International Journal of Computing and Digital Systems
2025, VOL. 17, NO.1, 1-10

http://dx.doi.org/10.12785/ijcds/1571029446

Digital Intelligence for University Students Using Artificial Intelligence Techniques

Ban Hassan Majeed[1], Wisal Hashim Abdulsalam[2], Zainab Hazim Ibrahim[3], Rasha H. Ali[4] and Shahlaa Mashhadani[5]

[1,2,3,5]*Computer Department, College of Education for Pure Science/Ibn-Al-Haitham, University of Baghdad, Baghdad, Iraq*
[4]*Computer Science Department, College of Education for Women, University of Baghdad, Baghdad, Iraq*

Received 11 May 2024, Revised 11 November 2024, Accepted 28 November 2024

Abstract: The research problem arose from the researchers' sense of the importance of Digital Intelligence (DI), as it is a basic requirement to help students engage in the digital world and be disciplined in using technology and digital techniques, as students' ideas are sufficiently susceptible to influence at this stage in light of modern technology. The research aims to determine the level of DI among university students using Artificial Intelligence (AI) techniques. To verify this, the researchers built a measure of DI. The measure in its final form consisted of (24) items distributed among (8) main skills, and the validity and reliability of the tool were confirmed. It was applied to a sample of 139 male and female students who were chosen in a random stratified manner from students at the University of Baghdad, College of Education for Pure Sciences/Ibn Al-Haitham, Department of Computer. The proposed AI model utilized three artificial intelligence techniques: Decision Tree (DT), Random Forest (RF), and Gradient Boosting Machine (GBM). The classification accuracy using DT was 92.85 and using GMB was 95.23. The RF technique was applied to find the essential features, and the Pearson correlation was used to find the correlation between the features. The findings indicated that students indeed possess digital intelligence, underscoring the potential for tailored interventions to enhance their digital skills and competencies. This research not only sheds light on the current DI landscape among university students but also paves the way for targeted educational initiatives to foster digital literacy and proficiency in the academic setting.

Keywords: Digital Intelligence, Artificial Intelligence, University Students, DT, RF, GBM, Pearson correlation.

1. Introduction

Digital intelligence (DI) enhances innovation and creativity capabilities through technology and digital tools, as individuals can transform their ideas into reality and develop new solutions to complex problems. This requires thinking innovatively and creatively using digital tools [1].

However, we must face some challenges associated with DI. For example, overreliance on technology can lead to a decline in basic skills such as concentration and critical thinking. We may also have to face challenges related to digital privacy and security. Therefore, we must be careful and learn to use technology safely and responsibly.

Artificial intelligence (AI) is rapidly emerging as the most important transformative technology of our time and is considered one of the biggest challenges facing organizations seeking to transform into the digital age, as recent developments, especially in machine learning (ML), have led to the computer's ability to improve its performance without human intervention, with the rapid spread of new applications that have changed the work laws of many institutions, ministries, and companies in almost all industries. AI can help accomplish many professional, functional, and commercial activities with greater accuracy and in a small fraction of the time compared to what it takes humans to do. It also provides an alternative to human judgment because AI can analyze and predict a lot of data based on available data that humans cannot easily discover, as demonstrated in references [2], [3], [4].

The importance of DI, is that it is a social, cognitive, and emotional ability that enables the individual to face the challenges and situations that he/she is exposed to in the digital world in a proper way and which gives the individual appropriate and responsible behavior during his/her interaction in the digital environment [5].

The contribution and importance lie at two levels, theoretical and applied. The theoretical importance comes from the absence of any study that measures DI using AI techniques for university students in Arab countries, especially Iraq, to the best of researchers' knowledge. This research is also important because it sheds light on DI, its skills, and the

E-mail address: ban.h.m@ihcoedu.uobaghdad.edu.iq, wisal.h@ihcoedu.uobaghdad.edu.iq, zainab.h.i@ihcoedu.uobaghdad.edu.iq, rashaha2003@coeduw.uobaghdad.edu.iq, shahlaa.t@ihcoedu.uobaghdad.edu.iq

importance of the role of university institutions in providing their students with these skills, and because technology, AI, and the products and services they provide are important in the state's development plans in all fields. Education has a particularly large share, which demonstrates the importance of technology. Furthermore, with AI and its entry into our lives and with this rapid growth in technology, many enormous ethical, educational, and technical challenges have emerged, and the use of AI, which is expected to result in unprecedented social phenomena, calls for the importance of thinking about the uses and applications of intelligence and that the needs of today's education are best met through the concept of developing DI that includes various areas and many skills. Also, the importance of this research stems from the fact that the researchers developed a scale to measure its availability among students of a college with a scientific specialization within a government university that is considered the mother university for Iraqi universities in Iraq.

Enriching educational content with DI and its skills, which are considered necessary skills in light of the technological developments and progress we are witnessing in our current era, and highlighting DI skills and the necessity of acquiring them for our students, because these skills will help students in the responsible, safe, and ethical use of digital space. It helps curriculum developers recognize the importance of including DI skills in content. Teaching and activities appropriate to the characteristics of the stage. The research results present the level of possession of DI by students, which contributes to developing plans and programs to develop it and enhance their skills. There is also a severe lack of educational research and studies that have dealt with DI, as well as the computerization of a measure of DI. This research is considered one of the first in Iraq, as DI, as we are witnessing, is considered one of the important goals in the educational and pedagogical process in the current era. Due to the technical revolution represented by AI products and services and the involvement of all members of society using it. The importance of DI has become a pivotal role in shaping the personality of the university student and directing his/her mental abilities and practical practices toward achieving a better reality through the optimal use of his/her mental and intellectual abilities. In addition, providing a computerized scale to measure DI among university students that can be used. This research is also important because it sheds light on DI skills, which prepare the individual to deal with technology in the digital world with sufficient awareness by improving and benefiting from the positives and preventing and avoiding risks. The practical importance comes from providing a computerized measure of DI for university students that other researchers can benefit from.

