Journal of Information Systems Engineering and Management
2025, 10(6s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Intelligent Tutoring Systems as A Solution to Emotional and Academic Challenges in Higher Education: Analysis of a Survey from Instituto Politécnico Nacional

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ARTICLE INFO

Received: 10 Oct 2024

Revised: 06 Dec 2024

Accepted: 20 Dec 2024

ABSTRACT

The use of artificial intelligence in education has opened new possibilities for personalizing teaching and providing comprehensive support to students. This study investigated the emotional and tutoring needs of students at the Instituto Politécnico Nacional, employing data mining techniques to analyze survey results. The methodology allowed the identification of key patterns related to academic motivations, emotional needs, and access to tutoring, offering a comprehensive view of the challenges faced by students. The findings reveal that 47.7% of students experience emotional problems, 70.4% are unaware of available tutoring figures, and 93.3% have not received any tutorial support. Additionally, 45.7% consider psychological support necessary, and 72.8% would request tutoring help.

Given this situation, the implementation of Intelligent Tutoring Systems (ITS) is proposed as a viable solution. These systems, with their ability to personalize learning, provide instant feedback, and continuously monitor progress, offer not only academic support but also tools to manage emotions such as stress and anxiety. The study presents concrete proposals for implementing ITS in higher education, demonstrating how these systems can enhance the student experience by integrating academic and emotional development through artificial intelligence.

Keywords: tutoring systems, emotions, students, artificial intelligence, EITS, tutoring, artificial intelligence

1. INTRODUCTION

Currently, higher education students face an increasing variety of emotional and academic challenges that affect their well-being and performance. A global concern that many face [1] is the significant percentage of students experiencing high levels of stress, anxiety, and depression, [2] both academically and personally, because of living in what is known as the "achievement society" [3]. This directly impacts their ability to obtain optimal academic performance. Furthermore, the lack of adequate and accessible academic guidance in many educational institutions exacerbates these problems.

The absence of effective mentoring systems leaves students without the necessary support to manage their emotional and academic difficulties, often leading to low retention rates and an increased risk of dropout. Despite the presence of mentoring figures in many institutions in Mexico, a large percentage of students remain unaware of their availability or do not receive adequate support when needed.

This situation highlights the need for more innovative and accessible solutions that provide personalized and continuous guidance. In this context, Intelligent Tutoring Systems (ITS), based on artificial intelligence, offer personalized instruction to students and have the ability to adapt the domain knowledge content installed in the system based on the students' knowledge levels and individual competencies. They focus on the needs of the students to provide guidance [4, p. 35]. Their goal is to emulate human tutoring by analyzing user behavior, adjusting content, and adapting teaching strategies according to the student's needs and knowledge level.

According to [4], students who used intelligent tutoring systems achieved better academic results than those who relied solely on conventional education. Notably, Emotionally Intelligent Tutoring Systems (EITS) can detect and analyze a student's emotional state and respond in a manner similar to human tutors [5].

In this research, a survey was conducted among students of the Instituto Politécnico Nacional to identify emotional and tutoring needs. ITS are proposed as a solution to address the identified challenges.

2. BACKGROUND

Young people are experiencing a period of major changes in the so-called "digital era," where their behavior evolves considerably due to their interaction with technology [6]. They spend more time in front of electronic devices, particularly mobile phones, and although they read more, they do so through various resources and audiovisual narrative applications [6]. The family remains a relevant factor in their adaptation to cultural contexts, while music has ceased to be merely a form of entertainment and has become a language and a marker of identity. Their consumption habits are influenced by these activities. There is a noticeable trend towards individualism, as they prefer to work alone rather than in teams [6], a situation evident in institutions like Instituto Politécnico Nacional (IPN) in Mexico.

The use of technology has increased considerably, being utilized for learning, obtaining information quickly, and satisfying the need for immediate gratification. Young people tend to operate more efficiently when connected to the internet, which relates to a conformity towards quick answers and a lack of patience. These dynamics have both positive and negative consequences. Negative consequences include sleep disorders, cyberbullying, unhealthy eating habits, the relationship between excessive alcohol consumption and social media, as well as addiction to new technologies [7]. Additional risks include grooming, cyberbullying, sexting, cyber addiction, among others [8]. These problems add to the stress factors and mental disorders resulting from significant life changes such as moving away from home to attend university [4], academic pressure, pressure from teachers or the educational institution, social pressure, uncertainty about the future, fears and distrust regarding the new challenges they will face upon completing their studies [9]. Additionally, they must confront a hyperculturalized work environment [10], within a capitalist world characterized by hyperproductivity and an increase in self-demand to be productive and achieve personal success. In Mexico, these stress factors are intensified by long commutes to university, traffic, family dynamics, and insecurity.

