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EXPERT SYSTEM FOR CAREER EARLY DETERMINATION BASED ON HOWARD GARDNER'S MULTIPLE INTELLIGENCE

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ABSTRACT
The problem that exists is how to design a tool to help students recognize their potential and abilities so that they can recognize the right potential in higher education based on their potential and abilities, with the influence of technological changes that have penetrated into life and even the world of education, then the purpose of this research is to develop software in the form of an expert system as a technology that can be used by students to be able to recognize their potential. The development of this expert system uses the Software Development Life Cycle (SDLC) method, the design of an expert system to determine the potential in higher education based on Multiple Intelligence. This expert system is designed using the Unified Modeling Language (UML).
Keywords:*Expert system, Career, Multiple intelligence, Forward chaining method*

1. Introduction

The development of technology and information today has affected all aspects of life, including education, not apart from vocational education. Vocational education is an integrated part of the national education system, where secondary schools also have an important role in forming competent students (Baygin et al., 2016; Sakti et al., 2020). High school is one of the educational divisions that also participates in shaping students so that these students have a high level of expertise in their fields. But in general, not all students can make the right choice of majors (Andryukhina et al., 2016).

Good education should be followed by guidance, such as student intelligence guidance to determine potential in higher education so that students can find out which potential is suitable for themselves through the identification of the intelligence earlier (Ghufron, 2018). Therefore, intelligence consultation to determine a career at the beginning is one of the important things for students, so that through this intelligence consultation students can find out which potential is suitable for them who will later continue their careers. Thus, consulting becomes a special service area in all school education activities which are handled by experts in that field. Like intelligence consultations to determine potential in higher education, this can be done by the child counseling guidance council. Before entering college, students can first consult with the child counseling guidance boards about their potential and abilities and through the identification of these potentials and abilities it can be seen which potential is suitable for the student.

In addition to getting subject matter, students are also entitled to get direction on their potential. But sometimes students feel lazy to come to the counseling guidance council and feel they don't need to consult about their intelligence and abilities, so students only choose potential based on fun and students are trapped with potential that sometimes doesn't match their intelligence abilities. Even though this intelligence consultation is one of the most important consultations for students, so that students can know their potential, and make it easier for them to find work and careers.

Along with current technological developments, intelligence guidance does not have to involve students to come directly to the counseling guidance board. Students can do this through an expert system developed to determine student intelligence (Williamson & Cox, 2014). This

expert system was chosen because of several advantages, namely the expert system can support ordinary people to solve cases without expert support, has the ability to access the expertise and expertise of both ordinary and rare experts, improves quality and productivity, as assistants to experts so as to facilitate work. experts and can adjust the time in quoting results (Pavlekovic et al., 2009; Collins & Knoetze, 2014).

Therefore, this study aims to develop an expert system to determine intelligence using Howard Gardners' multiple intelligence concept so that students can determine their careers earlier before entering vocational education.

2. Literature Review

The concept of an expert system is an application or computer software that functions to solve problems just like an expert or an expert. An expert system is a development of artificial intelligence or Artificial Intelligence (AI) (Kiselev & Kiseleva, 2015). AI is a special study in which the goal is to make computers think and act like humans. Expert systems are part of the development of artificial intelligence that combines knowledge and data search to solve problems that normally require human expertise (Hung et al., 2015). The purpose of developing an expert system is not actually to replace the role of humans, but to substitute human knowledge into a system form, so that it can be used by many people (Baird et al., 2017).

The concept of an expert system is also explained as a system designed in front of a computer by imitating the thought processes used by an expert to solve certain problems that usually require the expertise of an expert (van Hecke, 2011). There are many benefits that can be obtained by developing an expert system, including: 1) non-expert lay people can take advantage of expertise in a particular field without the direct presence of an expert; 2) increasing work productivity, namely increasing the efficiency of certain jobs and the results of work solutions; 3) saving time in solving complex problems; 4) provide simplification of solutions for complex cases that are repeated; 5) knowledge of an expert can be documented indefinitely; and 6) allows the merging of various fields of knowledge from various experts to be combined (Rukun et al., 2017).Comparison between the capabilities of human experts and computer systems that are considered by expert systems through the following table:

Table 1 - Comparison between expert and human abilities.

