Evaluation of a Voluntary Tutoring Program in Chemistry, Physics and Mathematics for First-year Undergraduates at Universidad Andres Bello, Chile

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Abstract

This work describes the preliminary results of a tutoring program that provides personalized academic assistance to first-year undergraduates enrolled in introductory chemistry, physics and mathematics courses at Universidad Andres Bello (UNAB), in Concepción, Chile. Intervened courses have historically large enrolments, diverse student population and high failure rates. The evaluation of the program was performed in terms of the academic results and perception surveys collected from 377 voluntary students who participated in the tutoring program during the first semester of 2014. Results indicate that participant students accomplished better academic results in their chemistry, physics and mathematics courses, compared to non-participants. In addition, survey results revealed a positive perception about the tutoring program and evidence the tutor's dedication, disciplinary knowledge and ability to explain things easily as favorable qualities that contribute to learning.

Keywords: Chemistry, Physics, Mathematics, Chilean universities, First-year undergraduates, Personalized academic assistance, Tutoring.

1. Introduction

Universidad Andres Bello (UNAB) is a leading Chilean private university created in 1988 in Santiago (Chile), with a current total enrolment of about 40,000 students across campuses. In 2011, UNAB became a part of the unified national admission system used by public and traditional-private Chilean institutions to select prospective students based on their results on a standardized achievement test called PSU, which is an acronym of University Selection Test (*Prueba de Selección Universitaria*, in Spanish) (Koljatic, Silva, & Cofré, 2013). In 2008, UNAB opened a campus in Concepción to provide alternative educational opportunities in the south of Chile. Around 1,000 first-year undergraduates are admitted each year in this campus, coming from both private and public high school education with diverse educational needs, academic backgrounds and PSU profiles. Close to 60% of these students take chemistry, physics and/or mathematics courses in their first semester of university studies. Unfortunately, in the period comprised between 2009 and 2011, the failure rate of these courses was higher than 60%, which constituted an alarming situation for our institution. In order to deal with this challenge, in 2012 UNAB created a pioneer Tutoring Program that provides personalized academic assistance in chemistry, physics and mathematics courses to first-year undergraduates. Tutoring is provided by highly motivated teachers that have mastered the discipline and also possess the pedagogical qualities to teach students with diverse academic needs. After three years of continuous operation, we have conducted a preliminary evaluation of our program based on the academic results of first-year undergraduates involved in the tutoring program. In addition, considering that attendance to tutoring sessions is

voluntary, we have collected information from perception surveys in order to identify the aspects that are most valuable for participant students, and the main reasons that lead students to desist from asking for tutorial help. Collecting this kind of information is relevant for our institution in order to evaluate the cost-effectiveness of the program and provide valuable input data to design and implement new pedagogical strategies to improve the academic outcomes in chemistry, physics and mathematics courses. Also, this information is expected to be helpful in the decision-making process of other universities with similar profiles.

2. Literature review

2.1 Tutoring

Educational literature contains several examples of tutoring experiences elementary, high school and university science education (Báez-Galib et al., 2005; Colomer et al., 2013; Navarra-Madsen & Ingram, 2010; Johnson, 2014; Liu et al., 2014), showing a positive impact of tutoring in the immediate academic outcomes of participant students (Cooper, 2010; Hendriksen, Yang, Love, & Hall, 2005; Maxwell, 1990; Topping, 1996). These positive effects are supported by Vygotsky's cultural and cognitive theory of development, which proposes that the students' independent problem-solving capabilities can be enhanced with guidance or collaborative assistance provided by a teacher that has mastered the particular skills that are to be developed and that is specifically devoted to teaching (Vygotsky's Educational Theory in Cultural Context, 2003). To develop such competences, tutors must encourage students to plan their own learning, to regulate it by identifying answers to the questions they confront, and finally, to evaluate the results obtained. This process should lead students to progress towards autonomy and independent learning (Colomer et al., 2013). From this perspective, tutoring can be conceived as a reflective practice that uses collaboration between students and tutors as a pedagogical tool.

Tutoring programs are particularly relevant in the case of first-year undergraduates who face the challenge of dealing with overwhelming amounts of assignments and academic tasks that are to be addressed in a short-time with high academic standards. In order to accomplish their goals, first-year undergraduates must experience a process of intellectual, social and emotional adaptation (Chow & Healey, 2008; Putwain, Larkin, & Sander, 2013). In this context, the close interaction between first-year undergraduates and highly-motivated tutors can be helpful to promote the early development of academic competences together with a system of beliefs that motivate students towards academic success (Hayamizu & Weiner, 1991; Monteil, Brunot, & Huguet, 1996). In addition, collaboration between pairs and tutors in a supportive learning environment can contribute to the development of adaptive expertise, which requires an individual to develop conceptual understanding that allows him/her to create new solutions to problems and even new procedures for solving problems (Hatano & Inagaki, 1986). As students work together and listen to each other's ideas, as is found in a tutoring setting, group members are encouraged to reflect upon their own thoughts and reconsider their points of view. In doing so, students might understand the concepts at a deeper level (Mercier & Higgins, 2013).