The COVID-19 pandemic exacerbated these conditions, creating an even more challenging academic environment where emotional support and professional guidance are often insufficient. In this intercultural context, characterized by the "encounter and coexistence with people of different identities" [11], traditional systems are no longer efficient and can even be considered obsolete.

In the case of public schools in Mexico, many teachers are not trained to address these challenges in their students. Moreover, there is a widespread lack of awareness among students about the existence of mentoring systems, and the available services are not designed to proactively respond to the emotional problems that directly affect their academic performance.

3. MOTIVATION

The growing recognition of the importance of mental, emotional, and physical health in the academic environment has highlighted the urgent need to improve the support systems available to students. It is observed that traditional tutoring systems fail to effectively address these emotional needs and do not provide comprehensive support that encompasses both academic and personal development.

On the other hand, soft skills [11] have gained importance for the holistic development of individuals and are valued in the business context, including ethics and socio-emotional skills. It is argued that emotions should be educated

within the context of a “dominant axiological polytheism” [11], alongside other factors such as character education and the construction of a moral personality. Therefore, it is essential to foster their development both in schools and society.

This context presents a challenge for educational institutions, which must seek innovative solutions to provide more personalized and effective support to students, addressing their individual needs with the assistance of technology and artificial intelligence.

Intelligent Tutoring Systems (ITS), considered [12] as computer-based educational systems that use independent databases for educational content and teaching strategies, aim to draw conclusions about a student's ability to understand topics and identify their weaknesses and strengths in order to dynamically adapt the learning process. These systems emerge as a viable solution to this challenge, as they integrate artificial intelligence to create adaptive learning environments that offer not only improvements in academic achievement [4] but also resources and strategies for managing emotions. These systems use artificial intelligence to create a personalized learning environment that analyzes students' behavior, needs, and progress in real-time, providing feedback and continuously monitoring progress.

4.OBJECTIVES

This study has two main objectives.

Objective 1: To identify the emotional and tutoring needs of students at the Instituto Politécnico Nacional (IPN) through the administration of a survey. This data collection instrument aims to provide a clear understanding of the emotional challenges students face, their awareness of available tutoring resources, and their willingness to receive tutorial support, in order to comprehensively understand the challenges that impact both their emotional well-being and academic performance.

Objective 2: To show and propose the implementation of Intelligent Tutoring Systems (ITS) as an innovative solution to the identified challenges, providing comprehensive support within the educational environment.

5.METHODOLOGY

Data was collected through a survey administered to 175 students from the 7th and 8th semesters of the Communications and Electronics Engineering (ICE) program at the School of Mechanical and Electrical Engineering, at IPN, Zacatenco campus, in Mexico City. The IPN is a public university renowned for its engineering programs. According to the Central Limit Theorem, for most populations, a sample size of 30 or more [13] allows for the appropriate use of normal approximation. To evaluate the reliability of the instrument, Cronbach's Alpha coefficient was applied. Data was processed using IBM SPSS Statistics software, yielding a value of 0.7, which is acceptable given that values above 0.7 and 0.8 are considered indicative of sufficient scale reliability.

The survey was administered via Google Forms during the second semesters of 2023 and 2024, consisting of 29 items. The initial questions gathered demographic data such as name, age, and gender. Subsequent questions examined the students' identity with the IPN, though these were not considered in this study. Following this, the survey investigated their motivations, reasons for choosing their major, their most frequent moods, common problems they face, academic performance, and the need for support. Finally, questions were included regarding awareness of tutoring figures at IPN and the support provided by them.

At the IPN tutoring for higher education students is defined as personalized guidance [13], where a teacher trained as a tutor provides attention to the student with the aim of fostering their full development in terms of growth, maturity, and the manifestation of attitudes of responsibility and freedom. Tutoring can have an inductive, preventive, or corrective approach. There are five tutoring figures at IPN: Individual Tutoring, Group Tutoring, Academic Recovery Tutoring, Academic Regularization Tutoring, and Peer Tutoring. This study sought to identify the degree of students' awareness of these modalities.

Initial analyses focused on sample quantification and descriptive statistics. Subsequently, an evaluation of different options was conducted through complex approach. This phase involved assessing multiple Intelligent Tutoring Systems (ITS), particularly Emotionally Intelligent Tutoring Systems (EITS) that provide emotional support, to identify those that could be integrated into an advanced technological educational framework. The complexity system analysis (considering both the current and desired scenario) enabled the identification of optimal solutions that

effectively and balancedly address both academic performance and emotional well-being.

For the analysis of the results, data science [14] was employed as a multidisciplinary academic method to extract knowledge from data, focusing on the emotional and tutoring needs of students. Additionally, data mining [15] was used to identify new relationships between variables and to summarize data sets in a comprehensible and useful manner, which is relevant in social research [16]. This technique allowed the identification of relevant patterns and trends regarding emotional needs, access to tutoring, and the academic challenges faced by students.

