

Predicting ICT Students' Profile Using AI and Social Network for a Post Pandemic Classroom

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Abstracts: The study investigates the impact of the COVID-19 crisis on education, focusing on computer science graduates and the importance of Information and Communication Technology (ICT) skills aligned with job expectations. Employing a questionnaire-based approach and data mining algorithms, the research assesses students' self-reported ICT skills post-pandemic. Findings indicate students generally possess fundamental ICT skills but exhibit areas for improvement. The study emphasizes addressing gaps in graduates' profiles to enhance skillsets and adapt university curricula. Practical implications highlight the need to prepare students for the evolving workforce, and the research contributes to literature by enriching understanding of post-COVID-19 education. The approach, combining questionnaires and data mining, offers valuable insights for assessing and predicting students' skills in a post-pandemic context. This research serves as a foundation for adapting teaching strategies and curricula to meet evolving learner requirements.

Keywords: ICT Skills, Covid'19, University Curricula, Education Strategies, Questionnaire, Data Mining, Social Network, Post-Crisis.

1. INTRODUCTION

Due to the global impact of the COVID-19 epidemic, it is evident that digital learning and learning required the development of more active methodologies, supported by a variety of traditional and emerging technologies, in order to manage time and space in a more creative and effective manner [1]. It provides empirical evidence through the application of a variety of methodological approaches. Moreover, it contributes to the discussion of the skills and methodologies required for their successful implementation in higher education [2], [3].

Teaching computer science in higher education aim to build solid background [4], boost the students' learning and help them to develop multiple skills. However, Computer Science as an academic field that deals with computing is a complex process [2], [3]. The teaching processes of this discipline combine theory; abstraction, design and implementation where problems can be solved differently by applying recurring conceptual principles [5]. It involves also cognitive aspects that are considered pertinent for promoting the development of the students' logic and critical skills to solve problems [6], [7]. Additionally, the employment of up-to-date initiatives to improve computer science education allows integrating technological aspects and new strategies into teaching in order to promote competencies [4] (known as different names like ICT skills including traditionally cooperation, interaction, discerning analysis, also innovation, along with knowledge, multimedia, and technological aptitudes, we add more such as intercultural skills, empathy, eco-literacy and translanguaging [6]–[9]).

ICT has been the focus of many researches in the last few decades due to its important role in economics and increasing chances for employability [10]. This is due to the upgrading of companies that adopt evolutions in its computerized data assets and connectivity systems [5]. The advancements required workers possessing high digital literacy. Hence, education institutions assume the full responsibility enhancing students' proficiency in ICT to reveal the demands of the labor marketplace. Higher education programs are undergoing rapid changes [11], [12]. Significant transformations have occurred and recognized; alterations in the certificates and the array of curricula they provide [13]. The escalating significance of ICT expertise has resulted into its integration into the majority of program's courses since they are growing more vital for individuals completing their academic journey [14], [15]. Nowadays, for graduate students in computer science, getting and mastering ICT skills, is crucial to succeed and

match the expected profile, and help to create the next generation of workforce since the actual working world witness a growing need in employing persons with these skills [16]. The market is seeking more capabilities and greater performance for newer technologies. So, they must to be agile in how to fill their need for the desired profile. Consequently, to be employable [6], persons must work, in harmony and have personal and emotional skill, with others who have divergent origins with possible competing priorities [7] [8]. Moreover, there is a growing demand for elevated cognitive abilities, including the capacity to critically evaluate information and opinions, the ability to brand more connections through grapple with intricate concepts and datasets, and employ creative thinking to resolve challenges [7]. Despite setbacks, future employees must maintain motivation; approach challenges with a positive mindset and work crisis, and to face constructively changes and uncertainty [17], [18]. To address these issues, this research seeks to answer the following questions:

1. What is the impact of the pandemic crisis on students' learning?
2. Do our students truly possess a comprehensive and adaptable ICT skills profile?

To answer these questions, we adopt the following steps. Our investigation is rooted in a survey that involved 152 students who are currently registered at three diverse higher education institutions.; University of Mustafa Stambouli of Mascara, higher Normal School of Technical Education of Oran and University Belhadj Bouchaib of Ain Temouchent. The collected database is analyzed and processed for exploratory Data Mining. The results show that students' profile involves the most important ICT skills even though the pandemic conditions. It could contribute also for searching gaps in within higher education instructional and learning approaches. In such instances, university strategies ought to encompass the promotion of these skills among students and enhance their backgrounds.

The subsequent sections of this paper are organized as follows. Section 2 scrutinizes the background of this research; Skills needed in time of Covid'19, definition of ICT skills and which are the most required in workplace, higher education challenges in preparing these skills and Educational Data Mining. Section 3 describes the survey sample and the process steps for designing and determining the computer science students' profile. Section 4 delves into the outcomes derived from our analysis. Ultimately, Section 5 provides a conclusion.

