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Oral communicative competence in the training of engineers for the 21st century

Competencia comunicativa oral en la formación de ingenieros del siglo XXI

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Abstract

This paper presents an action-research experience that was carried out with 12 students in their last semester of Civil Computer Engineering at a private Chilean university, whose objective was to contribute to the development of oral communicative competence from an academic and disciplinary point of view. A methodological distinction was made between formal and technical aspects that allowed the development of these skills through interdisciplinary work between engineering teachers and communication teachers thanks to the implementation of a didactic module that encouraged disciplinary communicative practice, self-evaluation, co-evaluation and timely feedback. The results obtained indicate that, at the group level, this experience contributed to obtaining scores with a narrower dispersion and shifted towards passing levels, while at the individual level, more than 90% of

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the students managed to improve their oral communicative performance.

Resumen

Este documento presenta una experiencia de investigación-acción que se realizó con 12 estudiantes de último semestre de la carrera de Ingeniería Civil Informática de una universidad chilena privada, cuyo objetivo fue contribuir con el desarrollo de la competencia comunicativa oral desde una mirada académica y disciplinar. Se realizó una distinción metodológica entre aspectos formales y aspectos técnicos que permitió potenciar el desarrollo de estas habilidades a través del trabajo interdisciplinar entre docentes de ingeniería y docentes de comunicación gracias a la implementación de un módulo didáctico que propició la práctica comunicativa disciplinar, la autoevaluación, la coevaluación y la retroalimentación oportuna. Los resultados obtenidos señalan que, a nivel grupal, esta experiencia contribuyó con la obtención de puntajes con una dispersión más estrecha y desplazada hacia niveles de aprobación, en tanto que, en el plano individual, más del 90% de los estudiantes logró mejorar su desempeño comunicativo oral.

Palabras clave/ Keywords

Engineering education, oral communicative competence, communicative skills, academic literacy, didactics of orality.

Educación en ingeniería, competencia comunicativa oral, habilidades comunicativas, alfabetización académica, didáctica de la oralidad.

Introduction

Since 2000, the CDIO initiative, which emerged from the Massachusetts Institute of Technology (MIT), has become a benchmark for the education of future engineers. This initiative, of which more than 200 universities around the world are part, stands out for establishing clear goals regarding what an engineer should be able to do at the time of graduation, i.e., conceive, design, implement and operate complex systems in work teams (CDIO, 2020). Among the aspects that stand out in this proposal, it is interesting the value given to the development of specific and generic (or transversal) competencies in an interrelated manner, directly linked to the

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professional world Chaibate and Bakkali (2017). In accordance with the above, as early as 2001, the Career Space consortium (2001) established that among the main needs of the industry are both technical and personal skills, among which communication and persuasion skills are mentioned.

At the international level, there are several studies worth highlighting given their interest in integrated engineering education. The first one we will refer to is called Philosophies and pedagogies that shape an integrated engineering programme Mitchell, Nyamapfene, Roach and Tilley, (2019), which highlights the importance of an engineering education that calls for students "...to develop a wide range of knowledge and skills. These range from technical, scientific and mathematical knowledge, through to transferable skills such as communications, teamwork, business acumen and critical analysis" (p. 180). To achieve this, they design a curriculum that, in four years, addresses mathematical and disciplinary knowledge and professional skills in an interrelated manner.

In Africa, specifically in Morocco, a study was conducted to compare the skills that the world of work expects and demands from an engineer with those stated in university curricula. The findings of this work, closely related to our motivation, indicate that the skill most required by employers is communication, followed by organization and the use of technologies; on the other hand, the training curricula effectively covered these skills, but in a superficial manner and without reaching the level of development necessary to perform successfully in the world of work (Chaibate, Hadek, Ajana, Bakkali and Faraj, 2020, p. 23).

In the South American field, we highlight the work of De Melo and colleagues (2018), who take as a starting point the importance of the development of transversal skills in engineers to achieve success and, from there, develop a program that seeks to strengthen skills such as problem solving, leadership, teamwork, communication, creativity and innovation. One of the main values of their proposal is that they consider the challenge for teachers to strengthen and evaluate these competencies, therefore, they rely on interdisciplinary work between engineers and specialists in communication and teaching. Although the case they present represents a limited experience, it already allows us to visualize the advantages of teaching that seeks integral development based on well-founded pedagogical decisions and interdisciplinary work.