Our limitations are:

1) The students are from all the 4^{th} grades (1-4) in the Computer Department in the College of Education.
2) 1st Semester 2023-2024.
3) DI Test.

2. Related Works

A. Digital Intelligence (DI)

It is the set of technical, cognitive, social, and emotional capabilities that enable people to use digital tools efficiently, and they have the right to know their digital identity and their rights and duties in using it, dealing with digital problems, and adapting to the requirements of digital life in a way that achieves safety and security for them [6]. It is also the ability to understand digital concepts through the Internet and use them appropriately, and to solve technological and information problems, and communication problems of communication via the Internet [7]. It is defined procedurally as the amount of score that students obtain when dealing with the items on the scale. It represents the ability of individuals to deal with knowledge and use digital technologies in a way that enables them to interact successfully and usefully with their digital environment. Their capabilities are divided into three levels as follows [8]:

1- Digital citizenship refers to the ability to use technology and digital media in a safe, responsible, and moral way.
2- Digital creativity refers to the ability to become part of the digital ecosystem.
3- Digital competitiveness refers to the ability to solve global challenges, innovate, and create new opportunities in the digital economy by stimulating increased business, jobs, growth, and impact.

B. Skills of DI

DI emerges from human values, such as respect, accepting differences, activating positive communication, and other things that enable the student to acquire DI skills and to be a leader in technology, not a coordinator of it. Teaching DI skills and imparting them to our students has become an urgent necessity in light of the developments we are experiencing in technology [9], the fourth industrial revolution, AI, and the Internet of Things (IoT) knowing that these technologies have been in the last few years. The future will be an essential part of everyone's life, and therefore students need these skills to have a better future and opportunities:

1- Screen Time Management (STM): It is the time spent using any device, whether it is a TV, A computer, a smartphone, video games, or a tablet for entertainment [10] It is the ability to manage time when using the screen. This skill aims to raise awareness among student users of the harms caused by prolonged screen time, such as electronic addiction and disruptive behavior, as well as the neglect of other responsibilities. This skill also enables the student to master the balance between screen time and his/her other tasks outside the Internet. It also determines his/her priorities, the need for parents to participate in Internet activities, and their awareness of them [11].

2- Digital footprint management (DFM): The digital fingerprint is the data that is formed during the use of the Internet, including the websites the student visits and logs in to, the emails, photos, and videos that he/she sends [12] indicated that the digital footprint includes activity in the digital environment and that what is published on the Internet lasts for years; even if it is deleted, it can be retrieved. Therefore, students must be creative and positive in using online content, understanding the benefits of cooperative and group learning using Internet tools, sharing knowledge and resources, and focusing on protecting their personal information and building a positive digital reputation. This skill aims at allowing the student to understand the nature of communication via the Internet, to raise his/her level of responsibility when he/she is in contact with the digital world, and to be sufficiently aware of the enrichment of his/her digital imprint, whether positive or negative, on his/her digital reputation. The student must realize that this digital imprint is permanent. They cannot be deleted or changed in the digital space, indicating that the digital footprint includes activity in the digital environment and that what is published on the Internet lasts for years; even if it is deleted, it can be retrieved. Therefore, students must be creative and positive in using online content and understanding the benefits of cooperative and group learning using Internet tools, sharing knowledge and resources, as well as focusing on protecting their personal information and building a positive digital reputation [13].

3- Management of privacy (MP): It is an important digital skill that enables an individual to protect his/her information, personal data, and contact information from theft, plagiarism, etc. This skill aims to raise awareness of the danger of sharing their data and their personal information and realize the importance of maintaining privacy on social media sites. The student also learns to handle his/her information and disclose it, especially since social networks collect users' personal information, and from this information and data, they can direct products, services, etc. to these users. This is the type of targeted advertising from which social media generates huge profits [14].

4- Managing Cyberbullying (MC): It requires a necessary skill for students to detect cases of bullying and bullying on the Internet and deal with them consciously and cautiously to avoid harm. The parties to cyberbullying are the bully, the bullied (the victim), the supporter of the bully, and the silent, passive person who does not accept bullying but is silent and ignores it [15].

5- Digital empathy (DE): Develop relationships in the digital community, pay attention to the feelings of others, and build good relationships in the online world. It is defined as the individual's ability to consider the needs and feelings of others, pay attention to them, and respond to them. Friends and acquaintances on social networking sites, respecting the point of view of others who disagree with their point of view and their opinion, confronting speeches, reducing hatred and violence, and controlling emotions when exposed to emotional situations electronically [7].

6- Digital Citizen Identity (DZI): [16], [17] Defined digital citizenship as a code of conduct concerning the optimal use of technology. Digital citizenship is important among learners, training them practically in dealing with modern digital technologies and providing them with the appropriate means and methods to take the proper solution if they are exposed to electronic blackmail.

