

Strategies to implement a continuous improvement plan in the ABET accredited mining engineering program

Maribel Guzman, PhD  0000-0002-7954-7679
Pontifical Catholic University of Peru, Peru, mguzman@pucp.edu.pe

Abstract– The process of accrediting an academic program is in many cases cumbersome. However, in many cases after obtaining the accreditation, the implementation of continuous improvement plans is even more difficult. Especially because the students, who are one of the actors in the process, do not stay at the university for long. In this article we present some strategies implemented in the process of continuous improvement of the mining engineering program. The results of these improvements were measured during 2 academic years.

Keywords– Assessment, ABET, continuous improvement, mining engineering, strategies, students’ outcomes.

I. INTRODUCTION

After obtaining accreditation, a continuous improvement plan is an important aspect that the educational institution must implement. In fact, the culture of continuous improvement needs three active actors: students, faculty and the institution itself [1]. Indeed, the effort of many actors is necessary to meet the requirements of ABET (Engineering and Technology Accreditation Board) [2], which is one of the most used accreditation bodies to evaluate the minimum standards of educational quality of engineering programs [3-8].

In a process of continuous improvement, it is necessary to take into consideration the Strategic Plan of the institution that contemplates, among other things, the mission, vision and project of institutional growth. The institution must provide the human and financial resources that allow the implementation and development of the various activities of the continuous improvement plan [9]. In fact, Evaluation for continuous improvement must be embedded in the culture of an educational process [10].

An accredited program will allow the institution, on the one hand, to stand out in a very competitive national market and, on the other hand, to position itself international in the rankings [11]. Also important is the perception of parents and students who want to be sure that they will receive adequate academic training and therefore a diploma that will allow them to get a job [12]. Among the different skills that a mining engineering graduate must present are: teamwork, command of the English language, leadership, research initiative, etc. [13,14].

To ensure research in the mining engineering program, it will be necessary to incorporate research-professors who are capable of designing and proposing lines of research in accordance with the program. Among the most important lines of research are: Evaluation of Mineral Deposits and Mining Planning; Mining Technology, Rock Mechanics and Automation; Geology-Mining-Metallurgy and environmental issues [15,16]. Finally, the perspectives of students, professors, external accreditation committee and administrative staff who support the daily activities required by the program must also be considered [17].

In this work we present the most important items to consider in a continuous improvement plan for an accredited mining engineering program. Data from the case study will be presented.

II. METHODOLOGY

A. Present situation and historical background of mining engineering program in Peru

In Peru, university higher education is taught in public and private institutions. Peru currently has 86 universities (37 public and 51 private). Of all of them, 36 are concentrated in Lima (15 public and 21 private). There are 23 mining engineering schools (21 public and 6 private), which means close to 600 graduates per year. Until 2015, no mining engineering program was accredited. Therefore, it was necessary to start with the process in our institution so that it can later be replicated by the other mining schools.

B. Mining engineering program at PUCP

The Mining Engineering Section at PUCP was created in 1970 thanks to an agreement between the British Government (University of Wales, Cardiff) and the Peruvian Government.

Thanks to the technical support of the British government, the Mining Engineering Section obtained the equipment for its laboratories and received a delegation of British professors who, together with their Peruvian colleagues, carried out academic work in the first ten years of its creation. Throughout its history, the Section has grown thanks to the support of private companies in the mining sector and its international cooperation alliances. In 1994, the company Southern Perú Copper Corporation (SPCC) sponsored the construction of the second and third floors of the Mining Engineering pavilion.

In 1998, thanks to the signing of the agreement with the Interuniversity Council of Francophone Universities (CIUF)

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of Belgium, the equipment of the Mineral Concentration, Pyrometallurgy, Hydrometallurgy, Environment and Chemical Analysis of Minerals laboratories was achieved. In 2005, the Hochschild company authorized the equipment of the computer laboratories. In 2008, the Glencore company sponsored the construction of the Hydrometallurgy Laboratory. In 2009, the Rio Tinto company sponsored the remodelling of the geological sample preparation room and the space to install the scanning electron microscope for quantitative evaluation of minerals, which is currently known as the Qemscan Laboratory.

C. Accreditation process

Given that one of the institution's strategic axes is the internationalization of engineering programs, an international accreditation agency that had previously accredited other engineering programs was chosen. It is in this sense that we opted for ABET. The accreditation process of the mining engineering program was carried out following several planning stages [18]. The self-study includes information on all the factors needed to carry out an accreditation process (Figure 1).