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Another interesting proposal is the one implemented by the University of Quidio in Colombia, with a cross-cutting training program in communication skills whose central axis is student monitoring and self-evaluation. The work is articulated in different courses of the curriculum, from the first semester, with virtual and face-to-face activities that are evaluated with generic rubrics, but known by the students, to ensure traceability. It also includes the creation of a Reading Center (CLEE) to support the formation of written and oral communication skills (Tasamá, Uribe and Hurtado, 2019, p. 44).

In Chile, public and private universities have expressed concern about this issue, which has led them to adopt educational models based on competency-based learning. As an example, we can mention the case of the Universidad Católica de la Santísima Concepción, a traditional private Chilean university, which carried out an evaluation of the impact of the implementation of reforms based on CDIO guidelines in the computer science program. In this analysis, they found that, among the main effects of the implementation, the following stand out: "an improvement of our curricular structure, less overloaded courses, a more integrated and flexible curriculum (...) and improvements in our teaching and learning processes with a better balance between technical knowledge acquisition and personal and interpersonal skills development" (Muñoz, Martínez, Cárdenas and Medina, 2020, p. 55). Also, following the guidelines established in CDIO, the University of Chile elaborates an action research project to develop an interdisciplinary work plan for training in generic competencies in initial engineering and science students, through innovation in teaching methodologies and the integration of pedagogical reflection within their teams Inzúa, Núñez and Arrones (2019). Their main result reports an increase in the positive satisfaction of students regarding new teaching strategies and new evaluation processes, and they also highlight that the interdisciplinary work between engineers-teachers and the teaching support unit facilitated the installation of a culture of deep reflection of teaching practice among academics.

For von Feigenblatt (2020) the Degree Project II course, in which we conducted this action-research project, corresponds to the last curricular activity of the Civil Informatics Engineering course at a private Chilean university. It is characterized by having a project approach, i.e., the development of activities revolves around the development of the project with which they will present their degree

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exam, which is why students must demonstrate the skills stated in the graduate profile through a comprehensive project.

On this basis, the objective of our project, namely, to contribute to the development of oral communicative competence from an academic and disciplinary perspective, arises from the need identified in the previous curricular activity, Degree Project I, in which the performance of students in the area of transversal skills, specifically, in oral communicative competence, was considered deficient by the teachers of the career. In order to carry out this objective, we proposed to carry out a collaborative work between communication teachers and teachers specialized in the discipline and, in addition, to develop a didactic module that would guarantee timely and effective feedback and enhance active learning strategies in the classroom.

Materials and Methods

This paper reports the results of an action research project that was designed from four phases that allow organizing this type of experience: diagnosis and recognition of the initial situation, which was carried out through a pretest measurement; development of an action plan to improve the current model; action and investigation of the effects in the context; discussion, reflection and basis for a new planning (Kemmis, S., & Mctaggart, 1992; Chiva-Bartoll, Peris, & Piquer, 2018).

As we have pointed out in the introduction, this course was implemented through the classroom collaboration of teachers specialized in engineering and expert teachers in the development of communication skills. The work presented here reports the results obtained in this second dimension.

Based on the above, the project was designed as a four-phase action research, for each of which different tasks were performed: for the diagnostic phase, students made an oral presentation of their degree project at the beginning of the course, which was evaluated with the instrument that will be detailed below; based on these results, the second phase was oriented towards the development of an action plan that gave rise to a didactic module that involved, among other aspects, peer evaluation and immediate feedback from teachers; This plan was then carried out, a stage that considered a permanent dialogue between teachers and students in order to democratize the formative

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process; finally, the results were collected and taken to reflection, a process of which this work of socialization of results is a part.

The project participants were 12 computer engineering students from a private Chilean university, who made up the total number of students in the course. All of them were students of the Degree Project II course, a final semester course oriented towards the preparation of their degree project from both a technical and academic perspective, as it involves the preparation of the oral defense of their work.

