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Immersion days as a strategy for STEM vocation development

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***Abstract*– Overcoming barriers and myths about STEM requires educational interventions that promote motivation and skill development in STEM disciplines. Therefore, an educational immersion is presented for 128 eleventh-grade students of Colegio Vista Bella in the city of Bogota, to bring them closer to the STEM disciplines. To this end, a survey of professional interests is implemented to collect the perceptions of the participants during the academic activities and guided visits to the Politécnico Grancolombiano. Although the eleventh-grade students do not have a clear preference for a university career, there is greater interest in STEM activities, due to their holistic approach to the 4 disciplines and the development of STEM competencies such as critical thinking, problem-solving, and creativity.**

Keywords—STEM, vocations, high school, higher education.

I. Introduction

The transition between secondary and higher education is a complex process involving many factors. Some authors emphasize the importance of factors such as decision-making, institutional support, required skills, educational level, and social and family conditions in this process [1], [2], [3].

For a proper college readiness process, [4] proposed a conceptual framework that includes four key elements to be developed in students:

a) Thinking skills (logical reasoning, critical thinking, creativity, problem-solving, effective communication, and analysis).
b) Attitudes towards and understanding of the content and understanding of the content of the core curricular areas.
c) Learning skills and techniques (time management, study techniques).
d) Knowledge of the processes of linkage to higher education and university culture.

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Ownership of learning, including motivation, engagement, self-efficacy, metacognition, and persistence, becomes important [5]. To address this transition, articulation programs have focused their efforts on providing students with the knowledge and skills needed to enter college, as well as preparing high school teachers to adapt their practice and help students become familiar with the college environment [1].

Some strategies involve strengthening connections between higher education institutions and non-university training institutions. Their activities include creating communication networks, activating articulation strategies involving interdisciplinarity, and building inter-institutional agreements aimed at improving the educational trajectory of students [2]. The strategies or activities employed play an important role in the transition of students to higher education and the world of work. These include visits to universities where information on training programs is presented, vocational orientation workshops or talks, and the application of skills tests [1], [2]. However, in their transition process, students often feel uncertainty and fear in the face of academic demands and the university environment [2].

Therefore, there is a need to rethink the articulation process since it plays a fundamental role in decision-making in terms of career guidance, and addressing the concerns and fears of students; it should focus on the student, valuing their interests and talents, providing an accompaniment that encourages informed decision making about their life project, eliminating gaps in access, learning, and permanence, in correspondence with the opportunities and needs of their cultural, social, economic and productive environment [6], [7].

Professional projection is based on the inner vocation that a person feels towards a profession. This call arises from a process of self-knowledge, considering personal tastes, emotions, and satisfactions. Personal preferences and tastes are fundamental in decision making and this choice must be personal, without external influences, such as that of parents. On the other hand, factors such as historical and socioeconomic conditions influence career choices [8].

Young people's career choices are mainly influenced by their perception of competence in the development of specific activities; they value more the activities in which they feel they have a better performance, and which give them greater value.

From early childhood, children show professions with which they dream of performing, but when they become adolescents there is a personality identity crisis, so it is necessary to experience different roles and set goals that give meaning to their choices [8].

In the case of STEM (science, technology, engineering, and mathematics) fields, the importance of providing a solid education in these areas is emphasized. This includes scientific and technological research and problem-solving skills [9]. It is important to combat gender stereotypes and promote equal opportunities in these areas to inspire students, especially girls. Some aspects that influence students' motivation in STEM subjects include skills acquisition, information about STEM careers, students' self-efficacy, and social perceptions of STEM careers in this sector [10]. Providing appropriate academic and career guidance is essential to provide a realistic view of career expectations in science and technology. STEM guidance strategies are based on fostering ingenuity, curiosity, creativity, and problem-solving skills in girls, boys, and young women [8].

In articulation activities, it is crucial to foster vocations towards STEM areas since they contribute to the development of competencies necessary for adequate decision-making in career choice. Through this type of activities, the development of thinking skills and attitudes towards knowledge indicated by [4] is promoted, since they coincide in several elements with what are currently recognized as STEM competencies, such as critical thinking and problem-solving, to address academic and professional challenges in these areas [11], including socioemotional competencies, which facilitate adaptation to the university environment and personal and professional growth in any field.

To achieve this purpose, it is essential to implement articulation strategies that promote the development of STEM and socioemotional competencies, while integrating elements of learning appropriation. These strategies have a significant impact on student achievement, interest, and retention in higher education [11], [12], [5]. Consequently, articulation becomes an essential tool to ensure that students are adequately prepared and can make the most of their educational experience in college [1], [2].

