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Smart guidance systems for Moroccan Students

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Abstract—**Academic orientation is a crucial step in the lives of students. This stressful phase has a significant impact on their academic and professional journey. However, poor guidance can lead to serious consequences, such as difficulties in pursuing further education, academic failure, and school dropout. In Morocco, orientation services are not readily available in schools, and guidance counselors can only visit educational institutions once or twice a year due to a shortage of human resources. In this regard, several intelligent orientation systems are designed to assist Moroccan students in making informed decisions about their academic paths. In this article, we analyze these orientation systems to gain a comprehensive understanding of the different technologies used, the considered orientation criteria, and the limitations of these existing systems. The analysis reveals that the studied orientation systems take into account various factors involved in the orientation process, including personal information, socio-demographic information, and academic records. Special attention needs to be given to the orientation of Moroccan students in secondary education. Furthermore, integrating artificial intelligence with the Internet of Things to implement effective and robust solutions can contribute to the enhancement of academic and professional orientation processes.**

Keywords— artificial intelligence; Internet of Things; academic guidance; academic orientation; Recommender Systems; Chatbots; Expert systems; Machine learning; Decision-Making methods; Morocco

I. INTRODUCTION

Smart cities are innovative urban centers based on advanced technologies aimed at enhancing the quality of life for populations by providing smart education and other intelligent services. Academic guidance is an integral part of the educational process. Advanced technologies can be deployed in smart schools to improve orientation and learning processes in smart cities. However, academic guidance is a crucial step in students' academic and professional journeys, significantly impacting their academic and career paths. They need assistance in finding universities, courses, and specializations that best match their profiles, personalities, interests, and goals. Nevertheless, poor guidance can lead to serious consequences such as academic failure, dropout, and difficulties in pursuing further education.

This article specifically focuses on Morocco's educational system. Morocco's 2030 vision prioritizes education and career guidance, outlining a comprehensive strategy to improve these areas throughout the entire education system. In response to existing guidance limitations, several intelligent systems have been developed to empower Moroccan students with the tools to make informed academic and professional decisions.

This article breaks new ground by examining and analyzing existing academic and professional guidance systems designed for Moroccan students. Our analysis will explore the types of guidance offered, the technologies employed, the factors considered during the guidance process, and identify potential limitations in these existing systems. The insights gleaned from this analysis will be valuable for educators, policymakers, and developers of future guidance systems in Morocco's evolving educational landscape.

The structure of the paper is as follows. Section 2 details the research methodology employed. Section 3 presents the results of our analysis of existing guidance systems for Moroccan students. Finally, Section 4 offers concluding remarks and highlights areas for future exploration.

II. METHODOLOGY

To identify relevant articles on smart guidance systems for Moroccan students, we used the Scopus and Google Scholar databases. The search period was limited from 2015 to 2023.

The following queries were employed:

("Academic guidance" OR "Orientation Student" OR "Vocational Guidance" OR "Academic and Vocational Guidance") AND "Morocco"

("Career Counselling System" OR "Counseling System") AND "Morocco"

*(Smart * guidance OR "Smart Orientation Student") AND "Morocco"*

The selected articles underwent a thorough content analysis to extract information related to the types of guidance, educational levels, technologies, and tools used, as well as criteria and theories employed in the examined smart guidance systems.

III. RESULTS AND DISCUSSION

A. Types of Guidance and Educational Level

According to Table 1, the majority of the studied systems [1], [2], [3], [4], [5], [6], [7] are designed for educational and vocational guidance of high school students or Moroccan students in higher education. Four systems [8], [9], [10], [11] are developed to guide students in choosing their secondary school study specialization, and only one system [12] has been proposed for the orientation of students in preparatory classes (CPGE-Morocco).

Regarding the methods used, most systems employ machine learning methods such as Huber Regressor [1], Random Forest [8], [9], [11], Decision Tree [3], [7], [8], [11], [12], Naive Bayes [8], [9], [12], K-nearest neighbors (KNN) [3], [5], [8], Logistic regression [3], Support Vector Machine (SVM) [3], [9], Neural Networks [5], [9], [12], [14], and Linear regression [11]. Other methods include Multi-Criteria Decision-Making methods (TOPSIS [2], AHP [2], and FAHP [5]) and recommendation algorithms (content-based filtering [1], [6], collaborative filtering [6], and popularity-based approach [1]).

Based on these results, it can be observed that artificial intelligence and the Internet of Things are emerging technologies in the field of guidance for Moroccan students.

