




Active learning in engineering education: Insights from a faculty development program in higher education

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Abstract

This study examines the enhancement of teaching practices within the school of engineering at a private Chilean university that emerged from a collective reflection of ideas/actions on the strengths, weaknesses, opportunities, and threats in the implementation of a professional development program in the school of engineering. It investigates factors influencing the efficacy of student-centered learning and teaching through the application of the World Café methodology among faculty participants in a structured training program aligned with institutional educational policies. Emphasizing long-term sustainability, the findings underscore the presence of motivated instructors committed to ongoing improvement, bolstered by comprehensive continuing education opportunities provided by the university. Despite notable progress, challenges such as limited financial resources and the imperative for strategic institutional commitment are acknowledged. Crucially, successful educational initiatives hinge on robust collaboration and dialogue between faculty and administration. The study advocates for tailored faculty training essential for adapting to evolving educational and technological landscapes. It concludes by highlighting the broader implications for engineering and STEM disciplines, advocating for a cohesive teaching community poised to meet future educational challenges.

Keywords: educational innovation, STEM education, higher education, faculty development, continuing education, active learning, engineering education, sustainability

INTRODUCTION

The quality of higher education is an increasingly important issue in the global context, especially in technical and scientific fields such as engineering (Elsafty et al., 2020a, 2020b, 2020c; Mora-Luis & Martin-Gutierrez, 2020; Resnawati, 2020; Ritz & Fan, 2015; Stains et al., 2018). In a globalized environment, where the knowledge economy and technological innovation are increasingly crucial, training highly qualified professionals becomes a fundamental pillar for the sustainable development of any society. However, the effective implementation of student-centered teaching methodologies faces several challenges that go beyond the classroom, encompassing institutional and global

factors that can significantly influence educational outcomes (Brown & Cross, 2020; Estévez Nenninger et al., 2014; Lattuca et al., 2014; Neves et al., 2021).

Understanding the multifaceted factors that influence the implementation of engineering education strategies is critical to creating impactful change. These factors, ranging from institutional elements to social and cultural considerations, play an essential role in determining the success and sustainability of educational reforms. For example, institutional support can provide the necessary resources and policy frameworks that foster innovation in teaching (Finelli et al., 2014; Santangelo et al., 2021). Educators' professional development is equally critical; they are at the forefront of knowledge delivery, and their skills and

Contribution to the literature

- This study offers a replicable model for institutions seeking to enhance faculty development in active learning through structured, community-building activities. It showcases best practices for fostering long-term faculty engagement. It presents a comprehensive examination of internal and external factors affecting educational policy implementation, enriching the discourse on sustaining innovations in STEM education.
- This research utilizes the World Café methodology for faculty reflection and strengths, weaknesses, opportunities, and threats (SWOT) analysis, introducing a novel participatory approach to engineering education studies, facilitating deeper understanding and collaborative input among faculty members.
- The analysis highlights the intricate relationship between institutional support, faculty motivation, and socioeconomic conditions, demonstrating the critical role of tailored development programs and structured support systems for sustainable educational change.

methodologies directly affect student outcomes (Diaz-Lantada & Martin-Nunez, 2021; Shekhar & Borrego, 2017). Global influences, such as emerging technologies or international educational standards, can provide valuable information about best practices in education and areas of opportunity for greater reach (Lattuca et al., 2014; Saif et al., 2022). Evaluation mechanisms ensure the teaching methodologies are effective and meet the desired objectives (Chu et al., 2019; Revilla-Cuesta et al., 2020). Technological infrastructure and support can enhance the learning experience, making it more interactive and relevant (Dominguez, 2024; Matusovich et al., 2014; Scogin et al., 2020). Finally, recognizing and addressing social and cultural factors ensures that the education provided is inclusive and resonates with diverse student populations (Kroll & Plath, 2022; Nakamura, 2022; O'Brien et al., 2020; Ramos et al., 2022; Thacker et al., 2022; Wong et al., 2022). Given these considerations, a program that trains engineering faculty to use student-centered strategies is invaluable (Castillo et al., 2021; Dominguez et al., 2018, 2019). Such a program equips educators with the tools to engage students more effectively and fosters an environment where students are at the center of the learning process. Understanding and addressing these factors can pave the way for a more dynamic, responsive, and practical engineering education.

Exploring the complexities of effectively implementing educational strategies in engineering, Finelli et al. (2014) highlight the importance of buy-in from both faculty and administration. The authors stress that a shared purpose between faculty and management is essential to the success of curricular change initiatives and emphasize aligning institutional culture and policies with the desired changes. They discuss barriers to adopt research-based teaching practices, such as lack of time and familiarity with new methodologies and institutional policies related to tenure and promotion. However, they identify facilitating factors such as collegial and administrative support and the potential for time savings and improvements in student learning. The authors advocate a holistic approach integrating

individual teaching practices and a broader institutional culture to transform engineering education significantly.

In this context of change and adaptation, Diaz-Lantada and Martin-Nunez (2021) delve into the changing landscape of engineering education, recognizing the rapidly evolving technological and international context. The study highlights the crucial role of engineering educators in shaping the profession's future. It discusses their challenges, including the need for continuing professional development and balancing research and teaching. They face bureaucratic hurdles that can detract from core teaching-learning processes, and the study presents cause-and-effect diagrams to understand better issues such as the technology gap between faculty and students and the challenges of teaching in international programs. Highlighting the importance of adapting to the changing environment, the authors promote innovative strategies that engage educators and students, encouraging universities to continually reinvent their teaching-learning processes to remain relevant and effective in an ever-changing world.

Following this line of research on continuing education for faculty members and its impact on engineering education, Lattuca et al. (2014) address the relationship between continuing education in teaching, departmental contexts, and using student-centered teaching practices among engineering faculty. The researchers relied on self-reporting participants' teaching behaviors rather than direct observations. According to the study results, there is a positive correlation between professional development activities and graduate training in teaching with the use of student-centered teaching practices. The study also suggests that supporting faculty participation in professional development activities may be more effective in promoting student-centered teaching practices than focusing on research and curriculum enhancement.

