

Mobile application as a technological alternative for the inclusion of women in STEM areas: UTN Case Study.

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Abstract

The low participation rate of women in science, technology, engineering, and mathematics (STEM) areas worldwide is one of the problems that has arisen in the majority of higher education institutions. The objective of this research is to develop a mobile application to strengthen the inclusion of women in STEM areas in the Faculty of Engineering in Applied Sciences (FICA) of the Technical University of the North (UTN) through the dissemination of different types of audiovisual content (images and videos) of profiles of success stories of STEM women. In addition, sections include news, vocational aptitude test, and initiatives to achieve female empowerment in engineering students, improving confidence, leadership, and communication skills. She also provides career counseling and guidance in FICA's academic mentoring program for female students during the October 2021 - February 2022 semester. As a result of the satisfaction survey, a high satisfaction rank was obtained concerning the variables related to the information and user interface. The mobile application objective's fulfillment level received an overall rating of 56.25%, which allows us to interpret that it has a high probability of strengthening the inclusion of women in STEM areas.

Concluding that the mobile application increases the participation rate, strengthens the inclusion of STEM women, and provides opportunities to reduce the gender gap in the first levels of technical career training.

Keywords

Mobile App, STEM Women Inclusion, STEM Mentoring, STEM Women.

1. Introduction

Women's participation in STEM (Science, Technology, Engineering, and Mathematics) careers has been a persistent challenge around the world [1]–[3]. Despite efforts to promote gender equality in these fields, women remain underrepresented, limiting their potential and hindering progress toward a more equitable and diverse society. The need to address this gender gap and foster inclusion has become a priority in recent years [4]–[6].

In this context, mobile technologies and applications have demonstrated their ability to play a significant role in education and promote equal opportunities [7]–[11]. Providing an interactive and personalized platform can inspire and empower young women, cultivate their interest in STEM, and promote greater gender equality in education and society at large. Therefore, creating a mobile application will promote the visibility of female models to impact the choice of careers in STEM areas. It will also promote a space to share experiences and receive guidance and mutual support. It will also foster a strong support network that fosters confidence and perseverance in earning a degree in a STEM career [12], [13].

In this article, we propose developing a mobile application specifically designed to strengthen the inclusion of women in STEM areas at the Faculty of Engineering in Applied Sciences (FICA) of the Technical University of the North (UTN). In order to strengthen female empowerment and

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provide young women with an interactive and accessible tool that allows them to explore, discover and develop their interest in STEM fields.

The mobile application is based on adopting the Mobile D methodology as a development framework and playful approaches, taking advantage of the potential of gamification and intuitive interaction to create an attractive and motivating experience through the dissemination of different types of audiovisual content (images and videos) of profiles of success stories of STEM women, as well as to encourage the participation of women in STEM careers from an early stage of their education.

In Section 2: the stages and methodology of the research are described; In Section 3: the interface and the tests that are carried out are presented; Section 4: Describes the results found from the application of an application satisfaction survey. Finally, in section 5: the points that stood out most from the research are concluded.

2. Stages and methodology

As a public university in Ecuador, the Universidad Tecnica del Norte (UTN) meets national parameters and guidelines related to the admission process of students to higher education institutions (IES).

In addition, as part of the international WSTEM project [14], the UTN, since 2020, has been participating and carrying out campaigns to attract and guide female students in STEM careers, particularly students of the careers of the Faculty of Engineering in Applied Sciences (FICA) [15],[16].

The UTN team has proposed to design a mobile application that strengthens the inclusion of women in STEM careers and creates a support tool in decision-making for a STEM career, focusing on two processes attraction and orientation. In this way, the process that has been taken has started with dialogue meetings with stakeholders in which ideas are shared, and possible structures for the mobile interface are raised. In order to determine the requirements and limitations of this.

2.1. Attraction and orientation FICA UTN

Figure 1 and Figure 2 present the flowchart of the process of attraction and orientation of FICA students, considering the information generated and the experiences learned from the attraction campaigns, as well as the orientation process of the WSTEM UTN project [15].

Outreach campaign activities to promote interest in STEM academic programs include outreach, talks, and workshops with women leaders in the engineering industry to inspire and motivate future STEM youth.

It is important to define the orientation process, such as the activities and services provided by public universities to guide students in their career choice, as well as to provide vocational counseling, orientation workshops, academic planning guides, psychological support, and tutoring programs to facilitate the adaptation and success of students in university life.

3. Mobile App

For the development of the mobile application, the Mobile D methodology was applied as a basis for the development of the solution, in order to present an adequate and quality product to end users (high school students of educational units and students of FICA UTN) [17].

Activities performed during development are described below.