7- Electronic (Cyber) Security Management (ECM): Cybersecurity is defined as targeting websites through other electronic means and is a group of practices that aims to protect systems, networks, programs, and individuals from digital attacks of any kind. These various practices have proactive precautionary measures before the failure occurs and remedial measures after the failure occurs. So, it is a digital skill that enables an individual to create word traffic and be strong, which will contribute to avoiding electronic attacks. This skill aims to empower the individuals to protect themselves from the dangers of the Internet from phishing, intrusion, and theft of his/her data and personal information [18].

8- Critical Thinking: Defined by [19] as the type of thinking that depends on careful examination of all premises and evidence, then is based on a slow step-by-step progression and is characterized by objectivity to the greatest extent possible with the aim of arriving at sound results characterized by validity, stability, and honesty. It is one of the most important types of thinking that must be paid attention to by those in charge of education in general, as the learner can distinguish between what is good from the information and ideas he/she receives and not accept any customs and traditions, whether inherited or imported, except after reconsidering them and making judgments. This skill makes the student positively critical in distinguishing between information and content. The real and false, between good and bad friendship relationships, and safe and unsafe activities, and how to beware of strangers in the digital world [20].

Researchers believe that these skills are a comprehensive set of technical, cognitive, social, and emotional skills that enable individuals and societies to face challenges and harness digital life, as a tool was built to measure DI based on these main skills.

C. The importance of DI lies in [21]

1- Enables students to face and adapt to the demands of digital life.
2- Manage student digital identity online and become aware of it.
3- The ability to use and control digital devices to achieve a balance between life online and outside.
4- The ability to manage risks and detect electronic threats.
5- Communicate, empathize with others via the Internet, and build good relationships with them.
6- Create and evaluate online content.
7- Understanding personal and legal rights and freedom of expression online.

3. Artificial Intelligence (AI)

Is a computer science field related to computer systems that possess characteristics associated with intelligence, decision-making, and similarity to human behavior in various fields [22]. It is the result of the contemporary technological revolution. AI initially aimed to simulate each of the various intelligence capabilities through machines by understanding the complex mental processes that the human mind performs [23].

A. Characteristics of AI

Among its characteristics is the ability for [24]:

1- Thinking and perception.
2- Discovering and applying knowledge.
3- Learning and understanding from previous experiences and expertise and using them in new situations.
4- Using trial and error to explore disputed matters.
5- Rapid response to new situations and circumstances.
6- Development, creativity, understanding, and perception of visual matters.
7- Providing information to support administrative decisions.
8- Finally, it is used to solve problems presented in the absence of complete information.

B. Features of AI [25]

These features highlight the benefits of AI in various fields, such as analyzing large amounts of data, developing innovative interactive applications, and solving complex problems.

1- Processing speed: the ability to process data and perform calculations quickly and effectively.
2- Accuracy: the ability to perform tasks with high precision and obtain accurate results.
3- Continuous learning: The ability to learn from previous data and experiences to enhance performance over time.
4- Dealing with large information: the ability to deal with, analyze, and extract information from large sets of data.
5- Diagnosis and problem solving.
6- Human interaction ability: The ability to interact and communicate with humans naturally and effectively.

C. The Importance of AI

1- The efficacy and effectiveness of AI; it is used with robotics in the mining and exploration process.
2- Digital assistance programs: Help us in daily work. For example, there are personal assistance programs that listen to us perform the task with one click and help us travel around the world.
3- Helping to make rational and correct decisions: For AI, logic has priority over the rest of the components, as it makes correct decisions if they are worked on rationally, but we see the opposite with humans, where at some point they use emotion. Robots or artificial thinkers have no side. Emotional intelligence is what makes people more effective, as it can make the right decisions in a short period.
4- Medical applications: Among the most important uses of AI in the medical field are those programs that are directed at assessing patients and their health risks with the help of machines [26].
5- Eliminating repetition in performing tasks: It is useful in eliminating repetition of tasks resulting from the multiplicity and frequency of tasks and the person being under a set of pressures, as it includes preparing specific programs for tasks, to avoid repetition or randomness in executing the orders entrusted to him, given its distinctive features. These programs are complex and organize the work that must be carried out in the form of a schedule that eliminates the possibility of repetition.
6- Time management: A large number of companies and institutions are under pressure resulting from mismanagement of time and repeatedly exploiting it to perform the same tasks. In the same context, AI works to save a lot of time for these companies by inventorying all data and collecting it in less than a period. Man saves time from wasting.
7- The possibility of representing knowledge: AI programs use a special structure to describe knowledge, and this structure includes facts and relationships linked to each other by rules, most notably the knowledge base, which provides access to a large volume of information about The problem to be solved with great ability to represent it.
8- Delving deeper into specializations: AI can help in in-depth research of users' desires and preferences, helping to identify individuals' tastes and requests, working to meet and implement them, and creating a complete vision of the required and desired product. This is one of the most important methods used in advertising and marketing products.
9- Software and humans at the same level: When AI is introduced on a large scale, software and humans will become like one team at work, as applications will be dealt with through software and not humans [27].

To the researchers' knowledge, this is the first study of its kind, as it included a sample of students from a college with a scientific specialization in the field of education and upbringing. This is considered positive for the researchers, as they are academic professors who used their students to measure a numerical variable.

4. Materials and Methods

This study used baseline data from the students' survey of stages (1-4) in the Computer Department / College of Education for Pure Science, Ibn-Al-Haitham / University of Baghdad, IRAQ. One hundred and thirty- nine students consented to participate.

Classification and Feature Selection

An overview of the feature selection and classification methods used is provided below.

