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# Conceptual Model of Hybrid Neural Expert System for Career Counselling

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**Abstract.** Artificial intelligence (AI) has been widely used in many areas of education, including career counselling, and its application has had a considerable impact on education, institutions, and legislation. In Oman, the system available for career counsellors for tenth grade is a manual professional orientation instrument. The proposed system entails studying the professional orientation instrument (POI), career decision making instrument (CDMI) and career maturity instrument (CMI). These measures will aid students in understanding their personalities prior to profession prediction. The counselling system combines two fundamentally distinct AI techniques namely expert systems (ES) and neural networks (NN), with the identification of the knowledge acquisition, knowledge base, and inference engine forming the foundation of the ES. This paper proposes a conceptual a counselling system to discover the personalities of tenth grade students and then predict the suitable career and personality's type.

## INTRODUCTION

Investing in education is one of the most important investments in developed societies, and the investment should be made as efficiently as possible and with as little economic waste as possible [1][2].Individuals who seek to progress their human potential and capabilities and achieve their independence and development, should guide learners to the type of learning that is appropriate for them and in line with their capabilities [3][4]. The world is keeping pace with modern developments, so this merger made information technology open to all disciplines and proved to the whole world that it can cover all fields. Today, the world is witnessing a rapid, vibrant, and dynamic development [5], and this requires individual and team skills with high creativity. This rapidly changing environment needs educated and creative young people who understand the importance of a future profession [6]

The most significant decision an individual can make in their life is selecting the appropriate career. If job profiles are not chosen based on personality, this can lead to several other issues [7]. These include career shifts, stress, and disability, as well as poor productivity and physical issues [8]. People spend time determining what job fits their personality because they are more concerned about job stability or income potential. In Oman, career counsellor used manual professional orientation instrument, which is a time-consuming activity that might result in manual errors. In 1958, John Holland proposed the POI theory, stating that individuals are classified into one of six personality types and that there are six types of career environments. Each of personality type corresponds to a particular element such as realistic, investigative, artistic, social, enterprise, and conventional, abbreviated RIASEC. RIASEC is formed based on the typology theory where it reflects on the interests and abilities of an individual and the environment [9][10][11]. Although the current manual system serves career counsellors based on their qualifications, it is time-consuming, complicated, and potentially error prone. However, because technological improvements have created a range of professional options, career counselling has become more difficult for counsellors. There is a requirement to close this gap by employing technology that will attempt to study a person's nature and, in a sophisticated manner, forecast an appropriate career goal. As a result, the development of a hybrid intelligence counselling system based on personality traits is required.

The mechanism available to career specialists for grade 10 students in Oman is a manual POI evaluation, which is used to assist students in choosing of future specialization and profession. When considering course selections in grade 10, it's crucial to analyze a wide range of options and be realistic about the job opportunities available. This is because

there are no more theoretical or technological career measures that can help students in tenth grade based on their personality. Furthermore, choosing proper subjects at this age can be challenging, and most teenagers lack sufficient knowledge to make an informed decision. Students in tenth grade go through a lot of disturbing psychosocial changes [12], and they require the assistance of a school counsellor expert to assist them in selecting the right profession path without being pressured by others [13]. Choosing subjects in the tenth grade has serious consequences that can affect a student's performance in eleventh and twelve grades and, as a result, have a big impact on the university major and career. Selecting the correct disciplines allows students an opportunity to pursue and prepare for their dreams in the right direction. Therefore, when students do not understand their professional tendencies, they cannot choose the subjects that suit their personalities and thus affect their choice of university major.

The hybrid Intelligence system combines several artificial intelligence approaches such as expert system (ES), neural networks (NN), genetic algorithms, and fuzzy. They may also represent a combination of these techniques with other methods such as numerical analysis, statistical analysis, distributed AI, and traditional computer systems. One of the main reasons for the building of this model that combines two intelligent techniques to overcome the limitations of each technique separately[14][15]. Hybrid systems are emerging because no single technique can resolve all the issues that a specific application may face. There is also a drive to build hybrids that can combine diverse data processing skills into a single architecture. Building hybrid intelligence technique has made some progress because of the complementing characteristics of neural networks and ES, these two technologies can be combined to create more powerful systems than may be made with only one of them [16][17][18].

## STRUCTURE OF THE SYSTEM

There are two significant objectives for this study. The first objective is to examine the existing career instruments (CI) and the prediction of appropriate ones that is adequate for grade, tenth students in Oman. The second objective is to study the structure of hybrid neural expert system based on personality.