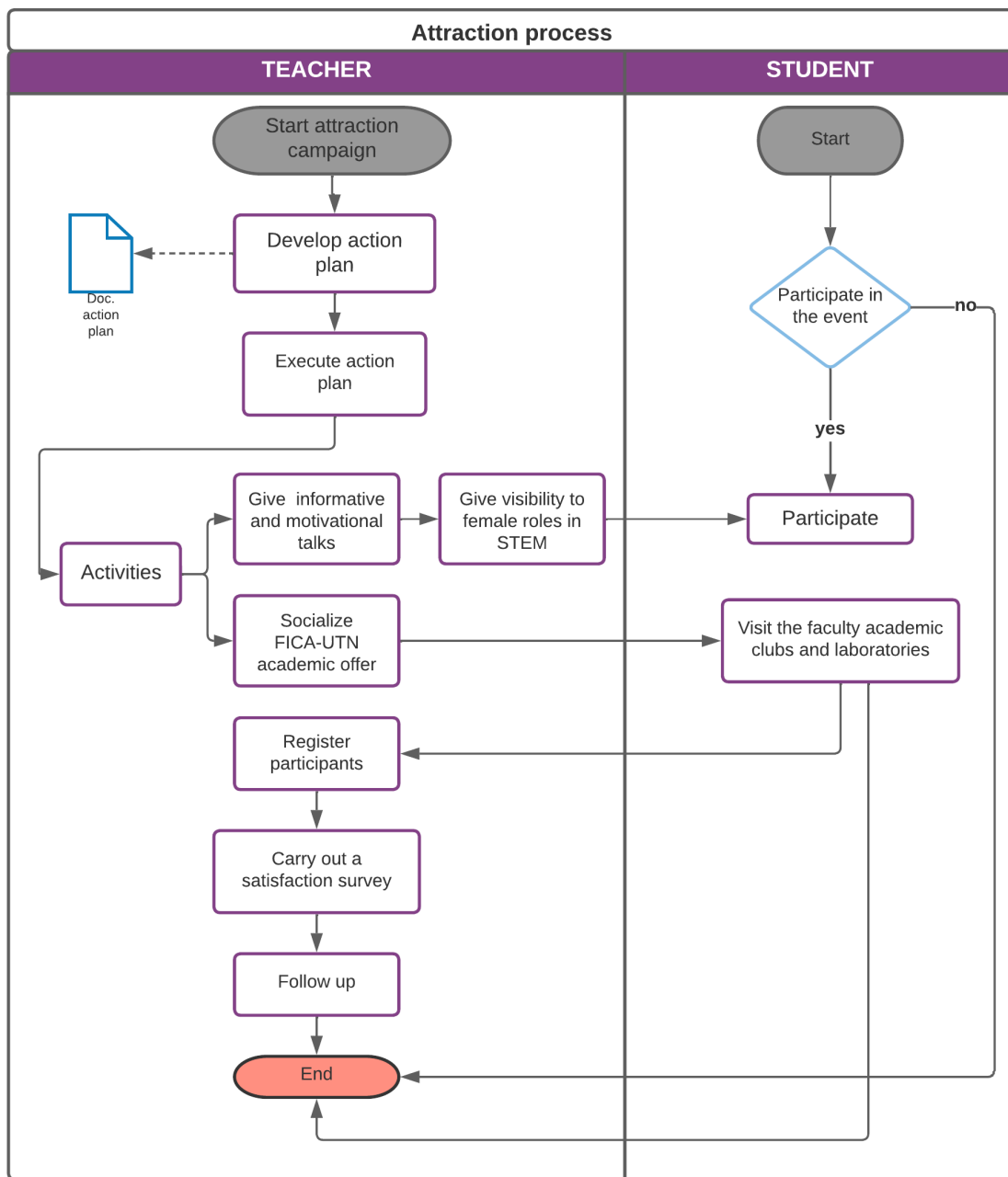


Figure 1: Attraction process FICA STEM UTN (readapted from [11])