The collection of information was carried out through an evaluation rubric < adapted from Gamboa et al., (2019), Murillo-Zamorano and Montanero (2014) in two versions: one to be applied by teachers and the other by students in co- and self-evaluation activities. At the time of selecting and adapting the instrument, it seemed necessary to direct our search towards evaluation instruments that clearly established the dimensions that would be considered when measuring oral performance, since, according to the study by Cruz, Saunders-Smits and Groen (2020), there is a tendency in engineering towards a not very rigorous evaluation of oral communication, without disaggregating its components, which is detrimental to the feedback received by students. Based on the above, the following dimensions were considered: introduction, development, conclusions, nonverbal communication, visual support and temporal adequacy. The differences between the student-oriented rubric and the teacher-oriented rubric are related to the technical and pedagogical language used in each of them. As a synthesis, Table 1 shows each of the dimensions and the minimum and maximum performance expected for each of them.

Table 1. *Dimensions and maximum and minimum performance.*

Dimensions	**Performance levels**
Introduction	The student does not make any introduction
	The student greets, introduces him/herself, briefly identifies the topic, states the objective and structure of his/her presentation.
Development	The student demonstrates a poor understanding of the

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	Technical contents	subject matter of the presentation.
		The student demonstrates a complete and thorough mastery of the subject matter.
	Clarity	The student does not develop ideas through a clear logical sequence.
		The student explains all ideas well,
	Ability to capture the attention of the audience	The student turns his presentation into a reading exercise.
		The student does not read his presentation: he modulates, establishes eye contact with the audience and interacts with them.
Conclusions	The student does not present conclusions or summarize what has been presented.	
	The most important ideas are summarized in relation to the initial objective, so that the final conclusion is clear.	
Non-verbal communication	During exposure, inadequate body posture is frequently adopted.	
	Body posture and gestures are confident and eloquent, giving strength to the presentation.	
Visual support	No visual support or poorly elaborated	
	Visual support is adequate, is used frequently and helps to better understand the ideas put forward	
Temporary adjustment	Exposure time is 50% less or more than the allotted time.	

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	The presentation time respects the allotted time, allowing the ideas to be fully developed.

Source: Adapted from Murillo-Zamorano and Montanero (p.429).

The didactic module was designed within the framework of the Degree Project II course, a course belonging to the last year of the degree course and with a clear orientation towards the development of the project with which they will face the degree process. Thus, for the development of the module, we carried out a series of activities that were organized following the stages mentioned in the design, which are systematized in Table 2:

Table 2. *Project design summary*

Objective: To make a formal oral presentation, of an academic nature, that complies with the discursive demands of the degree process from a communicative perspective as well as from a disciplinary point of view.			
Stages	**Instruments**	**Description**	**Pedagogical justification**
Diagnosis and recognition of the initial situation	Evaluation rubric (pretest)	An evaluation was carried out at the beginning of the course in order to determine the level of performance of the oral communicative competence of the students who participated in this experience.	Decisions made on the basis of a diagnosis allow for balancing time, clarity and accuracy of activities (Smolkowski and Cummings, 2015).
Development of a plan of action to improve the	Co-evaluation guidelines	In order to strengthen the weaknesses detected, two presentations were made, which, in a "project progress"	Co-evaluation activities represent a fruitful learning instance for both the evaluating and evaluated student, while contributing to critical thinking

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current model.		format, were co-evaluated by their peers.	(Fogg-Rogers, Lewis, & Edmonds, 2017).
	Video recording of presentations	The project progress presentations were recorded and commented by the teachers using Windows Movie Maker® software.	In the realm of orality, self-assessment through videos provides an opportunity to practice, reflect, and improve performance level (Nikolic, Stirling, & Ros, 2018)
	Self-assessment guidelines	The videos are sent with comments from the teacher in charge of the formal aspects through the virtual classroom, and each student is invited to complete an evaluation guideline that contains the same dimensions already mentioned.	
Performance and investigation of the effects on the context.	Evaluation rubric (post-test)	At the end of the semester, students make the final presentation of the course, the last instance of preparation before the defense of their degree project. This activity was	Studies such as Tsang's (2020) point out that autonomous rehearsal does not have a positive correlation with reduced performance anxiety, but rather, teacher-guided rehearsal is necessary, where improvisation, body

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		considered as a posttest.	language and confidence are addressed.
Discussion, reflection and basis for a new planning	Meeting minutes	Once the results of the pre- and post-test have been obtained, the technical and formal aspects teachers meet and comment on the results obtained.	"Evidence-based educational innovation (EBEI) (...) bases the changes on the evidence provided by researchers as a result of pedagogical practice (Rico, Ramírez, & Montiel, 2016).