Human Expert	Expert system
Limited time because humans need rest.	Unlimited because it can be used at any time.
The access point is local to any place where the expert is.	Can be used in various places.
Knowledge is variable and can change depending on the situation.	Knowledge is consistent.
The speed at which solutions are found varies.	The speed to provide solutions is consistent and faster than humans.
The fees to be paid for consultations are usually very expensive.	Lower costs.

The basic components of an expert system consist of a user interface, knowledge base and rule base, inference engine, workplace, knowledge acquisition, and system explanation facilities. The components of the expert system can be seen in the Data Flow Diagram of the basic components of the expert system below.

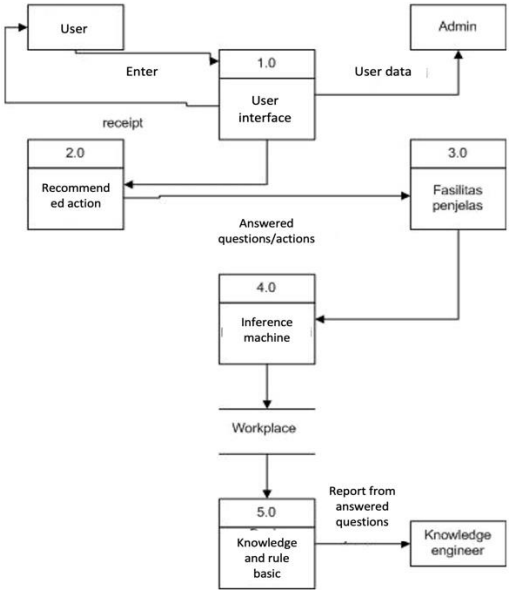


Fig. 1. Data Flow Diagram (DFD) of expert system basic component

Knowledge Acquisition Facility is a process to collect knowledge data about a problem from experts. Knowledge materials can be reached in several ways, for example, getting knowledge from books, scientific journals, experts in their fields, reports, literature, and so on. The sources of knowledge are used as documentation to be studied, processed and organized in a structured manner into a knowledge base (Debebe & Rajagopalan, 1995).

After the knowledge acquisition process is complete, the knowledge must be represented into a knowledge base and a rule base which is then collected, coded, organized and described in other designs in a systematic form. There are several ways to represent data into a knowledge base, namely in the form of attributes, rules, semantic networks, frames and logic. All forms of data representation aim to simplify the data so that it is easy to understand and streamline the program development process (Hayadi et al., 2017).

The system explanation facility is part of an expert system that provides an explanation of how the program is run, what should be explained to the user about a problem, provides recommendations to the user, accommodates user errors and explains how a problem occurs. In expert systems, system explanation facilities should be integrated into knowledge base tables and rule bases because this makes system design easier (Sánchez et al., 2016a).

The user interface provides communication facilities between the user and the system, provides various information facilities and various information that aims to help direct the flow of troubleshooting until a solution is found. In general, the user interface also functions to input new knowledge into the knowledge base of the expert system, display system explanation facilities and provide guidance on using the system as a whole step by step so that users understand what to do with the system. The main requirement to build a user interface is the ease of running the system. All difficulties in building a program must be hidden, what is shown is only an interactive, communicative and user-friendly display (Rahimova Ali & Abdullayev Hacimahmud, 2020).

The Inference Mechanism is part of an expert system that performs reasoning that uses the contents of a list of rules based on a certain order and pattern. During the consultation process between the system and users, the inference mechanism tests the rules one by one if the rules are true. In general, there are two main techniques used in the inference mechanism for rule testing, namely forward chaining and backward chaining (Kvesko et al., 2018). The reference mechanism used in this development is forward chaining.