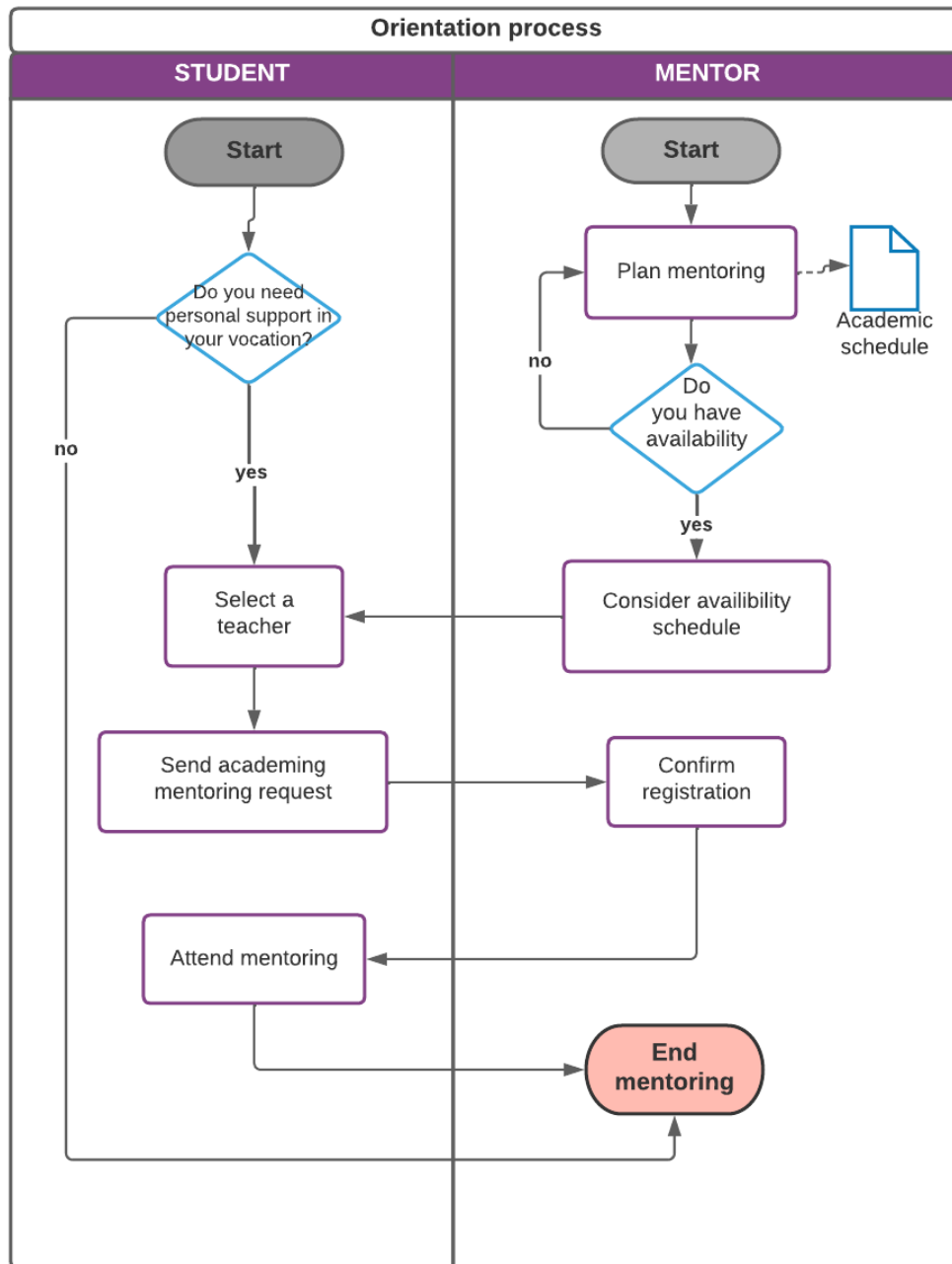


Figure 2: FICA STEM UTN Orientation Process (readapted from [11])

3.1. Definition of requirements and limitations

A qualitative approach was used through a focus group, where stakeholders' needs and requirements to strengthen the inclusion of women in STEM areas were identified, each supported by research and actions carried out in the institution.

Promote STEM content since the motivating content mirrors the experiences of professional women in STEM and events and initiatives carried out. As for the academic offer FICA UTN, it is because there is a low percentage of women. Representing 22.50% compared to men reaching 77.50% of the student population of the entire faculty. Likewise, generate a support network through academic mentoring in subjects with a greater degree of difficulty because there is a dropout rate of students from the first levels of the faculty careers [15], [11], [16].

All this is done through the requirements engineering application that has means of communication to collect and transmit the requirements where written user stories were applied

to define the functionalities of the mobile application from the user's point of view, according to Mike Chon [18].

Requirements

- **User types:** High school students of Educational Units and students of FICA UTN
- **STEM Content:** Users view information from STEM women's profiles, news, and initiatives. The profiles of women in STEM show the profile picture, detailed academic information, as well as a link to access the profile on LinkedIn, share on social networks, and rate with a reaction of interest to the content. The news shows an image next to the title and an option to view detailed content about educational programs, scholarships, and STEM career opportunities.
- **FICA academic offer:** High school students view audiovisual content (images and videos) related to the conceptualization and job opportunities of the careers offered by FICA.
- **Vocational aptitude test:** Aimed at high school students, formulated with 30 questions to determine the level of knowledge, skills, and general attitudes to study an engineering career that allows them to orient the occupational area better.
- **Schedule academic mentoring:** Aimed at female students of the first levels of FICA during the semester October 2021- February 2022 to schedule academic mentoring with university professors as support in the subjects that have a greater degree of difficulty in order to build a solid support network that fosters confidence and retention with the chosen career.