## CAREER INSRUMENTS

It is significant to clarify the variables before starting in the structure. Career instruments are assessments that are used to understand individual characteristics (such as data values, preferences, motivations, aptitudes, and abilities) influence their prospective success, enjoyment and satisfaction in various career possibilities and work situations [19][20]. In the last century, career assessments have contributed a significant role in professional growth and the economy. Holland's theory is used to assess occupational tendencies in the world. It was invented by the American scientist named (John Holland) and became known as the occupational theory. More than 40 million people in different countries of the world have benefited from this instrument in reaching the right employee and in accessing the job specialization compatible with the personality [21][22].

**TABLE 1.** Types of variables in neural expert system NES

| independent variables | Condition | dependent variables |
|---|---|---|
| Career Maturity Instrument | CMI>45 | very high level,<br>high level,<br>average level,<br>Low level,<br>Need Help |
| Career Decision Making Instrument | CDMI>37 | very high level,<br>high level,<br>average level,<br>Low level,<br>Need Help |
| Professional Orientation Instrument | - | 120 Sub-environments of Holland's theory,<br>616 professions |

As shown in table1, Students in the tenth grade in Oman will complete three career assessments; the first and second will determine their levels of professional maturity and decision-making. After completing CMI and CDMI, the students can see their level according to Likert scale. If the students receive a score of 45 on the CMI, they cannot

go to the DMI. If the students get score 37 on the DMI, they can't move to POI. Third assessment will predict their personality based on Holland's theory and predict future careers. In POI's assessment the student will be able to choose appropriate courses for tenth grade students and specialization in university.

## EXPERT SYSTEM

This paper discusses the conceptual model of the expert system and how neural networks can be integrated into a knowledge base system. Expert system (ES) is a popular technique and sub-discipline of artificial intelligence in the form of software that uses science, facts, and thinking techniques to solve problems in special domains that usually require human expertise [23]. ES use a rule-based algorithm to assist non-expert users in developing their abilities[24]. ES consists of the following components: knowledge acquisition and knowledge base system. Which are further explained below.

## KNOWLEDGE ACQUISITION

Knowledge acquisition(KA) is the process of extracting, eliciting, and organizing knowledge from domain expert and then interpreting the knowledge by expert system (ES) developers. This essentially implies KA from a human expert or other source(s) and then coding / representing such knowledge in the knowledge base(KB) of the expert system [25]. Knowledge acquisition is an essential component in the model's creation, so the most important aspect in the development of ES is its knowledge[26][27]. The knowledge acquisition process will cover five phases.

### *Domain Knowledge Determination (Planning)*

IT expert must define the domain and the issue, analyze different knowledge acquisition techniques and design appropriate procedures[28]. In Oman, career counselling is a paper-based approach that uses mathematical calculations to complete the POI assessment. Following the definition of the problem area and domain, a career specialist is chosen to investigate and learn more about the problem to produce an initial conceptual model of the hybrid system.

### *Knowledge Acquisition Resources*

In the early stages of knowledge acquisition, sources of knowledge are used to help IT expert get a deeper understanding of the subject. The most critical stage in knowledge acquisition resources is the selecting a domain expert (career guidance specialist) so the researcher needs to set attributes for select expert knowledge. There are a set of attributes in selecting domain expert so the expert must have [29][30]:

1. Experience to build the heuristics that arise from the insights into the field.
2. Knowledge and reputation are essential, so the system's output has credibility and authority.
3. Commit sufficient time to the system's development.
4. The ability to communicate knowledge, experience, judgments, and methods to It expert.
5. Cooperative and enthusiastic characteristic to collaborate on the task.
6. Easy collaboration with others.
7. Knowledge primary acquired from a single expert.

Knowledge resources can be built using references, written materials, handbooks, case studies, journals, and other sources. All knowledge is collected from primary sources Therefore, researchers from the Ministry of Education were contacted to provide the expert with the required documents.

### *Knowledge Acquisition Techniques*

Many approaches and instruments for knowledge acquisition have been created with different strengths and limitations. In ES, manual method techniques such as interviews, questionnaires, and conceptual graphs will be used. Crucial data will be collected from a variety of sources, including the Ministry of Education, Omani studies such as CDMI and CMI, questionnaires, and domain experts, as shown in Figure 1, and then placed in a file to be dealt with by an IT expert and added to the knowledge base [31].