Feature selection is a fundamental part of pattern recognition and ML, as it removes irrelevant, noisy, and extraneous data from raw features, which leads to an improvement in the effectiveness of prediction models. In this study, feature importance scores were derived with the Random Forest (RF) algorithm, which is employed in ML [28]. Builds several decision trees; each tree uses the Gini index (or another) to find the best way to split the data, favoring splits that maximize class separation. The final decision is determined by the majority vote of all individual trees. RF has many advantages, such as being able to handle complex data well, robust to outliers, and easier to interpret [29].

A Decision Tree (DT), a widely used method in machine learning, is considered highly valuable due to its reasonable accuracy and relatively low computational cost. This supervised learning technique classifies labeled training data into a tree or set of rules. Recursively divides a data domain (node) into two subdomains based on the highest information gain to optimize the split for maximum information gain [30].

The Gradient Boosting Machine (GBM) is a powerful machine learning algorithm that is gaining considerable traction in a wide range of data-driven applications, such as computer vision [31].

A. Correlation Coefficient

Pearson is a statistical indicator of how much the values of two variables vary from each other and shows how strongly two variables are linearly connected. The correlation coefficient, which measures the linear correlation between two discrete-time signals, is defined in (1) [32]:

$$P_{x,y} = \frac{Cov_{x,y}}{\sigma_x \sigma_y} \tag{1}$$

where x and y represent the standard deviations of $x[n]$ and $y[n]$, respectively, and $Covx, y$ denotes the covariance of two signals. The correlation coefficient, x, y, ranges in value from -1 to $+1$. There is no linear relationship between the two signals if the value is equal to zero. A significant positive correlation between the two signals corresponds to a value near $+1$ for the x, y values, and a strong negative correlation to a value close to -1.

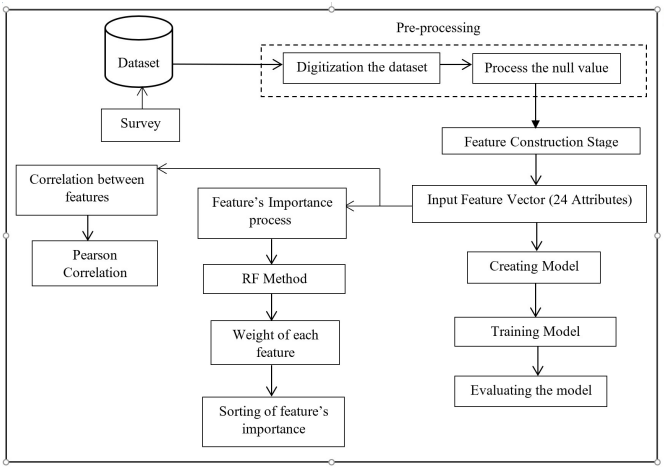

Figure 1. The proposed model architecture

5. The Proposed Model

In general, the idea of the suggested model is to create a model using the Decision Tree (DT) algorithm and Gradient Boosting Machine (GBM), which is one of the ML algorithms used in classifying the features of the dataset. This suggested model contains four stages: data collection, pre-processing, feature construction, and classification. As shown in Fig. 1, feature selection has been used using the Random Forest algorithm, which is one of the machine learning algorithms; this algorithm is used to select important features that affect classification, and the correlation between features has been calculated using Pearson's correlation.

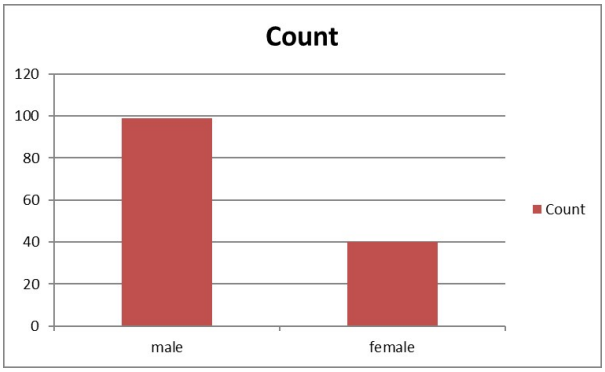

Figure 2. The histogram of male and female counting

A. Data Collection

Data were collected using a survey, which was completed by the undergraduate students of stages (1-4) in which they are a research sample. The questionnaire contained 12 groups with 24 questions, which were taken up by the specialists. The questionnaire statements were written in Arabic and distributed to students through Google Classroom. The students had answered only one hundred

TABLE I. THE DIGITAL VALUE OF THE ATTRIBUTES

Attribute	Scores Based on Likert Scale
I strongly agree	5
I agree	4
Neutral	3
I disagree	2
I strongly disagree	1

thirty-nine. Most of the responses are from males. Fig. 2 shows the male and female histograms in the dataset.

B. The Pre-processing Stage

This pre-processing step is vital in the prediction process, as it repairs the data to ensure that it can be employed in feature selection and hence the classification stage. Two processes were carried out at this stage. First, the discretization of attributes was conducted. In the questionnaire, the values of each attribute were divided according to "The Likert scale." The value of scaling digitally is presented in TABLE I. The class label classifies binary classification as either existing or not. The class label was computed by the threshold using Eq. (2) for each instance. In this work, the threshold value was (95). Secondly, processing the null values (if there are any) in the dataset by taking the mean using Eq. (3). The dataset contains 139 records. The dataset contained (87 for one-class labels and 52 for zero-class labels). Fig. 3 shows the histogram of the class label.

$$S = \sum(x); \quad T = \frac{\max x + \min x}{2} \tag{2}$$

$$\mu = \frac{1}{N}\sum_{i=1}^{N} x_i \tag{3}$$

C. Features Construction Stage

At this stage, the attributes are directly selected using the feature selection method to build the artificial intelligence model. There were 24 attributes in the dataset. Using the questionnaires indicated in the previous section, the students filled out these characteristics. The score of each feature ranges from 1 to 5. TABLE **??** presents the feature number in a model of artificial intelligence, attribute, and description of the feature, while TABLE II shows the group of features.