Limitations

- The mobile application is available only for Android devices in version 9.0.0 or higher and can be accessed through a distribution package with an extension .apk.
- The mobile application requires an internet connection to perform all functions.

3.2. Planning the application architecture

The solution is based on an architecture of distributed systems client server consisting of a web application server that generates requests for consumption of information stored on a database server, and its communication channel is through Rest API as a distributed web service in JSON format, the same that is consumed by mobile applications and web clients, who interact with the same data, as shown in Figure 3 [19].

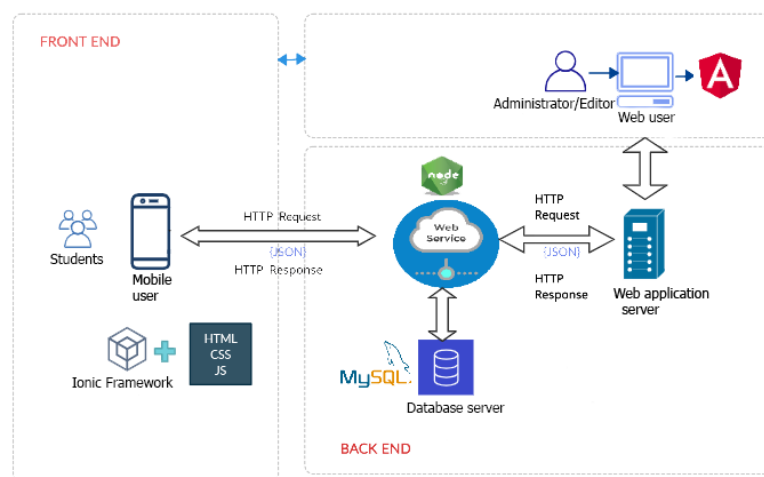


Figure 3: System architecture (readapted from [11])

4. Mobile App Interface

The mobile application was developed with two main views, one for high school students and another for FICA UTN students, each with a menu of personalized options, as seen in Figure 4. High school students visualize (Figure 4B) the sections of women in STEM, news and events, academic offer, and vocational aptitude test; and FICA students visualize (Figure 4A) the sections of women in STEM, news and events, scheduling mentorships and my mentorships.

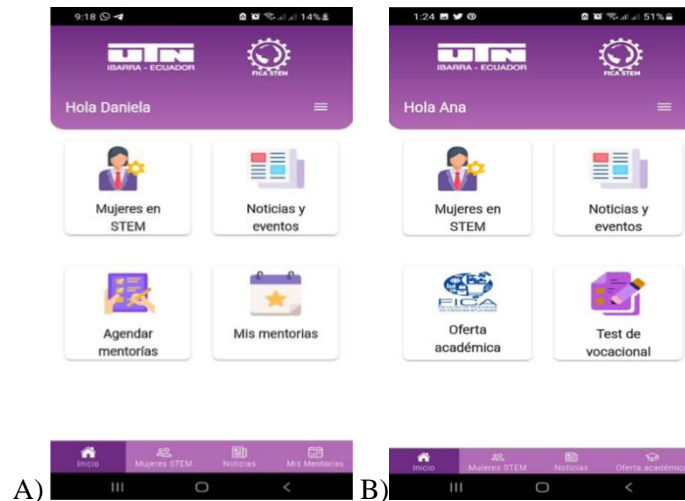


Figure 4: Main menu mobile application W-STEM UTN for both types of users. A) FICA students. B) High school students (readapted from [11]).

4.1. Profiles of women in STEM

Women in STEM profiles display detailed information from their academic information and a link to access the profile on LinkedIn. In addition, it allows sharing on social networks and assessing with a reaction of interest to the content, as evidenced in Figure 5. The interview option shows videos of women in STEM from the YouTube website.

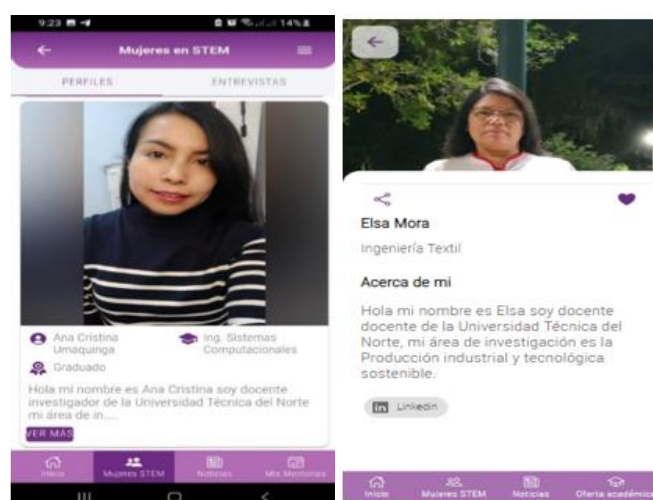


Figure 5: Screen of the women profile in STEM and description of the research teacher profile (readapted from [11]).