Social perception about STEM industries and careers also plays an important role. Gender differences influence the preference for certain aspects of STEM-related jobs, such as interest, challenge, and social image [10]; therefore, proper academic and career guidance is essential to provide a realistic and equitable view of vocations in these fields.

In this context, the Faculty of Engineering, Design, and Innovation of the Institución Universitaria Politécnico Grancolombiano proposed to develop university immersion days for students in the last grades of secondary education to contribute to the strengthening of STEM skills and socio-emotional skills, as well as to promote the best choices when making decisions regarding the profession and career field of students with this degree. To this end, from each of the schools of the faculty, the School of Optimization, Infrastructure and Automation (OPINA), School of Information and Communication Technologies (ICT), School of Design, and the School of Basic Sciences, academic activities were designed in which a small experience of some of the professional practices of the fields of study of the training programs offered in each of the schools was lived.

II. Method

The experience described in this document was developed with eleventh-grade students from Colegio Vista Bella in the city of Bogota. A total of 128 students participated. The activities carried out during the day are described below.

A. Talk on decision-making for university life guided by the psychology area and the enrollment management of the institution. The main fears, difficulties, and challenges that young people usually face when making decisions are mentioned and some strategies to face them are provided. At the end of this talk, a survey about the professional career of interest is applied.
B. Academic activities designed and guided by the teachers at the faculty schools.
C. Tour of the institution in which the main academic and welfare spaces of the university campus are recognized.
D. Application of a perception survey on the activities developed and the motivation for choosing a faculty program.

III. Results

A. Career Interest Survey

In this activity, 257 students from the tenth and eleventh grades participated, of which 141, corresponding to 54.86% are girls and 116 boys for a proportion of 45.14%. Of this population, 25 girls (17.73%) prefer careers related to Engineering and Design, which represents a lower percentage compared to 59 girls (40.13%) who expressed a preference for other careers. Finally, 51 of the girls responded that they do not know yet what career to study, which represents 35.17% of the total number of girls.

In the case of boys, 23 of them responded that they are interested in studying a career related to Engineering, Mathematics, or Design, which corresponds to 19.82%, 53 of them prefer other careers representing 45.68% and 39 boys

responded that they do not know yet what career to study, which corresponds to 33.62% of the total number of children.

The initial ideas of intervention were transformed to the point that the ways of designing and applying the workshops were rethought, as well as sensitive experiences were discovered, where the dialogue between the young people was more fluid and meaningful.

B. Academic activities

Considering that the school has an emphasis on technology, environment, and communication, the students were distributed in the different activities according to the emphases.

Table I describes the activities carried out together with a description of the main results obtained.

TABLE I
ACADEMIC ACTIVITIES

Activity	Objective	Description	Results
Fantastic binomials	Contextualize participants on the importance of creativity and transformation in design, through tools to explore the potential of creativity.	The main concept of this technique is spacing, which allows the creation of new ideas by combining two unrelated elements. This activity is expected to promote a short experiential space of problem-solving and creativity that are typical of the professional field of design, from co-creation activities to the participation of multidisciplinary teams (experts and common users) seeking solutions to problems [13]. In a short exercise, a process of research, conceptualization, and participatory co-creation of a fantastic product is carried out. Through four stages that show how a design proposal is arrived at: initial presentation to contextualize; inquiry through artistic experience; development of the activity in groups; delivery and presentation of the fantastic product with the whole group.	The students worked and participated actively during the contextualization and construction of the new word that corresponds to the first part; then, they relied on elements that facilitated the visual representation of their idea. The understanding of the interaction space where they are allows them to carry out a co-creation activity such as exchanging their points of view and defining the way they will make the presentation to the other participants and to the teachers who are accompanying them. Another valuable element is to understand the time management, delivery, and presentation of the fantastic product (name and brief description), which should not exceed two minutes.  Fig 1. Teamwork in fantastic binomials.  Fig 2. Socialization of fantastic binomials.
Industrial processes laboratory	Acquire knowledge about milling machines, turning machines, and other laboratory tools used in material machining processes.	The activity consists of presenting to the students the demos of a milling and turning process and the students can voluntarily program each one of the processes.	The students who participated in this activity showed interest in learning about the processes, as well as the applications of physics in the machining processes of the manufacturing processes laboratory. It was also observed that the simulations that were executed on the machines were performed by the students after

		a short induction process demonstrating the skills, as well as the recognition of the forces that act in the processes. These applications allow the students to experience physics in the laboratory and get closer to the processes they will find in the industry.

Fig 3. Work in industrial processes lab.