Concerning attendance, tutoring programs can be conceived as voluntary or mandatory activities for first-year undergraduates and usually do not involve any cost or registration fee. In the case of voluntary programs, participation depends on the extent to which students seek for tutorial assistance. Regarding this aspect, help-seeking constitutes a critical factor for tutoring results, since it determines the number of enrolled students and frequency of attendance. According to Ryan, Pintrich, and Midgley (2001) the help-seeking process require students to become aware of the need of help, decide to seek help, identify potential helper(s), and use strategies to obtain help. During the help-seeking process, students might desist of asking assistance owing to multiple factors, such as lack of confidence about their own competences, or prior unsatisfactory experiences in seeking help (Ames & Lau, 1982). In addition, students may perceive seeking help as a threat to self-esteem and/or autonomy (Deci & Ryan, 1987) (Huet, Escribe, Dupeyrat, & Sakdavong, 2011; Stuart A. Karabenick, 2004; Ryan et al., 2001), which would be detrimental for tutoring attendance. Based on the previous rationale, it is relevant for us to identify the tutoring aspects that students value most and the main reasons for desisting of attending to tutoring sessions, in order to implement more effective strategies to encourage the students' participation in our program, particularly in the case of most academically challenged undergraduates.

2.2 Science and Mathematics Courses

Introductory science and mathematics courses constitute critical aspects for higher education institutions. Successful completion of these courses is a prerequisite for many graduate and professional programs; however they failure rates are considerably high, which is a concerning situation for many universities at national and international levels (Barr, Matsui, Wanat, & Gonzalez, 2010; Freeman, Haak, & Wenderoth, 2011; Szu et al., 2011). Failure in science and mathematics courses has been attributed to several factors, such as the abstract nature of these disciplines, the

negative perception of students about science and mathematics, the lack of proper academic background to face university studies and the widespread persistence of instructional methods based on lectures delivered to large enrollment classes, where students remain essentially passive (Alberts, 2005; Freeman et al., 2014; Kardash & Wallace, 2001; Wieman, 2006). In the case of Chilean institutions, it is well documented that most high school students lack of science and mathematical preparation as they begin their university studies (Bos, Ganimian, & Vegas, 2014; Contreras, Gallegos, & Meneses, 2009; Valenzuela, Gómez, & Sotomayor, 2012), increasing the risk of academic failure in their first-year courses. In addition, many of the students taking these courses have no real enthusiasm for mathematics, physics, or chemistry *per se* and perceive them simply as obstacles to be overcome on the way to a career (Pérez V, Valenzuela Castellanos, Díaz M, González-Pienda, & Núñez, 2013).

Failure in science and mathematics courses has grave consequences for both students and institutions. Students who repeat gateway courses bear emotional and financial tolls and take longer to graduate, which also add a pressure on enrollments to higher education institutions. On the other hand, positive achievement and success in mathematics and science courses has been recognized as a key factor to enhance positive attitudes and raise confidence in students, resulting in increased effort and persistence and further academic success (Barr et al., 2010). In this scenario, different strategies have been implemented by higher education institutions in order to improve the rate of success of first-year undergraduates in science and mathematics courses. Most of these strategies have been focused on implementing active-learning methodologies during lectures to increase motivation and academic success in science and mathematics courses (Meltzer & Thornton, 2012; Paulson, 1999; Prince, 2004). Other approaches, include the implementation of tutoring programs to help students in science and mathematics courses, in a friendly, informal and approachable manner (Báez-Galib et al., 2005; Parsons, 2004). In 2004, Parsons reported the results of a learning support program that gave regular small groups and individual appointments on demand, to help the students with mathematics courses. In this study, the author identifies several features of the program as positive approaches to increase success in mathematics, such as student support and encouragement, early diagnostic testing with counseling of weaker students, and close communication between support and lecturing staffs. To the best of our knowledge, no information has been reported in the literature regarding the implementation and evaluation of tutorial programs in science or mathematics courses in the Chilean or Latin American university context. In this scenario, the present report is aimed at contributing to the existing knowledge by providing a preliminary evaluation of the effectiveness of a Tutoring Program by means of the analysis of academic results, admission profiles and perception surveys collected from first-year undergraduates at Universidad Andres Bello, Concepción, Chile.

3. Objective of the study

The main objective of this study is to provide a preliminary evaluation of the UNAB Tutoring Program on the basis of final grades, admission profiles and perception surveys gathered from 377 first-year undergraduates who were enrolled in the program during the first semester of 2014, aimed at answering the following questions: (a) Is tutoring an effective strategy to improve academic results in first-year chemistry, physics and mathematics?; (b) What aspects of tutoring are the most valuable for participant students?; (c) What are the main reasons that lead students to desist from asking for tutorial help in our institution? This information can provide a guide to design and refine tutoring programs, and to examine whether academic outcomes of first-year undergraduates can be significantly enhanced by tutoring considering also the influence of their admission profiles expressed as PSU-scores.

4. Method

A non-experimental cross-sectional descriptive study design was used in this research. According to (Hernández, Fernández, & Baptista, 2006), a non-experimental research is a type of study carried out without any deliberate manipulation of the variables and in which phenomena are only observed in their natural environment. The study was cross-sectional because the data were gathered on one occasion only, at the end of the semester.

4.1 Characteristics of the UNAB Tutoring Program

The services of the UNAB Tutoring Program are provided by three chemistry, physics and mathematics tutors, who are faculty members and highly-experienced teachers in the first cycle of the university degrees. Additional personnel associated with the tutoring program include one academic coordinator who is responsible for the smoothing functioning of the entire program. Students enrolled in the tutoring program belong to the different programs offered by UNAB in the Concepción campus. The tutoring service is free and does not involve any cost or registration fee. Also, participation is voluntary and does not result in any additional bonus points in final grades. Students can freely attend to a tutoring session, signing up in the different modules available in the teachers' schedules. In general, each tutor works with 5-10 students in collaborative sessions, where students are guided through the learning process by using different strategies. At the end of a tutoring session each teacher is responsible

of gathering attendance data. The program operates continuously through each semester, during 15 weeks approximately.