2. REVIEW OF LITERATURE

This pandemic forced an urgent transition in education to online learning; this calls for new technologies and learning approaches that weren't completely common, at least in Algeria's higher education institutions [19]–[21]. Previously, the distance education before Covid'19 was limited to the use of Learning Management Systems (LMS) strictly for uploading teaching content resources or displaying useful links [22]. Along with the academic approaches and materials, online learning requires new technologies and new roles for both teachers and students to ensure the proper learning results. Distance learning method change the paradigm of traditional to unconventional learning which foster student-centered learning, however, educators [2] indicated underdeveloped ICT setups, including subpar internet connectivity access, deficiency in teachers and students ICT skills [23], hampered the adoption of this method. Among other elements, ICT skills are essential for the deployment of distant teaching or learning methods during a pandemic [1], [3].

The skills required for professional environment business was named ICT proficiencies. A number of studies tried to give definitions by synthesizing these skills. [24] listed three types of skills: acquisition skills (creative thinking and innovation; critical thinking and analytical problem-solving; effective communication and collaborative abilities [9]), literacy proficiencies (information literacy; media literacy; ICT literacy), and essential life competencies (adaptability and quick responsiveness; initiative and self-directedness; interpersonal adeptness), with cross-cultural competencies; efficiency and responsibility be a leader as well as responsible). Another study grouped these abilities into four groups: Computational skills (creative thinking and innovation; analytical reasoning, problem-solving, and decision-making; adaptive learning and metacognition), collaborating techniques (interaction;

cooperation), working gears (knowledge mastery; ICT literacy), and [4], global skills (citizenship; languages; individual and communal accountability) [9], [10].

More authors presented the ICT skills Knowledge (Information), Communication, ethical considerations, and societal repercussions. With a rapid development in commercial activities on the web, companies recruit professionals who master the different branches of ICT and digital professions. For their part, business leaders must select valuable candidates taking into account their skills in order to make modern tools available to their employees and strengthen their presence on the web. The most exclusive ICT professionals are those who actively participate in the advancement of companies' digital infrastructures as well as corporate tactics on the web [6]. Depending on the size of each company, there are now new professions that are becoming essential to ensure the future of companies, whatever their field of activity [10]:

1. The ICT project manager: The ICT project manager is an engineer (or sometimes a technician) responsible for organizing all the IT projects of large companies: he must plan, supervise and reorganize the company's strategies, ensuring that the consistency and scalability of the information system. The intervention of this professional facilitates the projects' management. The ICT project manager must hold a Master certificate in ICT with five years of experience as an assistant, manager, consultant or even as an expert. Solid familiarity with the organization's information activities and mastery of the English language would be assets. He can earn higher income per year, depending on his experience and skills.

2. Software Architect: The software architect deals with the logical organization of the code of the programs developed for the company. In general, this function is assigned to experienced developers who have proven skills in software architecture. This professional must be able to have an overview and ensure a permanent watch of the competition in order to carry out all the missions entrusted to them.

3. The community manager: Also called "The architect of social network" or the "CM", he is in charge of the communication of the company on the web. He works under the direction of the marketing director and works to improve the image of his company. He must also take care of the promotion of the brands, products or services offered by his company on the Web (social networks, specialized forums, image or video sharing sites, etc.). The community manager must be able to discuss directly with potential customers online and distribute statuses that encourage them to react. He must also be able to blog and write articles on topics that interest the targeted Internet users.

4. The SEO manager: The SEO manager (search engine optimization) is a "marketer" who must be able to decipher the algorithms of search engines and closely follow the incessant developments introduced by the engines in order to improve the search results. This professional must be curious, have good analytical skills and be able to work in a team. Its mission is to improve the positioning of the company's site in the results displayed by the engines when an Internet user carries out a search related to the keywords on which the web pages are positioned.

5. Mobile application developer: Today, the creation of mobile applications is an essential step to increase its visibility on the web, because mobile devices are currently the main tools that allow individuals to connect. The intervention of the developer of mobile applications is therefore essential so that their web pages can be consulted through these terminals (BlackBerry, Android or iOS technologies) which have quickly conquered hundreds of millions of users throughout the world, in large cities around the world, but also in the most remote areas. By recruiting a qualified engineer, the management and security of mobile data are ensured throughout the year.

In other hand, companies in the IT sector (small, medium, large and startups) who invent digital tools (software, applications, etc.) directly for the general public or for businesses: an idea, a need or an identified lack. Who support other sectors of activity in their digital transformation by advising them, helping them to build and maintain

the tools they need or by creating and improving communication infrastructures (hosting platforms, 3/4/ 5G, smart electrical distribution network, etc.). In public and private companies, associations and communities (town halls, departments, regions), that use digital technology. Depending on their size, they may have an IT department (often involved in strategic decisions) or an internal specialist/referent. In addition, employees must be trained in digital uses, recent developments as well as data protection and security issues. They will be required to juggle with digital technology in their daily missions whatever their department (payroll and accounting, communication, customer relations, etc.). In education and research (AI, Blockchain, Big Data, Cybersecurity), digital technology is evolving very quickly as well as its uses. Training and research are therefore all the more important issues. In addition, computers are everywhere. It is an open door to all sectors. Everyone is attracted by the internet part, or by the development and management of projects or even the network part: the operating department, i.e. the operation of the machines, their configuration so that all communicate well, here like thousands of miles away.

