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Recommendations to improve collaborative learning of Latin American computer science students according to dominant learning styles

Recomendaciones para propiciar el aprendizaje colaborativo de estudiantes latinoamericanos de informática considerando estilos de aprendizaje dominante

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ABSTRACT. This paper shows a case study with students of Computer Science related undergraduate programs that involved more than 300 university students from Argentina, Colombia and Mexico. For this purpose, a learning styles model of four dimension (Processing, Perception, Input ang Understanding) was applied by an online. The analysis shows that visual-active-sensing-sequential was the style dominant presented in the students of three countries. The analysis also revealed that there are not significant statistical differences for the four dimensions in students from Colombia and Mexico. However, learning styles of students from Argentina and Mexico show only significant differences in Understanding dimension. In contrast, there are significant statistical differences in Input and Understanding dimensions between students from Colombia and Argentina. Finally, this work provides recommendations so teachers and professors in these countries can adapt their practices to the dominant style identified and some suggestions for designers and developers of collaborative educational applications.

RESUMEN. El presente artículo describe un estudio de caso con más de 300 estudiantes de pregrado relacionados con informática, de Argentina, Colombia y México. Se aplicó un modelo de estilos de aprendizaje de cuatro dimensiones (Procesamiento, Percepción, Entrada y Comprensión) a través de un cuestionario en línea. El análisis identificó que el estilo dominante, en los tres países, fue visual-activo-sensitivo-secuencial. También se evidenció que no se presentan diferencias estadísticas significativas para las cuatro dimensiones entre estudiantes de Colombia y México. Sin embargo, para los estudiantes de Argentina y México se encontraron diferencias significativas en la dimensión Comprensión, mientras que entre Colombia y Argentina, se identificaron diferencias significativas en las dimensiones Entrada y Comprensión. Finalmente, se ofrecen recomendaciones para que los profesores puedan adaptar sus prácticas a ese estilo de aprendizaje dominante y se brindan sugerencias para los desarrolladores de aplicaciones educativas.

KEYWORDS: Learning styles, Computer-Supported Collaborative Learning, IT-Computing students, Latin America High Education.

PALABRAS CLAVE: Estilos de aprendizaje, Aprendizaje Colaborativo Soportado por Computadora, Estudiantes de informática/computación, Latinoamérica.

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1. Introduction

Many educational institutions currently use Computer-Supported Collaborative Learning (CSCL) to design, develop, and implement their courses. Under this modality, students are organized into working groups to achieve a common goal while using technological tools to improve communication, collaboration, and coordination. These learning groups are structures formed by students who interact with the common purpose of learning through participation and collaboration.

Although in a CSCL environment, students are part of groups, it is important to mention that each student has a particular behavior when developing the necessary activities and tasks. That specific behavior describes the student's inclination toward a specific learning style, that is, the way that the student learns. As a member of a CSCL group, a student can, for example: explain and justify their opinions to their peers, articulate their reasoning, elaborate and reflect on their knowledge, encourage their peers to respond, share resources, negotiate with their peers, build new knowledge, acquire skills, resolve conflicts, among other attitudes. In a learning group, the construction of learning is done collaboratively, giving and receiving help and regulating individual behavior through the manifestation of interpersonal skills. Because of this, each student's actions are crucial for group performance.

Knowing the students' learning styles would allow teachers to define how best to address them to favor group work. If the teacher knows the dominant learning style in their students, they have a tool that enables them to modify or strengthen their teaching style to maximize learning achievement. On the other hand, knowing the students' dominant learning style would allow CSCL's application developers to make the necessary adaptations to make those applications more compatible with their students' preferences. Presumably, adapting practices and applications to this style will contribute to getting better results in teaching and learning processes.

Given the above, this research aimed to identify the learning styles manifested by informatics/computing students belonging to three universities in Argentina, Colombia, and Mexico and discover the differences and similarities between students' styles. Based on the results, suggestions are provided for teachers/professors to adapt their collaborative practices and developers to consider them when creating CSCL applications.

This paper is organized as follows. The next section presents a selection of relevant related work to analyze learning styles in several university student groups with attention to the works focused on Latin America. The third section explains sample choice and recollection/processing data methods used in the case study. The fourth section shows discussions of the main results. The last section presents the conclusions and recommendations to teachers/professors and developers of educational applications to improve collaborative learning in technology-mediated contexts.

