A Toolkit for Promoting a Learning Innovation Safe Space (LISS) in Computing Higher Education

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***Abstract*—This research-to-practice full paper describes the concept of Learning Innovation Safe Space and the development of a toolkit that affects the teaching and learning culture of computing education by encouraging emotional safety, autonomy and collaboration in the context of iOS development for undergraduate students in two different innovation education initiatives: a two-year program and a one-semester course. The initiatives are based on the Challenge-Based Learning framework and involved one group of forty students for the two-year program and three groups of twenty students for the one-semester undergraduate course. There are problems related to developing and maintaining a safe space in this context, such as the students' difficulty in perceiving their learning when developing innovative solutions, dealing with emotional safety issues such as imposter syndrome, and autonomously managing their learning objectives. The research is centered on defining the concept of Learning Innovation Safe Space and developing a set of tools: Asset Mapping, Future Self and Autonomous Learning Management. In this way, emotional safety, autonomous and collaborative learning among students is encouraged through the use of these tools and practices. As a qualitative research method, an action research process was used to describe the planning and execution of the experiment in the two different innovation education initiatives, as well as the use of questionnaires to evaluate the impact of using these tools to support the development of LISS. As a main contribution, the results support the development of safe learning environments for innovation using the findings of this study, which include the creation, development and evaluation of tools and practices capable of promoting emotional safety, autonomy and collaboration to deal with computing challenges and multidisciplinary learning domains.**

***Index Terms*—Challenge Based Instruction; Innovation; Collaborative Learning; Undergraduate Research; Action Research**

I. Introduction

Globalization and the growing demand for information and communication technologies (ICTs) have intensified competition and put pressure on companies to become more innovative, thus increasing the need for professionals capable of developing sophisticated products and services [11]. Innovation depends on individual knowledge and the convergence of skills and competencies that enable collaborative work supported by processes of collaboration and communication [12]. In this context, educational institutions based on science, technology and innovation are fundamental to economic development. Universities and research centers have expanded their missions beyond traditional education and research, also serving as promoters of innovation, continuous learning and socio-economic development [13]. Environments that promote innovation learning help students develop leadership, career motivation and skills applicable to adjacent sectors. It is therefore essential to prepare future professionals with 21st century skills, equipping them for continuous learning and the practice of innovation [14].

In education for innovation, initiatives in computing education focus on developing practical learning for technological and digital solution development [17]. This approach aims to cultivate skills and competencies within educational environments that impact organizations and economies systemically. Students in these environments engage with real-world challenges, investigate problems, and design transdisciplinary technological solutions. However, the success of innovation in computing education depends not only on technology but also on fostering safe learning spaces through strong relationships between students and mentors. Challenges in creating and maintaining these Safe Spaces include developing student autonomy, managing learning perceptions, and promoting multidisciplinary collaboration. This article addresses the research question (RQ): How can a Learning Innovation Safe Space (LISS) be supported with tools and practices in computing education initiatives?

Despite the potential to prioritize students and mentors, these actors are not at the forefront of the process of developing tools and practices for implementing Safe Spaces in these environments, nor have they been adequately included in their cycle of tool use [1]. From the point of view of use, the literature on Safe Spaces is largely focused on supporting students, as opposed to offering ways to implement and maintain them with the support of tools and practices in computing innovation education environments [4]. Similarly, students and mentors are rarely involved in the design process

of LISS tools, which could lead to resources more aligned with their needs. For example, research efforts in this direction have provided pedagogical help (e.g. Asset Mapping, Future Self and Autonomous Learning Management tools) for teachers to implement a LISS, as well as validating acceptance criteria with them. As far as we know, however, previous research has not yet put students and mentors first and sought to understand their needs and contexts in order to build the concept and implementation of a Learning Innovation Safe Space (LISS) in computing education initiatives.