6.RESULTS

The most important data is:

Demographic Information:

Age:

- 19 to 20 years: 5.5%
- 21 to 22 years: 51.9%
- 23 to 24 years: 28.7%
- Over 25 years: 1.9%

Gender:

- 40.2% are female
- 58.9% are male

Identity:

- 69.4% feel they have an identity with IPN, while the remaining 30.6% do not.
- 63% considered it was due to the school's prestige.

Table 1. Emotional problems and Tutoring

Indicator	Percentage (%)
Students with emotional problems	47.7
Students who consider psychological support necessary	45.7
Students who believe a tutor could have helped them	52
Lack of awareness about types of tutoring	70.4
Students who have never received tutoring	93.3
Students willing to request tutoring support	72.8

Table 1 shows the means of the responses from 175 higher education students regarding emotional problems, need of support, tutoring.

Table 2. Additional Modes

Category	Mode
Motivation to study	Achieving my personal goals
Most common emotions	Stress and anxiety
Need for psychological support	A general psychologist
Preferred type of tutoring	Individual tutoring

Table 2 shows some modes regarding motivation, emotions, support and tutoring.

7. DISCUSSION

Emotional Problems: A total of 48% of students reported experiencing emotional issues, with the most common emotional states being stress and anxiety, followed by anger and fear. The least reported emotions were rejection and abandonment. The mode suggests that the majority of students regularly experience these emotions, which adversely affects their academic performance. Regarding emotional stability, 40% of students consider themselves to have moderate stability, 30% rate their stability as low, and 9% consider themselves to have no emotional stability. This indicates that emotional stability is an area that requires attention from tutors and support systems.

Additional Information: In addition to emotional problems, 29.8% of students reported financial difficulties, and 22.1% cited family problems with parents or siblings. The least common issues were work-related problems (1%) and problems with drugs (1.9%).

Psychological Support: A total of 45.7% of students consider it necessary to receive support from a psychologist, and 52% believe that a tutor could have helped them manage their emotions and improve their academic performance; 42% were unsure from a tutor at the IPN.

Lack of Awareness About Tutors: Approximately 70.4% of students are unaware of the types of tutors available at their institution, and 93.3% have never received tutorial support.

Requests for Tutoring: Despite this lack of awareness, 72.8% of students indicated that they would request tutorial support if it were offered, with a preference for individual tutoring.

Main Academic Motivation: The most frequent response regarding motivation for studying was "Achieving my personal goals," indicating that students view education as a means to achieve personal objectives, which underscores a direct link between academic success and emotional well-being.

Intelligent Tutoring Systems (ITS): In a complexity approach, where a comparison between current scenario and expected scenario is made, data mining analysis revealed that in actual situation the tutor roles at IPN ESIME Zacatenco are not perceived by students as present or effective in providing support, either emotionally or academically. Stress and anxiety were identified as the most common emotional states, with nearly half of the students reporting emotional issues. Students are open to receiving help from a psychologist and believe that closer engagement with a tutor would be beneficial.

At IPN, five types of tutoring are available, and there is a course titled “Tutoring and the challenges of accompanying the integral formation of higher education students”; however, these measures are insufficient. The high incidence of emotional problems, combined with limited access to support figures, highlights the urgent need for innovative tools that can address both academic and emotional needs. Intelligent Tutoring Systems (ITS), with their ability to personalize learning and monitor student progress, offer a comprehensive approach that could simultaneously address academic and emotional challenges by responding to specific situations and problems.

For students with cognitive challenges, Intelligent Tutoring Systems (ITS) can assess whether a student requires assistance with specific problems [5] and provide targeted solutions to these challenges. These systems utilize artificial intelligence to deliver personalized and adaptive teaching, capable of modeling student profiles, providing instant feedback, monitoring progress, and adjusting content based on individual needs and abilities.

Beyond academic performance, some ITS are capable of detecting emotions during interactions with students [14]. By observing facial expressions [5], they can also identify social intelligence, attention levels, anxiety, and mental states, interpreting eye movements with an error margin of only 5%. ITS can function as cyber-psychology tools, adopting the best teaching styles from instructors and supporting emotional management, including stress and anxiety, thereby addressing key areas of academic and emotional intervention to enhance the learning process.

Emotional Interaction with Robots: Robots designed to react to human emotional cues are often treated as living entities by people [5]. This emotional recognition capability is integrated into ITS to improve interactions with students. Moreover, ITS can foster the development of soft skills through collaborative learning environments [15] and have the advantage of utilizing case-based reasoning [16]. It is well established that emotions significantly influence learning and cognitive processes [5]; happier students tend to perform better than those who are unhappy. Negative emotions such as anger, anxiety, and sadness lead to distraction, impacting students' confidence in their

work and their sense of competence. Thus, altering these emotions is crucial for academic success. ITS act as agents that can shift students' moods by encouraging and promoting positive feedback.