4.2 Data collection

Attendance data to the UNAB Tutoring Program was gathered from the tutors' records corresponding to the first semester of 2014. Students were classified as participants in the tutoring program if they registered three or more attendances to tutoring sessions in the same discipline. Thus, students that seek for assistance once or twice in one discipline were not considered as participants. Admission PSU scores of participant and non-participant students were collected from official institutional sources. Final grades in chemistry, physics and mathematics courses for participants and non-participants in the UNAB tutoring program during the first semester of 2014 were collected via the university reporting system. Grades are reported in a scale 1.0 – 7.0 with a passing grade of 4.0, which is the official assessment system of most Chilean universities.

Voluntary perception surveys were applied at the end of the first-semester of 2014 to all fist-year undergraduate students involved in chemistry, physics and mathematics courses, considering both participants and non-participants students. From the total number of participants (N=377), we collected 345 survey responses. From the total number of non-participants (N=1346), we collected 440 survey responses. A flowchart diagram showing the survey components is shown in Figure 1. At the beginning of the survey, students were asked to respond if they assisted or not to tutoring sessions during the semester in progress. In the case of participants, students were asked to rate some aspects of the tutoring program using a grade scale from 1.0 to 7.0. The aspects of tutoring that were considered in this survey are: (a) Time dedicated by the tutor, (b) Disciplinary knowledge of the tutor, (c) Tutor's ability to explain things clearly, and (d) Room allocated for tutoring activities. In the case of non-participants, students were asked to provide one or more reasons for not attending to tutoring sessions. At the end, students were asked to provide a comment about the tutoring program in an open-ended question. This tool was initially developed by a review of the literature in the field of tutoring at university level, followed by the selection of a minimum number of key terms that were considered as the most relevant for the evaluation of our tutoring program. The survey was validated by a group of experts revision (N=7), consisted of the 3 tutors involved in the program, 1 academic coordinator, and 3 disciplinary experts who are highly-experienced teachers in first-year science and mathematics courses. Each expert independently analyzed the survey for content, clarity, and appropriateness for the intended audience of first-year undergraduates (Barrera, Braley, & Slate, 2010). All survey responses were anonymous.

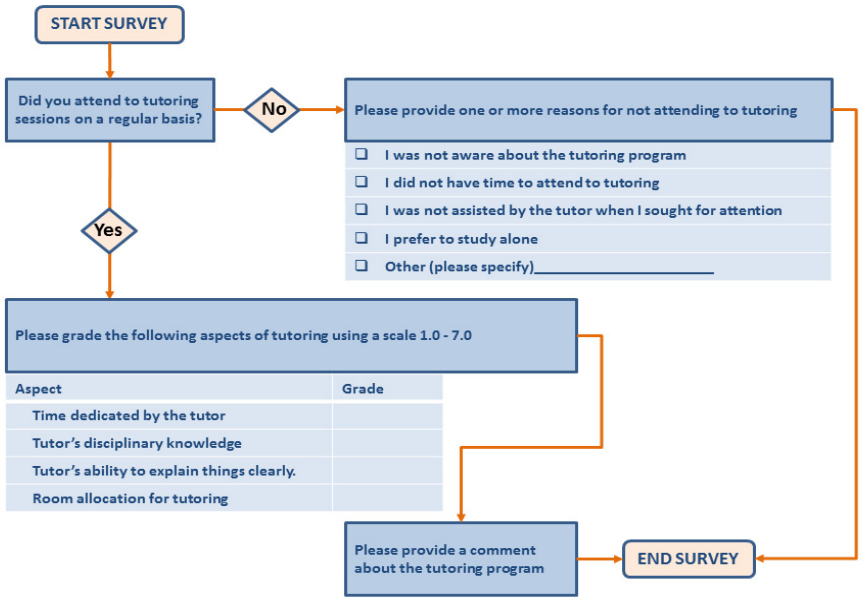

Figure 1. Flowchart diagram showing the configuration of the survey applied to participant and non-participant students in the UNAB tutoring program at the end of the first semester of 2014.

5. Results and Discussion

5.1 Description of the UNAB Tutoring Program

The UNAB Tutoring Program was created in 2012 aimed at providing students with academic help in chemistry, physics and mathematics by means of personalized assistance with highly motivated tutors, who are faculty members and experienced teachers in the first cycle of the university degrees. Participant students belong to the different programs offered by UNAB in the Concepción campus and attend to tutoring sessions on a voluntary basis. Participation in tutoring does not result in any bonus points in final grades. It is relevant to emphasize that tutoring is not an extension of the lecture, but a voluntary non-profit-making service that can be used by all first-year undergraduates without any distinction, which eliminates the potential perverse incentive found in for-profit programs to teach less during lectures in order to increase demand for tutoring, as described by Jayachandran (2014). In addition, tutoring offers a supportive environment for learning, and promotes active learning activities that are expected to be useful for the future academic life of participants (Barr et al., 2010). In general, each tutor works with 5-10 students in collaborative sessions, where students are guided through the learning process by using different strategies, focusing on the specific needs of students that seek for attention. As Fox (1993) has pointed out, "the immediate goal of tutoring… is inextricably tied to the particulars of the situation". In this sense, the first task of the UNAB tutors is to identify the academic needs of each student or group of students based on a short initial interview, in order to conceive an effective pedagogical strategy and apply it immediately, which is a quite challenging task for any teacher. Once the short interview has finished, the tutor decides which approach or combination of approaches will suit a particular situation, based on the following types of request, which have been identified by the UNAB tutors from their own experience in the program:

- **Students seek for assistance in specific aspects related to problem solving**. In general, this kind of assistance is required by highly motivated students with a quite solid understanding of the contents covered in classes but face difficulties in dealing with new conceptual situations or problems in the real-world context. According to the help-seeking differentiation described by Stuart A. Karabenick (2004), this type of request corresponds to instrumental help-seeking, in which students ask for minimal assistance in order to complete a task independently. In this case, tutoring is provided in short sessions that usually do not involve more than 15 minutes.
- **Students seek for assistance in general aspects related to problem solving**. This type of assistance is customarily required by students that have accomplished a basic understanding of the concepts during lectures, but lack of autonomy in general problem solving. According to the help-seeking differentiation described by Stuart A. Karabenick (2004), these students ask for executive help in order to decrease the cost of completing a task on their own (Stuart A. Karabenick, 2004). Customarily, this tutoring type lasts 45-60 minutes and besides teacher's assistance, students are helped with collaborative work between peers. During sessions, students are required to solve problems and encouraged to discuss their results and provide justification for their decision making. In this context, collaboration between pairs and tutors can help students to understand concepts at a deeper level, and to reflect upon their own thoughts and reconsider their points of view while listening to each other's ideas (Mercier & Higgins, 2013). A major challenge in dealing with these students is to promote the transition from routine expertise to adaptive expertise, which requires the ability to face new conceptual situations and even create new procedures for solving problems (Hatano & Inagaki, 1986).
- **Students seek for deep assistance in conceptual learning and problem solving**. In this case, academic assistance is required by highly academically challenged students, who do not have accomplished the basic understanding of the concepts covered in classes and require a deep academic assistance from the tutor. In this case, students remain longer in tutoring sessions (1-2 hours) and are encouraged to attend to tutoring on a regular basis. Besides direct academic assistance, students are provided with counseling and bibliographic orientation to guide their self-instruction as a first learning step. Then, students are helped through collaborative work between peers and encouraged to solve problems of increasing difficulty. During the session, the tutor provides continuous feedback about their progress, which is expected to be helpful to increase students' motivation and self-esteem. A major goal in dealing with this kind of students is to promote the development of self-regulating learning.

5.2 Participants in the Tutoring Program

During the first semester of 2014, the UNAB Tutoring Program registered a total of N = 377 participant students who belonged to the different programs of our institution and were enrolled in introductory chemistry, physics and mathematics courses, as shown in Table 1. According to the enrollment records at the beginning of the academic

period, the percentage of participation in tutoring activities ranges from 16 % to 27 %. This result might be discouraging, considering that more than 60% of students failed in chemistry, physics and mathematics courses in the past years in our institution. However, one must consider that attendance was voluntary and did not result in any additional bonus points in final grades. In addition, educational research concerning help-seeking reveals that most students, especially those who encounter more academic difficulties, decline to seek for help, particularly through formal channels (Knapp & Karabenick, 1991). Therefore, it is worth to note that a significant group of our first-year undergraduates overcame inertia and sought for academic assistance in the UNAB Tutoring Program on a regular basis.

Table 1. Number of participant and non-participant students in the UNAB Tutoring Program during the first semester of 2014

Discipline	Number of participants	Number of non-participants	Percentage of participation
Chemistry	194	518	27%
Physics	68	205	24%
Mathematics	115	623	16%

Percentages of participation were calculated from the total number of students registered in chemistry, physics and mathematics courses at the beginning of the academic period under study. Some students were simultaneously enrolled in chemistry, physics and/or mathematics courses.

Participants in the tutoring program were classified according to their admission profiles, based on the PSU scores registered by the institutional admission system in the Concepcion campus during the first semester of 2014 (Table 2). PSU distributions account for heterogeneous admission profiles for participant students, showing that 18 % and 22 % of the enrollment belong to the first and second quartiles of PSU scores, and 27 % and 33 % belong to the third and fourth quartiles of PSU scores, respectively. These results reveal that help-seeking in the UNAB Tutoring Program is not exclusive for most academically challenged students. In addition, the fact that students with better academic profiles seek for academic help together with students who encounter more academic difficulties is an important outcome for our program, since a major concern about the implementation of a tutorial intervention is the potential academic stigmatization of participant students who might perceive attending to tutoring as a threat to self-esteem (Knapp & Karabenick, 1991). In addition, the comparison between the PSU scores distributions for participants and non-participant students reveals that both groups possess similar profiles, which has been corroborated by two-tailed t-test analysis (p value = 0.62). Thus, one should expect that participants and non-participants constitute statistically comparable groups according to their admission characterization.

Table 2. Distribution of PSU scores for participant and non-participant students

Students	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Participants (N=377)	18 %	22 %	27 %	33 %
Non-participants (N=1359)	24 %	20 %	25 %	30 %

PSU quartiles were calculated considering the corresponding data for the 2014 cohort at the UNAB in the Concepción campus.