4.2. STEM News

The STEM news shows an image next to the title and the option to see the content in detail in which the information is displayed to share on social networks, assessed with a reaction of interest as evidenced in Figure 6. The content presented is relevant to commemorative dates, educational programs, scholarships, and STEM career opportunities.

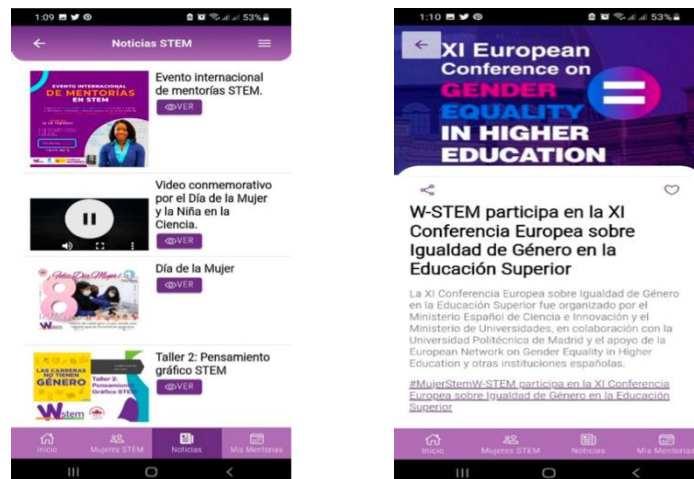


Figure 6: Example list of STEM news and detail (readapted from [11]).

4.3. Vocational aptitude test.

For the students of the Educational Units of high school level, a vocational aptitude test was elaborated as shown in Figure 7. Questions were formulated that determine the level of knowledge, skills, and general attitudes to study engineering; After that, 30 questions were designed to determine the affinity with the technical career that best suits each person.

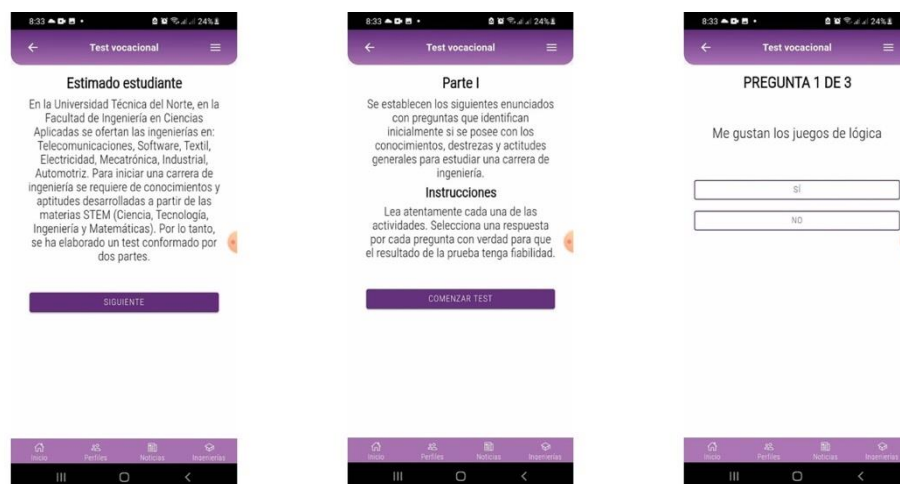


Figure 7: Vocational Test Screen (readapted from [11]).

4.4. Schedule mentorships

For the students of the FICA UTN, an option is visualized to schedule academic mentoring with professors at the university as support in the subjects that have a degree of difficulty to build a solid support network that fosters confidence, and permanence in the chosen career as shown in Figure 8.

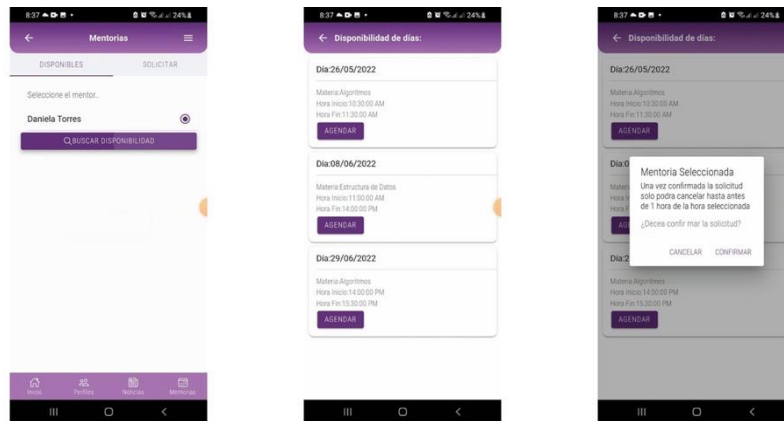


Figure 8: Screen to schedule academic mentoring (readapted from [11]).