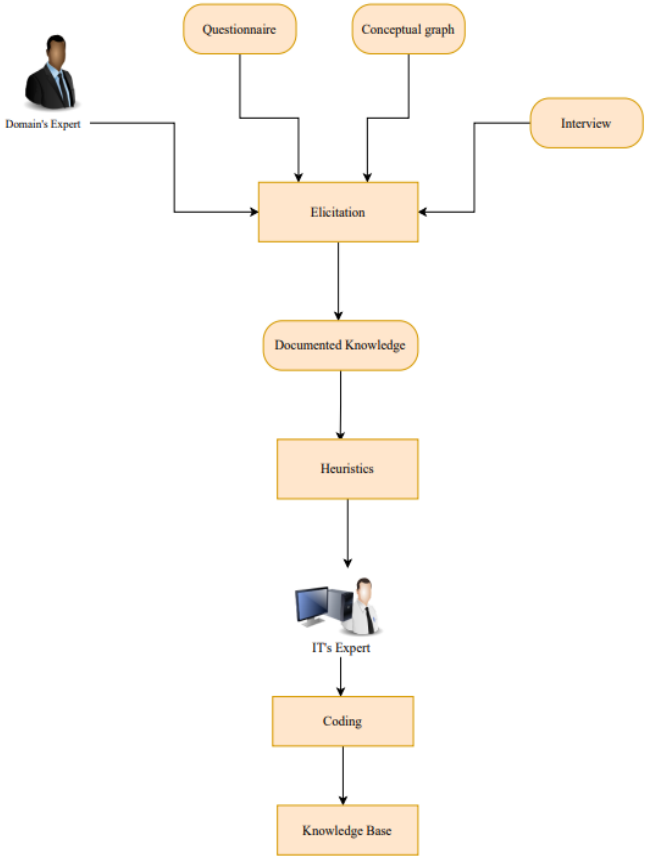


**FIGURE 1.** Manual method techniques

*Knowledge Validation*

Knowledge Validation is an essential process in knowledge acquisition life cycle [32]. Validation process can be divided as a combination of two types of tasks which are complementary with the variety of methods to achieve their goals as shown in Figure 2:

- Verification is actions aimed at ensuring that knowledge acquisition is structurally accurate.
- Evaluation is actions that indicate the ability to acquire knowledge and draw accurate judgments.

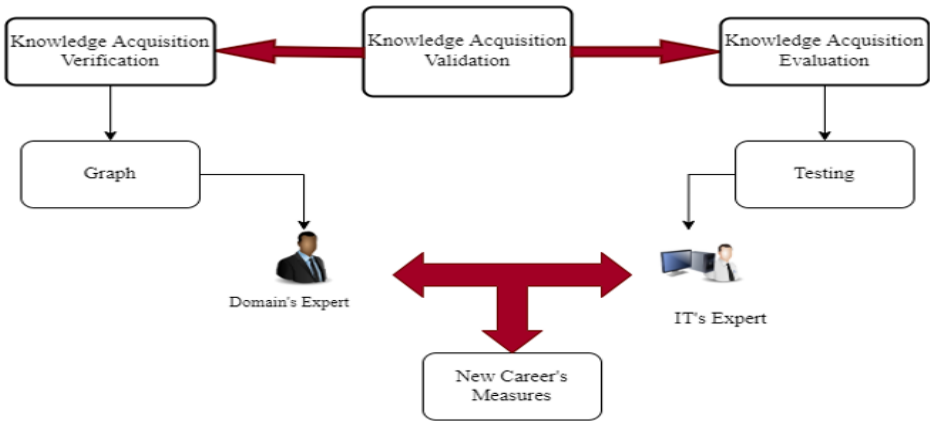


**FIGURE 2.** Process of Knowledge Acquisition Validation

*Knowledge Modelling*

Knowledge representation is a significant part of knowledge acquisition which is used as mechanism for organizing knowledge in a knowledge base. Most of the time, designing the entire system first and then implementing the design is not doable so instead of building the first prototype it is better to use to get further information from knowledge expert and re-implement the prototype. The determination of the general structure and framework of the ES's knowledge is set in the modelling phase [33].

## KNOWLEDGE BASED SYSTEM (KBS)

KBS extracts knowledge from Knowledge Acquisition and encodes it in the Knowledge base, inference engine, and user interface. According to the knowledge from the knowledge acquisition, suitable software and methods are identified.

*Knowledge base (KB)*

The knowledge base contains all the information required to understand, formulate, and solve problems. It is a repository for domain knowledge gathered from human experts by the knowledge acquisition module. To express knowledge, a set of rules is used. Each rule has structure of IF (condition) THEN (action) and defines a relationship, strategy, directive, recommendation, or heuristic. When a rule's condition is met, the rule is shown to fire, the action component is executed, and the database stores a set of facts that are compared to the IF (condition) portions of rules in the knowledge base. The ES's knowledge base comprises both factual and heuristic knowledge. Factual knowledge is information about a task domain that is widely disseminated, such as that found in textbooks, papers, journals, and case studies. Heuristic knowledge is a type of performance knowledge that is more experienced, and more judgmental, and is mainly individualistic. In the field, it is the knowledge of plausible reasoning, excellent practice, and good judgment [34].

