

RULE-BASED EXPERT SYSTEM TO LEAD FRESHMEN STUDENTS IN CHOOSING A SUITABLE COLLEGE MAJOR IN PALESTINE POLYTECHNIC UNIVERSITY

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ABSTRACT

Choosing a suitable college major is a challenging process for freshman students. This research focuses on switching the process of selecting a college major from the traditional method into a systematic and computerized method by deploying artificial intelligence and an expert system. In order to lead freshman students to a suitable college major, the research proposes to use rule-based expert system with multi-criteria analysis such as student general ability, personality character and market analysis for future careers. Results revealed that the proposed system has provided accurate outcomes based on the knowledge extracted from the domain experts. The outcomes of the proposed system suggested a minimum number of major alternatives, these alternatives were sorted based on the importance of each assessed criteria. Keeping into consideration that the proposed system was found to lead and help freshman students in choosing a suitable college major, but not to replace human experts within the same domain.

KEYWORDS

Expert System, Decision Support System, College Major, College Major Selection.

1. INTRODUCTION

In recent years, statistics have revealed relative increase in the total number of high school graduates who are planning to be enrolled in universities, with a total number of 77772 in 2016 according to (Palestinian Ministry of Education and Higher Education, 2016).

It should not be a surprise that the majority of those freshman students didn't receive any advice related to the college major selection process, the fact is, they count on their own judgment and evaluation to choose a suitable college major. However, (Arcidiacono Peter, 2012) stated that choosing an appropriate college major is absolutely necessary and important for determining the student's future attainment. Studies such as (Douglas, 2016) highlighted the importance of the selected college major on financial values, and other studies indicate that the academic major plays a significant role in work value and individual differences (Balsamo Michela, 2013).

Colleges and universities offer hundreds of choices, and it is a challenge for students to decide what major they are going to be enrolled in. However, most colleges and universities depend on admission and enrollment criteria, which primarily depend on the student's academic records as an indicator of general academic abilities. Nevertheless, studies such as (Bartolj Tjaša, 2012) suggest that it's not good enough, and other researches discussed the importance of using artificial intelligence theories in education (Gardner,

1995) and personality matching to college majors and career fields (Barak Azy, 1982), since the students' personality impacts the students' satisfaction, thus affecting the students' performance (Pawlowska, 2014).

Nowadays, Decision Support System DSS and Expert System ES have been widely used, and researchers from many disciplines studied and implement DSS and ES for almost 40 years (Burstein Frada, 2008) in Medical Issues (Patra, 2010), Business management and process (Arias-Aranda, 2010) (Hettiarachchi, 2016), Environmental (Pincinato, 2009), Architecture and Engineering (Ibáñez, 2016) and Education (Engin, 2014) (Kamarthi, 1992).

Considerable things can be done with DSS and ES to lead freshman students in their college major selection process. The presented work describes developing, implementing and testing the decision support system (expert system) to advice freshman students the most suitable college major. Thus, the overall objective of this research is to reduce number of students who drop-out due to bad choice by using artificial intelligence and expert system.

2. SYSTEM SPESIFICATION

The domain of this research can be summarized from the previous discussion as a system that aims to switching the college major selection process from the traditional method into a knowledge based expert system. Thus, the proposed system assesses the most important criteria that any student takes into consideration when choosing a college major, these include:

2.1 Admission and enrollment criteria

Being enrolled in a specific major primarily depends on set of predefined requirements in a particular college or university which any student has to satisfy, these predefined requirements including: general examination score and the field of study (Art, Science, Economy, Occupational and Technology) which differ from one university to another. As a case study, Palestine Polytechnic University has been selected to develop and implement this system; the university offers two, four and five years programs that include more than 50 majors, divided into 6 faculties (Palestine Polytechnic University, 2016).