2. Literature review

In literature is possible to find diverse studies oriented to analyzing learning styles in several university student groups, which derive important contributions for different knowledge areas. This section shows some relevant literature antecedents with special attention in the three countries target of this study. In Rodríguez Suárez, Dolci, Higuera Ramírez, and Francisco González Martínez (2006) a study is carried out with students of medical internships in Mexican hospitals, recognizing the existence of a dominant style in which the students' gender does not influence, a similar study by Amado Moreno and Brito Páez (2008) with Mexican students of accounting bachelor was conducted. Likewise, Oralia, Cruz, Cardoso Jiménez, and Beltrán (2015) determined the dominant learning style in Mexican students of psychology and that this learning style is characteristic of students with the highest academic performance.

Correa Bautista (2006) investigated Colombian students of the physiotherapist career to detect the dominant learning style and redefine the didactic strategies implemented by their teachers. Valencia (2014) presents a study with Colombian university students of the first academic period. This work, with 100 students

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from six academic programs, allows to identify that there are no significant differences in learning styles. Yacub, Patrón, Agámez, and Acevedo (2018) conducted a study that sought to determine the relationship between academic lag and learning styles in Biomedical, Electronic, and Industrial Engineering students from Antonio Nariño University. The study was conducted with 69 students, where the results revealed a correlation between academic lag and student learning styles. Loaiza Villalba (2018) carried out an analysis to establish the relationship between learning styles and argumentation competence in the English language with 47 Colombian students in modern languages, which allowed concluding that there is a significant relationship between these two variables.

Figueroa et al. (2005) investigated Argentine engineering university students, managing to differentiate the learning styles of newcomers in computer science from those of newcomers to other engineering careers. In the work of Di Bernardo and Gauna Pereira (2005), Argentine university biochemistry students participated in detecting the dominant learning style and adapting the practices implemented by their professors. Durán and Costaguta (2007) applied data mining on the result of the learning styles test applied to Argentine university students of computer science majors and concluded that the sensitive, visual, active/reflective, global style is the dominant one. In Argentina, Ventura and Moscoloni (2015) worked with 62 engineering students and 71 psychology students. The authors concluded that engineering students prefer active, sensing, visual, and sequential styles, while psychology students prefer reflective, intuitive, verbal, and sequential. Tocci (2015) investigated Argentinian students of different engineering careers. The results showed that active, sensing, visual, and sequential styles as dominant.

On the other hand, there are also investigations related to the subject in other countries. Cabral Pereira, Wollinger, Pereira dos Passos, and Marinho (2019) reveal the learning styles of administration and accounting students. Dos Santos, Panucci Filho, and Hein (2018) and Meurer, Pedersini, Antonelli, and Voese (2018) also discover a predominant style among university accounting students. Alaoutinen and Smolander (2010) compare computer science and engineering university students and conclude that there are no differences between them in the active/reflective dimension, but that computer science students are less visual than engineering students and that they tend to be global and more balanced in the sequential/global dimension than engineering. Chowdhury (2015) recognizes as the dominant style the active, sensing, visual, and sequential among the engineering students processed in his research and discover that this style does not correspond to the teaching style of their professors. Cengizhan (2009) concludes that most of the Turkish engineering students are active, sensing, visual, and global, and proposes some actions for teachers to adapt their face-to-face practices to this dominant style. Jamali and Mohamad (2017) worked with engineering students and concluded that most of them were visual, active, sensing, and sequential. Lai and Lee (2019) analyzed the learning styles of university students (digital natives) from China, Malaysia and Indonesia belonging to engineering and business careers, concluding that for all three nationalities, the students are visual learners. However, Malaysian and Chinese students are sensing, active, and sequential, while Indonesian students are intuitive, reflective, and global. Both engineering and business students presented a similar type, but engineering students were more sequential than business students. The authors further conclude that gender does not affect students' learning styles. Ngatirin and Zainol (2020) surveyed the learning styles of Malaysian university computer science students and concluded that gender affects students' learning styles. The authors showed that male students respond to a common visual, active, sensing, and global learning style, while female students prefer an intuitive, reflective, and sequential style. Nimkoompai and Paireekreng (2017) recognized the predominance of the visual, sensing, active, and sequential style over the first-year computer science students who taken part in the research.