Therefore, this article presents a qualitative study based on the application of questionnaires and the use of action research methodology to understand the contexts and needs of students and mentors of two educational innovation initiatives in computing to inform the development of a Learning Innovation Safe Space (LISS) with student-centered tools and practices to enhance computer science teaching. The rationale for this approach comes from the user experience (UX) literature, which demonstrates that educational artifacts are more likely to be used and useful to their target audience when they are created according to a user-centered design [9]. In doing so, the first step is to understand the contexts, objectives, needs, pains and profiles of the students and mentors involved, among other issues, to inform what decisions should be made in future stages (e.g. prototyping and evaluating the tools) [10]. Thus, this article first presents the stage of defining the LISS concept adapted for students and mentors in two computing innovation education initiatives. Secondly, it develops a toolkit to support the development of LISS into a Challenge Based Learning (CBL) challenge by the mentors of these initiatives in the student learning journey and, finally, it evaluates the use of this toolkit to support a Learning Innovation Safe Space [18].

Compared to previous research [4], this article advances the literature by putting students and mentors at the forefront of the process of developing Safe Spaces in computing innovation education initiatives with a toolkit and practices situated in this context. As a result, the questionnaires reveal perceptions that connect mentors' current practices with students' needs, which we discuss in the light of the context of innovation education initiatives in computing. This process was fundamental to the conceptualization of the Learning Innovation Safe Space (LISS). In addition, we presented considerations regarding the implementation of tools adapted for the development of LISS situated in the context of iOS development for undergraduate students in two different innovation education initiatives: a two-year program and a one-semester course, demonstrating the positive impact on the teaching and learning culture of computing education, encouraged by stimulating emotional safety, autonomy and collaboration in this context. Thus, our contribution corroborates the computing education literature by providing insights that can be used to deploy a LISS centered on innovation computing education initiatives with usable tools and practices. It also expands Safe Spaces and Computing Education research by enabling mentors to be empowered so that they can support each other to improve teaching and learning outcomes in computing through the deployment of LISS.

II. Methodology

This qualitative study aimed to (a) define the concept of a Learning Innovation Safe Space (LISS); (b) propose tools and practices in two computing innovation education initiatives that encourage the development of Safe Spaces through collaboration and autonomy among participants; (c) implement and evaluate the impact of using the tools in the development of a LISS experience for students and mentors in these computing learning environments. Due to the qualitative action-research nature of the objectives, their application took place in the context of iOS development for undergraduate students in two different computing innovation education initiatives: a two-year program and a one-semester course.

At first, questionnaires were used with students and mentors from the two-year program to assess which criteria made it difficult for them to create and maintain a safe space in their environment [8]. These criteria were then categorized using thematic analysis to guide the conceptualization of a Learning and Innovation Safe Space (LISS), the ten criteria for creating a LISS (emotional safety; autonomy; collaboration; self-discovery; critical thinking; learning; daring; multidisciplinarity; dealing with challenges and experimentation) and the three main obstacles to creating a Safe Space in learning environments for innovation in computing: emotional safety, autonomy and perception of learning.

After identifying the three main obstacles to creating a safe space in these environments and defining the criteria for LISS, we set about developing three tools to mitigate the main problems recognized in creating and maintaining a safe space in these initiatives. These three tools, called Asset Mapping, Future Self and Autonomous Learning Management, would be adapted according to the LISS criteria and implemented in the journey of a CBL challenge. These tools were adapted to promote emotional security, autonomy and the perception of learning in a group of forty students for the two-year program and three groups of twenty students for the one-semester undergraduate course of this computing innovation education initiative.

The Asset Mapping, Future Self and Autonomous Learning Management tools were applied sequentially over one semester to a group of forty students from the two-year program, in a CBL challenge in remote format due to COVID-19. Then, feedback and improvement implementations were collected through a questionnaire-based qualitative study to identify the effectiveness of applying the three tools to improve students' perception of learning when developing innovative solutions to real problem challenges, dealing with emotional safety issues during the learning process to innovate in computer science; a typical example is the impostor syndrome, characterized as the inability to internalize success and the tendency to attribute success to external causes such as luck, error or other people's ignorance [4]. Finally, improving the autonomous management of students' learning by defining and completing their learning objectives.

Once this first cycle of applications and implementation of improvements scored by the forty students in the two-year program had been completed, a second cycle of applications of the three tools in physical format began with three groups of twenty students for the one-semester undergraduate course of this educational initiative for innovation in computing. The introduction to the use and application of these tools took place face-to-face at the university during the three-class period provided for in the schedule, with continuous use by the students until the end of each semester. Questionnaires were then carried out to collect feedback on the promotion of emotional security, autonomy and the perception of learning resulting from the use of these tools throughout the learning journey. The aim was also to collect results and lessons learned from the use of the implemented tools.