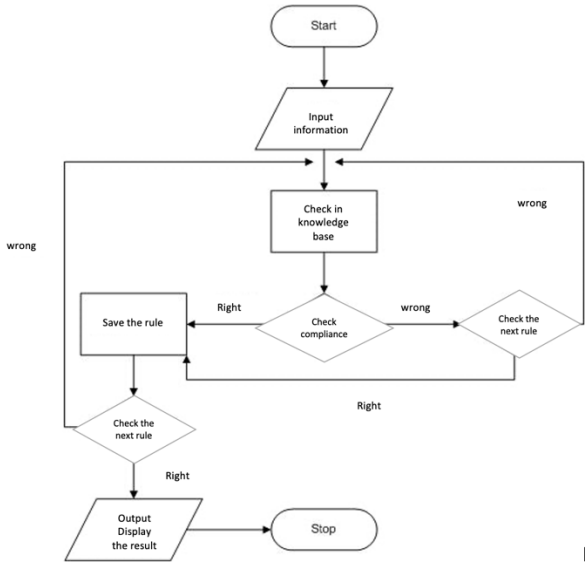


Fig. 2. Flowchart of forward chaining method

The picture above is the working mechanism of the forward chaining method or what is often also called forward reasoning. In forward reasoning, the rules are tested one by one in a certain order. The sequence may be the order in which the rules are entered into the rule base or some other order specified by the user. When each rule is tested, the expert system evaluates whether the condition is true or false. If the condition is true, then the rule is saved then the next rule is tested. Otherwise the condition is false, the rule is not saved and the next rule is tested. This process will be iterative until the entire rule base is tested with various conditions.

Intelligent behavior has something to do with the concept of intelligence. It is not a substance (an object) or force, which is located in a certain part of a person's body, but an individual behavior characteristic that shows the intellect used. Meanwhile, intelligence can only be detected by identifying indicators. Intelligence is the perfection of acting as manifested in efficient activity or activity. An efficient action, characterized by speed, success and adequate (Różewski et al., 2019).

Intelligence shows how individuals behave or, the way how individuals act, whether individuals act intelligently or not intelligently. Intelligence is not an object or power possessed in a few or many dimensions. Intelligence is concerned with complex mental functions as manifested in individual behavior. One of the main functions of intelligence is in learning. How individuals learn and what they learn is greatly influenced by the quality of their intelligence. Intelligence includes individual skills in recognizing relationships, remembering relationships, evaluating, making wise choices, applying past experiences to deal with current situations (Sánchez et al., 2016b).

Howard Gardner in his book The Theory of Multiple Intelligences, proposes eight kinds of intelligence components, which he calls Multiple Intelligences. The multiple intelligences include: (1) verbal-linguistic intelligence and (2) logic-mathematical intelligence that were previously known, he added with other intelligence components, namely (3) visual-spatial intelligence, (4) rhythmic-music intelligence, (5) kinesthetic intelligence, (6) interpersonal intelligence, (7) intrapersonal intelligence and (8) naturalist intelligence. This theory is the concept in the development of this expert system.

3. Research Methods

In designing this expert system, the Software Development Life Cycles (SDLC) research framework is used, which consists of the stages of problem identification, feasibility study, project planning, knowledge acquisition, knowledge representation, knowledge implementation, verification and validation, installation, transition and training, operation , evaluation and maintenance (Yoon & Adya, 2003).

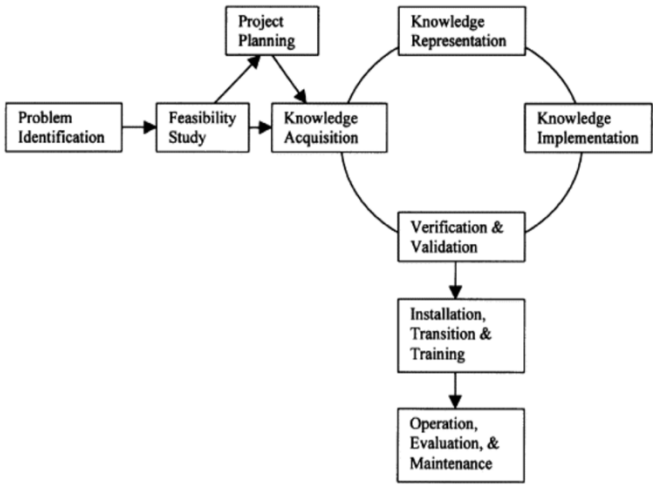


Fig. 3. SDLC Method
Sources: Yoon & Adya, 2003

Problem identification stage, at this stage the identification of problems and also the identification of opportunities about what benefits can be obtained when developing this expert system.