Marques, Araújo, Silva, and Costa (2020) surveyed university accounting students and recognized in them the predominance of the sensing, visual, reflective, and global style. Scott, Rodríguez, Soria, and Campo (2014) collected the interactions of computer science students and, applying association rules, discovered the sensing, active, visual, and sequential style as dominant. Tulsi, Poonia, and Priya (2016) worked with students of different engineering (computing, civil, electrical, electronics and communication, and mechanics). The authors show differences between their learning styles, but most of the students presented the active, sensing, visual, and sequential styles, except those of reflective mechanical engineering. Ventura and Moscoloni (2015)

surveyed Psychology and Engineering students, finding that students in the first years of university adopt similar learning styles regardless of the main academic discipline and that this changes in higher courses. The authors conclude that the engineering students are sensing, active, and visual, while psychology students prefer the opposite styles. On the other hand, fifth-year psychology students were more intuitive, reflective, verbal, and global than first-year students, and fifth-year engineering students presented sensing, visual, and sequential styles, responding to the active style in the first year. Jingyun and Takahiko (2015) recognized the active, sensing, visual, and sequential style as dominant in Chinese engineering students, without differences considering gender. Coto Jiménez (2020) concludes that in Costa Rica, the engineering students are sensing and neutrals for active/reflective, visual/verbal, and sequential/global styles. In Ecuador, Cuzco (2020) shows that 95 university students prefer the active style, and they are neutrals for sensing/intuitive, visual/verbal, and sequential/global styles.

Gomede, Miranda de Barros, and de Souza Mendes (2020) applied machine learning techniques to detect the learning styles of Brazilian university students and showed that most respond to a common visual and global learning style. Pasupathy and Shah (2021) analyzed learning styles of Malaysian primary school students and showed the intuitive, active, visual, and sequential style as dominant. In most of the studies mentioned previously, the researchers applied the learning styles model that we apply in our work. The exceptions are Correa Bautista (2006), Valencia (2014), Oralia et al. (2015), dos Santos et al. (2018), Yacub et al. (2018), Loaiza Villalba (2018), Meurer et al. (2018) and Cabral Pereira et al. (2019), who chose another model. Besides, coinciding with the purpose of our work, several detect a dominant style and give teaching recommendations. However, none of them make recommendations for teaching in collaborative environments, nor are guidelines suggested for designers of collaborative applications as in this work, which highlights the originality of our research.

3. Methodology

This study involved students of computer science (or similar) undergraduate program with the active course of programming or approved in the previous period (first years of bachelor). A three-month open call of voluntaries was sent by institution email to three universities, i.e., the Universidad Nacional de Santiago del Estero (Argentina), Universidad Militar de Nueva Granada (Colombia) and Universidad Autónoma de Zacatecas (México). Only 305 students fulfilled the inclusion criteria, 132 from Argentina, 121 from Colombia and 52 from Mexico. The sample was 132 students from the Universidad Nacional de Santiago del Estero (Argentina), 121 students from the Universidad Militar de Nueva Granada (Colombia), and 52 students from the Universidad Autónoma de Zacatecas (México). The three groups have a mixed population gender: Argentina, 93 men (70%) and 39 women (30%); Colombia, 86 men (71%) and 35 women (29%); and Mexico 35 men (67%) and 17 women (33%).

This case study used Felder and Silverman's learning style model (1988), which proposes a model composed of four dimensions, i.e., Processing, Perception, Input and Understanding. For each dimension, a student may reveal behavior that varies on a categorical scale whit two oppositive labels. Then, in the Processing dimension, the behavior may change from active (ACT) to reflexive (REF), Perception from sensing (SEN) to intuitive (INT), Input from visual (VIS) to verbal (VER) and finally, Understanding from sequential (SEQ) to global (GLO). Felder and Silverman (1988) established the existence of 16 different learning styles from the combinations of each dimension. Thus, a student may respond to an active, sensing, visual, sequential (ACT-SEN-VIS-SEQ) learning style, while others respond to a reflective, intuitive, verbal, global (REF-INT-VER-GLO) style; or any other possible combination.

According to this model, Soloman and Felder (1997) created the Learning Style Test, a questionnaire that determines a student's learning style. This questionnaire, validated by Felder and Spurlin (2005), consists of forty-four questions in which the student must necessarily choose an answer from two possible ones. In line with this model, Soloman and Felder (1997) created the Learning Style Test, a questionnaire that determines a student's learning style. This questionnaire, validated by Felder and Spurlin (2005), consists of forty-four

questions in which the student must necessarily choose an answer from two possible ones. When the students answer the Soloman and Felder (1997) learning style test, they receive a score for each model's dimensions. This score ranges from 1 to 11 and represents the student's correspondence with the assigned style for the labeled dimension. Thus, the information corresponding to a student's learning style is a string of four parts, each one indicating a value for the model dimensions. For example, the style of a hypothetical student A could be ACT1-INT5-VIS3-GLO10, while another student B, could respond to the learning style ACT10-SEN8-VIS10-SEC2.