D. Evaluation of the Classification Stage and Performance

As mentioned in the previous subsection, the feature vector was constructed from the responses to the questionnaire. The number of features is twenty-four. DT technique and GBM have been used for classifying the feature vector. The dataset contained 139 instances. The proposed work is evaluated using the following equations [33]

$$Accuracy = \frac{TP + TN}{TP + FN + TN + FP} \tag{4}$$

where $TP = true$ positive, $FN = false$ negative, $FP = false$ positive, and $TN = true$ negative.

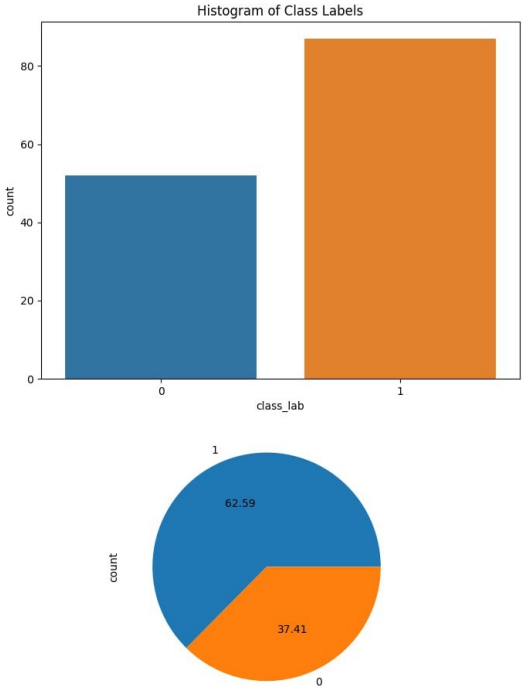

Figure 3. The histogram of the class label for databaset

Recall is the rate of correctly predicted positive observations for all observations in an actual class, as shown in Eq. (5) below:

$$Recall = \frac{TP}{TP + FN} \tag{5}$$

Precision is the ratio of correctly predicted positive observations to the total predicted positive observations, as shown in Eq. (6) below:

$$Precision = \frac{TP}{TP + FP} \tag{6}$$

The F1 score is a measure of the accuracy of a test. Considers both the precision and the recall of the test to compute the score, as appears in Eq. (7) below:

$$F1 - score = \frac{2 * Recall}{Precision + Recall} \tag{7}$$

E. The Classification Stage

In this stage, the model is created using a Decision Tree (DT) and Gradient Boosting Machine (GBM), and the dataset is split for training the model (70 %) and for testing (30%). The DT and GBM are used to classify the dataset. The model is trained using training data. By this step, the model learns the patterns of features and relationships in the data to class labels.

TABLE II THE ATTRIBUTE AND ITS DESCRIPTION.

Feature No.	Attribute in Arabic	Attribute in English
F0	اتحكم في ادارة الوقت عند استخدام أي شاشة الكترونية	Control screen time when using any electronic screen.
F1	اتحكم في إدارة الوقت عند المشاركة في الألعاب عبر الانترنت	Control screen time when participating in online games.
F2	اوازن بين وقت الشاشة ومهامي الأخرى خارج الانترنت	Balance screen time with my other offline tasks.
F3	اوظف مهاراتي لإدارة وسائل التواصل الاجتماعي بمسؤولية وخلق شخصية ايجابية رقمية	Use my skills to manage social networks and create a positive digital identity.
F4	احدد الملائم من التقنيات الرقمية للتواصل مع الآخرين إذ أن البصمة الرقمية هي مسؤوليتي ولا يمكن حذفها من الفضاء الرقمي	Determine the appropriate digital technologies to communicate with others.
F5	ادرك أن البصمة الرقمية هي نشاطي في البيئة الرقمية وهي دائمة	Understand that my digital footprint is my responsibility and cannot be deleted from the digital space.
F6	التوعية بخطر المشاركة بالبيانات والمعلومات الشخصية	Be aware of the dangers of sharing personal data and information.
F7	اتحكم بالمعلومات والبيانات الشخصية المشتركة على الانترنت بسرية	Control the personal information and data shared online with confidentiality.
F8	افهم حقوقي الشخصية والقانونية واتمسك بها في مواقع التواصل الاجتماعي	Understand my personal and legal rights and uphold them on social network.
F9	اكتشف حالات التنمر عبر الإنترنت واتعامل معها بحذر	Detect and deal with cyberbullying cases with caution.
F10	اتعامل مع المحتوى الضار بالتصرف الصحيح	Deal with harmful content in a right way.
F11	اتجنب المخاطر مثل مخاطر المحتوى ومخاطر الاتصال	Avoid risks such as content and communication risks.
F12	اتعاطف وابني علاقة جيدة مع الآخرين في العالم الرقمي	Empathize and build a good relationship with others in the digital world.
F13	امتلك ثقافة قبول الآخر عبر الإنترنت	Have a culture of accepting others online.
F14	عدم اصدار الاحكام على الآخرين بشكل سريع في البيئة الرقمية	Avoid making quick judgments about others in the digital environment.
F15	استخدام التكنولوجيا والوسائط الرقمية بطرق آمنة ومسؤولة وأخلاقية	Use technology, digital media in a safe, responsible, and ethical manner.
F16	بناء وادارة هوية رقمية ايجابية في الفضاء الرقمي	Build and manage a positive digital identity in the digital space.
F17	استخدم التكنولوجيا الرقمية في القيادة الرقمية	Use digital technology in digital leadership.
F18	لدي قدرة على حماية بياناتي من خلال إنشاء كلمات مرور قوية	I have the ability to protect my data by creating strong passwords.
F19	استخدم أدوات الأمان المناسبة لحماية البيانات تجنبا لأي هجمة الكترونية مثل غلق الكاميرا	Use appropriate security tools to protect data against any cyber attack, such as camera closing.
F20	لدي القدرة على اكتشاف المستويات المختلفة للتهديدات السيبرانية وتجنبها	I have the ability to detect and avoid different levels of cyber threats
F21	معرفة القراءة والكتابة الرقمية(القدرة على استخدام اللغة للقراءة والكتابة والاستماع والتحدث عبر الانترنت)	Understand digital literacy (the ability to use language to read, write, listen, and speak online)
F22	اميز جهات الاتصال الموثوقة والمشكوك فيها عبر الإنترنت	Distinguish between trusted and suspicious contacts online.
F23	اتمكن من نقد المحتوى الرقمي بطريقة صحيحة وبشكل ايجابي	I can critique digital content in a correct and positive way.