5.3 Academic Results of Participants and Non-Participants

Academic information regarding final grades and approval rates of participants and non-participants in the UNAB Tutoring Program have been collected in order to measure whether tutoring has a positive impact on students' academic outcomes. Final grades and approval rates of physics, chemistry and mathematics courses were retrieved from the official university report system at the end of the semester and are reported in Table 3 for participants and non-participant students in the UNAB Tutoring Program during the first semester of 2014. This data contains information concerning courses that registered both participant and non-participant students during the academic period under study. It is relevant to note that the courses' evaluations were independent from the activities of the tutoring program and participants did not receive any additional bonus points in final grades due to attendance. According to our results, there appear to be significant differences between the final grades and percentages of approval between participants and non-participant students in the UNAB Tutoring Program, at a level of confidence of 95 %. The main assumption under this approach is that participants and non-participants are comparable student

populations, which is supported by their similar PSU scores distributions (Table 2) and their similar dropout rates in chemistry, physics and mathematics courses during the first semester of 2014 (Table 3).

Table 3. Comparison of academic results and dropout rates in chemistry, physics and mathematics courses for participant and non-participant students in the UNAB Tutoring Program during the first semester of 2014

	Final Number of students	Initial number of students	Dropout percentage	Average final grade	Average percentage of approval
Participants					
Chemistry	187	194	4 %	4.1	56 %
Physics	61	68	10 %	4.9	77 %
Mathematics	96	115	17 %	4.4	74 %
Non-participants					
Chemistry	453	461	2 %	3.8	51 %
Physics	198	205	3 %	3.9	62 %
Mathematics	451	554	19 %	3.9	60 %
***p* value**					
Chemistry			0.68	0.02	0.01
Physics			0.74	0.01	0.01
Mathematics			0.72	0.01	0.01

Data was retrieved from the official university system report for the chemistry, physics and mathematics courses that registered participant and non-participants students during the academic period under study. *p* values correspond to the result of two-tailed t-test analyses performed between the data corresponding to participant *vs.* non-participant students.

However, the fact that PSU scores have also been recognized as good predictors of academic achievement during the first-year of university studies (Contreras et al., 2009; Comité Técnico Asesor Honorable Consejo de Rectores de las Universidades Chilenas, 2010; Medina & Flores, 2012), lead us to further examine the impact of tutoring attendance on the academic outcomes of first-year undergraduates by simultaneously considering the influence of PSU scores on the final grades of participants and non-participant students. This goal was accomplished by means of an ANCOVA analysis in which tutoring participation was taken as independent variable, final grades were used as dependent variable, and PSU scores were considered as covariable. A summary of ANCOVA results is provided in Table 4, showing that both PSU scores and tutoring participation have a significant influence on final grades (except in the case of physics tutoring, in which the only relevant factor is tutoring assistance) and that attendance to tutoring has a positive significant impact on the final academic outcomes of participant students. These results are in agreement with previously reported educational research that have revealed a correlation between help-seeking and academic achievement (Zimmerman, 2000). In this sense, one should expect that the close interaction with a highly motivated tutor in a supportive learning environment provides our first-year undergraduates with proper conditions to enhance learning in chemistry, physics and mathematics courses. In addition, the fact that tutoring modalities change according to the specific needs of a particular group of students is a favorable condition for learning, particularly for the most academically challenged undergraduates. Finally, the collaborative work during tutoring sessions can also be considered as a positive factor for learning in chemistry, physics and mathematics, since as students work together and confront their ideas with their peers' points of view, they might understand the concepts at a deeper level (Mercier & Higgins, 2013).

Table 4. Summary of ANCOVA analysis

Variable	*p* value		
	Chemistry	Physics	Mathematics
Tutoring attendance	0.01	0.02	0.04
PSU-score	0.00	0.84	0.00

Data was retrieved from the official university system report for the chemistry, physics and mathematics courses that registered participant and non-participants students during the academic period under study. In ANCOVA analysis the tutoring participation was taken as independent variable, final grades were used as dependent variable, and PSU scores were considered as covariable.

5.4 Students' Perception

A survey was developed and administered at the end of the first semester of 2014, in order to ascertain the students' perception about the UNAB Tutoring Program and the difficulties they have found in the process. Perception surveys were applied to both participants and non-participants in order to identify the critical aspects that discourage students' involvement in the tutoring program. Although attendance to tutoring was voluntary, answering the perception survey was applied to all first-year undergraduate students enrolled in chemistry, physics and mathematics courses in UNAB during the first-semester of 2014.

In the case of participants, students were asked to rate some aspects of the tutoring program using a grade scale from 1.0 to 7.0, as summarized in Table 4. According to our results, participant students gave a very positive evaluation to all tutoring aspects, including the teacher's dedication, disciplinary knowledge and ability to explain things easily. These results reveal a positive perception of students about the UNAB Tutoring Program, and provide us with evidence about the favorable tutor qualities that contribute to the learning process of our first-year undergraduates in chemistry, physics, and mathematics. The positive perception of tutoring can be attributed to the high level of interaction between tutors and students, which has been extensively reported in the literature as a relevant source for tutoring success (Báez-Galib et al., 2005; Barrera et al., 2010; Colomer et al., 2013; Schoenfeld, 1987). Concerning the open-ended question contained in the long-term survey, it is relevant to note that most students acknowledge the personal relationship with the tutor as a valuable experience for their university life, as exemplified by the following selected answers:

- "In my particular case, attending to tutoring in chemistry was helpful beyond approving the course, but to generate better study strategies, because the tutor first asked us to study before answering our questions. If it was not enough, she guided us in the revision of bibliography, and if we still had questions, she explained us everything again."
- "I often use the self-learning method taught by my tutor, with very good results."
- "The permanent disposition of the tutors made me feel confident and secure."
- "My tutor was always willing to clarify my questions, which made us feel valuable as students. I am grateful to my tutor"
- "Tutoring provides a personalized assistance, which let us to participate more than in regular classes."