Besides, according to Felder and Silverman (1988), the values assigned for each dimension can be analyzed by detecting pure, medium and neutral learning styles. For example, when the value does not exceed 3 for active or reflective, the student responds to a neutral style (NEU) in the Processing dimension. In contrast, if the value is close to the endpoints (values 9 to 11), the student responds to pure values of the Processing dimension, which can be Pure Active (ACT+) or Pure Reflective (REF+). Another possibility is if the student maintains between neutral and extreme (values 4 to 8), she/he shows a medium style, in Processing dimension are Active (ACT) or Reflective (REF). The same goes for the other three dimensions. Thus, the hypothetical student A has a learning style NEU-INT-NEU-GLO+, and the learning style of student B is ACT+SEN+VIS+NEU.

Then, the learning style of 305 students was identified following the guidelines of Soloman and Felder (1997) and Durán and Costaguta (2007). All sampled students answered an online version of the Learning Style Test (Soloman and Felder, 1997) from the COLLAB application. The collected data were processed considering each dimension of the Felder and Silverman (1988) learning styles model and by country of origin.

A statistical comparison of distributions was conducted to identify differences or similarities between the students of the three study countries' learning styles. The first step was to map Felder's learning styles on a numerical scale between −11 to 11, i.e., the learning style of a hypothetical A student, ACT1-INT5-VIS3-GLO10, is represented on a numerical scale as (−1, 5, −3, 10), and the learning style of B student (ACT10-SEN8-VIS10-SEC2) as (10, -8, -10, -2). The next step was to verify if the data had a normal distribution behavior, applying a Shapiro-Wilk test (Shapiro & Wilk, 1965). It is clarified that the analysis is carried out independently for each dimension of the learning styles model. Due Shapiro-Wilk test showing that the data could not adjust to a normal distribution, the statistical comparison, dimension by dimension, between countries was performed using the Kruskal-Wallis test (Kruskal & Wallis, 1952), the statistical comparison, dimension by dimension, between countries was performed using the Kruskal-Wallis test (Kruskal & Wallis, 1952). In those cases where the test showed statistically significant differences, the analysis requires identifying where are differences could be for this dimension. Thus, a Wilcoxon Signed-Rank test (Wilcoxon, 1945) to compare by pair, i.e., Argentina-Colombia, Argentina-Mexico and Colombia-Mexico was applied.

4. Results

Figure 1 presents a graphical summary of the main findings where each row shows the results of the respective learning style dimension and different colors identify each country. i.e., red for Argentina, green for Colombia and blue for Mexico.