Therefore, after four cycles of applying the tools with students from these two initiatives over a period of eighteen months, several improvements were implemented based on the users' experience throughout this period. These three refined tools were compiled into a toolkit to support the creation and maintenance of a LISS in a CBL challenge, promoting emotional security, autonomy and the perception of learning in these educational environments for innovation in computing.

A. Learning Innovation Safe Space (LISS)

A Learning Safe Environment is one in which students are able to openly express their individuality, even if it differs dramatically from the norms set by the instructor, the profession, or other students, which affects their sense of belonging, which is associated with academic success and motivation [1]. It is a space where students are encouraged to step out of their comfort zone in order to learn. The metaphor of the classroom as a "safe space" emerged as a description of a classroom climate that allows students to feel safe enough to take risks, honestly express their opinions and share and explore their knowledge, attitudes and behaviors [1]. Safety, in this sense, does not refer to physical security. Instead, safe space in the classroom refers to protection from psychological or emotional harm. In addition, the creation of a safe space is important for the students' perception of how much they learn.

Therefore, creating a Safe Learning Space requires actions to develop this environment in the classroom, such as using micro-affirmations, which is the process of affirming students' emotions, active listening, acknowledging and validating students' experiences, establishing ground rules for interaction with your students at the beginning of the course and writing a diversity and inclusion statement for your program of study [2]. However, when creating a Learning Safe Environment is linked to innovation education initiatives, the concept of Safe Space needs to be related to the context of promoting characteristics that directly involve 21st century skills and competencies, such as critical thinking, cooperation, collaboration, communication, creativity, facing challenges, problem solving, autonomy, computer proficiency, global and local citizenship [16]. These skills and competencies are often

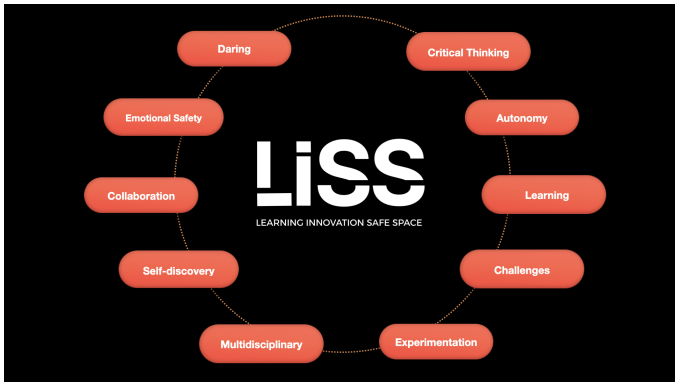

Fig. 1. Pillars for creating and maintaining a LISS

required and experienced by students and mentors in initiatives that promote innovation education in computing.

In the context of the 21st century skills and competencies that permeate computer science innovation learning initiatives, students often face barriers that make it difficult to create and maintain a Safe Space in this environment, such as the perception of learning when developing innovative solutions to real problems; they find it difficult to deal with emotional safety issues during the process of learning to innovate in computer science; a typical example is imposter syndrome. Finally, students find it difficult to manage their learning autonomously, defining and completing their learning objectives.

The concept of Learning Innovation Safe Space (LISS) was therefore created to define a safe learning environment that promotes self-discovery, the construction of a professional future vision, develops skills for innovation, proposes autonomy to learn to experiment, face real-world challenges and problems and develop solutions that can transform communities in a collaborative and creative, multidisciplinary way. In this way, it provides an environment with practices and methods for teaching innovation in computing that encourages the development and maintenance of a safe space in this context. From the process of thematic analysis of the questionnaires carried out with the initiative that includes the two-year program, the students and mentors of this initiative identified the main pillars of LISS, linked to 21st century skills and the competencies of education for innovation. In this sense, as shown in figure 1, the pillars that make up LISS are: emotional security; boldness; critical thinking; autonomy; learning; facing challenges; experimentation; multidisciplinarity; self-discovery and collaboration.