Table 4. Summary of perception survey responses provided by participant students (N=345) in the UNAB Tutoring Program during the first semester of 2014.

Aspect	Average Grade		
	Chemistry (N=169)	Physics (N=50)	Mathematics (N=126)
Time dedicated by the tutor	6.5	6.0	6.6
Tutor's disciplinary knowledge	6.9	6.9	6.7
Tutor's ability to explain things clearly	6.9	6.0	6.4
Room allocation for tutoring	6.1	6.9	6.4

Data retrieved from the university reporting system.

In the case of non-participants, the main purpose of the survey was to identify the factors involved in the decision of not seeking for tutorial help in chemistry, physics and mathematics courses. According to our records (Table 1) the majority of first-year undergraduates enrolled in chemistry, physics and mathematics courses do not seek for tutorial help, even though these courses are considered critical due to their high rates of failure in past years. The factors that encourage or discourage college students in seeking help have been examined thoroughly in the literature, and may include academic, social, and psychological factors, such as academic self-efficacy, threat to self-esteem, and social embarrassment (S. A. Karabenick, 1998). Research evidence in this area has shown that most students, especially those who are more academically challenged, decline to seek for help through formal channels (Knapp & Karabenick,

1991). In this scenario, it is relevant for us to identify the main factors that impede our students to attend to tutoring sessions, in order to design more effective strategies to increase the participation rates in the future. Table 5 summarizes the responses of non-participant students in the UNAB Tutoring Program during the first semester of 2014. According to our results, most non-participants argue they prefer to study alone or they did not have the time to attend to tutoring sessions, which is a common issue for first-year undergraduates who are overwhelmed by huge amounts of academic work to be addressed in a short-time. In addition, a minor percentage of non-participant students claim they were not aware of the tutoring program, which encourage us to implement broader diffusion strategies to reach all first-year students at the beginning of the next academic periods. In the option "Others" most students expressed they did not attend to tutoring because they asked for help directly to their lecturer or in the internet, which is a common behavior within undergraduates. A concerning situation was put in evidence by three students who claimed they were afraid to ask for help. Research in the field has shown that the process of help seeking is determined largely by the threat to one's self-esteem (Knapp & Karabenick, 1991). In this sense, attending to tutoring sessions might be interpreted by some students as a public admission of their academic problems or their lack of ability, which is a preoccupying situation for our program.

Table 5. Most frequent reasons for not participating in the UNAB Tutoring Program

Answer	Percentage		
	Chemistry (N=257)	Physics (N=64)	Mathematics (N=180)
I study alone	46 %	37 %	46 %
I did not have time	48 %	52 %	44 %
I did not know about tutoring exists	4 %	11 %	5 %
Others	2 %	0 %	5 %

Data collected from a survey applied to non-participant students (N=440) in the first semester of 2014.

Summarizing, the aforementioned results indicate that the UNAB tutoring program constitutes a valuable academic strategy that helps first-year students to achieve successful outcomes in chemistry, physics and mathematics courses. Students' perception about the tutoring program revealed the strong impact of the teaching-learning environment on the academic effects of tutoring. In this sense, students appreciate the personal interaction with highly motivated teachers that are involved with the progress of each student according to his/her specific needs. Students doing better in their courses and persisting in obtaining their goals early in their academic life are important objectives for our institution and constitute valuable results that support the continuation and growth or our tutoring program. However, more consistent data needs to be gathered in order to validate the preliminary results herein described. For instance, there is a need to collect information in order to assess the student improvement after a fixed number of tutoring sessions, since not all students attended to the same number of tutoring sessions during the semester. In addition, motivation needs to be addressed in order to identify whether tutoring motivates students to do well in their first-year courses or more motivated students attend to tutoring sessions in order to accomplish their academic goals. Also, our institution is encouraged to collect more data about participants and non-participant students, aimed at identifying to what extent the difference in students' performance can be attributed to the tutoring program or to individual students' characteristics. Finally, there is a need to optimize the benefit of tutoring for participant students by identifying the most effective pedagogical strategies in each discipline, which is the focus of our current and future efforts.

Concerning attendance, our institution faces a concerning situation, which is the lack of participation for most academically-challenged students and a general resistance to seeking for tutorial assistance within first-year undergraduates. With this in mind, we have reoriented our diffusion strategies in the following semesters towards avoiding the academic stigmatization of most challenged students when seeking for tutorial help. In addition, there is a need to evaluate the possibility of integrating tutoring into the course assessment as an incentive for student participation. However, the implementation of this last strategy requires the compliance of many institutional entities, which are far from the scope of action of the actors involved in the Tutoring Program.