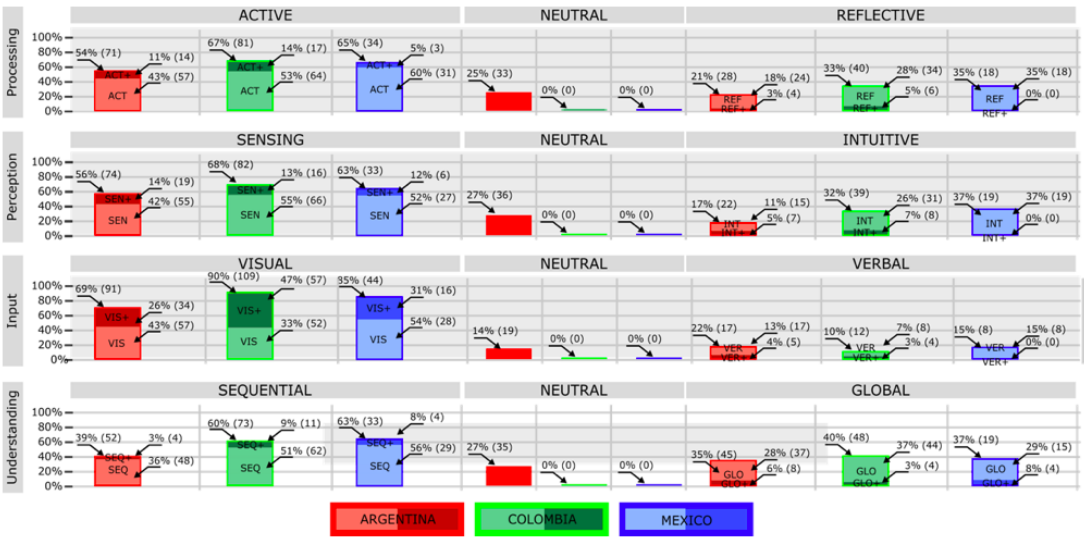

Figure 1. Graphical summary of the main findings. Each row shows the results of the respective learning style dimension. The data for each country are presented using colors, pure learning styles (+) are represented in dark and medium styles in light. Source: Self-made.

The first row of Figure 1 shows the results of the Processing dimension. Active students are predominantly in Argentina, Colombia, and Mexico; more than 50% of the total number of students respond to this learning style (Argentina 54%, Colombia 67%, and Mexico 65%). Reflective students are in the minority, in percentages approximately equal to half of the students classified as Active in the three countries. Furthermore, in the case of both the Visual and the Reflective styles, in the three countries, the medium styles (ACT or REF) dominate with a marked difference over the pure styles (ACT+ or REF+). On the other hand, only neutral students are detected in this dimension from Argentine in a considerable percentage (25% of the total).

The second row of Figure 1 shows the results corresponding to the Perception dimension. In Argentina, Colombia and Mexico, students are predominantly Sensing, with a percentage of around 60% of the total number of students responding to this style (Argentina 56%, Colombia 68%, and Mexico 64%). Intuitive students are in the minority, in percentages approximately equal to half of the students classified as Sensing in the three countries. Furthermore, in the case of both the Sensing and Intuitive styles, in the three countries, the medium styles (SEN or INT) dominate with a marked difference over the pure styles (SEN+ or INT+). On the other hand, only neutral students are detected in this dimension when it comes to Argentine students, which is evident in a considerable percentage (27% of the total).

The third row of Figure 1 shows the results corresponding to the Input dimension. It is evident that both in Argentina, Colombia and Mexico, students are predominantly Visual since a percentage that exceeds 60% of the total number of students in Argentina (65%) responds to this style and greater than 80% in Colombia (90%) and Mexico (85%). Verbal students are a minority in the three countries, although in different proportions. In Argentina, the percentage of Verbal students is close to a third of those recognized as Visual. The percentage of students recognized as Verbal is insignificant in Colombia (10%) and Mexico (15%). Thus, it is evident that both in Argentina and Mexico, the medium styles (VIS or VER) dominate with a marked difference over the pure styles (VIS+ or VER+). Similar behavior is observed in Colombia for Verbal students. However, it is evidenced that Colombian Visual students are equally distributed between medium (VIS) and pure (VIS+) styles. For this dimension, neutral students are detected only in Argentina and with a value over (14%).

The fourth and last row of Figure 1 shows the results corresponding to the Understanding dimension. Both in Argentina, Colombia and Mexico, the students are mostly Sequential. However, they are the majority in

different proportions. Sequential students are close to 60% in Colombia (60%) and Mexico (63%), while Argentina represents only 40%. Although in different proportions, global students are a minority in the three countries. In Argentina, the percentage of Global students is considerable (34%) and quite close to its counterpart (Sequential 40%). Global students are two-thirds of the students classified as Sequential in Colombia (40%) and Mexico (37%). Furthermore, in the three countries, the medium styles (SEC or GLO) dominate with a marked difference over the pure styles (SEC+ or GLO+). For this dimension, neutral students are detected only in Argentina and a considerable percentage (25% of the total).

Figure 2 shows a graphical summary of the statistical comparison of distribution analysis performed; as in Figure 1, each row shows the results of the respective learning style dimension, and a color identifies each country. In Figure 2 is possible to see the asymmetry of the data and even the presence of outliers represented in scattered points concerning the distribution. That is consistent with the results of the Shapiro-Wilk normal test (Shapiro & Wilk, 1965), which showed that the data could not adjust to a normal distribution. Each row shows in purple the results Kruskal-Wallis test (Kruskal & Wallis, 1952) used to compare students' learning styles between countries, shows no statistically significant differences in the dimensions of Processing and Perception ($p > 0.01$). In the case of Input and Understanding dimensions were necessary to compare with the Wilcoxon Signed-Rank test (Wilcoxon, 1945); where results Argentina-Colombia, Argentina-Mexico and Colombia-Mexico are depicted in cyan color. The results show no significant statistical differences between students from Colombia and Mexico in the dimensions of Input and Understanding ($p > 0.01$). Consolidating this with the previous result, it is possible to conclude that there are no representative statistical differences for the four dimensions of the learning styles model in the processed samples of students from Colombia and Mexico. The analysis of students' learning styles from Argentina and Mexico shows only significant differences in the Understanding dimension ($p < 0.01$). In contrast, there are significant statistical differences in Input and Understanding dimensions between students from Colombia and Argentina.