LISS is a safe learning environment for innovation that encourages the development of the skills and competencies needed to learn innovation. In this sense, LISS encourages the creation and maintenance of a learning environment for innovation that guarantees autonomy, collaboration, critical thinking, boldness, emotional security, self-discovery and experimentation. When developing a Learning Innovation Safe Space (LISS), it is understood that the creation of a Safe Space is a collective construction, which depends on maintenance

and adaptation to the context in which it is inserted. The construction of a safe environment cannot be confined to declarations; it needs to be concretized in the experience of those involved in order to increasingly stimulate diversity and plurality. In turn, this depends very much on people's commitment to maintaining the practices and processes that support this environment being considered a LISS. Safe Space is understood as an environment nurtured by practices that strengthen the emotional security and collective well-being of those involved [1], where people are active observers of their needs and potential.

In the process of developing the three tools that support the implementation of LISS in a CBL challenge, the aim was to have an impact on the teaching and learning of computing education, insofar as practices that encourage emotional safety, autonomy and collaboration are used in the context of iOS development for undergraduate students from two different computing education initiatives. The Future Self, Asset Mapping and Autonomous Learning Management tools [4] were developed and adapted to support the development of LISS in these two innovative computing education initiatives during the students' learning journey in a CBL challenge.

B. Implementation of a LISS instance in a CBL Challenge

The three tools developed for the implementation of LISS were created to go through the entire experience of a CBL challenge, as shown in figure 2. In the first stage of the CBL, in which the student is in the Engage process [5], in definition of the Big Idea, the Asset Mapping tool was used to map the students' abilities and strengths, as well as helping them to engage with the theme that will be part of the iOS development project they will be carrying out. This process also helps students to form teams so that they feel more confident about taking on new challenges, since they are alongside other people interested in the same topic or know that they can count on another student who has the same interest in the area that was identified in the Asset Mapping. In the second stage of the CBL, which corresponds to the Investigate process, until the challenge is defined, the Future Self tool is used to encourage students to project themselves at the end of the challenge and reflect on their learning objectives and goals. After defining the Future Self, in the Act stage of CBL, which is linked to the concept and the development of the application, the Autonomous Learning Management tool [4] is used to monitor the learning objectives defined by the students and enable them to materialize their learning until they reach the goals of the Future Self established.

C. Application of Asset Mapping

Asset mapping is a research method originally developed as part of the asset-based community development strategy for community building and community strengthening [6]. In the case of the LISS development, asset mapping was adapted to be applied in educational initiatives for innovation in computing, with the aim of stimulating the recognition of existing skills and strengths in the educational community to

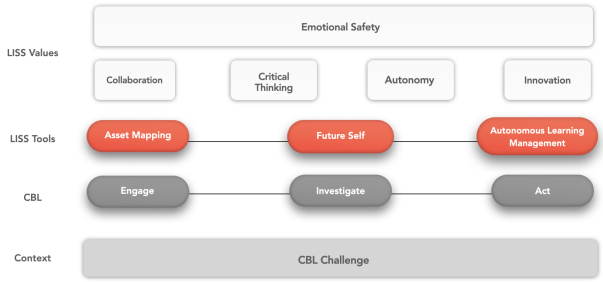

Fig. 2. Implementation of a LISS instance in a CBL Challenge

reduce the feeling of imposter syndrome during the innovation learning process. In addition, to promote the collaboration and personal and professional self-discovery of the students, mentors and teams involved in carrying out the asset mapping. In addition, to develop a community based on strengths and positive capacities to work on solving existing problems in the community, as well as proposing solutions that benefit it as a whole.

In line with the perspective of the CBL journey, Asset Mapping was used in the Investigate stage, before the process of forming teams to develop the iOS project, so that students could connect as a community around learning, feeling able to challenge themselves and experience innovative learning processes. It is understood that, as well as the social issues surrounding the skills and powers that exist in Asset Mapping [6], learning objectives are an aggregating factor for the development of a community that remains constantly nurturing a safe learning environment that is oriented towards computing and innovation.