2.2 Personality match

Many empirical researches found relations between a students' personality theme and suited college major, they stated that the college major and personality match led to locating student's future occupation and more work satisfaction (Prediger, 1992). However, in this research Holland's hexagon theory will be proposed as personality indicator and will be assessed as one of the selecting college major criteria.

Holland has defined six personality themes including: realistic, investigative, artistic, social, enterprising, and conventional, commonly identified by only the first letter I, A, S, E, and C. He suggested that people usually have more than one theme characteristic, usually two or more, and few people said that a person has a unique personality theme (Holland, Making vocational choices; a theory of careers, 1973,1985). However, a personality theme can be declared by two dominant themes such as RI, SE, EC or other, with strongest theme donated by primary and second strongest theme donated by secondary theme. Thus, an individual can be identified as some researchers suggest to use strongest three letters (Holland, Some speculation about the investigation of person-environment transactions, 1987).

2.3 Market analysis and future career

Choosing a suitable college major can lead to a better job opportunity, job satisfaction and guaranteed financial security. Since most students will be classified as a job seeker after completing one particular program in college or university, therefore it is increasingly important to think carefully about where their studies will lead them. The proposed system continuously assesses future careers as important criteria that must be taken into consideration when choosing a college major.

3. PROPOSD METHODOLOGY

The proposed methodology of this research is to develop an effective method to lead freshman student to choose the most suitable college majors using an expert system. This can be done by identification, conceptualization and formalization of all the proposed college major criteria. An expert system relies on two basic components as illustrated in figure 1,

- 1- Knowledge base, which is a set of organized facts about the system's domain.
- 2- Inference engine interprets and evaluates the facts in the knowledge base.

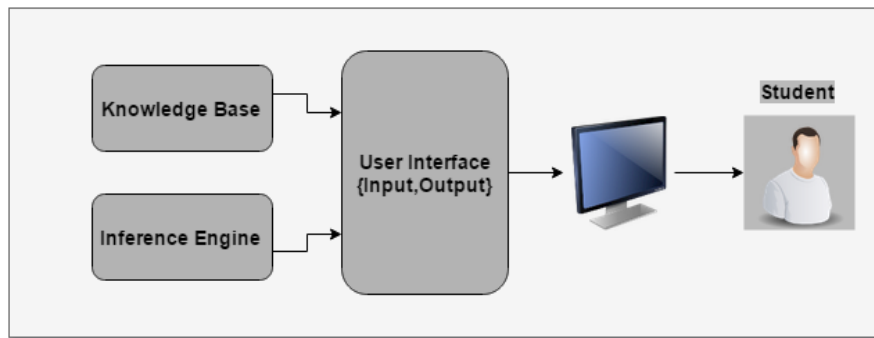


Figure 1. Basic components of Expert system.

However, the proposed system will pass through the following methodology illustrated in figure 2 which attempts to represent all major selection criteria. The methodology includes: Knowledge elicitation, knowledge representation and models design, Implementation and Testing and accuracy assessment.

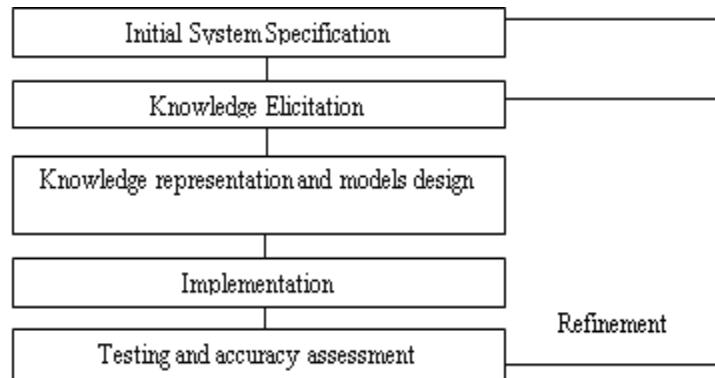


Figure 2. Proposed methodology .