In ICT, we will find very discreet people who prefer to stay on their job and people who will like to move around and do network cabling. One can easily find a place that suits his personality. And evolve over time[25]. Skills are one of the keys to labor force participation and labor productivity. Everyone knows that with the arrival of new technologies [26], often related to ICT, modifications in the organizational structure of labor, positions involving Tasks that follow a regular pattern and are straightforward to mechanize are gradually vanishing, as emerging positions require skills that exclude routine (logical, inventive, relational) and for which individuals persist ahead of devices. Reports show, young workers substantially adapting to these modifications in request, though older workers are more likely to face skills obsolescence [25].

According to several studies, many education systems are struggling to prepare young people for the new world with new required skills. Learning is frequently remains marked by memorization and repetition instead of fostering understanding, and critical thinking for students in engage in logical thinking and emphasizing addressing challenges and real-world concerns [13], [27]. While this observation obviously implemented for elementary and second stage education, it also applies to higher education. Skills have therefore become a serious obstacle to growth, a situation that employers have repeatedly deplored. Higher institutes play a vital role. Today's inquiry shall be seeing in what manner higher education systems may take up this challenge and intervene more actively to equipping students for the workforce markets. Universities must a potent catalyst for constructing an improved society, enhancing productivity, and fostering progress. Its contribution lies in the production of practical and theoretical knowledge and advanced skills, through and applied study, but also through its "engagement with the larger public", a broader assistance rendered assistance. This must operate as a cohesive structure composed of interrelated actors: organizations that intermingle together, companies' owners, firms, entrepreneurs, study institutes however this responsibility extends beyond institutions and facilitators at the previous levels. If these links are not operational, universities find it difficult to exploit their full potential [4], [5].

Every year, universities offer specific training to enable young people to specialize in these professions [14], [28], [29]. It is crucial for universities to ready and upskill professionals in an era where the need for routine tasks is gradually diminishing, given the rise of automation and machines. ICTs replace human beings [30]. Conversely, the need for a more intricate application of design thinking persists and grow. So, beyond their primary function of higher education and training, universities can and indeed should become more involved in lifelong learning. It is worth mentioning that the majority quality information is also a key factor in linking universities to labor markets. Curricula should derive from established consensus, vocational and/or achievement of technical educational objectives as they are designed jointly by the university [11], employers and other key stakeholders knowing that institutions should support guide students through hands-on internships or experiential assignments support for professional trajectory advice plus the dissemination of employment marketplace intelligence [31]. Despite the apparent importance, these provisions are frequently overlooked, leaving students to navigate challenges independently. Also connecting programs with working place, i.e., curricula will promote students who are with no sufficient training from an academic point of view (and who may already have work experience) to benefit from a better leaving for university by filling in the gaps between their level and the expectations of the tertiary curriculum

Participation in these programs not only plays a pivotal role in fostering student success but also serves as a key determinant for future career accomplishments. It is necessary to have appropriate systems of governance, management, financing and quality assurance to allow universities to fulfill their missions in the face of the expectations of society and the world of work [12]. In addition, a wide implementation of targeted measures holds the potential to bolster employability on an institutional level, a facet gaining escalating significance for clients, to which contributions are made through insightful advice and strategic actions. As new ICT applications emerge universities curricula should be reviewed and up dated with those skills programs, relying solely on the fluctuating demands of the job market or educational institutions is inadequate for equipping students with the requisite skills. Academics must conscientiously discern the specific ICT proficiencies demanded by diverse sectors and organizations. This discernment should then prompt the integration of these skills into their curriculum through a deliberate process of refinement and the introduction of innovative ICT courses. This strategy ensures the delivery of essential competencies that are crucial for navigating the perpetually shifting landscape of information.

Moreover, the possession of ICT skills transcends the mere acquisition of technical expertise; it serves as a catalyst for broadening students' intellectual horizons. By instilling these skills, educators stimulate students to engage in a diverse array of information and library-related activities, thereby enhancing their proclivity for employment and opening up avenues for continuous educational pursuits. The enrichment of students' skill sets not only augments their employability but also propels them towards a spectrum of opportunities for ongoing education and professional growth. In essence, an educational approach that is attuned to the dynamic demands of the information age is indispensable for cultivating individuals capable of thriving in a rapidly evolving technological landscape. [10], [12], [32], [33]. During the past ten years, a heightened scholarly curiosity has emerged in the exploration of the pivotal factors that exert a significant influence on students' academic accomplishments within higher education, notably via the use of AI data mining tools and techniques. This domain of inquiry is widely recognized as Educational Data Mining (EDM) [34]. The reasons for this interest include the research's capacity to detect low-performing students early enough to assist them overcome their learning issues and enhance their learning outcomes, which meets the institutional aims of delivering high quality educational environments [11]. Furthermore, EDM is developing as a significant topic of research because to its potential to extract new knowledge from massive amounts of student data [35].

For institutions of higher education committed to enhancing the quality of tertiary education, the efficacy of human capital development undergoes continuous scrutiny, as illustrated in Figure 1. Hence, forecasting student success becomes imperative for such institutions, given that the effectiveness of the teaching process hinges on its ability to cater to the diverse needs of students.