TABLE II. THE GROUPS OF THE FEATURES

Feature No.	Feature description
F0-F2	Controlling Screen Time
F3-F7	Managing Social Network
F8-F9	Protecting My Rights
F10-F11	Dealing with Harmful Content
F12-F14	Building Positive Relationships
F15-F16	Using Technology Responsibly
F17	Digital Leadership
F18-F19	Data Protection
F20	Cybersecurity
F21	Digital Literacy
F22	Distinguishing Reliable Sources
F23	Evaluating Digital Content

TABLE III. THE SCORE OF EACH ATTRIBUTE USING RF.

Feature No.	Feature score	Feature No.	Feature score
F0	0.016098	F12	0.02504
F1	0.011631	F13	0.05382
F2	0.031149	F14	0.02022
F3	0.021091	F15	0.06315
F4	0.029370	F16	0.01930
F5	0.038870	F17	0.05064
F6	0.022486	F18	0.03106
F7	0.023642	F19	0.18191
F8	0.013950	F20	0.02274
F9	0.00926	F21	0.04025
F10	0.07474	F22	0.05202
F11	0.11674	F23	0.03074

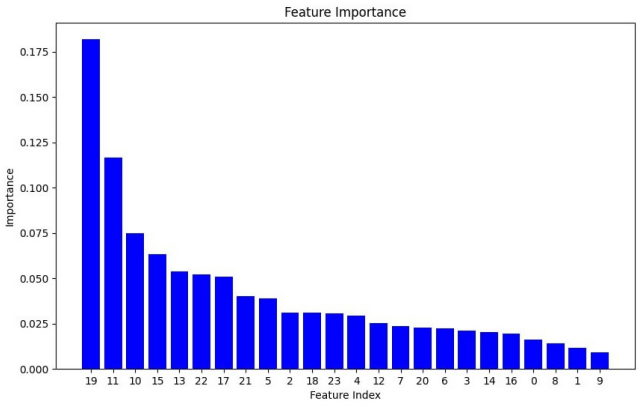

Figure 4. The Sorting of features depending on importance using RF

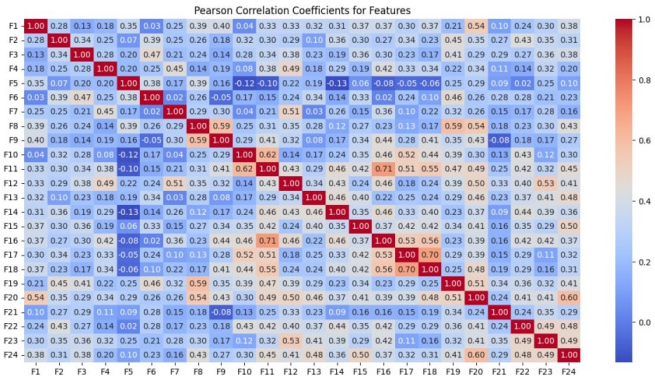

Figure 5. The Pearson correlation between features

F. The Importance of Features

The Random Forest (RF) was used to locate the importance of features by computing the Gini impurity for each feature. Therefore, each feature had a score and weight, while the gain type shows the average Gini impurity across all splits where the feature was used, and the weight shows the number of times the feature is used to split the data. Fig. 5 shows the histogram of important features using RF, while Table IIII shows the importance of each feature.

As shown in Fig. 4 and TABLE III, the feature "Use appropriate security tools to protect data against any cyberattack, such as camera closing," has the highest degree in the important features using RF technique, and the feature "Avoid risks such as content and communication risks" has the highest degree. The features "Detect and deal with cyberbullying cases with caution" and "Control screen time when participating in online games" have the lowest degree, respectively. This means that each feature has a degree that affects the prediction of DI.