3.1 Knowledge elicitation

Knowledge elicitation, known as the process in which all the information and facts that are related to one specific domain are extracted from closely related experts, the sources of the knowledge in this research is extracted from the admission and enrollment department in Palestine Polytechnic University, interviews and literature review.

Official admission and enrollment criteria has been acquired, since it's basic information that must be taken into consideration, the interviews were primarily based on human experts, advisors and specialists to provide greater understanding of the reasoning behind the selection process. In addition to admission/enrollment criteria and interviews with experts, previous research and empirical studies have been reviewed as part of literature review to provide greater understanding of the system domain.

3.2 knowledge representation and models design

What comes after knowledge elicitation is a set of logical models and decision tables to represent the acquired knowledge in a way that all selection criteria are connected to each other. In this research, the system has been divided into sub-models in which each model represents one criterion.

3.2.1 Admission and enrollment

A deep analysis has been done for admission and acceptance criteria based on the information obtained from the admission and enrollment department in Palestine Polytechnic University, students must belong to the predefined requirements in which the university asks students to satisfy, these include: General Examination score and field of study (Art, Science, Economy, Occupational and Technology). Table (1) clarifies colleges and majors that a student is allowed to be enrolled in, based on General Examination score and Filed of Study.

A build-in coding model has been developed for the purpose of dividing students into a set of groups based on their suitability; the build-in coding model assesses the degree in which General Examination score, Field of study and α contribute to the process of classifying students to university faculties. However, α was derived from the fact that some majors require high mathematical skills, critical thinking and logical skills. Such as engineering programs and applied science programs, we proposed that if the value of α is more than 80 % then the student is more suited to apply for the college of engineering. If the value of α is between 70 – 80 % then the student is suited to apply for the college of applied science or the college of information technology and computer science, and if the value of α is less than 70 % then the student is more suited to apply for other colleges.

α can be calculated by the average scores of Mathematics, Physics and English:

$$\alpha = \frac{\text{Mathematics \%} + \text{Physics \%} + \text{English \%}}{3}$$

The result of the build-in coding model is a set of total points divided into intervals in which each interval represents one faculty that the student is allowed to be enrolled in.

Table 1. Admission and enrollment criteria in Palestine Polytechnic University .

Field of study College	Science	Art	Economy	Occupational
College of Engineering	Accepted with an average score above 80%	Not Accepted	Not Accepted	Accepted with an average score above 80%
College of Administrative Sciences and Informatics	Accepted with an average score above 70%	Accepted with an average score above 70%	Accepted with an average score above 70%	Accepted in Information system with an average score above 70%
College of Information Technology and Computer Engineering	Accepted with an average score above 70%, except computer engineering with an average score above 80%	Not Accepted	Not Accepted	Accepted with an average score above 70%, except computer engineering with an average score above 80%
College of Applied Sciences	Accepted with an average score above 65%	Not Accepted	Not Accepted	Accepted in applied electronics with an average score above 65%
College of Applied Professions (Two years program)	Accepted with an average score above 50%	Computer information technology program, Administrative Science Program and Banking and Finance program	Computer information technology program, Administrative Science Program and Banking and Finance program	Computer information technology program and Engineering professions programs

Table 2 illustrates how the build-in coding model is working and how the total points is calculated, while Table 3 clarifies how the total points could be associated with the appropriate faculty.

Table 2. Build-In coding model decision table.

Build-In coding model		
Field of Study	Science	300 Points
	Art	150
	Economy	150
	Occupational	250
General Examination score	80 – 100 %	300
	70 – 79.9 %	250
	65 – 69.9 %	100
	50 – 64.9 %	0
α	80 ↑	150
	70 – 80	99
	70 ↓	0

Table 3. The appropriate faculty based on Build-in coding model.