Feasibility study stage, at this stage an assessment of the feasibility of developing this expert system is carried out, which is assessed from economic, technical and operational terms.

Project planning stage, at this stage a plan is made on the development of the expert system that will be carried out, including identifying who will be the development team of this expert system.

Knowledge acquisition stage, at this stage information gathering activities related to the expert system that will be developed are carried out.

Knowledge representation stage, at this stage activities are carried out to determine what information and concepts will be included in the basic knowledge of expert systems, linking between these concepts.

Knowledge implementation stage, at this stage activities are carried out to create code from concepts that have been collected so that they can be inputted into the basic knowledge of expert systems and also develop prototypes of expert systems.

Verification and validation stage, at this stage validation verification activities are carried out from the developed expert system, then validate the system to the experts, and revise the expert system in accordance with the feedback from the experts provided.

Installation, transition and training stage, at this stage the installation of a valid and final expert system is carried out, then trains users and develops manuals related to how to use the expert system.

Operation, evaluation and maintenance stage, at this stage the expert system has been operated in the intended work environment, then the expert system is also evaluated for its performance, and maintenance of the expert system is carried out regularly.

4. Results and Discussions

Achievement of identification of early career determination based on ability and potential with artificial intelligence technology. In this system analysis is emphasized on rules which are indicators of ability and potential based on multiple intelligences. In designing this expert system, the method used is the forward chaining method or commonly called forward reasoning. In forward reasoning, the rules are tested one after another in a certain order. When each rule is tested, the expert system evaluates whether the condition is true or false. This process will be repeated until the entire rule base is tested with various conditions. Then the expert system provides the results of the diagnosis based on the rules being tested.

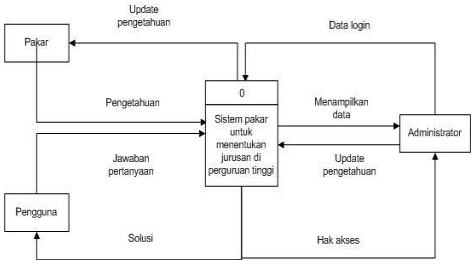


Fig. 4. Context Diagram of Expert System Design

The image above illustrates the workflow of an expert system. When the user enters or logs into the expert system and then fills in the data, the data filled in by the user will enter the user list and can be accessed by the administrator. Then the user can diagnose the symptoms through answering the questions given by the program. After the recommended question has been answered, the program will send the solution to the user. Experts function as giving knowledge to the admin and the admin inputs it into the system.

Analysis of system requirements designed will be tailored to the analysis of user needs. Analysis of system requirements includes: a) Input data required in the form of a classification of student intelligence and its indicators, symptoms, causes, solutions or conclusions, rules of causes and rules of solutions from intelligence. Intelligence data is needed because it is the core of knowledge that will be used for identification purposes. The system needed as input data specifications are (1) Intelligence data is needed because it is the core of knowledge as the purpose of identification. The intelligence data is also accompanied by the definition of intelligence; (2) Symptom or indicator data is data that will be selected by the user as input to the system; (3) Data classification of students' intelligence; and (4) conclusion data is data that contains the results of the identification of student intelligence. b) Data output (output), the system designed can provide output in the form of (1) Can display the intelligence capabilities possessed by the user from the identification results and (2) Can display solutions and conclusions from the results of intelligence identification.

There is also a further understanding of potential and abilities. In this final project, the author uses the theory of Multiple Intelligence by Howard Gardner. In the Multiple Intelligence theory, Howard Gardner divides intelligence into eight. From the eight indicators, the author designed an expert system for determining this potential. The target to be achieved from this designed system is to design an expert system for determining the appropriate potential of use, so that it can be useful for students to consult about their abilities and potential. So that students can determine their potential based on their abilities and potential.