D. Outcome evaluation process

This process consists of the creation of sub-student result based on the Student Results mentioned by ABET (1-8) to assess the scope of the results expected from the student. A rubric has been prepared for each sub-criterion as an assessment tool. Each rubric captures the learning of the students in relation to the competences and achievement of the goals of the evaluated courses. On the other hand, in order to establish which courses will be evaluated, all the courses of the program's curriculum were analyzed and the courses selected were those in which there was significant contribution to the preparation of the student. Therefore, the courses belonging to the last years of the program were chosen.

70% has been defined as the minimum level of performance expected from the students. This value is calculated taking into account the sum of the results obtained in levels 3 and 4 of each criterion. Table I and Table II summarize the results of assessment of Student Outcomes and the strengths, weaknesses, opportunities and threats (SWOT) of the program, respectively. At the end of each semester, the professors of the evaluated courses were informed of their results with the purpose of obtaining their opinions about them. Furthermore, meetings were held with the professors in order to propose improvement alternatives. In some cases, it was considered to modify the type of evidence, adjust the rubric or incorporate some courses to properly assess the component of the rubrics.

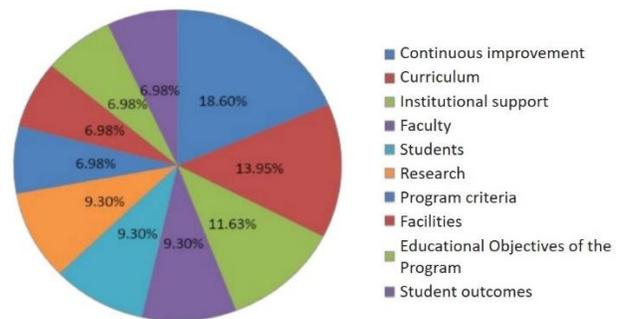


Fig. 1 Factors that contribute to the accreditation process.

E. Continuous Improvement Plan

The design of a continuous improvement plan will depend on the type of academic program that you wish to improve [19-22]. For the case study, a series of necessary activities have been established. Based on the results obtained in the self-study, it was decided to implement a series of continuous improvement activities.

TABLE I
SUMMARY OF CRITERIA ASSESSED DURING THREE CONSECUTIVE SEMESTERS

RESULTS OF MINING ENGINEERING STUDENTS ACCORDING TO ABET CRITERIA	% OF ACHIEVEMENT/SEMESTER		
	1st	2nd	3rd
The student identifies, analyses, and solves complex mining engineering problems by applying knowledge of mathematics, science, and engineering and design related to mining engineering.	67.5%	62,84%	81.6%
The student applies engineering design to propose solutions that meet specific mining engineering needs, taking into account economic, technical, environmental, social, political, ethical, and health and safety factors at work.	42.7%	65.0%	64.2%
The student effectively communicates his ideas, with clarity, coherence and consistency, to various interest groups linked to the mining industry.	80.4%	75.0%	83.7%
The student acts with ethical and professional responsibility in the development of mining activities, making informed decisions and proposing solutions that his profession provides to the economic, environmental and social context.	98.4%	65.5%	82.5%
The student works in diverse multidisciplinary teams helping to generate a collaborative and inclusive environment, to achieve the planned objectives.	85.2%	73.7%	40.0%
The student contributes to the design and implementation of experiments, using their judgment, based on aspects of mining engineering, to deduce, draw conclusions and improve processes.	84.6%	72.6%	42.2%
The student uses appropriate learning strategies, acquires and applies new knowledge.	61.6%	59.0%	49.1%
The ability to demonstrate knowledge and understanding of management principles in engineering and decision making, and their respective application.	97.6%	89.7%	51.8%

TABLE II
SUMMARY OF THE STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS (SWOT) OF THE STUDENT AND THE INSTITUTION.

	Strengths	Opportunities	Weaknesses	Threats
Of the institution	Part-time teachers linked to the mining industry	Incorporation of new full-time professors	Few full-time professors dedicated to the program	New mining engineering schools
	Solid academic curriculum	Incorporation of professors with the role of researcher		Rapid changes in courses due to new trends in mining
	Adequate facilities			
From the student	Comprehensive academic training	Implement technical field visits	Little contact with the mining industry	Student dropout due to being a private institution
		Organize seminars with mining experts	Little research development	
		Organize activities to develop soft skills	Low competencies in soft skills	

F. Continuous Improvement Plan

The design of a continuous improvement plan will depend on the type of academic program that you wish to improve [19-22]. For the case study, a series of necessary activities have been established.

- Annual review of study plans.
- Increase the number of full-time teachers
- Improve infrastructure.
- Develop research activities
- Update and expand the offer of specific software.
- Meeting with full-time and part-time professors
- Training Talks, Workshop, Seminars
- Leadership Workshops
- Technical visits
- Tutoring Program
- Cause-Effect Workshop with the Undergraduate Students
- Accreditation Training for the Administrative Personnel

To adequately comply with this continuous improvement plan, an institutional commitment is necessary in order to provide the necessary resources.