Total Points	faculty
0.0-399	College of Applied Professions (Two years program)
400-499	College of Administrative Sciences and Informatics
500-699	College of Applied Sciences and College of Information Technology and Computer Engineering
700 or more	College of Engineering

Now the whole process of selecting a major based on admission and enrollment criteria is moving on this track. First of all, the student must provide information about the program type that he/she may wish to belong to, and then provide an academic record and the general examination score. The system will assess this information and then lead the student to the accepted majors with reference to admission and enrollment criteria as illustrated in table 4.

3.2.2 Personality match

As discussed before, the students' general ability is an important factor to choose a college major but counting only on it is not good enough. Thus, in this research we link the students' general ability with his/her personality theme. Holland Personality Theme HPT which is based on HPTs theory stated that the personality is basically divided into six categories including: realistic, investigative, artistic, social, enterprising, and conventional. These donated by the first strongest letter and second strongest letter. This research proposed to use the two strongest personality theme to identify the students' general character as shown in table 5, and then define the college majors associated with each personality theme. All the majors offered by Palestine Polytechnic University were examined and represented with the help of human experts within the same domain.

3.2.3 Market analysis and Future career

As discussed before, choosing suitable college major will lead to career success and more job satisfaction. The final stage of the analysis is assessing the degree in which has an increasing demand for current and

future careers contribute in major selection process. The proposed system was based on local, regional and global indicators, this will help students to take into consideration the alternative majors they seek to apply for.

Table 4. Admission and enrollment criteria decision table

Conditions	Program Type	4 Years Program	N	N	N	N	Y	Y	Y	Y
		2 Years Program	Y	Y	Y	Y	N	N	N	N
	Total Points	0 – 399	N	N	N	Y	N	N	N	Y
		400 - 499	N	N	Y	N	N	N	Y	N
		500 - 699	N	Y	N	N	N	Y	N	N
		700 or more	Y	N	N	N	Y	N	N	N
Alternatives	College of Engineering					√				
	College of Applied Sciences					√	√			
	<i>College of Information Technology and Computer Engineering</i>					√	√			
	<i>College of Administrative Sciences and Informatics</i>					√	√	√		
	College of Applied Professions	√	√	√	√				√	

Table 5. Holland Personality Theme HPT Matrix.

	Secondary					
	R	I	A	S	E	C
	Primary	RR	RI	RA	RS	RE
I	IR	II	IA	IS	IE	IC
A	AR	AI	AA	AS	AE	AC
S	SR	SI	SA	SS	SE	SC
E	ER	EI	EA	ES	EE	EC
C	CR	CI	CA	CS	CE	CC

The system assessed the expanding industries and sector, careers availability in the future, wages and salaries and the employment growth, even in regional, if available, or global base, and then linked this information majors that Palestine Polytechnic University offers. In case of information unavailability about a specific major, then we proposed to use the most related information based on human experts and consolors.

3.3 Implementation

After data and domain knowledge has represented in set of models and decision tables to retrieve required knowledge, the next stage was implementing the system in a way which achieves its primary objective. This has been done through the use of basic architecture of expert system presented in figure 1.

A Rule-based method was used to implement all the decisions tables within the system. Since all criteria of the major selection is a symbolic criterion, it can be logically transformed to IF-THEN format. The proposed expert system was developed with an Object-Oriented Database which can symbolize all data and domain knowledge.

The system was developed as Web-Based expert system. PHP with MySQL environment was used to build up and structure the logical process flowchart. Figure 3 illustrates logical schema of proposed system.