In this sense, instructor participation in faculty training activities is related to instructor motivation. Matusovich et al. (2014) analyze the importance of instructor motivation in transforming engineering

education. They explore why instructors participate in the research-practice cycle and highlight the importance of success expectancy and value beliefs as critical factors. The study suggests that enhancing individuals' competence and fostering collective efficacy and value beliefs are crucial to driving change and innovation in engineering education. The article addresses several vital factors influencing instructors' participation in the research-practice cycle. First, their expectations of success play a crucial role; they are more inclined to participate when they believe their efforts will produce successful outcomes and recognize the value of merging research with practice. Second, they weigh the costs associated with this commitment, considering the time and effort required to incorporate research results into their teaching or initiate research based on their teaching experiences. The perceived utility of integrating research into practice also serves as a motivator, as instructors recognize the benefits of evidence-based teaching or present teaching challenges for research. However, time constraints are often a barrier, as faculty need help finding time for research activities or implementing research findings in their teaching.

Finally, about addressing social and cultural factors, Nakamura (2022) discusses the importance of fostering diversity, equity, inclusion, and respect (DEIR) in undergraduate chemistry education. He highlights incorporating activities that promote diversity awareness and understanding of implicit biases in courses as opportunities for extra points. These activities were voluntary and took place outside the classroom. The article presents the results of student surveys, which indicate that these DEIR activities successfully promoted the importance of diversity and inclusion and positively affected students' social awareness. It also emphasizes the need for a greater understanding of diversity and cultural heterogeneity in the classroom as students become more diverse. Overall, greater awareness of diversity and cultural heterogeneity creates a more inclusive, enriching, and respectful classroom environment that prepares students for a diverse and interconnected world.

Innovation in educational practice translates into positive results for students, both in improving their conceptual learning and developing skills and competencies. In addition, it promotes continuous and reflective faculty professionalization to enhance the quality of higher education, fosters the construction of an educational community, and raises the quality of education in institutions through reflection (Carlos-Guzmán, 2021). This paper dives into the complexity of this context to offer a comprehensive view of the factors that can facilitate or hinder the improvement of teaching in higher education in an engineering faculty where there is a program of professionalization of teaching practice as an educational policy. The study identifies several strengths and opportunities and threats and

weaknesses that affect the quality of education in this engineering faculty. Therefore, the objective of this article is to analyze in depth internal and external factors that, from the instructors' perspective, result in SWOT to the use and implementation of active learning strategies in the engineering classroom to provide a comprehensive view that will enable policymakers, administrators and educators to make informed decisions to improve the quality of education in the university's college of engineering. In this sense, the study contributes to the existing literature on improving teaching practices in higher education while offering specific insights into the particular context of an engineering faculty in Chile.

The following sections are presented in this research article: context, in which the contextual conditions under which the present study is conducted are presented; the methodology section, where the implementation processes of the conversation and socialization strategy are detailed; then the results section provides a report of findings according to the analysis tool; and finally, the sections that correspond to the discussion and conclusions of this study.

The relevance of this study is the following: the presence of a specialized unit like teaching and academic innovation unit (UNIDA), dedicated to faculty development and the implementation of active learning strategies, is highlighted as a potential model for other institutions. The importance of faculty training is underscored as crucial for enhancing educational outcomes, suggesting that continuous professional development is key to institutional success. Additionally, the findings from this study provide a valuable framework that other universities could adopt, serving as a proven model for improving the quality of STEM education. Lastly, the application of the World Café method itself is celebrated as a strategic tool that effectively gathers diverse insights and fosters a comprehensive understanding of the internal and external factors affecting educational programs.

CONTEXT

In 2015, as an educational policy to improve student learning, the school of engineering opened an educational unit to establish strategies to enhance courses in the institution. Thus, what is known as UNIDA was established with the following mission and vision:

1. **Mission:** To promote the use of active and innovative methodologies in teaching activities to strengthen the national structure of the school of engineering and ensure the dissemination of knowledge-generation results that foster a culture of development in the academic community.
2. **Vision:** To be a teaching development unit that positions the school of engineering internationally

for its academic community and stands out for its professional teaching practice, educational research, and commitment to disseminating results.

To achieve the mission and vision, a faculty development strategy was developed based on two fundamental pillars: the annual engineering education summit and the faculty development program on active learning for engineering (Dominguez et al., 2018, 2019).

The engineering education summit is an annual event for the social exchange of completed projects, conferences, workshops, and lectures, through which instructors who have already started their path in innovation and educational research in engineering can share their experiences, difficulties, and achievements. On the other hand, instructors who still need to have the opportunity can consult their concerns and interests in a pleasant space to exchange ideas.

For its part, the faculty development program on active learning for engineering is specifically aimed at strengthening the innovation processes that occur within the university classroom, particularly in engineering careers, providing tools to instructors that allow them to incorporate active methodologies in their work, directly in line with an educational model focused on the needs of students (Dominguez et al., 2018, 2019). This program last three semesters and runs different courses during the academic year. The courses aim to train teachers in active learning strategies, formative assessment (formal and informal), collaborative learning; in general, to offer the instructors a new vision of their role in the classroom. To complement their traditional view of teaching by engaging them into promoting a more active role of the students in the classroom, and congruent assessments techniques.

The proposed activities allow participating instructors to understand the need for a paradigm shift in teaching, to design specific didactic interventions for their disciplinary area, and to design and implement didactic innovation projects that contribute to solving current problems related to quality in university teaching. This program emphasizes fostering the exchange of experiences among the participating instructors to build a solid learning community that can sustain itself over time.

The complete training cycle for each group of instructors consists of three semesters. The first semester of workshops addresses active learning and collaborative learning, questioning techniques, and authentic assessment. The two subsequent semesters are focused on designing, implementing, and improving innovations in their courses' didactic units. To this end, they work on developing and documenting these innovations incorporated into the chosen course program, with peer review and the accompaniment and advice of UNIDA team.