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References

Alberts, B. (2005). A Wakeup Call for Science Faculty. *Cell, 123*(5), 739-741. http://dx.doi.org/10.1016/j.cell.2005.11.014

Ames, R., & Lau, S. (1982). An attributional analysis of student help-seeking in academic settings. *Journal of Educational Psychology, 74*(3), 414-423. http://dx.doi.org/10.1037/0022-0663.74.3.414

Báez-Galib, R., Colón-Cruz, H., Resto, W., & Rubin, M. R. (2005). Chem-2-Chem: A One-to-One Supportive Learning Environment for Chemistry. *Journal of Chemical Education, 82*(12), 1859. http://pubs.acs.org/doi/abs/10.1021/ed082p1859

Barr, D. A., Matsui, J., Wanat, S. F., & Gonzalez, M. E. (2010). Chemistry courses as the turning point for premedical students. *Advances in Health Sciences Education, 15*(1), 45-54. http://dx.doi.org/10.1007/s10459-009-9165-3

Barrera, A., Braley, R. T., & Slate, J. R. (2010). Beginning teacher success: an investigation into the feedback from mentors of formal mentoring programs. *Mentoring & Tutoring: Partnership in Learning, 18*(1), 61-74. http://dx.doi.org/10.1080/13611260903448383

Bos, M. S., Ganimian, A., & Vegas, E. (2014). América Latina en PISA 2012: Chile en PISA 2012: Logros y desafíos pendientes.

Colomer, J., Vila, X., Salvadó, V., & Casellas, R. M. (2013). Tutoring as Evidence of a Reflective Practice: A Case Study. *Procedia - Social and Behavioral Sciences, 93*(0), 356-363. http://dx.doi.org/10.1016/j.sbspro.2013.09.203

Comité Técnico Asesor Honorable Consejo de Rectores de las Universidades Chilenas. Validez diferencial y sesgo de predictividad de las Pruebas de Admisión a las Universidades Chilenas. Documentos Técnicos. http://www.consejoderectores.cl/web/pdf/validez_diferencial.pdf.

Contreras, D., Gallegos, S., & Meneses, F. (2009). Determinantes de desempeño universitario:¿ Importa la habilidad relativa. *Revista Calidad en la Educación, 30*, 17-48.

Cooper, E. (2010). Tutoring Centre Effectiveness: The Effect of Drop-In Tutoring. *Journal of College Reading and Learning, 40*(2), 21-34. http://dx.doi.org/10.1080/10790195.2010.10850328

Chow, K., & Healey, M. (2008). Place attachment and place identity: First-year undergraduates making the transition from home to university. *Journal of Environmental Psychology, 28*(4), 362-372. http://dx.doi.org/10.1016/j.jenvp.2008.02.011

Deci, E. L., & Ryan, R. M. (1987). The support of autonomy and the control of behavior. *Journal of Personality and Social Psychology, 53*(6), 1024-1037. http://dx.doi.org/10.1037/0022-3514.53.6.1024

Ewing, R., Freeman, M., Barrie, S., Bell, A., O'Connor, D., Waugh, F., & Sykes, C. (2008). Building community in academic settings: the importance of flexibility in a structured mentoring program. *Mentoring & Tutoring: Partnership in Learning, 16*(3), 294-310. http://dx.doi.org/10.1080/13611260802231690

Fox, B. A. (1993). *The human tutorial dialogue project: Issues in the design of instructional systems*. Hillsdale, NJ: Erlbaum.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences of the United States of America, 111*(23), 8410-8415. http://www.pnas.org/cgi/doi/10.1073/pnas.1319030111

Freeman, S., Haak, D., & Wenderoth, M. P. (2011). Increased Course Structure Improves Performance in Introductory Biology. *CBE Life Sciences Education, 10*(2), 175-186. http://dx.doi.org/10.1187/cbe.10-08-0105

Hatano, G., & Inagaki, K. (1986). Two courses of expertise. In H. Stevensor, H. Azuma, & K. Hakuta (Eds.), *Child development and education in Japan* (pp. 262-272). New York: Freeman

Hayamizu, T., & Weiner, B. (1991). A test of Dweck's model of achievement goals as related to perceptions of ability. *Journal of Experimental Education, 58*(3), 228-234. http://www.jstor.org/stable/20152287

Hendriksen, S. I., Yang, L., Love, B., & Hall, M. C. (2005). Assessing Academic Support: The Effects of Tutoring on Student Learning Outcomes. *Journal of College Reading and Learning, 35*(2), 56-65. http://dx.doi.org/10.1080/10790195.2005.10850173

Hernández, R., Fernández, C., & Baptista, P. (2006). *Metodología de la Investigación* (4th ed.). Mexico, D.F: McGraw-Hill Interamericaa.

