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OPERATIONAL FEASIBILITY OF AN INTELLIGENT TUTORING SYSTEM IN COMPUTER SYSTEMS AT THE INSTITUTO TECNOLÓGICO DE TLAXIACO

OPERATIONAL VIABILITY OF AN INTELLIGENT TUTORING SYSTEM IN COMPUTATIONAL SYSTEMS ENGINEERING AT THE TECHNOLOGICAL INSTITUTE OF TLAXIACO

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Abstract -- In response to the evolving landscape engineering education, this study investigates the feasibility and impact of implementing an interactive GitHub tutor for Systems Engineering students at the Instituto Tecnológico de Tlaxiaco. Using the operational feasibility methodology. The increasing reliance on digital tools in education underscores the need for personalized resources, which motivates the exploration of GitHub as a learning platform.
The study addresses the lack of personalized guidance for students navigating the complexities of GitHub, thus defining a central problem. Methodologically, a comprehensive assessment was conducted that examines the operational feasibility based on student perceptions and attitudes about GitHub Intelligent Tutoring System (ITS) to propose a new strategy in increasing knowledge regarding the Version Control System (VCS).
In conclusion, the student community had a favorable level acceptance to the implementation of an interactive tutor as a strategy for increasing knowledge about GitHub.

Keywords: Engineering Education, GitHub, Systems Engineering, Educational Platforms, Interactive Tutor, Academic Feasibility, Intelligent Tutoring System.

Abstract -- In response to the evolution landscape of engineering education, this study explores the feasibility and impact of implementing an interactive GitHub tutor for Computer Systems Engineering students at the Technological Institute of Tlaxiaco. The growing dependence on digital tools in education underscores the need for personalized resources, wich motivates the exploration of GitHub as a learning platform.
The study addresses the lack of personalized guidance for students who navigate the complexities of GitHub, thus defining a central problem. Methodologically, a comprehensive evaluation was carried out that examines the operational feasibility based on student perceptions and attitudes about the GitHub Intelligent Tutoring System (ITS).
To propose anew strategy in increasing knowledge regarding the Version Control System (SVC).
In conclusion, the student community had a level of acceptance favorable to the implementation of an interactive tutor as a strategy for increasing knowledge about GitHub.

Key words - Engineering Education, GitHub, Computer Systems Engineering, Educational Platforms, Interactive Tutor, Academic Feasibility, Smart tutoring system**.**

INTRODUCTION

In the digital era, engineering education requires innovative strategies. In this context, the concern arises to evaluate the feasibility of integrating an interactive GitHub tutor for Systems Engineering students at the Instituto Tecnológico de Tlaxiaco. The background reveals a growing reliance on technological tools in education, but there is still a gap in the implementation of specific platforms such as GitHub. The current state highlights the need for more interactive guidance in programming and project management. This study defines the central problem: the lack of customized resources for academic development in the GitHub environment. The objectives include assessing the impact of the interactive tutor and proposing improvements. Rationale According to Gehring [1] in the GitHub octover, In 2012, most companies were only using open source software (OSS) to run their web servers, and even when Red Hat achieved a valuation of$ $1 , other critical big-name projects, such as Kubernetes and Docker, had not yet been released. Today, 94 million developers are on GitHub, 90% of enterprises use open source, 90% of the world's

Fortune 100 companies use GitHub and 413 open source contributions by 2022.

DEVELOPMENT

Nowadays, the use of version control and collaboration tools, such as Git and GitHub, has become increasingly relevant in the field of software development and technology project management. These tools allow to keep accurate track of changes made to source code, facilitate collaboration between developers and promote good development practices.

Frame of reference

Within the educational context, the integration of Git and GitHub into curricula has become a growing trend. Several studies and research have explored the potential benefits of teaching and using these tools in educational settings, especially in the field of computer science and software engineering.

For example, a study by Wang *et al.* [2] entitled "Impact of GitHub on students' collaboration and performance in team-based software engineering courses" analyzed the impact of GitHub on student collaboration and performance in team-based software engineering courses. The results indicated significant improvements in collaboration and quality of student work.

In addition, Garousi [3] conducted a systematic review entitled "The impact of Git and GitHub on coordination and collaboration in software engineering", where they examined a number of studies on the influence of Git and GitHub on coordination and collaboration in software engineering. They found that these tools can facilitate communication and teamwork in software development projects.