ITS can include modules designed to detect emotional states such as stress and anxiety, adjusting interactions based on the student's emotional condition. For example, if a student exhibits signs of stress, the ITS might suggest taking breaks or engaging in mindfulness activities.

Combining Academic and Emotional Support: ITS offer individualized tutoring that integrates academic and emotional support, addressing the needs of students who require assistance in both areas. For instance, the Intelligent Tutor with emotional recognition for Mathematics [17] can adapt teaching based on academic progress while simultaneously providing resources or recommendations for managing stress, such as study techniques, time management strategies, or positive reinforcement. The advantage of continuous and immediate positive feedback encourages students by fostering a sense of progress and motivation, thus reducing stress associated with academic uncertainty. Additionally, constant monitoring can alert the system when academic performance declines due to emotional issues, prompting interventions such as contacting a human tutor.

Examples of ITS: Various ITS are currently in use or development across different educational fields. Notable examples include:

A. AutoTutor

An intelligent tutoring system that helps students improve their learning skills [18], reading comprehension, and problem-solving through natural language conversations. It offers personalized feedback in subjects like science, mathematics, and writing.

A. Carnegie Learning's MATHia

An ITS specialized in mathematics that provides personalized tutoring and real-time feedback [19]. It analyzes student interactions and adjusts lessons to enhance learning. Additionally, it offers detailed progress reports for teachers. Carnegie Learning also offers the Cognitive Tutor [20], which focuses on teaching mathematics through cognitive modeling, adapting lessons based on student errors and needs, and is widely used in U.S. schools.

B. Other ITS

Other ITS include Scholar, Why, Sophie, Guidon, West, Buggy, Dbuggy, Streamer, Meno, Proust, Sierra, Andes, Metutor, ALEKS (Assessment and Learning in Knowledge Spaces), and ANDES, each with their specific specializations

Proposal for Emotional ITS: The proposed use of Emotional Intelligent Tutoring Systems (EITS) involves detecting student emotions and motivating them to correct mistakes and continue progressing, while simultaneously developing emotional intelligence. This approach creates a learning environment that closely resembles human tutor behavior. For instance, if a question causes stress, the EITS can rephrase it in two or three variations to alter the mood, offering encouragement such as "You got it!", "Your opinion matters", or "You can do this." An EITS could also play music, make a joke, or assign tasks based on performance. It can even provide additional information for curious students.

Access to ITS: Access to ITS like ALEKS or MATHia requires paid subscriptions, typically acquired by educational institutions or individual students. Some systems are integrated into broader educational platforms, such as Learning Management Systems (LMS), and may be part of a school's or university's curriculum. Others, such as AutoTutor or ANDES, are often available to academic institutions as part of research projects, with some versions accessible to the general public online or through pilot programs.

Areas of Application: For example, if a student is performing poorly in mathematics, a subject monitored by the ITS, the system could detect a pattern of repetitive errors and increased time to complete tasks, which might indicate distraction or emotional exhaustion. Based on this observation, the ITS might:

- Suggest a break to prevent burnout.
- Provide simpler exercises to restore the student's confidence.
- Recommend contacting a human tutor specializing in stress management or offering emotional wellness

resources, such as meditation guides or relaxation techniques.

By combining the personalization and real-time interactivity of ITS with insights into students' emotional health, it is possible to positively impact both academic performance and overall well-being.

8.CONCLUSION

Some public institutions are primarily focused on delivering knowledge, and although spaces have been created to address student needs, such as the tutoring roles at IPN, students continue to face challenges in both emotional and academic domains. Data analysis using mining techniques revealed clear patterns indicating a prevalence of emotional problems such as stress and anxiety, which directly impact students' academic performance. Additionally, there is significant unfamiliarity with the available tutoring figures, exacerbating the lack of adequate support.

The implementation of Emotional Intelligent Tutoring Systems (EITS) emerges as an innovative and viable solution to address these issues. It is proposed to evaluate various options for implementing these intelligent systems to achieve more personalized support without the need for constant intervention from trained personnel, which is currently lacking. The capability of EITS to monitor progress and provide instant feedback allows for early intervention in cases where students exhibit emotional or academic difficulties. Thus, by transforming the tutoring approach in higher education, a comprehensive support system for academic performance and emotional well-being can be provided, enhancing the educational experience through artificial intelligence that mimics human behavior to counteract the shortage of qualified personnel for tutoring.

ACKNOWLEDGEMENTS

We thank to Instituto Politécnico Nacional for their invaluable support in the execution of this study and for financial support. Their commitment to education and research has been fundamental in carrying out this project.

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