G. Correlation of Features

The correlation between features was computed using Pearson's correlation to understand the relationship between features and to find out whether the attribute depends on one or multiple features. The correlation was calculated using Eq. (1). The positive correlation between two or more than one feature, the positive correlation value greater than zero, which represents a slight cell in Figure 5. A positive correlation means that any increase in the value of one feature causes an increase in the value of the correlated feature. As shown in Fig 5 there is more than one feature that is correlated: feature (F8) The description is "Control the personal information and data shared online with confidentiality." more correlated with feature (F20), whose description is "Use appropriate security tools to protect data against any cyberattack, such as camera closing.". The feature (F23) that the description is ("I can critique digital content correctly and positively") is more correlated with feature (19), which is the description ("Use appropriate security tools to protect data against any cyberattack, such as camera closing"). Also, the feature ("Control screen time when using any electronic screen") correlated with the feature ("Use appropriate security tools to protect data against any cyber attack, such as camera closing").

6. Results and Discussion

This work was carried out using the Python (V.3.9) programming language and the Jet Brains Pycharm (V.2018.2)

TABLE IV. THE CLASSIFICATION REPORT OF DT.

Technique	Precision	Recall	FI	Support	Class label
DT	0.79	1.00	0.88	11	0
	1.00	0.90	0.95	31	1
			0.93	42	Accuracy
GBM	0.85	1.00	0.92	11	0
	1.00	0.94	0.97	31	1
			0.95	42	Accuracy

framework. As mentioned, this work contained four main stages. Firstly, data collection by answering the survey. Secondly, data preprocessing by processing the null value. Thirdly, construct a feature vector by selecting all features for classification in the next stage. Finally, the classification stage was carried out using the DT and GBM. The DT and GBM algorithms were applied to the dataset to predict the digital intelligence of university students. The classification accuracy was 92.85 % and 95.23,% respectively. TABLE IV shows the classification report for the DT classifier.

As shown in Table IV, the classification report for RF and GBM was measured to clarify the results, especially in the imbalance of the dataset. Generally, the value of F1 _score was 0.95% and 0.97, % respectively, for the class label (one) and 0.88% and 0.92, % respectively, for the class label (zero). The values of the accuracy and F1 _score were biased for the class label (one) because the number of class labels (one) is higher than the class label (zero). As shown in the results, the proposed model using DT and GBM was successful in predicting the digital intelligence of university students by training the factors of digital intelligence using a machine learning algorithm (DT) and (GBM). Also, by using the machine learning algorithm (RF) for computing the importance of features that affect the decision, measure digital intelligence.

7. The Conclusions

In the current digital age, DI is essential for individuals and organizations. Technology is used to achieve goals and solve problems. Recently, AI techniques in general, have been used for predicting behavioral and social diseases, as well as medical diseases. So, the current study presented the prediction of the digital measure for university students using AI techniques. One hundred thirty-nine students completed an online survey that contains the statements of digital measures, numbered forty-four features to investigate the degree of benefit or damage. The proposed model used three AI techniques: decision tree, gradient boosting machine, and random forest. The classification accuracy using DT and GBM was 92.85 and 95.23, respectively. The RF technique was applied to find the essential features and the Pearson correlation to find the correlation between features.
The researchers recommend holding training courses for academic teachers in educational institutions dedicated to developing their digital intelligence skills, which would increase and enhance their student's ability to think with precise digital skills consistent with the development taking place in the technological field. In the future, a study will be done to determine the relationship between digital intelligence and strategic intelligence among university students. In addition, we suggest performing a comparative study between public and private universities by adopting a large sample and using deep learning methods to generalize the results.

References

[1] S. S. Hammadi, B. H. Majeed, and H. A. K., "Impact of deep learning strategy in mathematics achievement and practical intelligence among high school students," *Int. J. Emerg. Technol. Learn.*, vol. 18, pp. 42–52, 2023.

[2] R. H. Ali and W. H. Abdulsalam, "The prediction of covid 19 disease using feature selection techniques," *Journal of Physics: Conference Series*, vol. 18, p. 022083, 2021.

[3] W. H. Abdulsalam, R. S. Alhamdani, and M. N. Abdullah, "Emotion recognition system based on hybrid techniques," *International Journal of Machine Learning and Computing*, vol. 9, pp. 490–495, 2019.

[4] R. H. Ali and W. H. Abdulsalam, "Attention-deficit hyperactivity disorder prediction by artificial intelligence techniques," *Iraqi Journal of Science*, vol. 65, pp. 5281–5294, 2024.

[5] M. R. Yousif, L. T. Ameen, B. M. Jassim, and B. H. Majeed, "The impact of two proposed strategies based on active learning on students' achievement at the computer and their social intelligence," *International Journal of Engineering Pedagogy*, vol. 14, 2024.

[6] M. S. K. Wahib, Z. A. A. Alamiry, B. H. Majeed, and H. T. H. S. Alrikabi, "Digital citizenship for faculty of iraqi universities," *Periodicals of Engineering and Natural Sciences*, vol. 11, pp. 262–274, 2023.

[7] D.-M. Cismaru, P. Gazzola, R. S. Ciochina, and C. Leovaridis, "The rise of digital intelligence: challenges for public relations education and practices," *Kybernetes*, vol. 47, pp. 1924–1940, 2018.

[8] D. K. A.-R. Al-Malah, B. H. Majeed, and H. T. H. S. Alrikabi, "Enhancement the educational technology by using 5g networks," *International Journal of Emerging Technologies in Learning (Online)*, vol. 18, p. 137, 2023.