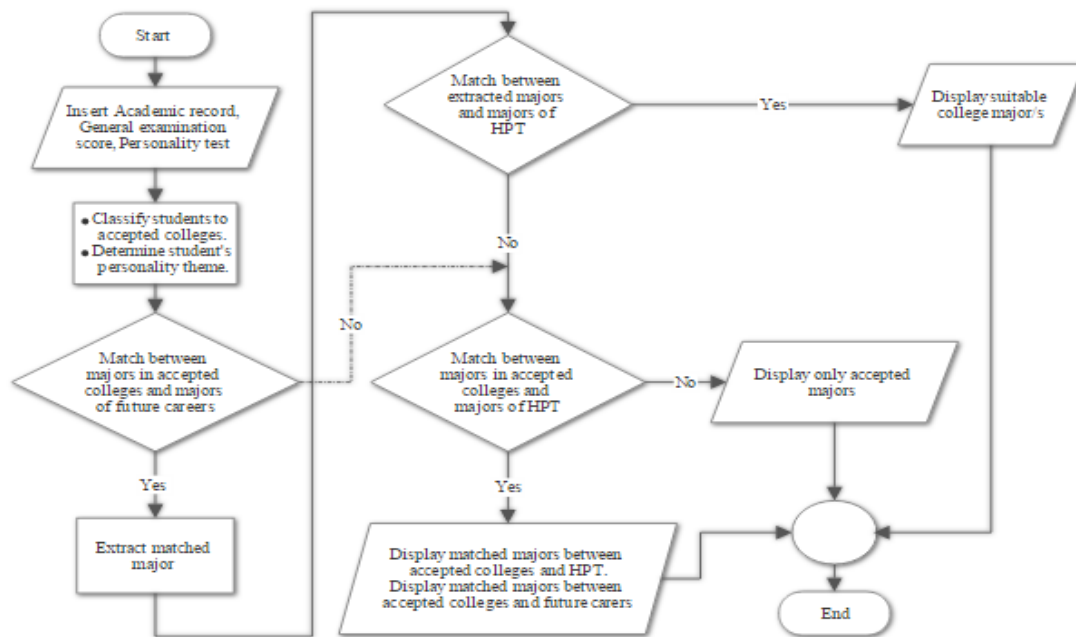


Figure 3. Logical schema of proposed system.

3.4 Testing and accuracy assessment

A sample data were collected from students (n= 887, 443 Female and 443 Male) at Palestine Polytechnic University and analyzed for the purpose of applying testing process. The testing process which includes verification and accuracy assurance was applied to ensure that the proposed system meets its primary objective and provides accurate results based on the predefined criteria. However, functional testing and random data testing were applied as a part of the testing process. In functional testing, sub-functions inside the proposed system such as testing accepted colleges based on admission and enrollment criteria and majors of HPT were separately tested and examined to ensure that each sub system functions as planned. Random data testing process examines system results if random data was provided by a student.

Accuracy assurance testing process which assesses the degree to which the proposed system provides an accurate result, this is basically done through presenting results to human experts and counselors.

4. RESULTS AND DISCUSSION

The proposed system was successfully implemented in a way which meets its predefined primary objectives. the system provides either one of two alternatives that include: 1) most suitable college major/s that would be student's academic record, personality general character and career availability, 2) majors that would be eligible for personality general character or career availability.

The results offered by the system was fully accurate based on information provided by the student and knowledge-based acquired by the domain experts. The results were previewed by academic advisors and the discussion of these results stated that it can be reliable based on the fact that all analyzed criteria were significant for the process of choosing the college major.

Discussion of the results revealed that 11% of the students touched by their gender aspect when choosing their major. Females tend to choose a college major which will usually lead them to desk jobs, while males more likely tend to choose majors which will lead them to on field and vocational jobs. Further, 7 % of the students choose a major based on family suggestion and their parent's jobs, while 21 % said that funding issues and financial aspect affect their decisions

The knowledge that related to the market analysis and future career must be continuously updated, in this research the knowledge was derived from global statistics, but local and regional market trends must be assessed and taken into consideration to provide more accurate results.

5. CONCLUSION

In this research, a rule-based expert system for leading freshmen students to select the most appropriate college major has been proposed, designed, implemented and tested. The proposed system considered criteria such as student general ability, personality character and market analysis for future careers. Each used criteria has been analysed and discussed. The system provides reliable and accurate results based on information provided by students and knowledge extracted from experts and specialists. Extra environmental and cultural factors can be easily merged in the proposed system.

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