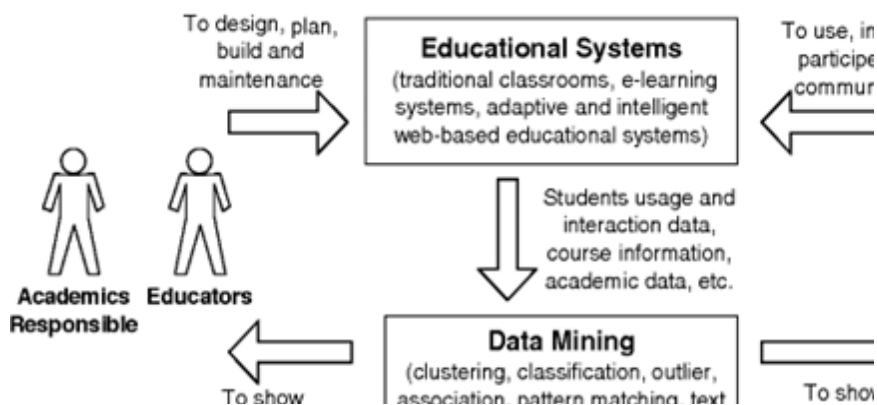


Figure 1. Datamining deployment cycle in higher education institutions [36].

Consequently, essential data and information are systematically collected and subjected to regular review by relevant authorities, with established standards serving as benchmarks to uphold educational quality. Quality in higher education extends beyond meeting the needs of students to encompass the satisfaction of academic staff

and other participants in the educational system. Participants in the educational process contribute significantly through their respective activities, generating substantial data that necessitates collection, integration, and utilization. Through the transformation of this data into knowledge, the contentment of all stakeholders is realized, including students, faculty, administration, and the broader social community [36].

The objective of data mining is therefore to enhance the value of the data contained in the information systems of companies. The first applications were made in the field of customer relationship management, which consists of analyzing customer behavior to better retain them and offer them adapted products. The search for information in large medical or health databases (surveys, hospital data, etc.) using data mining techniques is still relatively undeveloped, but should develop very quickly once the tools exist. The objectives of data mining methods can be grouped into four main functions[35], [37]:

Classify: we examine the characteristics of a new object to assign it to a predefined class. The classes are well characterized and we have a training file with pre-classified examples. We then build a function that will allow us to assign a new individual to such and such a class.

Estimate: classification refers to discrete events (for example: the patient has been hospitalized or not). Estimation, on the other hand, relates to continuous variables (for example: the length of hospitalization).

Segmenting: this involves determining which observations naturally go together without privileging any variable. A heterogeneous population is segmented into a number of more homogeneous subgroups (clusters). In this case, the classes are not predefined.

Predict: this function is close to classification or estimation, but the observations are classified according to a future behavior or estimated value. The previous techniques can be adapted to prediction using training examples where the value to be predicted is already known. The model, built on the example data and applied to new data, predicts future behavior.

It is very important to understand that data mining is not only the problem of discovering patterns in a dataset. It is only one step in a whole process followed by expert who seeks to extract knowledge from data.

3. MATERIEL AND METHODS

In order to accomplish our purpose concerning the ICT graduate students' profile, Figure 2 shows an empirical exploration employing the survey methodology and utilizing a questionnaire for data collection, to collect the data, social networks and AI datamining algorithms to predict students' profiles after the pandemic.

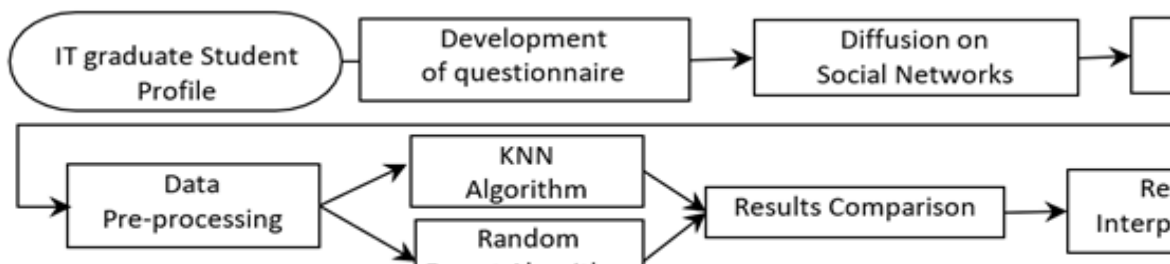


Figure 1. Different steps for designing and determining the computer science students' profile.

3.1. Questionnaire

The formulation of the questionnaire ensued subsequent to an exhaustive examination of pertinent literature and extant online surveys concerning competencies and skills pertinent to the computer science student profile. Noteworthy among the advantages of the questionnaire is its capacity to efficiently gather data from a substantial number of individuals at a comparatively modest expense. Its design requires minimal staffing and logistical arrangements, even for sizable samples. Additionally, the questionnaire enhances reliability by fostering consistent uniformity. The absence of variations in questioning, as may arise with different interviewers, contributes to the questionnaire's overall reliability. The questionnaire serves to diminish bias by eliminating the potential for intentional or unintentional influence by the interviewer on the responses. Due to the challenges associated with acquiring or offering clarification and additional information, meticulous design of the questionnaire becomes imperative. This meticulous design ensures that the questions encompass all essential information and maintain clarity and precision. Specifically, the auditor must thoughtfully deliberate on the audit objectives to precisely determine the required information achievable through the questionnaire. Furthermore, crafting a high-quality questionnaire necessitates a profound understanding of the subject matter and the respondents' capacity to provide the required information. It also mandates that the questionnaire developer possesses adequate familiarity with the respondents to formulate questions in a manner that ensures comprehension. The significance of prior knowledge becomes more pronounced when employing closed-ended questions (such as yes-no, selecting a choice, or indicating a degree on a scale) as opposed to open-ended questions (like filling in the blank, providing a short answer, or responding in a paragraph). The effective utilization of closed-ended questions necessitates the accurate indication of the potential range of answers. In situations where respondents lack essential knowledge or when the terminology is unclear or undefined, the likelihood of inaccurate responses increases.