METHODOLOGY

The World Café conversation, created by Brown and Isaacs (2005), is an intentional and structured way of making a conversation network around critical issues. Its dynamics resemble the experience of being in a coffee shop, where conversations flow naturally, and people are grouped at small tables to discuss specific topics. Participants then rotate and join new tables to continue the conversation. This rotation process and multiple conversations promote various perspectives and broaden the shared understanding of the challenges and opportunities present. This article reports a World Café to analyze strengths (positive internal critical factors that we have), opportunities (positive external aspects that we can take advantage of using our strengths), weaknesses (negative internal essential factors that need to be eliminated or reduced) and threats (negative external aspects that could hinder the achievement of our goals), according to the instructor's perspective on the use and implementation of active learning strategies in the engineering classroom.

The activity was developed with 40 instructors from the three sites of the school of engineering, Concepción (11), Viña del Mar (6), and Santiago (23), who had participated in the faculty development program on active learning for engineering offered by UNIDA. The main objective of the activity was to stimulate the collective reflection of ideas/actions on the SWOT in the implementation of a professional development program.

The activity was organized on two discussion tables.

1. **Table 1. Internal factors:** Strengths and weaknesses. The school of engineering can take action to modify its processes and resources.
2. **Table 2. External factors:** Opportunities and threats.

Although they are external to the school of engineering, it is possible that the school of engineering can influence their modification.

Two working groups were established, each equipped with stickers and markers for participants to express and organize their ideas—one idea per sticker. The facilitator initiated a collective discussion, systematically organizing and categorizing the input from the instructors. One group focused initially on strengths and the other on opportunities for 10 minutes each, followed by weaknesses and threats. The facilitator spent five minutes summarizing the outcomes generated by the participants for each factor. After 30 minutes, the tables were switched, allowing all participants to contribute to both discussions.

The table facilitator fostered a dynamic exchange of ideas, encouraging active participation from all members to draw out each participant's best contributions. Throughout the session, the facilitator effectively synthesized the most pertinent conclusions

from each group, emphasizing the critical points of the discussions. After the activity, the facilitator compiled a report that categorized the ideas into the most frequent, the most original, those with the least consensus, and the most prominent trends, offering valuable insights into the session's outcomes.

The activity coordinator adeptly managed time and closely monitored each table's progress to ensure active engagement throughout the session. The coordinator also made certain that all necessary materials were always available to facilitate the activity's smooth development. Additionally, the coordinator facilitated the final comments, guided the conclusion of the activity, and provided clear direction to help summarize the discussions and extract valuable lessons.

The resulting product of each roundtable discussion was cards with paper labels on which the participating instructors shared their ideas. Each of the ideas contained in these labels was transcribed in digital format, together with the information of the category in which it was placed throughout the conversation generated in the activity and the corresponding SWOT dimension. Each of these ideas will be considered a unit of analysis. A total of 272 ideas distributed in the four dimensions were collected.

With the data obtained from the different digitized working groups, an inductive categorization was carried out, which emerged from the data themselves based on the analysis of patterns and recurrences present, respecting the meaning and perspective assigned by the participants to their contributions. In addition to generating the categories for each of the SWOT dimensions, the actors involved were also characterized in a "from whom?" and "for whom?" format to identify, in each case, which actor is responsible for generating each of the issues revealed and which actor can ultimately be reached by their effects.

It is important to note that the school of engineering was considered a reference to differentiate internal from external factors. Thus, internal factors mean issues originating from actors within the school of engineering, while external factors are related to problems from outside the school. This means that university on which school of engineering depends will be considered for analysis as an external actor to the school of engineering while recognizing the close link between the two.

RESULTS

The findings are presented in the following sections to reflect the working structure of the World Café: a table on internal SWOT factors, strengths and weaknesses, and another table on external factors, opportunities, and threats. A descriptive analysis of the data obtained can be seen in **Table 1**, where the accounting concerning the dimensions of the SWOT is presented. In addition, two cross-classifications are presented: internal factors

Table 1. Descriptive by category: The dimensions within the methodology are the internal and external aspects and the positive and negative aspects

Dimension	Frequency (n)	Percentage (%)
Strengths	65	23.9
Opportunities	59	21.7
Weaknesses	92	33.8
Threats	56	20.6
Total	272	100
Factors		
Internal (F+D)	157	57.7
External (O+A)	115	42.3
Total	272	100
Factors		
Positive (F+O)	124	45.6
Negative (D+A)	148	54.4
Total	272	100

corresponding to strengths and weaknesses and external factors corresponding to opportunities and threats. The second classification was based on positive factors corresponding to strengths or opportunities and negative factors corresponding to weaknesses and threats. It can be observed that in each of these divisions, both the dimensions sought, and the different factors are in balance. In the case of dimensions, the largest frequency is weaknesses, and the least frequency is threats. This is reflected in the following factors. The highest frequency was internal, with 157 as opposed to 115 external. Instructors were more familiar with something close to them, represented by internal factors. Although the difference is not that strong, it is interesting to note that in the case of positive/negative classification, there are more negative factors than positive, indicating a slight tendency of participants for weaknesses.

Internal Factors: Strengths and Weaknesses

In educational institutions, the development of the actors involved in the teaching-learning process is paramount. In this sense, institutions can be nourished by the interaction among their members and the joint construction of knowledge about the situation in which the institution finds itself from the perception, in this case, of the instructors. This is why conducting the World Café on the strengths and weaknesses perceived by faculty for implementing active learning strategies in the school of engineering is essential.

An analysis of the words with the topics most frequently used by instructors on the blackboard stickers within the strengths, in the context of the faculty of engineering, has observed a growing emphasis on the importance of continuing education on engineering education for faculty. Instructors are actively involved in continuous learning and improvement processes, seeking to increase the implementation of active student-centered teaching strategies. This commitment translates

Table 2. Categorization of strengths and those responsible show the percentages of strengths about the total number, considering all categories

Category	P (%)	Definition	The main ideas of the participants
Support	36.9	Training and development support for teaching practices.	Existence of support from managers. Support, accompaniment, and feedback from UNIDA. Clear regulations and protocols.
Motivation	21.5	The reason is that orients detonate and maintain the transition process towards active methodologies.	Instructors with availability, commitment, and flexibility for change. Students with good reception.
Community	16.9	A group of instructors who are willing and open to improving teaching practices.	Teamwork, knowledge among colleagues, permanent training. Shared best practices.
Attributes	12.3	Quality or characteristics of a person that are favorable in implementing active methodologies.	Trained faculty have the skills to detect the talent of students and know how to perform the teaching task.
Resources	7.7	Means available to meet the requirements for the improvement of teaching practices.	Existence of an e-learning platform. Budget available.
Curriculum (syllabus)	4.6	Structure and adaptation of the curriculum to favor the transition to active learning.	Subjects with flexible content. Competitive advantages over the industry.
Actors responsible for strength		Stakeholders benefiting from strength	
Actor	P (%)	Actor	P (%)
School of engineering	33.8	Instructors	64.6
Instructors	29.2	Students	29.2
UNIDA	21.5	School of engineering	6.2
Institution	12.3		
Students	3.1		

Note. P: Percentage

into community participation, where socialization and exchanging experiences and best practices become fundamental tools for professional development. UNIDA's role is central in forming this learning community towards transforming a teaching practice aligned with current educational trends and challenges.