TABLE I. TYPES OF GUIDANCE AND EDUCATIONAL LEVEL

Ref.	Year	Types of guidance	Educational Level
Majjate et al. [1]	2023	Academic guidance and Counseling	High school seniors
Badrani et al. [8]	2023	School guidance	Middle school Students
Ouatik et al. [2]	2022	Academic guidance	High school students
El Mrabet and Ait Moussa [3]	2022	Academic and vocational guidance	Secondary School students
Ouatik et al. [9]	2021	School guidance	Secondary School students
El Mrabet and Ait Moussa [10]	2021	School and vocational guidance	Secondary school students
Zahour et al. [4], [13], [14]	2020	Educational and vocational guidance	University students and graduate students
EL Haji and Azmani [5]	2020	Educational and vocational Guidance	Students and young people seeking their first job or retraining
Tarik and Farhaoui [11]	2020	School guidance	Students of the core curriculum (High school)
Mimis et al. [12]	2019	Academic guidance	Preparatory classes for Grandes Ecoles (CPGE)
Ghanjaoui et al. [6]	2016	Academic guidance	University students
Imane and Omar [7]	2015	School guidance	University students

B. Technologies, Methods, and Tools used

In order to design and develop intelligent guidance systems, numerous technologies, methods, and tools have been employed. Table 2 presents these techniques and tools used in the development of the studied guidance systems.

According to this table, it is noteworthy that the majority of the developed systems are based on artificial intelligence technologies, such as Recommender Systems [1], [2], [6], [11], [12], Chatbots [4], and Expert Systems [5]. Meanwhile, only one system [10] employs Internet of Things (IoT) technology.

Robust platforms and tools are used to implement these intelligent technologies, such as PyCharm editor for implementing a university recommendation application [1], DialogFlow for developing a chatbot for educational and vocational guidance [4], [13], and JADE, Protege, JENA, JESS, and SPARQL for implementing a Multi-expert system [5]. Other big data tools are used for managing and processing massive data, as well as extracting relevant information from real-time social network data, including Hadoop [5], [9], HDFS [5], [9], MapReduce [9], HBase [5], Sqoop [5], Flume [5], Pig [5], and Hive [5]. Additionally, machine learning tools are used to implement and compare the accuracies of machine learning algorithms, namely Python [3], Anaconda [3], Jupyter Notebook [3], Weka [9], [12], and MOA [9].

C. Factors Orientation criteria, and theories uses

Student guidance is a complex process linked to several important factors. These orientation criteria are summarized in Table 3.

According to this table, some proposed systems [1], [5], [6], [7], [10], [12] aim to predict the appropriate academic and professional orientation of students based on their personal and socio-demographic information, as well as academic records. Personal criteria such as personality type, skills, and interests are taken into account. Demographic criteria include age, gender, parents' occupations, parent’s income, social support, city, social origin, family status, father’s occupation, mother’s occupation, while students' academic records encompass bachelor type, auto-didacticity, bachelor mention, and type of prior teaching.

Most developed systems [1], [5], [6], [7], [10], [12] are based on the personal and academic profile of the student, while some systems rely solely on the personal [3], [4], [13] or academic profile [2], [8], [9], [11]. Additionally, some studied guidance systems do not consider students' interests and personalities, which may result in imprecise and inappropriate guidance.

TABLE II. SUMMARY OF TECHNOLOGIES, AI METHODS AND TOOLS USED IN THE DEVELOPMENT OF INTELLIGENT GUIDANCE SYSTEMS

Ref.	Technologies	AI Methods	Platforms and tools
Majjate et al. [1]	Recommender System	Content based filtering Popularity-based approach Huber Regressor	PyCharm
Badrani et al. [8]		Random Forest Decision Tree Naive Bayes KNN	
Ouatik et al. [2]	Recommender System	TOPSIS, AHP	SMOTE
El Mrabet and Ait Moussa [3]		Logistic regression SVM, KNN Decision tree	Python, Anaconda, Jupyter Notebook
Ouatik et al. [9]		Naive Bayes, SVM Random Forest Neural Network	Weka, MOA Hadoop, MapReduce, HDFS
El Mrabet and Ait Moussa [10]	Internet of things (IoT) RFID, Mobile devices UHF Readers, Arduino board Servers		JAVA JEE, SPRING Framework TOMCAT web server HSQLDB database
Zahour et al. [4], [13], [14]	Chatbot	Multiclass Neural Network	DialogFlow
EL Haji and Azmani [5]	Multi-expert system Multi-agent system Semantic Web ontologies Virtual agents	FAHP KNN Neural networks	JADE, Protege, JENA, JESS, SPARQL HDFS, Hadoop, HBase, Sqoop, Flume, Pig, Hive
Tarik and Farhaoui [11]	Recommender System	Linear regression Decision tree Random Forest	
Mimis et al. [12]	Recommender System	Decision tree, Naive Bayes, Neural networks	Weka
Ghanjaoui et al. [6]	Hybrid recommendation systems	Collaborative filtering Content based filtering	
Imane and Omar [7]		Decision Tree (CART)	