At the beginning of the course, students were asked to make a presentation of the progress of their work done in the Title Project II course. This presentation was evaluated with the aforementioned instrument as a pretest. After the application of the didactic module, the level of development of oral communicative competence was measured in the final instance of the course, which was used as a post-test. In order to avoid biases in the data analysis, the results presented here correspond to the average of each of the evaluations made by two specialist teachers in both the pre-test and post-test; in this way, it is possible to mathematically resolve any discrepancies that may arise in the evaluation (Johnson, R. L., Penny, J., & Gordon, B, 2001).

Results

This section is organized as follows: first, the general results obtained in the pre-test and post-test are presented, followed by a comparison of the score obtained by each student in each of these instances. Figure 1 shows the results obtained from the pre- and post-test at the global level. It allows us to compare not only the final and initial status of the course, but also the relationship between this status and the passing scores for the oral communicative performance domain. Thanks to this, we can observe that the curve that plots the results obtained by the students in the pretest instance shows a greater dispersion (almost 40 points between the lowest and highest scores) and, moreover, located under the passing level (48 pts.). On the other hand, the parabola that shows the results obtained in the post-test is narrower, since the difference between the minimum and maximum scores is

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almost 25 points, and the highest concentration of scores is located above the passing level.

Figure 1. Pre- and post-test results

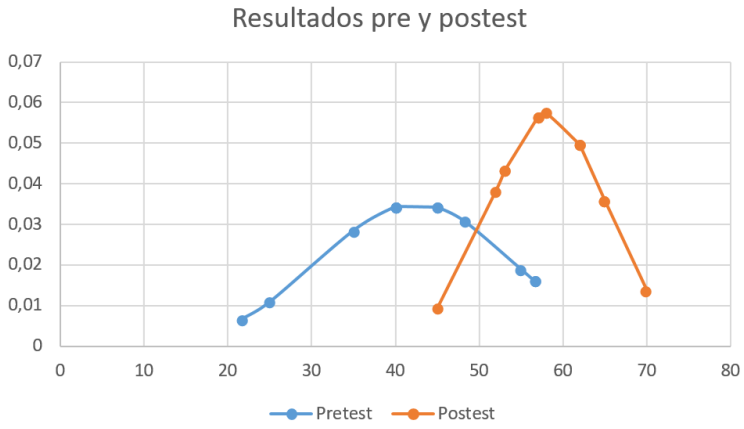
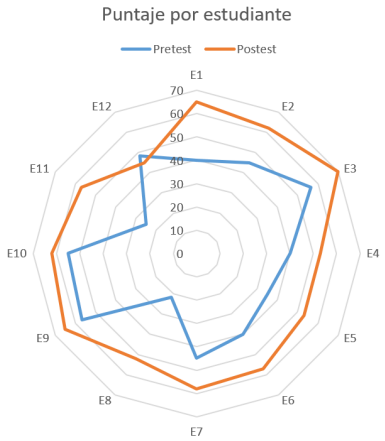


Figure 2 provides information related to the score obtained by each student in the pre- and post-test instances. Although it is possible to see a considerable increase in almost all participants, we highlight the case of students 8 and 11 (E8 and E11) who considerably increased their level compared to students 9 and 10 (E9 and E10). We also highlight that only one of the participating students (E12) decreased his performance, which corresponds to 8.3%.

Figure 2. Scores obtained by each student in the pre- and post-test.