In other sources, Gunnar Wolf [4] conducted a study entitled: "Use of the Git version control system as a replacement for a learning management system" that invited the institution's faculty to be part of the collaborative work. He emphasized that:

Ultimately, the teacher's intention in introducing the use of Git is to provide an intellectual challenge that will make students better prepared for professional life.

With the progress in the field of computer science, specifically in the field of artificial intelligence (AI), supported by its powerful and complex algorithms, it is possible to endow computer programs with certain intelligence, intelligent tutoring systems (ITS) emerge, which make use of ICT, new pedagogical models, student-centered education and meaningful learning [5].

ITS were designed with the idea of imparting knowledge by guiding the learner through the process of learning through some form of intelligence. A system that exhibits behavior similar to that of a human tutor, assisting the student with cognitive help, i.e., that can adapt to the 's behavior, identifying how the student solves a problem in order to offer help when required, was considered [6].

It can be concluded that an ITS is a computerized cognitive tool that seeks to improve the teaching-learning . The term intelligent refers to the ability of the system on what to teach, when to teach and how to teach imitating the activity of a real teacher.

ITS are programs that approach a teaching session as a cooperative process between the tutor and the learner with the objectives of teaching and learning certain concepts; their design and construction is the basis of cognitive psychology, educational research and artificial intelligence [7]. As for ITS development, this is a topic related to the birth of artificial intelligence (AI) and the documentation of the use algorithms such as Bayesian networks, neural networks or fuzzy logic, which are alternatives for the construction of an increasingly intelligent and empathetic tool for learning support in software development.

ITSs began to be developed in the 1980s and were designed with the idea of imparting knowledge based on some form of intelligence to guide the student in the learning process [8].

An intelligent tutor, therefore, "is a software system that uses artificial intelligence (AI) techniques to represent knowledge and interacts with students to teach it to them" [9].

This background and other similar studies have demonstrated the potential of Git and GitHub courses through Intelligent Tutoring Systems in technical skills, effective collaboration and academic performance in the field of computer science and software engineering.

According to, Tarongí [10], personalized tutoring is the most effective way to teach, but it is a laborious and costly task, however, intelligent tutoring systems are computerized personalized learning systems, which do not require the intervention of human tutors and reduce the cost, by automating the selection of course materials, their presentation and the evaluation of students.

Learning styles can be measured by various instruments, among which the learning styles index questionnaire stands out. Bloom's taxonomy is used to measure the level of knowledge. Tutor module: according to Lage & Cataldi [11], the tutor defines and applies a pedagogical teaching strategy, contains the objectives to be achieved and the plans used to achieve them. It monitors performance and selects the learning material for the student.

As a counterpart, Lage [12], proposes a methodology with a focus more on the learner's module.

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It recognizes that an ITS with a very detailed learner module would fully guarantee the 'intelligent' qualification of the system, as it would be even more tailored to the particularities of its learners.
On the other hand, there are methodologies that pursue the integration of a learning management system (LMS) with an ITS [13], thus endowing the latter with a Web-based approach.

Design for the development of an ITS

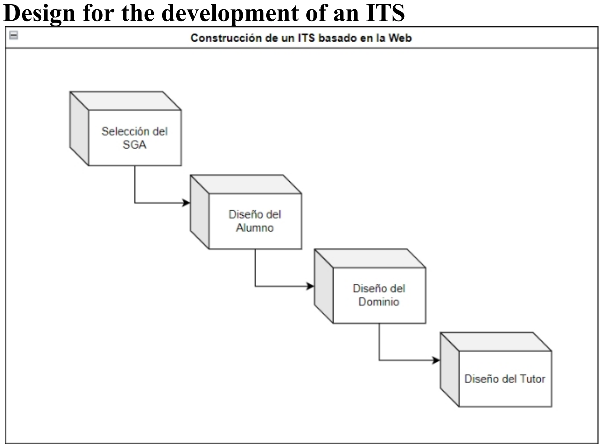

Image 1. Construction of a Web-based ITS.
Source. Own elaboration based on the descriptive analysis of the literature.

Selection of the EMS platform
There are different LMS platforms that support the teaching-learning process. In the development of this research, for the construction of an ITS applied to the teaching of computational algorithms at the undergraduate level, the Moodle platform was chosen because it is open source and fully modifiable. It is an option for integrating the ITS because of its modular structure, which offers the option of adding or removing code without affecting the operation of the learning management system (LMS); it also integrates various database managers, such as PostgreSQL and MySQL, which are easy to install.