G. Institutional Support

The academic organization of the PUCP is as follows: 16 academic departments, 2 general studies units (Science and Art), 13 schools and 1 post-graduate school.

1) Financial Support

❖ Recurring budget

Each academic department manages the budget assigned to each section. In the case of the engineering department, it must manage the budget so that 7 engineering sessions can satisfy the needs of each academic program.

The University assigns an annual budget for the management of various programs. As for the Engineering programs, the budget has increased in the last nine years, and it will be maintained in order to cover the needs of both students and freshmen of each semester.

Table III shows the Annual Budget of the Mining Engineering Program. This budget covers the maintenance of equipment, salaries of teachers and administrative staff. The rest is used for other activities (Table IV). This budget is generally enough to meet the annual operating needs of the Mining Engineering Section. Investments are annually proposed to the authorities.

TABLE III
EVOLUTION OF THE ENGINEERING PROGRAMS BUDGET (\$/).

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
Engineering Department	26,970,283	27,611,290	31,736,332	34,895,517	37,823,095	37,373,407
Mining Engineering	1,229,503	1,075,058	1,181,231	1,511,482	1,816,177	1,696,463
Exchange rate **	3.01	2.83	2.75	2.64	2.70	2.84
USD	408472.757	379879.152	429538.545	572531.061	672658.148	597346.127
%	4.56%	3.89%	3.72%	4.33%	4.80%	4.54%

TABLE IV
MINING ENGINEERING BUDGET FOR THE LAST FIVE YEARS PERIOD (\$/).

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
General	312,351	336,929	393,117	417,882	530,146	572,221
Visits to Companies	3,691	5,177	4,567	7,692	4,805	12,755
Graduate comradeship lunch	731	655	774	----	----	----
Magazine	2,827	2,259	1,232	----	----	----
Civil works	38,360	2,966	12,116	5,747	876	40,691
Laboratory equipment: Software, computers and furniture	40,804	37,183	21,147	50,389	114,243	62,393
Social projects	13,450	2,846	1,146	----	----	----
Total	412,214	388,015	434,099	481,710	650,070	688,060
Exchange rate *	3.01	2.83	2.75	2.64	2.7	2.84
USD	136948.17	137107.77	157854.18	182465.91	240766.67	242274.65

The item for lab equipment, software, computers and furniture includes periodical investments made for the acquisition of special software licenses and lab equipment for the corresponding major. In the two last year, the program of Mining Engineering made a significant investment to equip new computers. Microscopes, a hydraulic press, an acoustic brick, a manometer and a digital camera were purchased for the laboratories. Finally, the special projects item includes training activities or international projects that happen every now and then.

❖ *Facilities and Equipment*

The PUCP has implemented a triennial investment plan where it has captured the main institutional requirements. There is also a smaller annual fund –which should not be less than 10% of the University budget for the previous year– to cover all the orders not included in the triennial plan for IT equipment, furniture, academic and administrative equipment, among other fixed assets.

The distribution of investment funds among the various budget items is based on the institutional priorities and the strategic plan. The allocation of funds by item for each Unit is based on the following criteria:

- Strategic use by the Unit.
- New program, office or section.
- Obsolescence.
- Wear out.

2) *Research*

For students to acquire soft skills as well as critical thinking, it is necessary that they participate in some way in research projects. In this sense, since 2009, the Vice-Rector's Office for Research (VRI) has been implemented at the University, which is the institutional body in charge of promoting, financing, coordinating and disseminating the research work carried out at the University. The Director's Office of Research Management (DGI), which depends directly on the VRI, is a body having the main responsibility of designing, preparing and implementing the VRI policies, as well as of giving operating support to all its initiatives.

The DGI is in charge of designing and applying strategies to promote research among teachers, students and other members of the university community, as well as of organizing contests and providing discussion boards, workshops or training courses for research. It is also responsible for centralizing the PUCP research production, creating right quantity and quality indicators to plan the VRI policies, managing the funding for the University research projects, whether with own or external resources, and making a qualitative follow-up of the researches, thus guaranteeing the quality of results.

The Engineering Department has a policy to support professors in taking part of international congresses, thus encouraging research. Defined in the Institutional Strategic Plan we find academic excellence, interaction with the

environment and internationalization to be the strategic action axis of the university.

The University is committed to the continuous education of its professors –which is reflected in the budgets for the units and departments of the institution– assigning a fund for professors training, development and aid.

3) *Professors*

The full-time professors of the Mining Engineering program are kept up to date in their performance areas by means of specialization courses, scientific research, interaction with national and international academic activities and memberships to professional associations.