*Inference Engine (IE)*

An inference engine simulates human reasoning by implementing artificial intelligence's reasoning process. The purpose of IE is to work with the system's and the user's data to provides predictions, answers, and suggestions based on the facts and relationships found in the knowledge base. IE is a brain of expert system. It uses the control structure (rule interpreter) and provides methodology for reasoning. It behaves as an interpreter which analyses and processes the rules. It is used to perform the task of matching antecedents from the responses given by the users and firing rules. The major task of IE is to trace its way through a forest of rules to arrive at a conclusion [32].

*User Interface (UI)*

The user interface is responsible about how the end-user interacts with the system and the purpose of UI is to give an easy way for the end-user to communicate with the ES. Also, UI permits a user to query (ask) and obtain guidance from an ES. The user interface should be created to be as simple as possible to use. The function of the user interface is to ease the usage of an expert system by developers, users and administrators[34] [35].

## INTEGRATION BETWEEN ES AND NEURAL NETWORK

As shown in Figure 3, NN and ES use the test data as input. As a result, a trained NN system and a trained ES are created. The NN units are comprised of several neurons, differentiated by weights via layers. In contrast, the educated ES extracts rules from the neuronal knowledge base, resulting in implicit rules. When working with new input data, the reasoning prerequisites explain to the user how the neural ES arrives at a given answer [36]. The user interface is the way via which the user and the neural ES communicate. Finally, the inference engine controls data flow in the system and begins reasoning over the neuronal knowledge base. Among all the modules, the prediction module is the most important. This module uses a variety of technologies to train the machine learning model, including machine learning algorithms, APIs, and datasets. The C# programming language is used for all the implementations. C# is a

general-purpose programming language that may be applied to practically any aspect of the models. In the prediction module, the framework is primarily built with C#[37].

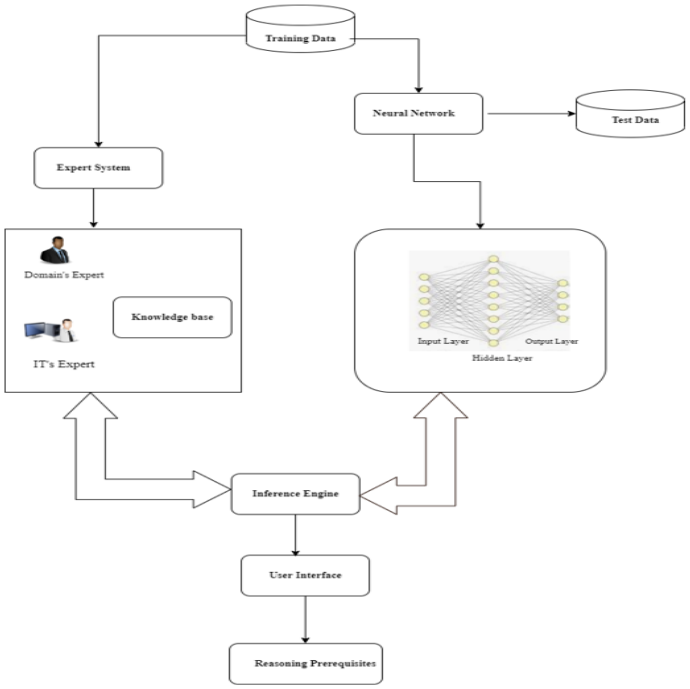


**FIGURE 3.** Neural Expert System

The directions for integrating artificial neural networks with knowledge bases that have been studied will aid in the solution of more high-level tasks, making the process more structured and clearer. The implementation of the given intellectual system for artificial neural network theory, as well as an intelligent environment, aids in lowering the requirements for developer abilities for methods of solving tasks utilizing artificial neural networks. The intelligent environment's ability to memorize the state of the artificial neural network during learning allows for a deeper study of its work, allowing for

## CONCLUSION

The rapid advancement of Internet technology has affected the development and distribution of expert systems. This study aims to propose a method for designing a neural expert system that can be helpful in counselling. The neural network will implement in knowledge base system and will includes three instruments of career counselling. Hybrid system will help career's specialists in their work. The further research will explain the details of the dependent and independent variables in knowledge base system. More independent variables and domain complexity will affect the quality of the hybrid system in detecting the personality of the student.

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