On the other hand, closed-ended questions are easier in measuring and analyzing closed-ended questions pose fewer challenges compared to open-ended questions. The technical intricacies and time-intensive nature associated with disentangling numerous responses to open-ended questions, where respondents employ diverse terminologies, present significant difficulties. Additionally, the issue of illegible responses further complicates the analysis. Many questionnaires strive to strike a balance between incorporating both types of questions. In order to obtain information regarding the profile of computer science students, we conducted an exploratory empirical study using a questionnaire based on a personality test (Soft Skills) and a questionnaire on the competencies acquired during the university curriculum (Hard Skills). Our examination and assessment of every one is represented by a score characterized by a range of values as in the table below. Our questionnaire has been developed based on the skills that are most in demand in the IT field, both on the national and international IT markets. We divided the questionnaire into three parts: Personal Information, Soft Skills, Hard Skills (about 62 questions). It is worth mentioning that the study underwent a comprehensive review and obtained approval from the Institutional Review Board (IRB).

3.2. ICT Students' Profile

In order to describe the ICT students' profile (see Table 1), we checked every course and laboratory sessions of computer science curricula took before the pandemic to assume competencies from the objectives of learning. We used three parts of questions to cover the ICT profile and we asked 62 questions about personal information, and different Skills (Soft, Hard . . .). The examination and evaluation of each item resulted in a grading system with values delineated as presented in Table 2I below. Various software tools, namely Google Forms, Meta, and Twitter, were employed to formulate, disseminate, and test the research hypothesis. The ensuing statistical procedures are outlined in the following steps:

1. Statistical data analysis was employed to elucidate the characteristics of the study participants' profiles.
2. An assessment was conducted to determine whether the items constituting the profile measurement instrument are indicative of a singular latent dimension.

Data analysis was undertaken with the objective of elucidating pre-existing structures within the multivariable data.

Table 1. Skills, Characteristics, and Sources.

Skills	Characteristics	Sources
Text editing skills	Generating spreadsheets, constructing tables, developing pivot tables, executing and devising macros, conducting data analysis, visualizing data, validating data, and composing documents are fundamental skills within the realm of information management and analysis.	1st year laboratory sessions, all years projects and presentations,
Designing websites	Visual Design, Communication and Client Management, Time Management, User Experience, Behavioral Design, Coding Skills, Augmented Reality Design, Website SEO, Design Tools.	Websites design Lectures and laboratory sessions (1st and 2nd year)
Programming languages	Data structures and algorithms, Database management and SQL, Object-oriented programming (OOP) languages, Integrated Development Environments (IDEs), Cloud computing, Web development, Containers, Text editors, and Git version control represent a comprehensive array of fundamental elements within the domain of computer science and programming.	Programming Lectures and laboratory sessions (1st and 2nd year)
Operating systems	Clearance, Continuous Improvement, Technical Support, Data Entry, SQL, Linux, Disaster Recovery. System Issues, Windows, Vmware, Os, Hardware, Business Process, Sharepoint	Programming Lectures and laboratory sessions (2nd and 3rd year) Licence and Master
Communication and teamwork	Interpersonal communication, efficient allocation of time, adept problem-solving skills, active listening, analytical thinking, cooperative teamwork, and effective leadership represent essential competencies.	Collaborative laboratory sessions, cultural activities, students' Clubs, volunteering...
Entrepreneurship	Effective and proficient communication, the capability to advocate for oneself and articulate ideas or products persuasively, a heightened level of concentration, a proactive attitude toward learning and adaptability, and the development of a robust business plan are crucial attributes.	entrepreneurial endeavors events
Computer Networks	Working with Windows, Os or other operating systems, must know how computers work, build computer systems, techniques required to install computer components and softwares and how to upgrade systems	Computer Networks Lectures and laboratory sessions
architecture of Computers	Microarchitecture, Instruction set architecture, System design	Computer architecture Lectures and laboratory sessions
Crucial skills for adaptation	Effective and fast learner with strong memory,	Internship in companies for the graduate
Database Administration	Outstanding problem-solving skills, logical reasoning, practical judgment, and above-average memory, coupled with curiosity and a robust inclination for continuous learning.	Lectures and laboratory sessions
Mobile App Development	knowledge of multiple programming languages, Experience in Agile Methodologies, Cybersecurity Guidelines,	Projects, Development Lectures and laboratory sessions,
Foreign languages	Boosting Memory, Listening, Outgoing and Sociable, Creative, Tolerant of People, Nonverbal Intelligence, Lateral Thinking	Lectures, self-learning, special courses...