Regarding the weaknesses participants reported on the blackboard stickers, the educational environment faces significant challenges regarding time management, available infrastructure, and adequate resource allocation. These challenges can lead to tensions between expectations and reality, affecting instructors and students. Also, latent lack of communication between administration and faculty can influence morale and overall motivation, increasing the need for instructor recognition. But it is a reality that the infrastructure and available resources are only sometimes aligned with the current curricular and pedagogical demands. This situation leads the instructor to perceive the lack of time and the lack of participation of more instructors to meet the demand without so much overload. Note that the lack of trained faculty emerges as a crucial aspect, where the lack of training can hinder the implementation of curricular innovations aligned with the educational model. Resistance to change, both on the part of instructors and students, can impede the adoption of new methodologies and pedagogical approaches. Finally, continuous evaluation and monitoring of educational processes are essential to ensure quality and consistency in delivering content and skills.

An analysis of the reflections related to the Strengths was carried out, resulting in categories. In this categorization, the actor responsible for the strength (whose?) and the actor who benefited from the strength (for whom?) were also analyzed for each case. The categories that organize the main findings and those responsible are presented in **Table 2**.

About the emerging categories of the strengths mentioned by the attendees, the most relevant is support (36.9%). This category incorporates all the mentions of the existence of training and supports possibilities for the development of innovative teaching practices. On the other hand, in the second order of relevance appears the motivation category (21.5%), which concentrates on those topics related to various reasons that trigger, guide, and maintain the transition process toward using active methodologies in the school of engineering. In third place, the community category (16.9%) stands out, which is responsible for grouping the mentions about a group of instructors with a good disposition and openness towards improving teaching practices.

In the case of the actors responsible for the strengths, we find the school of engineering (33.8%), the instructors (29.2%), UNIDA (21.5%), the institution (12.3%), and the students (3.1%). It is essential to highlight that, although this is an analysis focused on the internal factors of the school of engineering, it was identified the need to distinguish specific institutional characteristics that, although they are manifested through the school of engineering, were considered internal factors that

Table 3. Categorization of weaknesses and responsible parties, showing the percentages of weaknesses about the total number, considering all categories

Category	P (%)	Definition	The main ideas of the participants
Management	27.2	Strategic and operational decisions of the IF that make teaching practice complex.	High workload, no focus on teaching. Few permanent instructors. We have limited class time. A large number of students. Privilege of “what” over “how” to teach.
Characteristics of the actors	18.5	Particularities of students and instructors that slow down the improvement of the teaching-learning process.	Uneven training, resistance, and instructor fatigue. Unmotivated and unwilling students.
Resources	17.4	Limited infrastructure and availability of resources to meet the needs of teaching practice.	Inadequate classrooms. Few workspaces for instructors.
Protected time	14.1	Limited time dedicated exclusively to guiding, triggering, and sustaining the process of improving teaching practices.	Lack of protected time for the design of innovations and instructor training tasks.
Curriculum	8.7	Characteristics of the curriculum that jeopardize the implementation of active learning strategies.	Overloaded programs and impossibility to comply with them.
Indicators	8.7	Insufficient measurement mechanisms to follow up on the teaching-learning process.	Lack of follow-up measurement, validation of innovations.
Communication	5.4	Little reciprocal action among intervening actors that hindered the teaching work.	Existence of some failures in communication and structured socialization.
Actors responsible for strength		Stakeholders benefiting from strength	
Actor	P (%)	Actor	P (%)
School of engineering	80.4	Instructors	63.0
Instructors	10.9	Students	26.1
Students	7.6	Accreditation	8.7
Institution	1.1	Institution	2.2

Note. P: Percentage

contribute to some of the strengths mentioned by the instructors.

The qualitative analysis of the reflections on the weaknesses yielded specific categories that organized the main ideas. As in the case of the strengths, the actor responsible for the weakness (whose?) and the actor affected by the weakness (for whom?) were also analyzed for the weaknesses. The categories and those responsible for these weaknesses are shown in **Table 3**.

Regarding the emerging categories for weaknesses, it is possible to mention that the most frequent is management (27.2%). This category includes those mentions related to the faculty’s strategic and operational decisions that make teaching practice more complex. Next come the categories characteristics of the actors (18.5%) and resources (17.4%). The former considers the mentions of the particularities of students and faculty that slow down the improvement of the teaching-learning process. At the same time, the latter refers to the mentions of infrastructure limitations and the availability of means to meet the needs of teaching practice. Due to its frequency, the last category to highlight is protected time (14.1%), which gathers mentions referring to instructors’ scarce or non-existent exclusive dedication time to detonate, guide, and maintain the process of improving classroom practice.

In the case of the actors responsible for the weaknesses, we find the school of engineering (80.4%), instructors (10.9%), students (7.6%), and the institution (1.1%). The actors most affected by the weaknesses are the instructors themselves, with 63%, and the students, with 26.1%, and to a lesser extent, the accrediting agency and the institution were mentioned, with 8.7% and 2.2%, respectively.

Up to this point, the results of the analysis of the strengths and weaknesses mentioned by the instructors participating in the World Café have been presented, highlighting the most relevant keywords and categories that emerged from the collective reflections on this topic. The most significant result that stands out in strengths is a developing instructor-learning community, which will be explored in subsequent sections. On the other hand, in the weaknesses, in first approximation, it could be said that the issues that most concern instructors are related to matters that directly hinder the consolidation of an instructor-learning community, as will be further explored below.