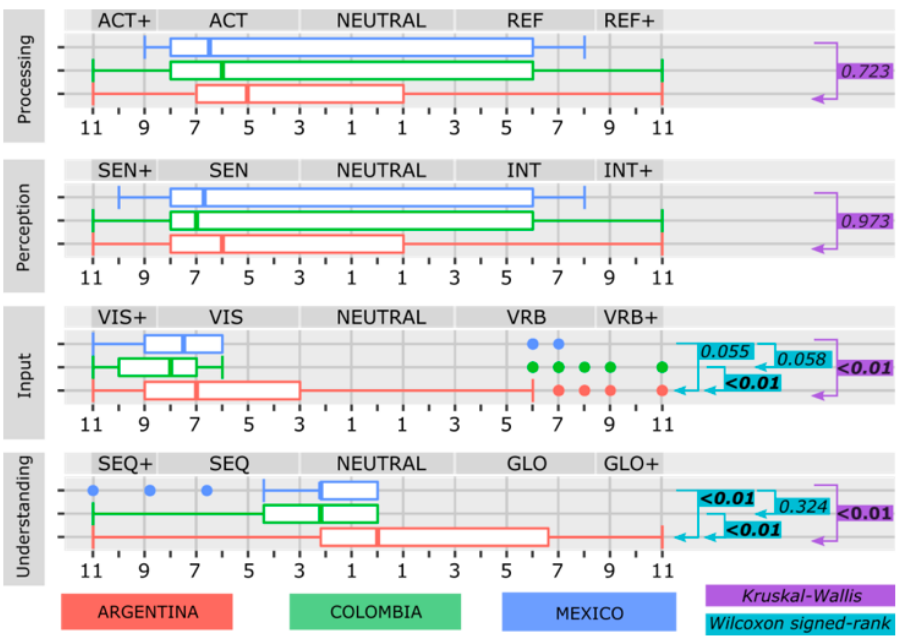

Figure 2. Graphical summary of the statistical analysis performed, using box-and-whisker plots. Each row shows the analysis of a particular dimension of the learning styles model. The data for each country are presented in a different color. To the right of the graph are presented in purple and cyan the results of the statistical tests. Source: Self-made.

5. Conclusions and recommendations

This paper presented a study conducted at three universities in Argentina, Colombia and Mexico; the document describes the learning styles detected in college students in computer science careers. A Felder and

Silverman's learning style model 1988 was used, and also, the learning style test created by Soloman and Felder (1997) with adaptations of Durán and Costaguta (2007). An online questionnaire version of Soloman and Felder (1997) test was answered by 305 students.

According to research conducted, all the learning styles described by Felder and Silverman (1988) are present in university students of computer science careers in Argentina, Colombia, and Mexico. Most of the students were found to belong to the "active" style for the Processing dimension, the "sensing" style for the Perception dimension, the "visual" style for the Input dimension, and the "sequential" style for the Understanding dimension. Moreover, in all four dimensions, the styles in their middle versions predominate. On the other hand, analyzing differences, neutral styles were observed only in Argentina, which was detected in the all model's dimensions.

The dominant style identified (ACT-SEN-VIS-SEQ) coincides with those raised by Chowdhury (2015), Cengizhan (2009), Jamali and Mohamad (2017), Lai and Lee (2019), Ngatirin and Zainol (2020), Nimkoompai and Paireekreng (2017), Scott et al. (2014), Tulsi et al. (2016) and Jingyun and Takahiko (2015) for engineering, computer science and informatics students.