2.3. Data Pre-processing

In order to process the raw data received, it must be preprocessed before being injected into the chosen algorithms (RF and KNN Algorithms). The answers have been transformed into the standard form 1, 2, 3 in order to facilitate the input of data into algorithms. After that, answers that have a minimal percentage of answers were eliminated by calculating the number of answers for each question. Then, grouping of similar questions is intended to reduce the number of values that must be considered by the algorithm.

- Preliminary determination of student’s profile: The last column displays the variable result of data collected, which indicates whether the student has an ICT profile or not, so it has been coded as (1) for an ICT Student otherwise as (0) for a non-ICT student.

- Transforming Data into CSV file: At this stage, building a compatible and easy/quick to process CSV file for the input of the classification algorithms, supervised learning, in the form of the lines in 1, 2 and the last column represents our Preliminary determination of student’s profile, the latter is in the form of 1/0.
- Implementation of classification algorithms: Since Students already answer the question” I believe that I have an ICT student profile” than our investigation aligns with supervised learning, specifically employing the K-nearest neighbors algorithm method. In scenarios where there is a lack of prior information regarding the distribution of incoming data, K-nearest neighbors (KNN) emerges as an optimal approach. This method involves calculating the distance between the query and the complete training dataset, subsequently classifying it based on the majority labels of its k-nearest neighbors. The rationale for selecting this approach in fault identification is rooted in the dynamic nature of the distribution of incoming current values, which varies with each instance.

After KNN, Random Forest Algorithm is used to assess KNN classifier’s accuracy rate. Both algorithms were executed in Python, a programming language renowned for its simplicity in syntax, along with its vibrant community and extensive array of libraries and resources. This choice aligns with the preferences of professionals in data science applications, who seek to avoid intricate programming demands and value Python’s user-friendly nature.

3. RESULTS AND DISCUSSIONS

After the distribution of the questionnaire, the target sample is composed of 152 students. They are enrolled in three different universities (Mascara, Oran and Ain Temouchent) in computer sciences departments Licence and Master. Table 2 provides an overview of group demographic characteristics, including gender and age.

Table 2. The Gender and Age Variables.

Gender		Age	
Male	Female	20-25	Over 25
78.94 %	21.05 %	27.63 %	72.36 %

Data collection spanned a duration of six weeks. The raw data received requires pro-processing before injecting it into the chosen AI Datamining algorithms; Figure 3 shows percentage of students’ titles.

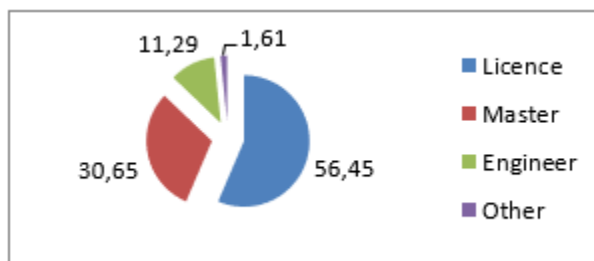


Figure 3. Percentage of students’ titles

This paper has the objective that consists of trying to determine the profile of students from their assessments according to the questionnaire and with datamining algorithms that can predict whether a student has the skills in computer science or not. The Soft Skills characteristics that define the computer science student, as described in the questionnaire, are much better than those indicative of individuals well-adjusted to the social and cultural milieu are prevalent traits. The rationale underlying this observation posits that computer scientists tend to be more socially adept, having matured within a society centered around computing. Simultaneously, within an era of heightened communication, a notable proportion comprises individualistic students reserved and less socially inclined individuals who prioritize internal contemplation over external social engagement. This characteristic proves

advantageous in the IT job market, as these individuals require fewer external incentives for achieving satisfactory motivation levels, as evidenced by social network analysis results (where individualists dominate and gravitate towards job opportunities emphasizing technical skills). Consequently, they may be more aptly suited for software development, particularly tasks demanding intricate concept analysis, advanced projection, or algorithmic proficiency.

Conversely, the study reveals a significant cohort of socially inclined students who may exhibit lower motivation levels during programming tasks, irrespective of language or environment. This is attributed to their heightened need for social interaction, implying a better fit for roles involving programming related to social activities. On the other hand, the university curriculum and teaching methodologies have an important impact on the construction of future computer scientists. Obviously, if the issue of professional and personal profiles is the learning required to exercise the professions in their diversity, the framework of the latter is presented as a reasoned sequence of reasonable risk-taking and constitutes an essential vector for professional development. Moreover, these methodologies or teachers guide professional development by being actualized in the institutional training project as each student represents it. But, beyond the generalized implementation, what lessons can be drawn from these results to ensure that the pedagogical organization of the Bachelor's or Master's degree best contributes to students' projects and, consequently, to their professionalization? Our work confirms, first of all, the results obtained at other levels of higher education. As shown by the weight of discursive references to peers and collaboration in the three lexical sets, the construction of individual projects takes advantage of the developmental spring of social interactions within the Licence's or Master's training group. The program of study must therefore give students the time and means to explore, at the beginning of their training, various possible fields of insertion (documentary research, meetings and exploratory interviews with "people in the profession") in relation to a problem or a question of a professional nature, while circumscribing the relevant fields of practice. The anchoring and confrontation of projects with professional realities must also lead students to better learning experience.