TABLE III. GUIDANCE CRITERIA USED

Ref.	Factors
Majjate et al. [1]	Gender, Field, Academic scores, Desired University, Institution’s requirements
Badrani et al. [8]	Grades
Ouatik et al. [2]	General average of the 1st year and the 2nd year of the baccalaureate, Repeating in 1st year or 2nd year of the baccalaureate, Number of hours of absence for each subject, Scores, grades
El Mrabet and Ait Moussa [3]	Personality traits
Ouatik et al. [9]	Grades, the number of absences for each subject
El Mrabet and Ait Moussa [10]	Cognitive tendencies, Professional tendencies Professional and cognitive skills Interests, Personality type, Self-esteem
Zahour et al. [4], [13], [14]	Type of personality
EL Haji and Azmani [5]	Interests and professional tendencies, Personality trait Skills and training (disciplinary skills), Labor market trends
Tarik and Farhaoui [11]	Notes of the core curriculum
Mimis et al. [12]	Gender, Motivation of CPGE choice, Average weekly hours of work at home Father education level, Selection rank allowing access to preparatory classes, Quarterly rankings of the student for each subject
Ghanjaoui et al. [6]	Age, gender, field, marks gotten, fathers job, mothers job, preferences, city, type of personality, skills
Imane and Omar [7]	Age, Gender, Parent’s income, Social support, Bachelor type, Auto-didacticity, Social origin Family Status, Bachelor mention, Type prior teaching, Father’s Occupation, Mother’s Occupation

TABLE IV. APPROACHES AND THEORIES USED

Ref.	Approaches Or Theories
El Mrabet and Ait Moussa [3]	Holland's theory
El Mrabet and Ait Moussa [10]	ETC-guidance approach and Holland's theory
Zahour et al. [4], [13], [14]	Theory of John Holland and the RIASEC questionnaire
EL HAJI and Azmani [5]	Holland RIASEC model Big Five model
Ghanjaoui et al. [6]	John Holland's theory

Regarding the approaches and theories used, the John Holland theory [3], [4], [5], [6], [10] and the Big Five model [5] are employed for student personality identification. The ETC guidance approach [10] is utilized to assist students in identifying their skills, professional opportunities, and aptitudes.

IV. CONCLUSION

The analysis of existing intelligent guidance systems for Moroccan students paints an optimistic picture for the future of education in the country. Artificial intelligence (AI) and the Internet of Things offer innovative and powerful tools to personalize student guidance and empower them to make informed choices. However, to truly unlock their potential, these systems need to evolve beyond a purely academic focus.

While academic performance is important, relying solely on grades creates a narrow picture of a student's potential. Effective guidance systems should incorporate a holistic approach that considers a student's personal profile, interests, sociodemographic background, and even personality traits. Integrating psychometric assessments, career aptitude tests, and exploring factors like family background and learning environment can provide a more nuanced understanding of a student's strengths, aspirations, and potential challenges. This comprehensive data can then be used by AI algorithms to generate personalized recommendations that consider not just academic ability, but also passion, skillset, and future career goals.

The focus on high school and university students in most existing systems creates a gap in guidance during crucial formative years. Developing guidance systems specifically for middle school students can be highly beneficial. Early intervention allows students to explore a wider range of academic options, develop essential study skills, and build self-awareness to make informed decisions about their future paths. Imagine a system that can identify a student's talent in science during middle school, recommend relevant extracurricular activities, and connect them with mentorship opportunities to nurture that passion.

The true power of these systems lies in the potential for Artificial intelligence and IoT integration. Imagine AI algorithms analyzing data collected through wearable sensors to identify a student struggling in a particular subject, then providing real-time personalized learning resources or suggesting additional tutoring support. This fusion of technologies could revolutionize learning by providing constant, data-driven guidance that adapts to individual needs.

For these systems to be truly transformative, they must be accessible to all students. This means addressing the digital divide and ensuring these systems are available in Arabic, French, and Berber languages to cater to Morocco's diverse linguistic landscape. Furthermore, ethical considerations are paramount. Developers must implement measures to address algorithmic bias and ensure data privacy to maintain student and parent trust.

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