External Factors: Opportunities and Threats

For the case of opportunities and threats reported in the World Café, it is possible to start by analyzing the words with the highest presence in the participants’

comments. In this analysis of the labels for opportunities, engineering faculties face a constantly evolving educational landscape driven by rapid digitization and the changing demands of the labor market. Faculty recognize the need to spot talent and integrate advanced tools and innovative methodologies into education to ensure the competitiveness of their graduates by offering cutting-edge training. This adaptation in both programs and students. That is, adaptations to the curricular content are oriented to the trends of Industry 4.0, which consists of integrating advanced technologies and innovative pedagogical methodologies to prepare students for an increasingly technological and multidisciplinary working world. On the other hand, students develop competencies to adapt, communicate, and collaborate in a globalized environment. All this is framed in a social and political context that demands a quality education that is reflective and aligned with the country's and industry's needs. Therefore, interaction with industry and society in general and the continuous revision of educational models are crucial to maintaining the relevance and competitiveness of the academic programs offered.

In the case of threats, there is a growing concern about management and available institutional resources, particularly in infrastructure (space and the Internet). Engineering faculty members perceive these factors as threats to responding to a changing socioeconomic context, given the social instability, the latent economic recession, and the government's lack of support for education. This uncertain environment impacts society as a whole. From an external point of view, the engineering faculty, on the one hand, the changing labor market faced by its graduates, and on the other hand, a narrow vision of education by professionals to be hired with a lack of pedagogical specialization, commitment, and motivation. Due to social instability, the transition to online education presents its challenges, and there are concerns about the lack of institutional, technological infrastructure, the implementation of active learning in virtual environments, the preparation of new faculty, and the possibility for students to have the resources to learn from home. Here emerges the call by instructors for formalization and respect for their time to dedicate to teaching and their personal and family needs. In this sense, there is a notable concern about accreditation as instructors mention that requirements are often perceived as excessive or meaningless and take time away from them. Another external threat is the preparation of students in secondary education, as instructors perceive it as deficient in knowledge and skills as well as in motivation. Part of this is manifested in the entry scores on the national college test. This threat becomes a weakness once students enter college. Clarity and vision are essential in this complex environment but need more alignment and policy changes.

As in the previous dimensions, some categories emerged as organizers of the primary reflections from the qualitative analysis of the reflections on opportunities. Similar to the previous dimensions, the actors generating opportunities (from whom?) and the actors with possibilities of taking advantage of these opportunities (for whom?) were also analyzed in the case of opportunities. The categorization and actors can be consulted in **Table 4**.

Of the emerging categories for opportunities, we can highlight enablers (23.7%), which is the category that incorporates all the mentions of potentially favorable characteristics for teaching practices that are found in the university ecosystem. Next, it is possible to mention the categories resources and trends, both with 20.3%. The former refers to the existence of external means available and potentially beneficial to meet the requirements of the processes of improvement of teaching practices. In contrast, the latter refers to those macro guidelines that guide fulfilling the institutional mission of professional university training.

About the generators of opportunities, it is possible to highlight the institution (47.4%), global (39%), and society (10.2%). In the case of opportunities, as an external factor, it is relevant to highlight those actors that can take advantage of such opportunities. In this sense, the leading actor is the school of engineering with 79.7%, followed by students and instructors with 10.2% each.

Four categories emerged from the qualitative analysis of the threats identified by the participants. The actors responsible for the threats (from whom?) and those potentially affected by the threats (for whom?) were also identified. The categories and responsible actors are shown in **Table 5**.

The most frequent resulting emerging categories are educational context and socio-economic context, both with 28.6%. The former groups mention the characteristics of the educational system and its actors that slow down the student-centered teaching-learning process. The second category includes references to socioeconomic traits or situations that generate a framework of uncertainty in education. The other two categories are management, which is related to the strategic and operational decisions of the institution that make teaching work complex, and resources, which are associated with the scarcity of means and support services for the improvement of teaching work, with 21.4% each.

Considering those responsible for the threats, the most present in the reflections of the participants are the institution (39.3%) and the global context (26.8%). In turn, about the actors affected by the threats, the main one is the school of engineering, with 71.4%, followed by students (16.1%) and instructors (12.5%).

Table 4. Categorization of opportunities and responsible people: The percentages of those accountable for the opportunities about the total number take all categories into account (P: Percentage)

Category	P (%)	Definition	The main ideas of the participants
Enablers	23.7	Potentially favorable characteristics for teaching practices.	Communication between faculties. Multidisciplinary teamwork. New technologies
Trends	20.3	Guidelines that guide the fulfillment of the mission in university professional training.	Requirements of accreditation entities. Industry 4.0 requirements. Employers' requirements. Globalized and competitive world.
Resources	20.3	Available external means potentially useful to meet the requirements for improving teaching practices.	Money for the financing of education. Abundant bibliography. Virtual classrooms. IT tools available.
Student attributes	13.6	Qualities or characteristics of students that are favorable in implementing active methodologies.	Committed, motivated students with a good command of technology. New generations that demand quality education.
Quality	11.9	Strategic and institutional management tools that favor the teaching-learning process.	Variety in the academic proposal. Flexible admission, existence of remedial courses and tutoring. Measurement of results.
Social context	10.2	Social characteristics that invite reflection on teaching practices	Climate of reflection, debate at the country level. Contingency management and adaptation.
Actors responsible for strength		Stakeholders benefiting from strength	
Actor	P (%)	Actor	P (%)
Institution	47.4	School of engineering	79.7
Global	39.0	Students	10.2
Society	10.2	Instructors	10.2
Accreditation	1.7		
Employer	1.7		

Table 5. Categorization of the ideas presented by the instructors when talking about threats and the actors responsible for the threats and the actors affected by the threats (P: Percentage)