At last, the impact of the pandemic crisis on students' ICT skills is multifaceted. Firstly, the sudden shift to remote learning necessitated by lockdowns and safety measures has accelerated the reliance on digital tools and platforms. Students, out of necessity, had to adapt quickly to virtual classrooms, online collaboration tools, and digital resources. This rapid transition has both highlighted existing disparities in ICT proficiency among students and created a learning curve for those less familiar with technology. Furthermore, the increased screen time and dependence on online resources during the pandemic have influenced the nature of ICT skills needed. There is a heightened emphasis on skills such as digital communication, information literacy, and the ability to navigate various online platforms effectively. However, challenges such as the lack of access to reliable internet and appropriate devices for some students have widened the digital divide, exacerbating inequalities in ICT skill development. So, the pandemic has underscored the importance of ICT skills in education, with both positive and negative impacts. It has expedited the integration of technology into learning but has also accentuated disparities in ICT access and proficiency. In another hand, assessing whether students possess a comprehensive and adaptable ICT profile reveals a nuanced landscape. While many students exhibit a familiarity with basic digital tools, such as word processors and email, the comprehensive nature of their ICT profile becomes more intricate when considering advanced skills and adaptability. Students may proficiently use social media and common applications but might lack proficiency in more specialized tools needed for educational and professional purposes. The adaptability of their ICT profile is influenced by their capacity to swiftly learn and navigate new technologies. The pandemic has accelerated the need for adaptability, as students had to quickly transition to new online platforms and modes of learning. However, disparities exist among students based on factors like socioeconomic status and prior exposure to technology. Some students may possess a more adaptable ICT profile due to prior experiences, while others may face challenges in embracing new technologies. While many students exhibit a baseline ICT proficiency, the extent of their comprehensive and adaptable ICT profile varies. Factors such as prior exposure, socio-economic conditions, and the rapid technological changes introduced by the pandemic contribute to this diversity in students' ICT capabilities.

Table 3. Summary of research on ICT skills of student profile using datamining algorithms.

Ref.	Context	Focus	Methodology	Key Findings
Our study	assessing the impact on education and the ICT skills of CS graduates during COVID-19 crisis.	reveal that while students generally possess basic ICT skills, areas for improvement exist.	questionnaire-based approach alongside social network and data mining algorithms	emphasizing the need for continual adaptation of education strategies.
[38]	Predicting Student Dropout in Computer Science	Higher education dropout rates in Computer Science.	Educational data mining techniques.	Logistic Regression best predicts dropout with identified causes.
[39]	Early Diagnosis of Autism Spectrum Disorder (ASD)	Early diagnosis of ASD using language modalities.	LSTM networks, vocal turn-taking metrics.	Proposed framework outperforms industry algorithms in predicting ASD severity.
[40]	Mixed Methods in Data Mining for Sports Performance	Data mining complementing mixed methods for sports performance.	Data mining techniques on the Psychological Inventory of Sports Performance.	Decision trees reveal relationships among performance factors, gender, and age.
[41]	Data Mining for Admissions Decision Making	Predicting applicants' academic performance for admissions.	Data mining techniques on a dataset from a Saudi public university.	Early university performance prediction based on pre-admission criteria, with Artificial Neural Network outperforming other techniques.
[42]	Student Performance Analysis in Educational Data Mining (EDM)	Systematic review of EDM studies on student performance in classroom learning.	Identifying predictors, methods, and temporal aspects in 140 studies.	Efficient prediction during the course but challenges in predicting before course commencement.
[43]	Data Mining for Education Resource Planning in Ghana	Analyzing Ministry of Education data for accurate education resource planning in Ghana.	Data mining techniques to identify inaccuracies in population projection.	Proposed expert system to assist in managing inaccuracies.
[44]	Predicting Students' Performance using Ensemble Models	Predicting students' performance at different stages using ensemble models.	Graphical, statistical, and quantitative techniques for feature analysis; ensemble models.	High accuracy and low false positive rate achieved at all stages with proposed ensemble models.
[45]	Student Success Analysis with Random Forest (RF)	Student success analysis and prediction using data mining.	Supervised learning with different classification models, focusing on RF	Random Forest found to be better and more accurate in predicting student academic performance.
[46]	Modeling Students' Effort and Learning Ability.	Modeling students' effort and learning ability in a dynamic scenario.	A generative model considering temporal variations.	Proposed model outperforms other competitive methods.
[47]	Factors Affecting Students' Academic Performance	Identifying factors influencing students' academic performance.	K-means & X-means clustering on various factors.	Parents' occupation, qualification, and income rate identified as significant factors.