D. Application of Future Self

The Future Self tool was based on studies dedicated to the construction of Foresight, the prospecting of futures for innovation, the process and systematic attempt to look into the long-term future of science, technology, the economy, the environment and society, with the aim of identifying emerging generic technologies and strategic research areas that are likely to produce economic and social benefits in their environment [7]. This concept has been adapted in the implementation of LISS to help students and mentors involved in the process of analyzing trends in computing, technology and innovation to design their "Future Self" during their journey in a CBL challenge. In this sense, the learning objectives will be oriented towards the learning that the student has planned to obtain during a CBL challenge, thus achieving their "Future Self". The search for trends and visions of the future positions students to learn innovative technologies, to get out of their comfort zone, to seek challenges and to learn technologies they haven't mastered yet.

The planning of the Future Self encourages participants to deal with existing challenges in the CBL and in the innovation

process, understanding the existing resources in the environment from Asset Mapping and being aware that the difficulties, doubts or uncertainties that exist in the learning process for innovation in computing can be overcome with collaboration and the development of a safe environment in which co-participation in learning is paramount. In this way, the Me of the Future becomes a prior moment in Learning Management in which students have already identified, through Asset Mapping, all the existing assets in the learning environment, and all they have to do is identify what their individual priorities are. In this way, it is encouraged that the students' professional and personal interests are taken into account in the learning environment, and it is also proposed to produce a sustainable, strategic and active vision for the development and maintenance, in the present, of a safe learning environment for innovation, based on the computing learning interests of those involved.

E. Application of Autonomous Learning Management

The Learning Management tool, the third tool adapted for the implementation of LISS, behaves like a variation of the CBL approach, through which the students themselves define the challenges that will guide what they need to learn. It's important to note that in both education initiatives for innovation in computing, the learning needs come from three different sources: what they want to learn, the content proposed by the program and the needs related to the challenges [4]. As the content of the program is only one of the motivations for learning, and often not the main one, the student becomes the manager of their learning journey and can plan their learning, taking into account the demands of the project and their learning interests. They are also able to measure the results of the process when it is carried out and, in turn, improve their actions autonomously, without the direct help of mentors involved in the process.

From another perspective, in the CBL method there are some crucial phases for the learning process, one of which is the Investigate cycle, in which students research, investigate and delve deeper into the Challenge they are going to work on. Faced with the Learning Management methodology adapted by LISS in its use, participants need to: Define the Learning Objectives (LOs); Establish alignment and communication of the LOs with colleagues; Plan the execution of the LOs; Execute the LOs; Verify the completion of these LOs with the team; and Reflect on the learning acquired with the execution of each LO.

III. Results

After applying questionnaires with the aim of conceptualizing LISS, defining the main objectives of the three tools developed and evaluating the impact of using these practices to support the development of LISS with forty students for the two-year program and three twenty students cohorts for the one-semester undergraduate course, data analysis showed the validation of three main aspects of the implementation of Learning Innovation Safe Space (LISS) in this context: 1. LISS Concept; 2. Application of LISS Tools; 3. Perception of a CBL Challenge as a LISS. Hereafter, Pn refers to participant number n.

A. LISS Concept

This theme concerns how the concept of LISS was recognized by the students after the introduction of its tools in the learning context. In this sense, it was found that students recognize that LISS builds an environment of collaboration and collective growth (see Quote 1 - C1), provides self-knowledge and, together, belonging in the learning environment (see C2). Another impact that was recognized by the LISS was the positive impact on the learning experience (see C3) and the maintenance of the Safe Space concept (see C4).

- C1: *"LISS builds an environment of collaboration and collective growth, mistakes are celebrated and seen as learning, this contributes to the development of technical and social skills. You can listen better to people and communicate better, with empathetic and constructive feedback and comments [...]* (P2)
- C2: *"I took part in all the proposed activities, I can say that the impact of LISS is to make us recognize ourselves, the other, the environment we're in, and act in a kinder way towards all those involved."* (P1)
- C3: *"They had a positive impact on me by making me reflect on my learning and experiences gained in the process."* (P5)"
- C4: *"I think it would be the reinforcement and maintenance of these Safe Space ideas. Something that allows for greater self-knowledge and a very rich exchange between the people around us who also build this space. It makes me feel an integral part of it, above all." (P3)"*

B. Application of LISS Tools

This theme concerns how the three tools adapted by LISS (Asset Mapping, Future Self and Autonomous Learning Management) were incorporated into the innovation education initiative. It was recognized by the participants that Asset Mapping helped to recognize individual and collective abilities and strengths (see C5); to diverge, converge and collaborate (see C6); to provide a sense of security in personal and professional development and to help build a Safe Space (see C7); to compact the community's sense of belonging in favour of learning (see C8). In addition, Future Self was recognized for its self-reflective impact, contributing to assertive decisions in learning (see C9); and strengthening the idea of Safe Space (C10). Finally, Autonomous Learning Management provides a sense of engagement around learning (see C11).