Student module design
From the different types of pedagogical methods, equivalences have been established with the different dimensions of learning styles, the style that predominates in each method is marked, according to the characteristics of the student and according to his deficiencies; these are taken into account with the aim of instructing him in the best possible way [14].

Tutor module design
The tutor module is the execution engine of the adaptive system, as it codifies the teaching methods that are appropriate for the target domain and the learner. It selects the most appropriate educational intervention based on the knowledge and learning styles of the learners [15].

Domain module design.
Finally, the domain module consists of integrating a deep learning neural network through artificial intelligence libraries that will allow to compare the actions and choices of the learner in an expert system in order to evaluate what the user knows and does not know. The domain module is composed of the learning path that is defined by the tutor module.
This learning path contains the sequencing to be applied to define and structure the topic, which should be materialized in a series of activities (tasks, questionnaires, surveys, etc.) that are designed and conditioned by the course and offered to the student through a user interface, adapted to the characteristics of the student [16].

Methodology

Methodological framework.
Source. Own elaboration based on the analysis of the literature.

Literature Review
1. Definition of the research problem: Clearly identify and define the problem you wish to address with the intelligent tutoring system in the context of computer systems engineering.
2. Documentary research: this is used when defining the factors that influence the implementation of the Git and GitHub course, since for its recognition the documentary information of the ITS must be collected.
3. Establishing objectives and research questions: define the specific objectives you wish to achieve with your research. Formulate research questions to guide your work.

Methodological Application
4. Design of the feasibility methodology.

Feasibility methodology

Source. Own elaboration based on the descriptive analysis of the literature.

The feasibility methodology is given in 3 dimensions, which measured properly we obtain the Operational Feasibility of the GitHub ITS.

5. Sample selection: using cross-sectional research, data are obtained from simple random sampling at a specific point in time with no follow-up over time.
6. Data Collection: By applying the questionnaire using field research, data are obtained and analyzed cross-sectionally to be housed in a database.
7. Data Analysis: using descriptive research, descriptive statistics of the data are carried out.
8. Interpretation of results: correlational research is used to interpret the data, seeking to identify relationships or correlations between two or more variables, but it does not establish a cause and effect relationship.

Conceptualization and Operationalization of Variables
Feasibility of Implementing an Interactive Git and GitHub Tutor is defined as the probability that the implementation of an interactive Git and GitHub tutor in the educational setting of ISIC students can be successfully carried out.
The following are indicators to measure the impact of the implementation that may be achieved:

Table 1. Operationalization of the Impact Variable

Dimensions	Indicators
Impact	**Level of knowledge:** indicator that defines the level of knowledge of GitHub and Interactive Tutor.
	Learning style: Learning styles as defined by the theory of intelligences multiple.
	Level of interaction with technology: To assess students' comfort and previous experience with **technology** tools. technology tools similar.
	Attitude towards collaborative programming: Evaluate the student opinion on collaborative programming.
	Degree of autonomy in the learning: do you think the tutor will help you help them a develop skills from independent learning?

Source: Own elaboration based on the descriptive analysis of the literature.

The following are indicators to measure the effectiveness of the implementation:

Table 2. Operationalization of the Efficiency Variable

Dimensions	Indicators
Efficiency	**Goal Expectation:** To measure students' expectations of their ability to achieve the goals of learning proposed using the interactive tutor.
	Perspective on continued adoption Assess whether students expect to continue to use Git and GitHubat future projects.
	Grade improvement forecast: measure students' expectations on whether their grades will improve at the subjects related to Git and GitHub.
	Preference for Active Participation: Evaluate the predisposition of the students to actively participate in the activities and lessons proposed by the tutor interactive.
	Anticipation of Practical Application: To assess the extent to which students believe that will be able to apply the skills learned in real projects.

Source. Own elaboration based on the descriptive analysis of the literature.

The following are indicators to measure the quality of the implementation that may be in place:

Table 3. Operationalization of the Quality Variable

Dimensions	Indicators
Quality	**Security and privacy:** measuring students' concerns about security and **privacy**. the privacy of your data when using the app.
	Level from Variety from Resources: Measure the

	expectations as to whether the software will provide a variety of resources, such as videos, exercises and practical examples.
	Level of Accessibility: Assess students' expectations regarding the ease of accessibility of the software from different devices and platforms.
	Extent of Intuitive Interface: To assess the extent to which students expect to the interface is easy to use and navigate.
	Ease of self-management: Measuring whether students expect the software to allow them to make progress at your own pace and understanding.