Huet, N., Escribe, C., Dupeyrat, C., & Sakdavong, J.-C. (2011). The influence of achievement goals and perceptions of online help on its actual use in an interactive learning environment. *Computers in Human Behavior, 27*(1), 413-420. http://dx.doi.org/10.1016/j.chb.2010.09.003

Jayachandran, S. (2014). Incentives to teach badly: After-school tutoring in developing countries. *Journal of Development Economics, 108*(0), 190-205. http://dx.doi.org/10.1016/j.jdeveco.2014.02.008

Johnson, P. A. (2014). Peer Tutoring in College Learning Assistance Centers: A Qualitative Study of Sociotransformative Theory in Action (Doctoral dissertation, Indiana University of Pennsylvania). http://hdl.handle.net/2069/2186

Karabenick, S. A. (2004). Perceived Achievement Goal Structure and College Student Help Seeking. *Journal of Educational Psychology, 96*(3), 569-581. http://dx.doi.org/10.1037/0022-0663.96.3.569

Karabenick, S. A. (Ed.). (1998). *Strategic Help Seeking Implications for Learning and Teaching*. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Kardash, C. M., & Wallace, M. L. (2001). The Perceptions of Science Classes Survey: What undergraduate science reform efforts really need to address. *Journal of Educational Psychology, 93*(1), 199. http://dx.doi.org/10.1037/0022-0663.93.1.199

Knapp, J. R., & Karabenick, S. A. (1991). Relationship of academic help seeking to the use of learning strategies and other instrumental achievement behavior in college students. *Journal of Educational Psychology, 83*, 221-230. http://dx.doi.org/10.1037/0022-0663.83.2.221

Koljatic, M., Silva, M., & Cofré, R. (2013). Achievement versus aptitude in college admissions: A cautionary note based on evidence from Chile. *International Journal of Educational Development, 33*(1), 106-115. http://dx.doi.org/10.1016/j.ijedudev.2012.03.001

Liu, Y., Phelps, G., & Yao, J. F. (2014). Design and benefits of an on-site tutoring program for the first programming class. *Journal of Computing Sciences in Colleges*, 29(5), 42-49.

Maxwell, M. (1990). Does Tutoring Help? A Look at the Literature. *Review of Research in Developmental Education, 7*(4), 3-7.

Medina, A., & Flores, M. (2012). ¿Predicen los requisitos de ingreso a odontología el rendimiento académico durante primer año?. *Journal Of Oral Research, 1*(1), 15-18. http://dx.doi.org/10.17126/joralres.2012.004

Meltzer, D. E., & Thornton, R. K. (2012). Resource letter ALIP–1: active-learning instruction in physics. *American journal of physics, 80*(6), 478-496. http://dx.doi.org/10.1119/1.3678299

Mercier, E. M., & Higgins, S. E. (2013). Collaborative learning with multi-touch technology: Developing adaptive expertise. *Learning and Instruction, 25*(0), 13-23. http://dx.doi.org/10.1016/j.learninstruc.2012.10.004

Monteil, J. M., Brunot, S., & Huguet, P. (1996). Cognitive performance and attention in the classroom: An interaction between past and present academic experiences. *Journal of Educational Psychology, 88*(2), 242-248.

Navarra-Madsen, J., & Ingram, P. (2010). Mathematics Tutoring and Student Success. *Procedia - Social and Behavioral Sciences, 8*(0), 207-212. http://dx.doi.org/10.1016/j.sbspro.2010.12.028

Parsons, S. J. (2004). Overcoming Poor Failure Rates in Mathematics for Engineering Students: A support Perspective. *Newport: Harper Adams University College*.

Paulson, D. R. (1999). Active learning and cooperative learning in the organic chemistry lecture class. *Journal of Chemical Education, 76*(8), 1136. http://dx.doi.org/10.1021/ed076p1136

Pérez V, M. V., Valenzuela Castellanos, M., Díaz M, A., González-Pienda, J. A., & Núñez, J. C. (2013). Dificultades de aprendizaje en estudiantes universitarios de primer año. *Atenea (Concepción)*, 135-150. http://dx.doi.org/10.4067/S0718-04622013000200010

Prince, M. (2004). Does active learning work? A review of the research. *Journal of engineering education, 93*(3), 223-231. http://dx.doi.org/10.1002/j.2168-9830.2004.tb00809.x

Putwain, D. W., Larkin, D., & Sander, P. (2013). A reciprocal model of achievement goals and learning related emotions in the first year of undergraduate study. *Contemporary Educational Psychology, 38*(4), 361-374. http://dx.doi.org/10.1016/j.cedpsych.2013.07.003

Ryan, A., Pintrich, P., & Midgley, C. (2001). Avoiding Seeking Help in the Classroom: Who and Why? *Educational Psychology Review, 13*(2), 93-114. http://dx.doi.org/10.1023/A:1009013420053

Schoenfeld, A. H. (1987). *Cognitive science and mathematics education*. University of Califormia. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Szu, E., Nandagopal, K., Shavelson, R. J., Lopez, E. J., Penn, J. H., Scharberg, M., & Hill, G. W. (2011). Understanding Academic Performance in Organic Chemistry. *Journal of Chemical Education, 88*(9), 1238-1242. http://dx.doi.org/10.1021/ed900067m

Topping, K. J. (1996). The Effectiveness of Peer Tutoring in Further and Higher Education: A Typology and Review of the Literature. *Higher Education, 32*(3), 321-345. http://dx.doi.org/10.2307/3448075

Valenzuela, J. P., Gómez, G., & Sotomayor, C. (2012). The role of reading engagement in a case of national achievement improvement: analysis of Chilean results in PISA 2001-2009.

Vygotsky's Educational Theory in Cultural Context. (2003). (A. Kozulin, B. Gindis, V. S. Ageyev, & S. M. Miller Eds.). Cambridge, United Kingdom: Cambridge University Press.

Wieman, C. (2006). A New Model for Post-secondary Education: The Optimized University: Campus 2020.

Zimmerman, B. J. (2000). Chapter 2 - Attaining Self-Regulation: A Social Cognitive Perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of Self-Regulation* (pp. 13-39). San Diego: Academic Press.