5. Results

In order to validate the fulfillment of the needs of the interested parties and the functionality of the mobile application, a pilot test was applied to 16 female students of the first levels of each of the careers of the FICA UTN; For this, a test plan was carried out with the description of 23 user stories with a level of compliance of 100%.

Evaluating the temporal behavior of the feature, that is, efficiency in the performance of ISO/IEC 25010 [20].

Once the mobile application was delivered and the tests were carried out to the users, the research instrument called CSAT methodology (Customer Satisfaction Score) was applied, which is an indicator of the customer with the product, in which a satisfaction survey was elaborated with [21] validation questions based on a Likert scale frequently (nothing, low, medium, high, very high) concerning the information provided in the solution, as well as based on the fulfillment of the stated objective.

Validation questions:

VQ. 1: The level of user satisfaction is evaluated regarding the information and user interface detailed in Table 1.

What is the satisfaction level with the information and user interface of the mobile application?

VQ. 2: The satisfaction level of items related to the achievement of solution objectives, detailed in Table 2, is assessed.

Do you consider the mobile application as a supportive tool to strengthen the selection of a STEM career?

VQ. 3: The mobile application is assessed in a general manner regarding its contribution to the empowerment of women in STEM, as detailed in Table 3.

Overall, how would you rate the functionality and usability of the mobile application?

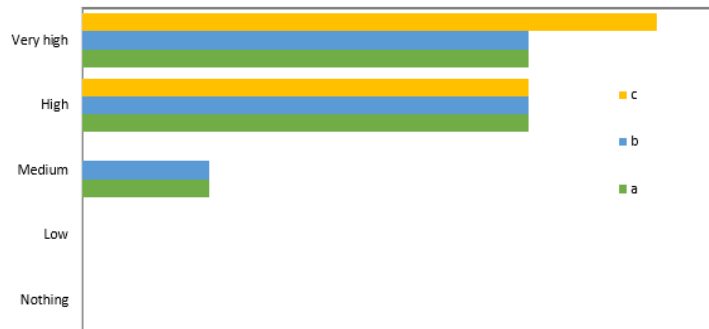
Table 1 shows validation question 1 where the level of satisfaction of users is evaluated with respect to some of the items related to the functionality, and content shown in the mobile application.

Table 1
Validation items for question 1

No.	Question	Scale
a	Is the information displayed in the mobile application about women in STEM inspiring?	Nothing, Low, Medium, High, Very High

b	Does the information presented by STEM news in the mobile application feel useful and inspiring?	Nothing, Low, Medium, High, Very High
c	Are the colors used in the mobile application's user interface visually appealing?	Nothing, Low, Medium, High, Very High

From the items belonging to validation question 1, it was found that the level of satisfaction of users for the information of profiles of women and news displayed obtains a medium, high, and very high range in the same way concerning the appropriate use of colors the high and very high range. Therefore, a positive result is obtained since there is no rating of low or nothing, as shown in Figure 9.



a. Is the information displayed in the mobile application about women in STEM inspiring?
b. Does the information presented by STEM news in the mobile application feel useful and inspiring?
c. Are the colors used in the mobile application's user interface visually appealing?

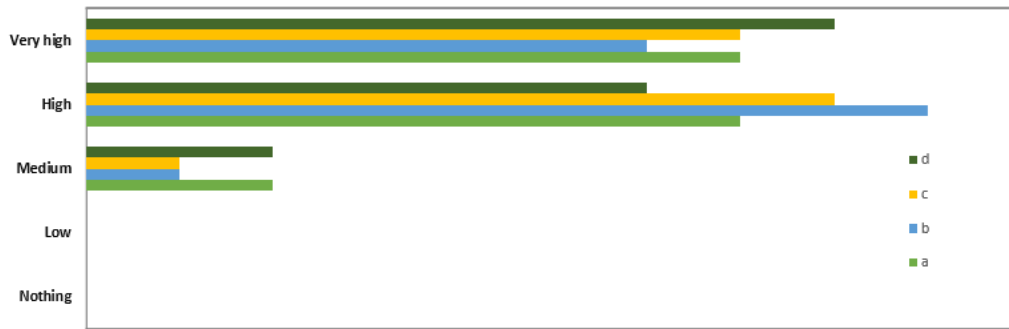
Figure 9: Satisfaction level for Validation Question 1 items

Table 2 shows the validation question 2, which evaluates the level of satisfaction of users with respect to some of the items related to the fulfillment of the primary objective of the mobile application.