Source. Own elaboration based on the descriptive analysis of the literature.

The measurement instrument is based on these indicators.

DISCUSSION AND ANALYSIS OF RESULTS

In this study, the sample is composed of the students of the Computer Systems Engineering Career from the 1st to the 13th semester of 2023B with a total of 127 students, of which, according to the simple random sampling given, in population and sample; 65 (51.18%) answered the survey. Of which 38 (58.46%) are male and 27 (41.53%) are female.

Also, to explain the level of significance between dimensions, Cronbach's analysis is used as a method for calculating the reliability coefficient:

$$\alpha = \frac{k}{k-1}[- \frac{\sum V_i}{V_t}]$$

giving a total of 0.941852.

Impact dimension

1. The Correlation between IMP02-NTC01 (Have you heard about GitHub) and PSAC07 (Have you used GitHub in your school and personal projects?) is equal to 0.90476773. Which indicates that in addition to the fact that students have heard about this version management tool (MCS), they use it for their school and personal projects. This means that it is a tool that is indeed useful in managing both personal and grid software projects.
2. The correlation between IMP07-NTC01 (What is the instruction to clone a repository from GitHub to LocalHost?) and PMC08 (Do you consider it important to master GitHub for your school performance?) which corresponds to 0.84717544, reflect a strong tendency that mastering GitHub instructions is important for school performance.
3. The correlation between IMP12-PMC08 (Do you consider it important to master GitHub for your school performance?) AND PMC08 (How do you think GitHub mastery influences your school development?) which corresponds to 0.84532538, expresses that, just as GitHub is an important tool in school performance, there is the same influence of GitHub mastery school development. Which indicates that, school performance can be improved with the mastery of this technological tool. This is a similar result to the study of Herminia [17], when the hypothesis "H1 - The Intelligent Tutor System for teaching Mathematics, allows improving the academic performance students in the sixth year of primary school" is accepted.

Efficiency dimension.

1. The correlation between GAA05 (Have you ever heard of Systems) AND GII14 (How would you prefer the platform interface to be?) which corresponds to 0.98431181, indicates that the interface should be intuitive.
2. The correlation between PPA09 (What do you think about an Intelligent Tutoring System that will help you master GitHub in the course of the Career?) and GII14 (How would you prefer the platform interface to be?) which corresponds to 0.98431181, expresses that, being intuitive the platform interface would facilitate the mastery of the technological tool.
3. The correlation between PPA09 (How would you like to take a modular course on GitHub with Intelligent Tutoring to reinforce your GitHub knowledge?) and GII14 (How would you prefer the platform interface to be?) which corresponds to 0.98431181. emphasizes that there is a considerable level of acceptance regarding the modular course for GitHub mastery, so, when implemented, it would make it an efficient ITS.

In comparison with the study conducted by Wolf [4],

when you get the results of the post-course survey on the question "Have you used Git again?". Where 25 (37.31%) of the respondents said that Git was
use it for their personal projects (either for development or to organize information). In addition to the good results of this study, it also indicates that the system is efficient.

Quality dimension.

1. The correlation between NAB13 AND NAB13 corresponding to 0.94556984, indicates that students tend to occupy a cross-platform ITS support tool, running on multiple operating systems.
2. The correlation between NAB13 (Do you feel more comfortable using apps or learning resources that work on both IOS and Android operating systems?) AND GII14 (How would you prefer the interface to be.

of the platform?) which corresponds to 0.91257895, states that for the system to have quality, it must have the requirement of multiplatform and intuitive interface.

3. The correlation between GII14 (How would you prefer the platform interface to be?) and NVR12 (What kind of additional resources would you like to have at your disposal to enrich your learning experience?) which corresponds to 0.98431181, establishes that in order to achieve an intuitive user interface the system must have additional resources to enrich the learning experience. Once these three requirements mentioned in this 3rd dimension are fulfilled, the system will be of Quality.

The implementation of this system not only shows acceptance by the students; as stated by Jiménez [18] "The performance of the students in a given group following the traditional teaching method is unequal, due to the fact that not everyone can learn in the same way. When looking at the results of the students who used the tutor, a higher level of performance can be noted, as well as a greater balance between the grades obtained".