[9] B. Hamilton, "Integrating technology in the classroom: Tools to meet the needs of every student," *International Society for Technology in Education*, 2022.

[10] L. S. George and C. L. Park, "Meaning in life as comprehension, purpose, and mattering: Toward integration and new research questions," *Review of general psychology*, vol. 20, pp. 205–220, 2016.

[11] M. Shanmugasundaram and A. Tamilarasu, "The impact of digital technology, social media, and artificial intelligence on cognitive functions: a review," *Frontiers in Cognition*, vol. 2, p. 1203077, 2023.

[12] A. K. Jain, S. R. Sahoo, and J. Kaubiyal, "Online social networks

security and privacy: comprehensive review and analysis," *Complex & Intelligent Systems*, vol. 7, pp. 2157–2177, 2021.

[13] S. Venkadasubbiah, D. Yuvaraj, S. Ali, and M. U. A. Ayoobkhan, "Data footprinting in big data," *Big Data Analytics and Computational Intelligence for Cybersecurity*, vol. 18, pp. 203–218, 2022.

[14] J. Puhakka, "Challenges of targeted ads in social media," 2021.

[15] E. V. Ugochukwu, I. A. Okenwa-Fadele, M. N. Nwikpo, U. I. Oparaugo, and C. C. Okoro, "Students' and teachers' perception of cyberbullying and its influence on the academic grit of senior secondary school students in onitsha south lga, anambra state," *Asian Journal of Education and Social Studies*, pp. 28–38, 2022.

[16] M. S. Ribble, G. D. Bailey, and T. W. Ross, "Digital citizenship: Addressing appropriate technology behavior," *Learning & Leading with technology*, vol. 32, p. 6, 2004.

[17] Z. H. Ibrahim, "Analysis of computer textbook for the second intermediate grade according to digital citizenship," *Opción: Revista de Ciencias Humanas y Sociales*, vol. 28, 2019.

[18] W. A. S. . Z. M. J. K. . S. S. Ahmed, "Novel standard polynomial as new mathematical basis for digital information encryption process," *Advances in Decision Sciences*, vol. 27.

[19] B. H. Majeed, L. F. Jawad, and H. AlRikabi, "Tactical thinking and its relationship with solving mathematical problems among mathematics department students," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 16, pp. 247–262, 2021.

[20] B. H. Majeed, "Impact of a proposed strategy according to luria's model in realistic thinking and achievement in mathematics," *Int. J. Emerg. Technol. Learn.*, vol. 17, pp. 208–218, 2022.

[21] H. T. H. Salim, A. L. Rikabi, M. J. Al-Dujaili, B. H. Majeed, and I. R. N. Alrubeei, "Information and communication technology and its impact on improving the quality of engineering education systems," *International Journal of Engineering Pedagogy*, vol. 14, 2024.

[22] W. H. Abdulsalam, R. S. Alhamdani, and M. N. Abdullah, "Facial emotion recognition from videos using deep convolutional neural networks," *International Journal of Machine Learning and Computing*, vol. 9, pp. 14–19, 2019.

[23] J. Sublime, "The ai race: Why current neural network-based architectures are a poor basis for artificial general intelligence," *Journal of Artificial Intelligence Research*, vol. 79, pp. 41–67, 2024.

[24] G. F. Luger and W. A. Stubblefield, "Ai algorithms, data structures, and idioms in prolog, lisp, and java: Pearson addison-wesley," 2009.

[25] B. Pliuskuvienė, U. Radvilaitė, P. Stefanovič, and S. Ramanauskaitė, "Machine learning-based chatgpt usage detection in open-ended question answers," 2023.

[26] S. Sabeeh and I. S. Al-Furati, "Issues and research fields of medical robotics: A review," *Iraqi Journal for Electrical & Electronic Engineering*, vol. 19, 2023.

[27] W. H. Abdulsalam, S. Mashhadani, S. S. Hussein, and A. A. Hashim, "Artificial intelligence techniques to identify individuals through palm image recognition," *International Journal of Mathematics and Computer Science*, vol. 20, pp. 165–171, 2025.

[28] X. Sang, W. Xiao, H. Zheng, Y. Yang, and T. Liu, "Hmmpred: accurate prediction of dna-binding proteins based on hmm profiles and xgboost feature selection," *Computational and mathematical methods in medicine*, pp. 1748–670X, 2020.

[29] W. H. Abdulsalam, R. S. Alhamdani, and M. N. Abdullah, "Speech emotion recognition using minimum extracted features," *1st Annual International Conference on Information and Sciences (AiCIS) Fallujah, Iraq*, pp. 58–61, 2018.

[30] T. B. Alhijaj, S. M. Hameed, and A. A. Bara'a, "A decision tree-aware genetic algorithm for botnet detection," *Iraqi Journal of Science*, pp. 2454–2462, 2021.

[31] S. Touzani, J. Granderson, and S. Fernandes, "Gradient boosting machine for modeling the energy consumption of commercial buildings," *Energy and Buildings*, vol. 158, pp. 1533–1543, 2018.

[32] H. Bakhshayesh, S. P. Fitzgibbon, A. S. Janani, T. S. Grummett, and K. J. Pope, "Detecting synchrony in eeg: A comparative study of functional connectivity measures," *Computers in biology and medicine*, vol. 105, pp. 1–15, 2019.

[33] J. Davis and M. Goadrich, "The relationship between precision-recall and roc curves," pp. 233–240, 2006.