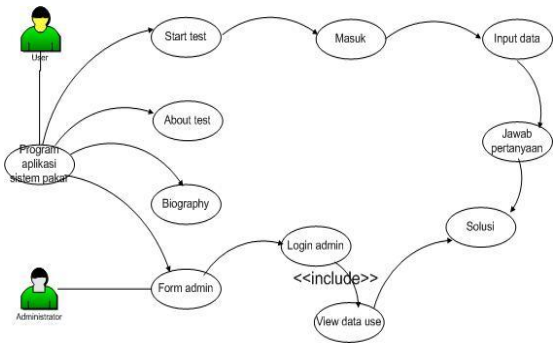
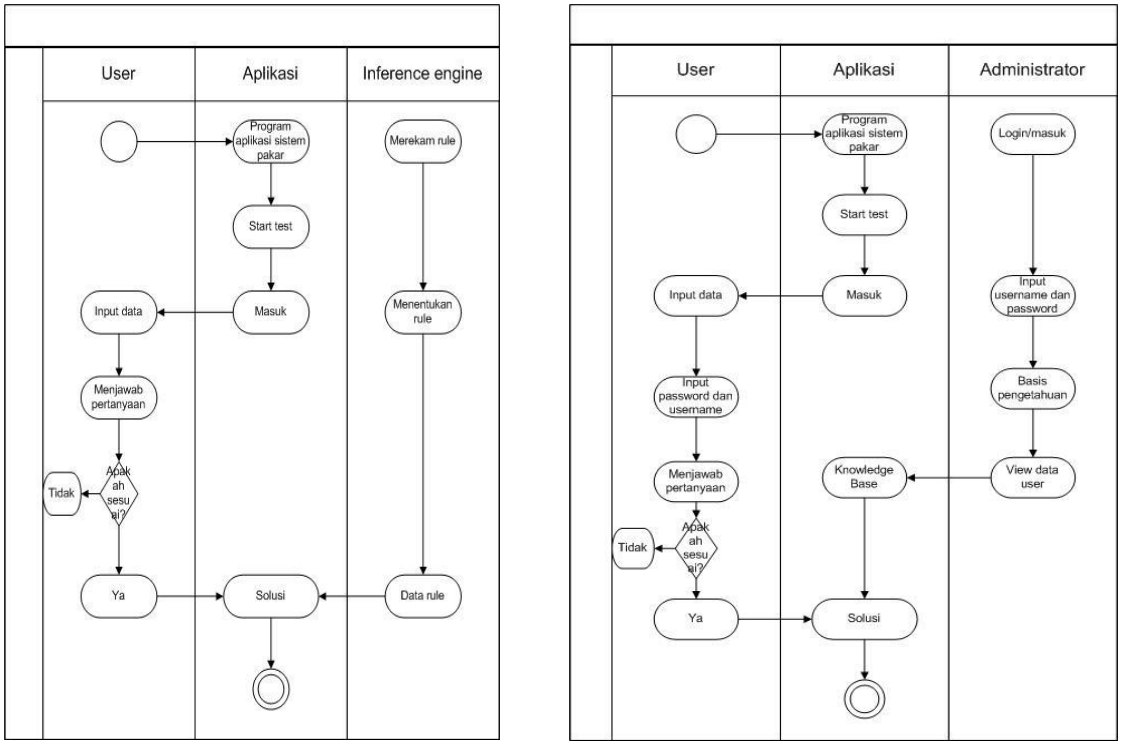


Fig. 5. Use case Diagram of Expert System Design

Figure 5 shows how the sequential use of the application by the user starts from the test start menu, then the application system will show a login or login form, followed by filling in visitor data, then visitors can fill in test answers on the form on the monitor screen. After the test