For the regression analysis, the independent variables corresponding to Quality and Tutor impact explain 0.51 (51%) of the dependent variable Tutor efficiency. This makes sense, since it is proposed that the quality and impact that the software could have is given by its efficiency.

Correlation table

Table 4. Correlation of variables.

Correlaciones

		IMPACTOTUTOR	EFICIENCIATUTOR	CALIDADTUTOR
IMPACTOTUTOR	Correlación de Pearson	1	.538**	0.244
	Sig. (bilateral)		0	0.05
	N	65	65	
EFICIENCIATUTOR	Correlación de Pearson	.538**	1	
	Sig. (bilateral)	0		0
	N	65	65	65
CALIDADTUTOR	Correlación de Pearson	0.244	.587**	1
	Sig. (bilateral)	0.05	0	
	N	65	65	65

** La correlación es significativa en el nivel 0,01 (bilateral).

Source. Own elaboration based on the regression performed in the SPSS program.

The previous box shows that the correlation between the efficiency and impact dimensions is of 0.538. Between the dimensions quality and efficiency the correlation is 0.587. This indicates that the correlation is significant at 0.01 bilaterally.

Regression table

Table 5. Regression analysis of model b.

Resumen del modelo b

Modelo	R	R cuadrado	R cuadrado ajustado	Error estándar de la estimación	Estadísticos de cambio: Cambio en R cuadrado	Cambio en F	gl1	gl2	Sig. Cambio en F
1	.714a	0.51	0.494	4.487	0.51	32.286	2	62	0

a Predictores: (Constante), CALIDADTUTOR, IMPACTOTUTOR
b Variable dependiente: EFICIENCIATUTOR

Source. Own elaboration based on the regression performed in the SPSS program.

For the regression analysis, the independent variables corresponding to Quality and Tutor impact explain 0.51 (51%) of the dependent variable Tutor efficiency. This makes sense, since it is proposed that the quality and impact that the software could have is given by its efficiency.

CONCLUSIONS

This research presented a descriptive analysis of the operational feasibility of implementing an interactive tutor. This tutor should handle the personalization in terms of the learning styles of each user. The conceptual design of the software architecture is also described. For this purpose, artificial intelligence should be used, even today there is talk about augmented reality. In particular, this type of project corresponds to a series of technological trends for 2024 (Linkedin, 2023).

Therefore, a teaching-learning strategy is proposed for Computer Systems Engineering students to have a foothold in terms of online software project management.

The design model for the development of a Web-based ITS is closely linked to the Impact dimension, which measures the level of impact of an ITS on the development of students as professionals. The Effectiveness dimension, which measures the level of embodiment of the application in terms of learning theories. And, the Quality dimension, which measures the security that the application may have.

Therefore, when the survey was conducted, it was realized that the operational feasibility is given in terms of the effectiveness of the students. That is, when it is proposed that viability is given on student perceptions and attitudes, we are saying that it is effectiveness. Therefore, the dependent variable is the efficacy dimension; therefore, quality and impact are independent.

To define the perceptions and attitudes regarding the effectiveness of the Intelligent Tutoring System in students, the general descriptive analysis of efficiency was used. This was given in the operationalization of variables. For the potential impact regarding the introduction and implementation of the ITS in the study program, it is obtained by conducting the survey.

What was obtained was an acceptance level of 51% given by the regression analysis. This indicates that there is a considerable level of acceptance for the implementation of the ITS. Furthermore, the ITS should be governed by effectiveness. In other words, the application must be efficient and customized to achieve the quality and impact required. Therefore, the application must be customizable, intuitive and interactive. These are given as non-functional requirements, since the nature of the ITS states it as such in its knowledge base. It should be considered that the major functional requirement will be the effectiveness of the software, and these are given in the customization, speed of response, easy to use graphical interface.

Recommendations for software developers.

Below are some recommendations for the developers of the application, based on the descriptive analysis of the research:

- ✓ Review and analyze the conceptual scheme on the design of the application with 4 management modules.
- ✓ It should be considered that the major functional requirement will be the efficiency of the software, and these are given in the customization, speed of response, easy to use graphical interface.
- ✓ The application must be customizable, intuitive and interactive. These are given as non-functional requirements, since the nature of the ITS states it as such in its knowledge base.
- ✓ The application should be multiplatform and open source, for software updates. In addition, it would serve as academic practices for students.

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