Wastewater study	Apply laboratory techniques in the analysis of wastewater to explore strategies to improve water treatment in a specific context of the locality of Bogota.	The activity is based on experimentation, collaborative work, analysis of a problem, and the development of possible solutions. The experimentation involves studying wastewater samples in the laboratory collected from the locality where the students live, while the collaborative work addresses the problem of water pollution and the search for sustainable strategies to treat wastewater. Students work in groups of three, each contributing a water sample, which can be rainwater, standing water, or wetlands. Physical parameters evaluated include turbidity and pH, which are key indicators of water quality in various contexts.

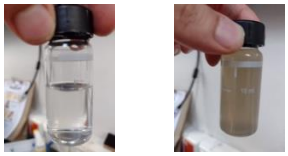

Fig. 4. Samples of wastewater and rainwater from a puddle.

The student's experience in this workshop highlighted the importance of competency in critical analysis of information. While exploring rainwater quality using a purple cabbage indicator and subsequently using a potentiometer in the laboratory, students were faced with the challenging task of comparing and evaluating the results obtained in both methods. Critical analysis became critical, as students had to discern differences and similarities in the color response of the cabbage indicator and the pH data measured by the potentiometer. This required not only the ability to observe and record accurately but also the ability to question, interpret, and contextualize the results. This process allowed them not only to acquire scientific knowledge but also to develop critical skills necessary for scientific thinking and problem-solving in the STEM context by inspiring curiosity and fostering the ability to ask fundamental questions and seek answers through investigation and experimentation.

C. Institutional visit

In this space were presented the academic spaces such as libraries, specialized rooms such as laboratories, the Gesell Chamber of the psychology program, the audiovisual media area, and the radio station where a group of students were able to make a radio episode. The university welfare spaces such as the gymnasium, dance rooms, and sports facilities were also presented.

D. Application of perception survey

A survey was applied to know the students' perception of the activities developed. The first questions were framed around the institutional talks on decision-making and presentation of the institution's portfolio of programs; the second on academic activities, inquiring about interests and perspectives, topics, methodology, the leader who carried out the activity, and whether it generated interest and participation.

Regarding institutional activities, 54.5% are more interested in the presentation of the Politécnico Grancolombiano portfolio and 46.4% in the decision-making activity.

Regarding the industrial processes' laboratory activity, it obtained ratings of 4 and 5 in the questions on topics (68.8%), methodology (93.8%), interest and participation (87.6%), and activity leader (87.5%). For the Wastewater Study activity, the percentages were as follows: topics (67%), methodology used (67%), interest and participation (43%), and activity leader (80%). For the Fantastic Binomials activity, scores of 4 and 5 were observed in all questions, with a value of 50% in each of them.

With these results, it is concluded that the students perceived better in front of the industrial processes laboratory activities in terms of grades, in second place, the Wastewater Study. Finally, the Fantastic Binomials activity reflected equal percentages in the upper and lower extremes of the evaluation. However, when asked about their vocational preference, it was found that 44% of the respondents do not prefer any program of the faculty, 34% for the design program, and 22% for engineering and basic science programs.

Finally, we inquired about the interest in continuing to participate in activities associated with the faculty's programs, to which 78% responded positively. In addition, 97% recognize that this type of activity contributes to their transition process to the university and adequate decision-making regarding their professional vocation.

IV. Conclusions

The results show that a significant percentage of participating students do not have a clear preference for any professional program, which suggests that they are in a stage of decision-making and exploration of their vocational interests, which may be due to what was stated by [8] regarding the identity crisis that young people are going through. Additionally, the percentage of girls whose vocation is directed toward engineering and basic science careers is still low. These aspects highlight the importance of providing additional accompaniment and support so that this population can discover their vocations and overcome the obstacles involved in this process.

Understanding what generates an activity that is proposed in groups in addition to short times, makes the space with the other allows them to experiment in the workshops, get to know each other opt for creative paths, which will consider these meeting spaces, where the voice and experience of all is considered.

Despite the low vocational preference by some students, most were interested in academic activities related to faculty programs, indicating that university immersion and academic orientation activities are crucial in the consolidation of vocations and the academic and professional decision-making process [1], [9], [3].

The academic activities, especially those related to STEM, received positive ratings in terms of subject matter, methodology, interest, and participation, indicating that these types of experiences can influence students' career choices and foster their interest in specific fields. In the first piloting, these activities proved to be effective in developing STEM competencies among students. These competencies include critical thinking, problem-solving, and creativity skills, which are essential in fields such as engineering and science [11], [12], [5]. From the methodological aspect, all of them have the common characteristic that they start from experimentation and active participation by students, which is an aspect that is positively valued by students.

