, the framework of the expert system consists of two main sections, namely the production environment and the consultant environment (Lee & Turban,

2001). The development environment is intended as the knowledge base of one's expertise to be utilized by the existing expert system, while the consulting environment is an environment intended for someone who is not an expert to explore or learn the experience of an expert which has been stored on the knowledge base of the expert system that has been developed.

The basic concept of an expert system contains several elements such as expertise, expert, expertise transfer, inference rules and the ability to explain (Lee & Turban, 2001). From **Figure 3**, it can be seen that the expert system is simply a database of knowledge transferred from experts. The experts here refer to people who have special expertise in solving problems that ordinary people cannot solve. Knowledge from experts is then transferred to the database known as knowledge engineer, and it is the database of the expert research findings which will be built up. In the previous step of knowledge engineering data from various sources and several experts are examined in advance to acquire reliable data sources. The process is known as knowledge acquisition and it is also a process of extracting, structuring, and organizing the knowledge from one or more sources.

After the database is organized and designed, the next step is inputting the data into the database system. It is a knowledge base process which is a type of database used for knowledge management. This database provides facilities for the collection, organization and computerized knowledge retrieval. The most important part of the knowledge base is the accuracy of the information it contains. After the database process is ready to use, the next step is the explanation subsystem. It is usually in an interface in the form of certain functional types. The explanation subsystem is part of an expert system that acts like an expert that provides services or explanations about specific expertise. The experts program structure is a combination of many experts and they are experts in their fields, we then create a technology database so everyone, at anytime and anywhere can access the database. The expert system provides flexibility in the educational process, especially in the implementation of practicum during the COVID-19 pandemic.

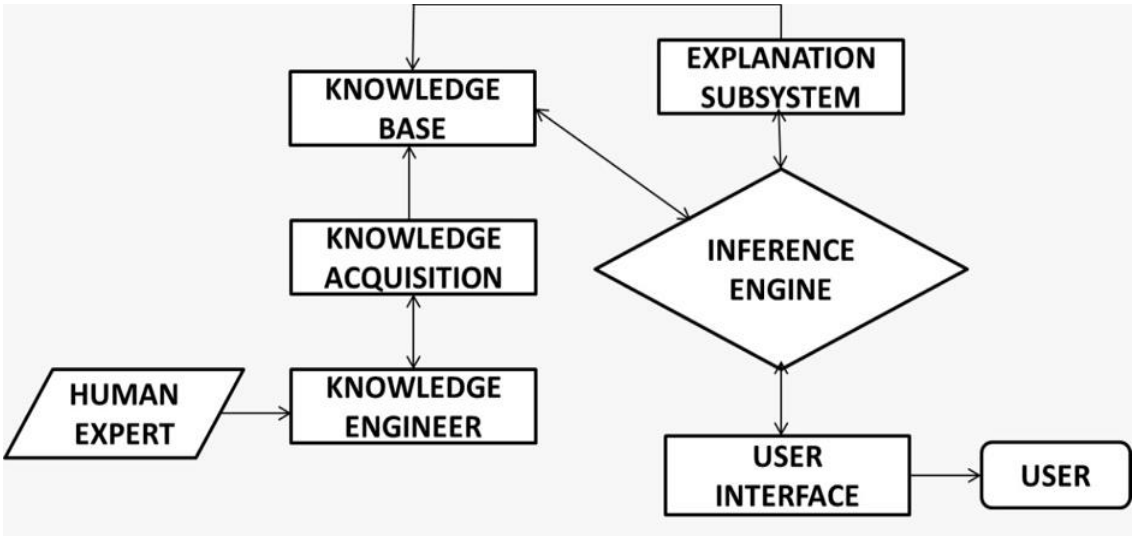

Figure 3. The expert system structure

5. CONCLUSION

The emerging COVID-19 affects various areas, one of which is education. As a result, almost all institutions adopt social and physical distancing as the prevention. This definitely affects the education system, and eventually, education can only be conducted by e-learning. The learning implementation using e-learning requires methods and strategies in order to help the students to absorb the lesson materials. However, for vocational education, particularly in practicum implementation, special strategies and tools are required, so students are still able to develop their knowledge and skills although the lesson conducted virtually. The solution to the aforementioned issue is designing an expert system. An expert system as part of AI is a system that is often researched in various fields. The trend of its usage in education has been long conducted.

Furthermore, the use of expert systems as learning software not only makes the educators, such as teachers, lecturers, and tutors work more efficiently, but also helps students to learn more effectively. An expert system can provide a unique learning experience for students, as it can also provide new insights for students and stimulate their creativity. Therefore, when it is difficult to meet the experts directly, users can be supported using an expert system based on users' needs. An expert system can help in problem-solving and act as experts representative.

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7. AUTHORS' NOTE

The author(s) declare(s) that there is no conflict of interest regarding the publication of this article. Authors confirmed that the data and the paper are free of plagiarism.

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