Table 2
Validation items for question 2

No.	Question	Scale
a	Does the mobile app contribute to the enhancement of women's inclusion in STEM?	Nothing, Low, Medium, High, Very High
b	Based on the content displayed in the mobile application, do you perceive it as a decision-making tool?	Nothing, Low, Medium, High, Very High
c	Do you regard the mobile application as a supportive tool in the academic mentoring process?	Nothing, Low, Medium, High, Very High
d	Does the mobile app successfully capture the interest of women and girls, encouraging them to consider engineering as a career choice?	Nothing, Low, Medium, High, Very High

From the items belonging to validation question 2, it was found that the level of satisfaction of users for whether the application is considered a tool to strengthen the inclusion of women, a support tool in the academic mentoring process, and if it captures the interest of women to consider the engineering career as a possible choice obtains a medium range, high, and very high therefore, a positive result is obtained in the fulfillment of the general objective since a low rating range is not visualized, and nothing, see Figure 10.



- a. Does the mobile app contribute to the enhancement of women's inclusion in STEM?
- b. Based on the content displayed in the mobile application, do you perceive it as a decision-making tool?
- c. Do you regard the mobile application as a supportive tool in the academic mentoring process?
- d. Does the mobile app successfully capture the interest of women and girls, encouraging them to consider engineering as a career choice?

Figure 10: Level of satisfaction of the items of validation question 2

In addition, at the end of the survey, the third question was asked that allowed obtaining a general rating of the product value with a scale of 0 to 10 in which zero is not likely, and 10 is highly likely the satisfaction of end users with the mobile application, based on the NPS methodology (Net Promoter Score) [21] as an indicator to measure loyalty, and user satisfaction detailed in Table 3.

For this, it is called as follows.

- Promoters. – The product rating is between 9 -10
- Liabilities. - The product rating is between 7 - 8
- Detractors. – The rating of the product is between 1 - 6

Table 3
Question 3, validation through the NPS Methodology

No.	Question	Scale
1	Please provide the rating for the final version of the WSTEM FICA mobile app in terms of its effectiveness in promoting the inclusion of women in STEM	0 to 10

As a result, **56.25%** are promoters, **43.75%** are passive, and **0%** are detractors, or there is no dissatisfaction with the product detailed in Figure 11, applying equation 1.

$$NPS = Promoters(\%) - Detractors(\%) \quad (1)$$



Figure 11: NPS Validation Question (readapted from [11])

Once the formula for obtaining the general qualification of the mobile App to strengthen the inclusion of women in STEM has been applied, a result of 56.25% is obtained. This allows us to interpret that the mobile App has a good probability of strengthening the inclusion of women in STEM, therefore the proposed objective is met.

6. Conclusions

- The results obtained from the satisfaction survey on the mobile App users, which promotes: female models in STEM, news, and initiatives, show a satisfactory percentage compliance rate of 56.25%. The app's development effectively encourages women's participation in STEM careers, and it can potentially address female students' barriers and challenges in this field. In addition, it provides opportunities for women to participate in engineering-related extracurricular activities, such as science and technology clubs and events.
- Likewise, it can be deduced that most users show a high degree of satisfaction when considering the mobile application as a support tool in the mentoring process since it effectively manages the process and thereby encourages the participation of the women from the first levels of the faculty, and contributes to the goal of achieving gender equality and diversity in these fields.
- The studio used the agile and interactive Mobile D methodology to develop an alpha version of the application, focusing on getting quick feedback from UTN users. A minimum viable product (PMV) validated by segmented users and parental consent when they are minors is required to apply to high school students. For this reason, it was not considered due to the established institutional times and deadlines.
- In addition, the study looks at the persistent challenge of the underrepresentation of women in STEM careers worldwide. Efforts to promote gender equality in these fields have run into obstacles, hindering progress toward a more diverse and equitable society. To address this gender gap and encourage inclusion, the study proposes a mobile application specifically designed to strengthen the inclusion of women in STEM areas at the Faculty of Engineering in Applied Sciences (FICA) of the Technical University of the North (UTN).

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8. References

- [1] T. Z. Badilla, "Estrategias de aprendizaje STEM," *Revista Académica Institucional*, vol. 3, no. 2, pp. 63–73, 2021, Accessed: May 21, 2023. [Online]. Available: <https://rai.usam.ac.cr/index.php/raiusam/article/view/50>
- [2] C. Muñoz Rojas, "Políticas públicas para la igualdad de género en ciencia, tecnología, ingeniería y matemáticas (CTIM): desafíos para la autonomía económica de las mujeres y la recuperación transformadora en América Latina," Dec. 2021, Accessed: May 21, 2023. [Online]. Available: <https://repositorio.cepal.org/handle/11362/47565>
- [3] C. A. Hernández Herrera, "Las mujeres STEM y sus apreciaciones sobre su transitar por la carrera universitaria," *Nova Scientia*, vol. 13, no. 27, Aug. 2021, doi: 10.21640/ns.v13i27.2753.