In summary, the collection of academic papers covers a diverse array of applications within the realm of data mining and educational analysis, expanding to include a study on the impact of the COVID-19 crisis on education and the skills of computer science graduates. This particular work is situated in the context of the pandemic, emphasizing the need for continuous improvement in teaching and learning abilities for students and teachers. The primary focus is on assessing the influence of the crisis on education and underlining the importance of students acquiring ICT skills, especially in the context of computer science graduates. The methodology involves a questionnaire-based approach combined with social network and data mining algorithms, providing a comprehensive assessment of students' ICT skills and experiences. The key findings indicate that, overall, students possess fundamental ICT skills, but there are areas that require attention for improvement, aligning with the broader theme of adapting education to meet evolving needs. This research not only contributes to understanding the post-COVID-19 educational landscape but also provides a valuable methodology for assessing and predicting students' skills and behaviors, serving as a foundation for educational adaptation in the changing landscape.

CONCLUSION

TheAn array of ICT skills has emerged as an essential tool for individuals and professionals alike in the rapidly evolving digital age. It is becoming increasingly important for developers to be proficient in programming languages such as Python and Java, since these languages enable the development of applications, websites, and software solutions. By mastering data analytics skills, including data mining and machine learning, individuals will be able to extract actionable insights from vast datasets in order to make informed decisions across a wide range of industries. With the rise of cyber threats, cybersecurity expertise has taken center stage, with specialists protecting digital assets and confidential data. Proficiency in cloud computing platforms like Amazon Web Services (AWS) and Microsoft Azure is crucial for efficiently storing and processing data in a scalable manner. Further, for businesses seeking success in the online marketplace, proficiency in digital marketing tools and strategies is essential. Individually and collectively, these skills represent the foundation for success in today's technologically driven world, and their acquisition is crucial for both personal and professional development. The COVID-19 pandemic has highlighted the importance of ICT skills and online learning in contemporary education. In light of unprecedented challenges, we have found that these skills are not just advantageous, but have become indispensable. We have delved into the demands of the contemporary labor market, which consistently seeks individuals proficient in a spectrum of ICT competencies, making these skills pivotal for students aspiring to become sought-after professionals in various industries.

Moreover, through our comprehensive approach combining data mining and social network analysis, we have been able to gain valuable insights into the skills and behaviors of computer science students. This journey has illuminated the inadequacies of conventional teaching methods and has the potential to pave the way for education transformation. By generating real profiles of computer science graduates, we aim to bridge the gap between academic curricula and global industry requirements. Looking ahead, this study holds promising prospects. It can extend its reach to universities, evaluating the effectiveness of their programs and modules in cultivating ICT skills. Simultaneously, it can be employed by companies to enhance the efficiency of their employees' tasks, creating a synergy that links students, universities, and the professional world.

In our quest for precision, we integrated the outcomes of our research into two datamining well-known algorithms Random Forest (RF) and K-Nearest Neighbors (KNN), with RF demonstrating higher accuracy based on our dataset. These results constitute a tangible contribution toward better understanding the profiles of computer science students. Ultimately, our study is poised to serve as a guiding beacon for students and parents alike, offering invaluable insights into the choices they make regarding higher education programs. As we extend this research further, we anticipate a broader and more profound impact on the educational landscape, one that not only equips students with the ICT skills they need but also ensures that their education is closely aligned with the evolving demands of the global workforce. The journey towards an ICT-rich future in education has begun, and it promises to be an exciting and transformative one.

More comprehensive perspective on the multifaceted role of ICT skills in contemporary society, ranging from education and work to digital literacy and ethical considerations might be:

1. Remote Collaboration and Communication: the experienced crisis highlighted the ICT skills' critical role by facilitating remote collaboration and communication. Proficiency in tools like video conferencing, project management software, and virtual teamwork platforms has become essential for maintaining productivity and connectivity in remote work environments.
2. E-Learning and Educational Technology: Beyond the pandemic, the integration of educational technology and e-learning platforms has transformed traditional education. ICT skills are not only essential for students but also for educators who must adapt to new teaching methods and technologies.

3. **Digital Literacy:** Digital literacy, encompassing skills related to internet safety, online information evaluation, and digital citizenship, has become crucial in the age of information. Individuals with strong digital literacy can navigate the vast digital landscape effectively and responsibly.
4. **Data Privacy and Ethics:** As data collection and analysis become ubiquitous, understanding data privacy laws and ethical considerations is paramount. ICT professionals and users must be aware of the ethical implications of data handling and analysis.
5. **IoT (Internet of Things) and Automation:** The Internet of Things and automation technologies are reshaping industries. Proficiency in ICT skills related to IoT, sensors, and automation programming can drive innovation and efficiency in various sectors.
6. **Artificial Intelligence and Robotics:** ICT skills encompassing artificial intelligence (AI) and robotics are at the forefront of technological advancements. These skills are not only sought after in the job market but also have far-reaching implications for industries like healthcare, manufacturing, and finance.
7. **Cybersecurity Awareness:** With the increase in cyber threats, ICT skills related to cybersecurity have become indispensable. Organizations and individuals require expertise in threat detection, prevention, and incident response to safeguard their digital assets.
8. **Adaptive Learning and Continuous Skill Development:** The ever-evolving nature of technology necessitates continuous learning and adaptability. Proficiency in ICT skills is not static; individuals must commit to lifelong learning to stay relevant in the fast-paced digital world.
9. **Global Connectivity and Multilingualism:** ICT skills can bridge geographical and language barriers, enabling global connectivity. Multilingualism and cross-cultural communication skills are increasingly valuable in an interconnected world.

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