The experience described in this document highlights the importance of continuing to design and develop articulation activities, such as the university immersion days, which aim to promote the development of STEM and socioemotional competencies among high school students. These activities contribute to preparing students for higher education and decision-making regarding their professional vocations, especially in the STEM field.

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References

[1] A. De Gatica, M. Romero, L. Bort, and N. Gatica, "Representaciones contrapuestas: la escuela secundaria piensa a la universidad," *Inter-Cambios Dilemas y Transiciones de la Educación Superior*, vol. 6, no. 2, Dec. 2019, doi: 10.29156/INTER.6.2.3.

[2] M. C. Nin, "La articulación de la Universidad y la Escuela secundaria. Desafíos educativos ante la agenda 2030," *Huellas*, vol. 23, no. 2, pp. 193–198, Oct. 2019, doi: 10.19137/huellas-2019-2318.

[3] E. Rodríguez Rocha, "El rol de las elecciones educativas en la transición a la Educación Media Superior en la Ciudad de México," *Revista*

Latinoamericana de Población, vol. 8, no. 15, pp. 119–144, Dec. 2014, doi: 10.31406/relap2014.v8.i2.n15.5.

[4] D. T. Conley, *Getting ready for college, careers, and the Common Core: What every educator needs to know*. John Wiley & Sons, 2013.

[5] D. T. Conley and E. M. French, "Student Ownership of Learning as a Key Component of College Readiness," *American Behavioral Scientist*, vol. 58, no. 8, pp. 1018–1034, Jul. 2014, doi: 10.1177/0002764213515232.

[6] Ministerio de Educación Nacional, "LINEAMIENTOS PARA LA ARTICULACIÓN DE LA EDUCACIÓN MEDIA," 2010. Accessed: Nov. 13, 2023. [Online]. Available: https://r.search.yahoo.com/_ylt=AwrNPg.33lNlm0cUxBKrcgx.;_ylu=Y29sbwNiZjEEcG9zAzEEdnRpZAMEc2VjA3Ny/RV=2/RE=1700024120/RO=10/RU=https%3a%2f%2fwww.mineducacion.gov.co%2f1621%2farticles-299165_archivo_pdf_Lineamientos.pdf/RK=2/RS=a9qpf7l95JIAvzKz6cSNrCQDtic-

[7] Ministerio de Educación Nacional, *Orientaciones para promover la trayectoria educativa desde la educación media a la educación superior, en el marco de la educación inclusiva*. 2020. Accessed: Nov. 13, 2023. [Online]. Available: https://colombiaaprende.edu.co/sites/default/files/files_public/2020-12/Documento%20Educacio%CC%81n%20Media%20accesible.pdf

[8] G. G. Macias Gonzalez, F. Sánchez Carracedo, and M. N. Salán Ballesteros, "Cómo fomentar vocaciones en infantes y jóvenes en México para cursar carreras STEM," 2021.

[9] C. A. R. Álvarez and R. S. G. Junca, "La formación vocacional, un diagnóstico desde la educación STEM y los ambientes escolares," *Tecné, Episteme y Didaxis: TED*, pp. 1198–1204, 2021.

[10] T. Lupión-Cobos, A. J. Franco-Mariscal, and J. R. Girón Gambero, "Predictores de vocación en Ciencia y Tecnología en jóvenes: estudio de casos sobre percepciones de alumnado de secundaria y la influencia de participar en experiencias educativas innovadoras," *Revista Eureka sobre enseñanza y divulgación de las ciencias.*, vol. 16, no. 3, pp. 1–21, 2019, doi: 10.25267/Rev_Eureka_ensen_divulg_cienc.2019.v16.i3.3102.

[11] L. F. Pantoja Amaro, J. M. Peña Aguilar, and C. P. Mendoza Torres, "Desarrollo de habilidades STEM en media superior como mecanismo para impulsar la continuidad en educación superior: Caso programa Bases de Ingeniería," *RIDE Revista Iberoamericana para la Investigación y el Desarrollo Educativo*, vol. 10, no. 20, Feb. 2020, doi: 10.23913/ride.v10i20.614.

[12] M. M. Blesio, R. F. Hernández, I. S. Morelli, and L. M. Odetti, "Proyecto Nexos. Una experiencia de articulación entre la escuela secundaria y la Universidad Nacional del Litoral," *Itinerarios Educativos*, no. 12, Dec. 2019, doi: 10.14409/ie.v0i12.8833.

[13] N. Morales, "Escenarios de co-creación a partir de la experiencia," *Cuajimalpa: Edculab*, 2016.