Category	P (%)	Definition	The main ideas of the participants
Socio-economic context	28.6	Socio-economic characteristics that generate uncertainty in education.	Country scenario of uncertainty. Economic crisis. Possible termination of student loans.
Educational context	28.6	Characteristics of the educational system and its actors slow down the student-centered teaching-learning process.	Reduction of content in secondary education. Lack of clarity on future educational policy. Unmotivated students with problems in critical analysis and reading comprehension. Type of university entrance (PSU).
Management	21.4	Strategic and operational decisions of the institution that make the teaching work complex.	Lack of formalization of instructors' protected time. Changing institutional priorities. Administrative requirements. Coordination with basic sciences.
Resources	21.4	Shortage of resources and support services for the improvement of teaching.	Inadequate infrastructure. Internet service. Efficiency of support units (teaching services & library). Uncertain annual budget.
Actors responsible for strength		Stakeholders benefiting from strength	
Actor	P (%)	Actor	P (%)
Institution	39.3	School of engineering	71.4
Global	26.8	Students	16.1
Applicants	12.5	Instructors	12.5
Society	12.5		
Potential instructors	5.4		
Employer	3.6		

DISCUSSION

In the previous section, we presented the results from various analyses of the information obtained from the World Café working groups held with faculty from the school of engineering. This section discusses the results in light of our interpretations and previous research. To

support this discussion of the emerging issues for SWOT, it is possible to analyze the transcripts of the participants' mentions by making word trees providing more transparent access to the context of word usage. **Figure 1** is the result of this analysis for three of the most important actors: UNIDA, instructors, and students.

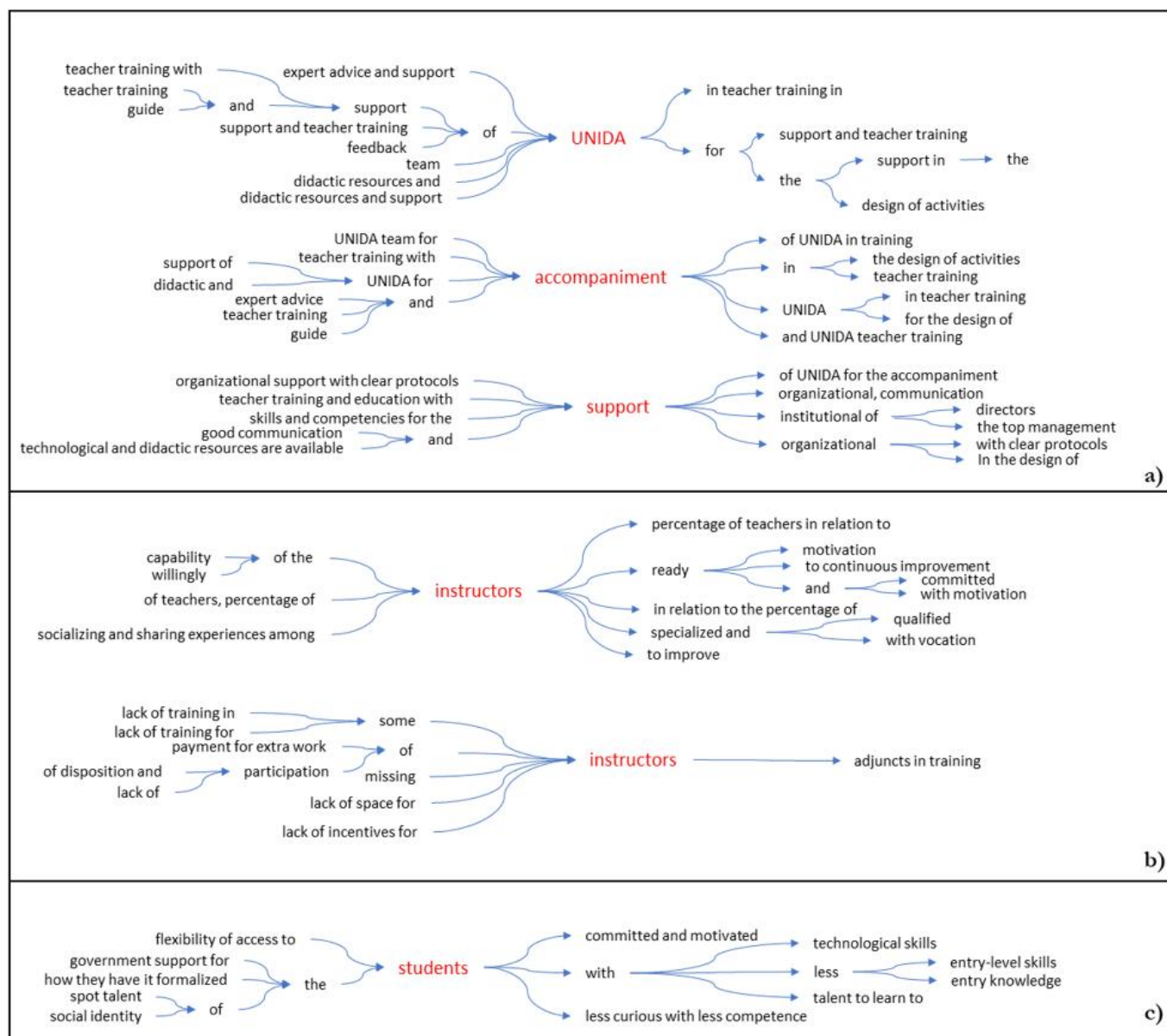


Figure 1. Contexts where (a) UNIDA, (b) instructors, & (c) students are involved (Source: Authors’ own elaboration)

Part a in Figure 1 presents the role of UNIDA as a unit, as an accompanying entity and support for instructors. Part b in Figure 1 presents the role of the instructors as their willingness to be prepared, with its strengths and needs. Part c in Figure 1 presents the role of students with their strengths and weaknesses.

In the following paragraphs, we will discuss the different dimensions, SWOT, making a connection, if necessary, with Figure 1.

The categories emerging from the qualitative analysis carried out for the strengths (Table 2) indicated that the main topics surveyed by the participating instructors are related to the opportunities for faculty training and support for the design and implementation of innovative teaching practices (support, 36.9%); with the existence of various reasons that originate and sustain the transition processes towards the use of active methodologies (motivation, 21.5%); and with the presence in the faculty

of a group of instructors with predisposition and openness towards the processes of improving their practices (community, 16.9%). These topics, as expected, are supported by the most frequent words: UNIDA, accompaniment, faculty training, active teaching, and organizational support, among others.