Besides, in a study presented by Chicher and Lorenzati (2017) about the opinions of a group of professors at an Argentinean university, the authors conclude that it is necessary to rethink teaching according to the characteristics of today's students, individuals who are highly exposed to technologies and have the skills to operate them. A way to reach this goal is to implement CSCL as a regular teaching/learning practice; the following guidelines are suggested for teachers of computer science in Argentina, Colombia, and Mexico to adapt their practices in university contexts of CSCL, according to dominant style identified:

- The "active" learning style requires a teaching style that encourages active student participation. Activities that are more about doing than reflecting are advisable, with options to collaborative working with others to encourage exchanging opinions and reaching consensual decisions. In this way, the student group must build a product collaboratively, i.e., the collaborative editing of a document, a presentation, a wiki, a video, among others, is appropriated. Also, the use of chat, forum, group video calls, among others, as group communication tools is suggested.
- The "sensing" learning style requires a teaching style that provides concrete information (facts, data, experiments, among others.) because they prefer details and are not prone to making mistakes. Clear and documented guidelines on the group's activities are expected during the collaborative construction of their group product (document, wiki, among others.) is desirable. Also, to describe the method to be followed, the individual and group behaviors expected, the specific type of product to be delivered, the evaluation criteria to be applied, the deadlines for work execution and delivery date, the communication tools to be used, the applications to be used to carry out the deliverable product, among others, are suggested actions.
- The "visual" learning style requires a teaching style that uses diagrams, figures, videos, demonstrations, among others, rather than lectures and oral explanations. When designing lessons and practical work, using the many resources now available on the web in terms of images and videos is suggested. It should also be considered that the applications or tools recommended to students for use in their group products should have facilities for generating or reusing images and videos.
- The "sequential" learning style requires a teaching style that tends to increase the understanding of the contents in logically linked steps. It is suggested to have a virtual classroom where the theoretical and practical contents and the groups' different activities are arranged in sections according to the logical order of the topics addressed. It is also recommended to include a graphic or scheme in header of each section that links the topics developed there. It would be advisable to have a general graph at the beginning of the virtual classroom that shows the links between all the subject topics.

It is suggested to consider the above guidelines for the recognized majority styles. Still, since no learning style corresponded to the students' 100%, it is also advisable to include some activities that respond to the minority styles. For example, an individual reading and reflection task before the collaborative editing of a wiki

or presentation. Thus, it is possible to improve the learning of all students in the degree course and not only those who respond to the styles detected as the majority. It should be noted that Argentinean students benefit from this situation because they respond to neutral styles, which allows them to adapt both to the teaching strategies implemented considering the majority styles and to those oriented to minority styles. Considering the discovered dominant learning style, some suggestions for the design and development of user interfaces in CSCL applications for university students of computer science in Argentina, Colombia and Mexico are established:

- The "active" learning style requires applications where students can experiment, solve, dialogue, reach consensus, i.e., applications that allow and facilitate active interaction with their group mates. Because of this, it is recommended that the interfaces contain elements of interaction-communication typical of groupware environments (Luna et al., 2015). For example, some object that allows requesting the use of the word during a conversation-participation, highlighting and notification of unread contributions or new actions performed on the product generated collaboratively to encourage feedback, and visual alarms or e-mail messages notify new developments in the state of communication.
- The "sensing" learning style requires applications that allow students to solve problems, where data are provided collaboratively, and the methods to be applied are described in detail. Because of this, coordination is a fundamental aspect; it is suggested that CSCL applications have functionalities to define each member of the group's role and allow for task and activity management (Luna et al., 2015).
- The "visual" learning style requires applications with an attractive screen design and where there is a suitable use of images and videos, colors or movements. It is suggested that the colors for user interfaces are yellow, red and orange Laureano-Cruces, Velasco-Santos, Lilia, and Mora-Torres (2009). It is also recommended to consider principles, guidelines, and patterns of interface design already established by the academic community from the perspective of usability and accessibility, such as those established in Van Welie (2008).
- The "sequential" learning style requires applications that guide the learner in logically progressive navigation from the simplest to the most complex. It is suggested that the interfaces of the applications record the learner's progress in the activities that she/he performs and display appropriate notifications of activity status, learning history, tasks and activities, i.e., tools that allow the learner to locate themselves (visually and aurally) within the learning process in the application.

Finally, a relevant result is that there are considerable similarities and few differences between the styles of undergraduate computer students learning in Argentina, Colombia and Mexico. Besides, it allows intuiting a similar behavior in other Latin American countries, allowing teachers/professors to share and adapt methods, materials, and systems to generate a Latin American ecosystem that improve collaborative practices in high education.

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