- C5: *"Asset Mapping helped me recognize my skills, strengths and points I could improve with the help of people close to me, and that was the most interesting part, learning about my colleagues and understanding their journey and the experiences that make them so unique"* (P6)
- C6: *"The impact of Asset Mapping is getting to know people and getting to know yourself. The biggest impact*

of the activity was getting to know people better, learning more about them and their journeys [...]. Listening to people and feeling at ease to say what I thought or felt, the environment allowed me to differ from others or agree." (P7)

- C7: *"Through the process I was able to recognize my skills and experiences, which I often didn't value. This helped create in me a desire to share and help. I also realized through the process that in our community we have many people willing to help with difficulties and challenges, so I don't have to be afraid to ask for help. [...] But I believe that the process and the feeling of security that I had throughout it was fundamental in making this process of personal and professional construction and growth that I have been seeking even greater."* (P6)"
- C8: *"I thought Asset Mapping was incredible, because it helped me to recognize myself, value my abilities and see that I can be very important to the community, as well as helping me to get to know some of my classmates a little better." (P9)"*
- C9: *"The impact of Future Self is to make an individual and collective self-reflection in which you can see different aspects of things you've experienced, learned, improved, gone right or wrong as well. And about seeing yourself more closely, and others supporting you in your choices." (P10)"*
- C10: *"I think that LISS, when it applies Future Self, reinforces the maintenance of these ideas of Safe Environments. Something that allows for greater self-knowledge and a very rich exchange between the people around us who also build this space. This makes me feel an integral part of it, above all." (P11)"*
- C11: *"It gave me a sense of engagement among team members in the search for knowledge related to the Learning Objectives, which stimulated learning." (P12)"*

C. Perception of a CBL Challenge as a LISS

This theme concerns how the method of implementing and maintaining LISS in a CBL challenge was understood by the students of the innovation education initiative. The students identified that the method of implementing LISS was, in fact, seeing themselves in a Safe Space and appreciating how building this environment is capable of positively transforming the people involved (see C13). In addition, the importance of using the LISS method beyond the innovation education initiative for computing was also recognized, as the students considered that they probably won't find these methods and practices easily in other educational and corporate spaces (see C14) and also felt very comfortable participating in the whole process (see C15). Finally, the LISS method also contributed to the recognition of the computing learning environment as a Safe Space, as well as reaffirming that the construction of a Safe Space occurs through individual and collective spheres in learning, which has a positive impact on everyone who is part of it (see C16).

- C13: *"The first impact is realizing how, in a safe space (which was provided by each of these activities), safety 'transforms' people. It transforms them because they can be themselves and that makes everyone freer. After that, being freer, our time is focused on other details and everything works better".* (P12)
- C14: *"I think I was able to realize how much this is proper [to the computer innovation education initiative], and that if I don't take this culture with me, I probably won't find it outside [in other educational and corporate spaces".* (P13)
- C15: *"It was wonderful! These are experiences that I'm even going to take outside [the computer innovation education initiative] because they've done me a lot of good". (P14)"*
- C16: *[The LISS method] really helped to reaffirm the idea that [the computer innovation education initiative] is in fact a joint safe space and everyone present is in a constant process (both individual and collective) of learning and experimentation. In other words, everyone goes through the same difficulties and celebrates the same achievements, because in the end everyone helps each other". (P15)"*

IV. Summary

The results revealed three main topics involving the validation of the LISS concept, the application of the LISS tools and the implementation of the LISS method in the computing innovation education initiative. The first topic, the validation of the LISS concept, covers the positive impact of implementing LISS on the computing learning experience of the students involved and on maintaining a Safe Space in the environment analyzed. In addition, it is also stated that how LISS and its tools contribute to the dimensions of self-knowledge, collaboration and learning. The second topic, the application of the LISS tools, highlights how Asset Mapping, Future Self and Autonomous Learning Management respectively helped to recognize students' individual and collective abilities and strengths; emotional security in the personal and professional spheres; impact on self-reflection; critical thinking and engagement in learning. Finally, the third topic, the implementation of the LISS method, validated the relationship between building a Safe Space and positive transformation in the people involved. At the same time, it was analyzed that initiatives and methodological practices like these are not easily found in educational and corporate spaces. Another important issue was the validation of the LISS methods for recognizing the computer learning environment as a Safe Space, with a positive impact on all those involved.