Since part a in Figure 1 shows the importance given by the participants to the role of UNIDA, the support received, and the support provided by the Faculty and UNIDA, it is possible to indicate that the participants are identifying strengths that, if well exploited and leveraged, could lead to creating a teaching-learning community, with the support of the faculty, with a certain degree of formalization and sustainability over time. A shared purpose can be established between instructors and management through UNIDA that can help in this community, as expressed by Finelly et al. (2014). In addition, a group of instructors with shared interests, with mutual support, generating shared

learning about their professional practice, increasing their professional commitment to impact student learning as expressed by other authors (Carlos-Guzman (2021); Engin & Atkinson, 2015; Lakkala et al., 2021; Samaras et al., 2019; Ward & Selvester, 2012; Zheng et al., 2019).

For the case of the weaknesses reported by the participants (**Table 3**), the most prominent emerging categories compile topics related to strategic and operational decisions of the faculty that make teaching practice more complex (management, 27.2%); particular characteristics of instructors and students that slow down the improvement of the teaching-learning process (characteristics of the actors, 18.5%); limitations of infrastructure and means to cover the needs of teaching practice (resources, 17.4%); and the limited or non-existent exclusive dedication time by instructors to work on the processes of improving their classroom practice (protected time, 14.1%). These themes agree, as expected, with the most frequent words: lack of time, lack of participation, and lack of follow-up, among others.

By analyzing the context of the words used by the participants, it is possible to deepen the findings above. For example, in the case of instructors who are recurrent in strengths and weaknesses as important actors (**Table 2** and **Table 3**), part b in **Figure 1** shows the context in which instructors are included in strengths and weaknesses. As can be seen, instructors who participate in faculty training activities are available and motivated, as they are committed and have a vocation. However, many instructors either need to learn about this initiative (mostly adjunct faculty) or have not wanted to get involved, so instructors are also involved in the weaknesses. It reflects then much that, in the process, the status of the instructor is an essential factor, as Brown and Cross (2020) mentioned.

In addition, if we take from the strengths the support/support as something that exists, on which instructors can count, and in the weaknesses the lack of something that can be material or intangible, we find that there is support from different instances of the faculty that helps the program to be on the road to success. However, in the "lack of," there is still a long way to go since essential aspects such as infrastructure, impact measurement, instructor incentives, and commitment are mentioned. Regarding the latter, the phrases refer to the need for more commitment of instructors who have not been part of the initiative, either due to lack of knowledge or by choice.

These are findings related to the lack of some necessary conditions for the creation of a community of teaching practice, such as availability of specific time for work oriented towards the improvement of classroom activity, infrastructure limitations (e.g., workrooms for instructors), limitations of economic resources to cover some need for innovations (Engin & Atkinson, 2015;

Miller & Metz, 2014; Pietryka & Glazier, 2022; Ward & Selvester, 2012; Zheng et al., 2019). Likewise, some decisions inherent to institutional management, such as the participation of adjunct faculty in training processes and workload distribution, among others, also influence this context (Borda et al., 2020; Karabulut-Ilgu et al., 2021; Neves et al., 2021; Santangelo et al., 2021). On the other hand, they also reflect the lack, according to the participants, of some conditions for the concrete implementation of improvements in the teaching-learning process, such as the number of students per classroom, the characteristics of the classrooms, and unresponsive students (Alonso-Nuez et al., 2021).

In general, for the internal factors, participants identify the possibility of forming a teaching-learning community supported by the faculty and sustainable over time, where knowledge is shared and professional commitment is fostered. However, these findings also point to the need for some necessary conditions for the continuity of a teaching community of practice, such as specific time to improve their practice, adequate resources, and management decisions that sustainably support the formation of a teaching community of practice.

In the case of opportunities, the main topics emerging from the qualitative analysis (**Table 4**) were related to those characteristics found within the university that are potentially favorable for teaching practice (enablers, 23.7%); the existing external resources and means potentially helpful to respond to the requirements of the processes of improvement of teaching practices (resources, 20.3%), and those macro, global guidelines that guide the fulfillment of the institutional mission about university professional training (trends, 20.3%). As was to be expected, these themes expressed by the participants are also reflected in the most frequent words: detect talent, competitiveness, social context, and educational trends, among others.

With these results, it is possible to point out that the participants recognize the existence of an institutional context (university) favorable for the implementation of improvement processes, such as communication between the different faculties, the possibility of multidisciplinary work, the existence of new technologies, the abundant bibliography, the existence of an LMS whose operation has been massified, etc. As suggested by Lattuca et al. (2014), supporting faculty participation in professional development activities effectively promotes student-centered teaching practices.

On the other hand, it is essential to highlight the existence of a global context in which financial resources are available to support education. In addition, specific guidelines for university professional education, such as the requirements of accrediting bodies, the demands of industry and employers, and the needs of a globalized

and competitive world, can be beneficial. This context demands well-trained professionals with continuous learning skills and adaptability (Azofeifa, et al., 2024; Bamrungsin & Khampirat, 2022; Sababha et al., 2016; Chonsalasin & Khampirat, 2022; González-Salamanca et al., 2020; Van Laar et al., 2020).

In the case of threats (Table 5), the main ideas pointed out by the participants were related to characteristics of the educational system and its actors that slow down the student-centered teaching-learning process (educational context, 28.5%); socioeconomic characteristics that generate uncertainty around education (socio-economic context, 28.5%); the existence of strategic and operational decisions of the institution that make teaching complex (management, 21.4%); and the scarce availability of means and services to support the improvement of teaching practice (resources, 21.4%). This is in line with the words with the highest frequency: respect time, institutional resources, socioeconomic context, and first entry, among others.

By analyzing the context of the words used by the participants, it is possible to deepen the findings above. In the case of students, we have both opportunities and threats. Part c in Figure 1 presents the relationships of the phrases with connection students.

In the same way that the internal factors refer to the instructors regarding strengths and weaknesses, the external factors refer to the students regarding opportunities and threats. This indicates that the participants see that students play an essential role in the process and that the type of faculty training can detect talent, have more flexibility in entry, and consider the student's previous knowledge and social context. This would take better advantage of their technological capabilities and motivation. This is relevant because, according to Diaz-Lantada and Martin-Nunez (2021), it is necessary to involve instructors and students to achieve significant changes in the teaching-learning process. On the other hand, the flexibility of entry can be a threat, as well as their financial problems during their program (Zhu et al., 2021).