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It is evident that the two main aspects that we have found in this experience are related to the increase in performance at the individual level and to the tendency of scores towards passing levels. Although we are very clear that in this type of work it is impossible to isolate the variables in a way that allows us to attribute these improvements only to the implementation of the didactic proposal, we also know that there is evidence of other pedagogical experiences oriented towards the development of transversal competencies that, thanks to an interdisciplinary, structured and pedagogically based work, have obtained equally or more successful results. This need to address the development of transversal communicative competence has been covered in different ways and with different approaches: with an academic look, through the elaboration of posters and reports in disciplinary courses (Tasamá, Uribe and Hurtado, 2019) or through participation in extension activities, such as workshops or congresses (De Melo et al., 2019); with a professionalizing approach, through projects linked to the world of work (England, Nagel, & Salter, 2020; Chassidim, Almog, & Mark, 2018) or pedagogical strategies such as problem-based learning (Beagon, Nially Ní Fhloinn, 2019; McQuade, Ventura-Medina, Wiggins, & Anderson, 2020); or putting the disciplinary in the foreground, but with a variety of didactic strategies that enhance collaborative work, peer learning, and critical reflection, among other skills(Mitchell, Nyamapfene, Roach, & Tilley, 2019; Fogg-Rogers, Lewis, & Edmonds, 2017). Thus, beyond the emphasis on which the researchers have focused, interdisciplinary work and the diversity of didactic methodologies that go beyond the traditional expository class seem to be the constant in this type of experiences.

Regarding this last aspect, we consider that the use of ICT in the classroom enhanced timely and effective feedback during the development of the project. Thanks to the recording of videos that were shared through the virtual classroom (see Figure 3), videos that had been commented on by the teachers, the students had a reflective space that allowed them to self-evaluate themselves and, thus, identify their strengths and weaknesses. The potential of videos as a pedagogical tool to enhance oral communicative performance has been quite exploited these last years both in mother tongue and in foreign language learning (Benlloch-Dualde, Gil-Salom, Calduch-Losa, López-Mateo, & Lemus-Zúñiga, 2018; Pando, González, Gracia, Rodríguez, & Busto, 2018; Nikolic, Stirling, & Ros, 2018).

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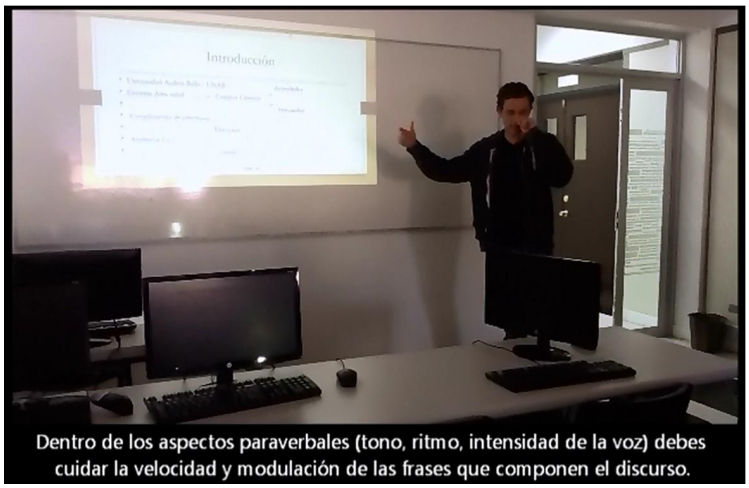
Figure 3. Example of oral production feedback given to students.



Likewise, the variety in formative evaluations also seems to us to be a good idea. Self- and co-assessment, in conjunction with active learning methodologies and timely feedback, have been shown to contribute positively to the development of both transversal and disciplinary competencies, which is evidenced in the research of Fogg-Rogers, Lewis and Edmond (2017), Ramis, Payeras and Carrasco (2018) and García (2019), among many others.

Conclusions

Based on the results of this work, we can consider that this action-research experience aimed at contributing to the development of oral communicative competence from an academic and disciplinary perspective was successful, since more than 90% of the students increased their performance and, at the group level, there was a marked tendency towards scores above the passing level. These results can be attributed to two major decisions: the collaborative work between specialists from the engineering area and specialists from the communication area; and the design of a didactic module that provided students with timely and effective feedback and enhanced active learning strategies in the engineering classroom. As a limitation to the study, it is necessary to mention that the experience was carried out with a limited group of students and, likewise, it is not possible to uniquely attribute the improvements in oral communicative

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competence to the design of the didactic module we propose, but we value that its implementation facilitated both teachers and students to maintain a reflective attitude regarding the learning process, which undoubtedly contributed directly to the results of the project (improved learning). As future work we propose the need to articulate this didactic design in the different courses of the initial level of engineering to improve the development of oral communicative competence and install a reflective culture of the learning process among students and teachers.

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