V. Limmitations

Readers should consider the limitations of this study when interpreting its insights. The use of questionnaires and an action research to develop the LISS concept and its tools provided deep insights into the needs of creating and maintaining a Safe Space in a learning environment for innovation

in computing, and also identified students' experiences in this environment. However, relying solely on questionnaires and the methodological process of action research may have led to the possible neglect of other relevant aspects. In addition, convenience sampling may have introduced a selection bias, as our sample cannot be representative of all initiatives based on computer innovation education in Brazil. Although this limitation could affect the generalizability of the results to a wider population of students, it allowed for a practical and efficient recruitment process, enabling timely access to participants, which allowed us to obtain insightful results. In addition, the analysis process employed categorization with a focus on discourse analysis. While this approach allowed for an in-depth exploration of students' perspectives and meanings, it is important to recognize the possible subjectivity in interpreting and categorizing the data. Despite these limitations, the research method led to valuable insights that enabled the aim of this article to be achieved. Therefore, although readers should be cautious when interpreting our results, future research should consider employing a mixed-methods approach and expanding the group of participants to increase the breadth and depth of the findings.

VI. Conclusions

The creation and development of Safe Spaces generate significant results in innovative computing learning environments by providing students with the emotional security to develop skills and competencies in line with the 21st century (9). In this sense, they can deal with real-world challenges, investigate existing problems and design technology-based solutions in the learning process. However, their success depends on the creation and maintenance of practices and tools that stimulate a Learning Innovation Safe Space (LISS), because a computing innovation environment has methodologies that need to provide emotional support so that students can challenge themselves, be innovative, autonomous and collaborative as they develop in the computing learning process. Despite this, computing education initiatives have not yet been sufficiently involved in the design, development and use cycle of tools that enable the implementation of a Learning Innovation Safe Space in their environments.

Therefore, this article aimed to define the concept of a Learning Innovation Safe Space; propose tools to be applied in formal learning environments that encourage the development of Safe Spaces through collaboration, autonomy and stimulating learning, as well as implement practices that encourage the creation and maintenance of a Learning Innovation Safe Space for students and mentors in these computing learning environments. By conducting questionnaires, categorizing data through thematic analysis and using action research to develop the LISS concept and its respective tools, our findings highlighted the importance of considering the contexts of students and mentors and the main considerations in building a Safe Space for learning initiatives in computing, such as the development of emotional security in the process of autonomy in learning, multidisciplinary collaboration, perception and management of learning in computing.

Overall, our findings emphasize the key role of students and mentors in implementing and maximizing the effectiveness of the development of a Learning Innovation Safe Space (LISS). By prioritizing the involvement of mentors and understanding how students' needs during the learning process could be improved through the use of LISS tools, led by mentors throughout a CBL Challenge, it becomes possible to develop learning initiatives for innovation in computing that are linked to the creation and maintenance of effective Safe Spaces, aligned with educational values and objectives. Furthermore, our findings provide valuable guidance for the creation of Learning Innovation Safe Space-oriented tools customized for computing learning environments, ultimately improving teaching and learning experiences.

We recommend that future studies explore the potential of mentor-centric LISS concepts and tools, investigate their impact on student learning outcomes, and consider the scalability and feasibility of widespread implementation. In addition, more tools should be explored that can encourage other dimensions of LISS to be contemplated as well, such as daring, self-discovery, experimentation and dealing with challenges in the learning journey. Thus, the research promotes LISS by defining this concept; emphasizing the involvement of the mentor in a student-centered educational design experience, supporting with the aid of tools; as well as the development of a Learning Innovation Safe Space with the use of concepts and tools that significantly improve learning outcomes and effective teaching practices around computing and the proposition of computing technology solutions.

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