- [4] A. Bello, "Las mujeres en Ciencias, Tecnología, Ingeniería y Matemáticas en América Latina y el Caribe," in ONU Mujeres, 2020.
- [5] A. García-Holgado and F. J. García-Peñalvo, "El Proyecto W-STEM y la Mujer en la Ciencia," 2021, doi: 10.5281/zenodo.5675000.
- [6] A. Bello, "SAGA STI Policy Survey," *Journal of Information Technology Research*, vol. 12, no. 4, 2019, doi: 10.5281/zenodo.2615109.
- [7] V. Angélica Costa, K. A. Rizzo, J. Inés, and G. Sagastume, "Educación STEM: integrar conceptos de fotometría a la clase de matemática usando tecnología STEM education: integrating photometry concepts into math class using technology," 2019. [Online]. Available: www.revistas.unc.edu.ar/index.php/revistaEF/
- [8] L. A. Laurens-Arredondo, "Evaluation of the use of mobile learning in STEM Education: An experience of university students in times of pandemic," *Revista de Investigación en Educación*, vol. 20, no. 2, pp. 172–187, 2022, doi: 10.35869/reined.v20i2.4224.
- [9] A. García-Holgado, S. Verdugo-Castro, M. C. Sánchez-Gómez, and F. J. García-Peñalvo, "Facilitating Access to the Role Models of Women in STEM: W-STEM Mobile App," in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, Springer, 2020, pp. 466–476. DOI: 10.1007/978-3-030-50513-4_35.
- [10] M. A. Lozada Sánchez and C. E. Moncayo Rodríguez, "Diseño de interfaz web informativa sobre ecuatorianas icónicas en Ciencia, Tecnología, Ingeniería y Matemáticas.," 2021, Accessed: May 21, 2023. [Online]. Available: <http://www.dspace.espol.edu.ec/handle/123456789/56293>
- [11] P. G. Cuascota Cabascango, "Desarrollo de una aplicación móvil para fortalecer la inclusión de mujeres en las áreas de ciencia, tecnología, ingeniería y matemáticas (stem) en la Facultad de Ingeniería en Ciencias Aplicadas de la Universidad Técnica del Norte, integrando las tecnologías Api Rest y el Framework Ionic.," Jul. 2022, Accessed: May 21, 2023. [Online]. Available: <http://repositorio.utn.edu.ec/handle/123456789/12639>
- [12] S. Mateos Sillero and C. Gómez Hernández, *Libro Blanco de las mujeres en el ámbito tecnológico*. 2019.
- [13] L. Amores García, F. García Peñalvo, and J. J. Mena Marcos, "La brecha de género: Análisis de perfiles de estudiantes y profesionales en las áreas STEM," 2020.
- [14] A. García-Holgado, "Women and STEM disciplines in Latin America: The W-STEM European Project," *Journal of Information Technology Research*, vol. 12, no. 4, 2019, DOI 10.5281/zenodo.3531553.
- [15] Equipo W-STEM de la Universidad Técnica del Norte, "Campañas de atracción W-STEM. Caso de la Universidad Técnica del Norte," Jul. 2022, doi: 10.5281/ZENODO.6844978.
- [16] Equipo W-STEM de la Universidad Técnica del Norte, "Propuesta de las Mentorías STEM," Jul. 2022, doi: 10.5281/ZENODO.6841648.
- [17] D. M. Pérez Carvajal, "Sistema de información geográfica para la gestión de parqueaderos privados utilizando el framework phonegap y metodología de desarrollo Mobile-D," Universidad Técnica del Norte, 2016. [Online]. Available: <http://repositorio.utn.edu.ec/handle/123456789/7805>
- [18] M. Cohn, "User Stories Applied for Agile Software Development," 2004, Accessed: Jul. 26, 2023. [Online]. Available: www.wowebook.com
- [19] A. Schiaffarino, "Modelo cliente servidor: ¿Qué es? Características, Ventajas y Desventajas," Mar. 12, 2019. <https://blog.infranetworking.com/modelo-cliente-servidor/> (accessed May 27, 2021).
- [20] ISO 25000, "ISO 25010," 2021. <https://iso25000.com/index.php/normas-iso-25000/iso-25010> (accessed Sep. 10, 2020).
- [21] N. Gomez, "CSAT: ¿qué es y cómo calcularlo?" <https://www.zenvia.com/es/blog/csate-que-es-y-como-calcularlo-2021/> (accessed May 21, 2023).