It is possible that the participants expressed concern about external and internal issues at the university, which may affect the development of activities within the faculty. Externally to the university, they mention concern about some measures related to the country's educational policy in a context of uncertainty about the contents of secondary education, the university entrance system, the possible end of credits for students to pay for their university studies, and the general economic crisis. On the side of internal threats to the university, they pointed to management issues mainly related to the lack of formalization of protected teaching time, changes in institutional priorities, and high administrative demands as part of teaching tasks. In addition, they pointed out some infrastructure problems that depend

on the institution, such as the Internet service, which could be improved, the efficiency of some support units for instructors, and the uncertainty that the different careers have about their annual operating budget.

It could be said, then, for the external factors, that the participants are identifying the existence of an institutional (university) and global (society) context with favorable characteristics for the processes of improvement of teaching practice towards a student-centered teaching-learning process, enhanced by the availability of resources and oriented to the requirements of professional training required by the current labor field. However, they also recognize the existence of certain contextual conditions that generate uncertainty and slow down this process, such as the scarcity of economic resources, means and support services, and institutional decisions that favor teaching.

In the case of threats, the main actors responsible are not all from the university. The threats that can be mitigated with the strengths are those related to those institutional strategic and operative decisions of the institution that could make the teaching work complex and those associated with the scarcity of some means and support services for the improvement of the teaching work (management and resources; threats). The rest of the threats are related to social and educational contexts in which there is little influence to produce changes, but which can be addressed by an institution with flexible, motivated actors with the possibility of adapting to changes (attributes, motivation, community, and support; strengths).

In the case of the weaknesses found, we found that several of them can be overcome with the existence of the reported strengths. In this sense, for example, it is reported that there are programs overloaded with contents (curriculum; weaknesses), but at the same time, the possibility of adapting the curriculum to the flexibility of contents and class-by-class activities is recognized, with the support, accompaniment, and training that is available (curriculum and support; strengths). On the other hand, the existence of strategic and operational decisions at the faculty level that can make teaching practice more complex, the existence of some failures in the structured socialization of information, as well as the lack of sufficient time for the design of innovations and training (management, protected time, and communication; weaknesses) can be overcome given the flexibility and motivation of the teaching staff, the existence of a community with shared good practices and the available support and training (support, motivation, community, and attributes; strengths).

The implications of the SWOT analysis extend beyond identifying factors influencing the implementation of active learning strategies. The findings suggest that institutional support and faculty

motivation are crucial, but their interaction with external socioeconomic factors can significantly impact sustainability. For example, robust support systems may mitigate financial or policy-related threats, emphasizing the need for adaptive strategies that balance institutional resources with external pressures. Furthermore, fostering a culture of continuous faculty development helps bridge gaps between policy and practice, ensuring long-term engagement and resilience in teaching innovation. This layered understanding positions institutions to respond dynamically to internal and external challenges, aligning educational objectives with broader societal and economic shifts.

CONCLUSION

In this report, we detail the implementation of a World Café to analyze the strengths, opportunities, weaknesses, and threats from the instructors' perspectives on active learning strategies in the engineering classroom of a private Chilean university's school of engineering. This method helped delineate the internal and external factors impacting educational policy in the current context. While challenges like resource limitations and socioeconomic uncertainty were identified, several positive aspects were also highlighted, including the faculty's strong motivation and commitment, along with institutional support from UNIDA. These factors are seen as key pillars that could drive significant improvements in the quality of the education provided.

Based on the results and the discussion presented in the paper, it can be concluded that institutional support, especially from the faculty and UNIDA, a specific unit within the faculty that promotes faculty training and implementation of active teaching strategies, is a critical factor for the success of the educational program. A significant result is that universities could consider having such a unit in their schools and colleges. However, areas for improvement are also identified, such as infrastructure, impact measurement, instructor incentives, and the commitment of those who have yet to be involved in the initiative. These findings suggest the need for specific conditions for creating a community of practice, such as the availability of time, adequate infrastructure, and economic resources.

In addition, study participants express external and internal concerns to the university that could act as threats. Externally, worries about the country's educational policy, uncertainty about high school content, and the university entrance system are mentioned. Internally, management issues and the lack of involvement of some faculty members are pointed out as weaknesses that could affect the program.

Finally, students are seen as a factor of both opportunity and threat. Faculty training can be used to detect talent and to have more flexibility in entry,

considering the social context of the students. However, the same flexibility of entry and students' financial problems during their program may represent threats. These findings suggest that a comprehensive strategy that addresses these multiple factors may be more effective in improving the quality of education offered.

The findings of this study should be considered in decision-making at various levels, from the faculty administration to the institution's top management. Improving educational quality is a collective effort that requires the active participation of all stakeholders, including administrators, faculty, and students. This study, therefore, not only provides a solid foundation for future research but also provides a framework for the development of more effective educational policies. Implementing these policies could establish a model for other colleges and universities seeking to improve the quality and effectiveness of their education in STEM fields.

This study contributes to existing literature by comprehensively analyzing the SWOT associated with implementing active learning strategies in engineering education. Unlike previous works focusing solely on the benefits or challenges of active learning, this research highlights the dynamic interplay between institutional support, faculty motivation, and external socioeconomic conditions. The findings emphasize the significance of tailored faculty development programs and structured support systems, such as UNIDA, as essential for sustainable educational innovation. Additionally, the World Café methodology application is a replicable model for other educational institutions seeking to understand and navigate their unique contexts. These insights offer a robust framework for fostering collaborative environments that enhance faculty engagement and contribute to sustained teaching improvement within STEM disciplines.

In conclusion, the World Café has been an effective tool for analyzing the internal and external dynamics that influence the implementation of active learning strategies in the school of engineering of this Chilean university. Implementing these recommendations will benefit engineering programs and serve as a model for other disciplines and universities seeking to optimize their education in STEM areas. This comprehensive approach promises to improve student's learning experience and foster a more engaged and prepared faculty community for the challenges of the educational future.

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Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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