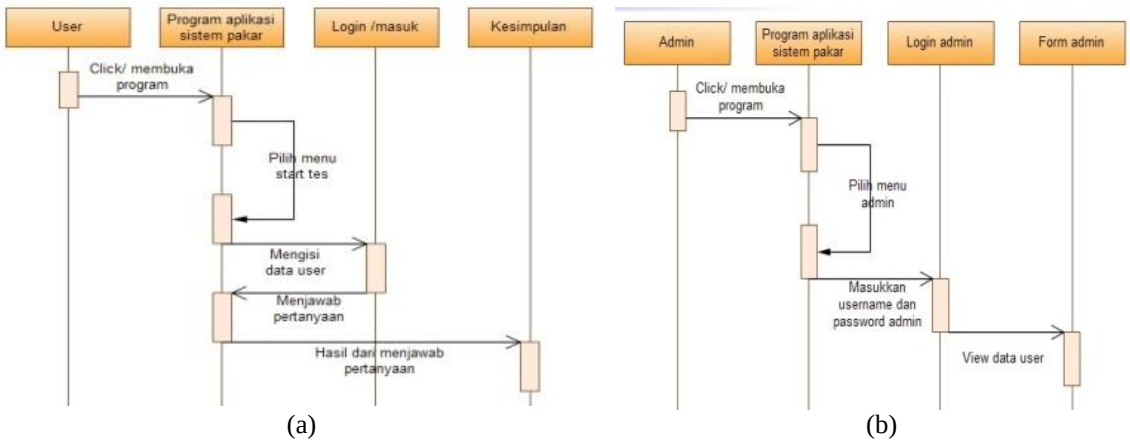
answers are completed, the system will check the user's answers by referring to the existing knowledge base, which will then issue test results in the form of explanations and solutions.



(a) (b)

Fig. 6. activity diagram of user and inference engine (a) user and admin (b) form design

Activity diagrams describe the processes that occur when the activity starts until the activity stops. Activity diagrams are similar to flowchart diagrams. While this Sequece diagram serves to model usage scenarios.



(a) (b)

Fig. 7. sequence diagram of user (a) and admin (b) form design

Knowledge base (Knowledge Base) component of the expert system which consists of two elements, namely facts and rules. Facts are information about objects in a particular problem area, while rules are information about how to obtain new facts from existing facts.

The inference engine is part of an expert system that performs reasoning by using the contents of a list of rules based on a certain sequence of patterns. In this case, how the system can

draw a conclusion based on existing characteristics or signs, provides a mechanism for thinking functions and patterns of system reasoning used by an expert. Based on the existing rules and facts, an inference engine was developed as shown in the following figure.

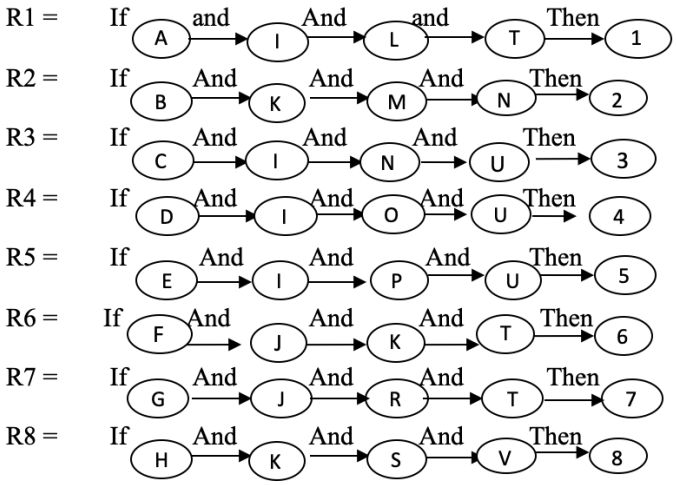


Fig. 8. Forward Chaining Inferential Engine

Figure 8. This shows how the inference engine for forward chaining works. In forward chaining, all data or rules will be tested to achieve a goal or solution. As seen in Figure 14 above, if the situation meets the rules A, I, L, T then the situation enters the condition R1, and R1 will issue a solution, namely 1. All these rules will be tested until they meet the eight rules above. .

Forward chaining is an inference method that makes reasoning from a problem to its solution. If the rule data matches the situation (value is TRUE), then the process will declare a solution. If the database sends data according to the rules in the knowledge base, the knowledge base will issue a solution according to these rules. If the rules in the database meet R1, namely A, I, L, T then R1 will issue a solution, namely 1, then R1 has met the rules. And so on until R8.

Fig. 9. Expert System Software

5. Conclusion

The research and design that has been done has resulted in an expert system to recognize potential based on multiple intelligences using this forward chaining method that is feasible to use. This expert system meets the criteria for the validity of the knowledge base and this system is highly accepted by meeting the criteria for the acceptance response value. This research can contribute to existing knowledge of expert system applications that can help students recognize their potential. The drawback of this study is that this expert system only assesses using the theory of multiple intelligences by Howard Gardner. So that it can be used as a guide for future researchers who will conduct similar research.

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