The interaction of part-time professors with the mining industry allows them to keep in touch with real problems and to share their experiences with their students. In this way, the students will be motivated and will keep contact with situations and circumstances similar to those to which they will be exposed during their professional practice.

In general terms, Criterion 6 shows the way in which our professors keep a superior level that corresponds to the program strategic axis: Academic excellence, interaction with the environment and internationalization. The interaction with our environment implies the strengthening of our commitment towards society and the scientific and technological community.

The academic excellence implies, among other things:

- First-class personnel, with professors continuously updating academically and in teaching methodologies.
- Research as a source of knowledge.
- Constant search for methods to improve the teaching-learning process.

The interaction with our environment implies the strengthening of our commitment towards society and the scientific and technological community.

Internationalization mainly requires:

- Creating and maintaining spaces for exchange, interinstitutional cooperation and creation of international networks that can expand our educational services.
- To strengthen our comparative advantages in the international academic context.

Finally, the Mining Engineering Program looks for the integrated education of the undergraduate student. Therefore, this self-study estimates it is appropriate to carry out an academic and humanist analysis to help the graduate reach an excellent professional performance as a Mining Engineering, based on the needs of the corporate mining sector, both locally and internationally.

4) *Procedure to recruit new teachers*

An important aspect for continuous improvement is having a good teaching staff. The teaching career in the PUCP is structured based on two large categories: Tenure track and tenure. The University Law rules the general guidelines for the

tenure career in the following aspects: Processes and requirements for recruitment and promotion, confirmation and ratification in various categories: Assistant teacher, associate teacher and full professor. The processes corresponding to the teaching career –recruitment, becoming a tenure track professor, promotions, confirmation and ratification– are developed by the academic departments and the Academic Director's Office of Faculty (DAP), and the results thereof are finally approved by the University Council.

Within the two large categories (tenure-track and tenured), the professors have different dedications: Full-time professors (TC) and part-time professors (TPC), who can develop the different established roles, and the part-time professors per course (TPC), mainly dedicated to teaching.

In order to guarantee the selection and permanent insertion of professors to the university, it has been proposed to recruit them through an examination or an invitation, which would vary based on the dedication and the career of the professionals called.

In order to guarantee the quality of the faculty in our institution, it is necessary to have institutional mechanisms that allow to summon and select new professors among the best professionals and academicians, pursuant to the preset and divulged objective criteria. These actions will begin with public calls or direct invitations, both locally and internationally. In this way, the academic departments will have a potential faculty that guarantees teaching excellence.

This process should be proactive so as to meet –in a timely manner and with the necessary quality– the requirements of the professors of the academic units, which entails considering the short-term demand of professors, as well as the needs linked to other performance areas in the medium term. In short, different summoning methods for the recruitment of new faculty are proposed:

- a) Support for the Professional Development of the Faculty

❖ Teaching training

Another important factor is not only recruiting new teachers but also ensuring their continuous updating. For this reason, the Institute for University Teaching (IDU) promotes updating programs in teaching methodologies. In that sense, its actions create a space that integrates the educational and academic principles of the PUCP, the daily good teaching practices in the classrooms and the theoretical reflection on learning and university teaching.

The IDU effectively and competently supports –based on the best international standards– the development of university teaching in the PUCP, enriching and creating knowledge and exchanging experience with the local and international university means, supporting the teaching policies of the Vice-president for Academic Affairs and the Academic Director's Office of Faculty. It also implements actions in search for effective responses to different challenges posed by the development of quality teaching in the PUCP.

The Pontificia Universidad Católica del Perú being an institution committed to educational quality has an institutional policy aimed at ensuring that their professors have an excellent performance as professionals in charge of the teaching and learning processes.

The IDU offers basic educational resources programs related to planning sessions of learning and evaluation, as well as the most important tools of PAIDEIA. The offered programs are the following:

- University Class Planning (virtual mode)
- Design and effective use of Power Point (attending mode)
- Collaborative teaching strategies: Case Study
- Evaluation for Learning I – virtual mode

The Director's Office for Continuous Education is an academic-administrative unit in charge of conducting the continuous education of the administrative personnel to use the platform to enter requests.

The activities of the Director's Office for Continuous Education aim to improve the personnel professional knowledge and competences in preparing proposals for Diploma Courses, Workshops and Courses.

❖ Scholarships and licenses

The University is committed to the continuous education of its professors –which is reflected in the budgets for the units and departments of the institution– assigning a fund for professors training, development and aid.

The Engineering Department has a policy to support professors in taking part of international congresses, thus encouraging research.

The University grants –unilaterally– the following licenses and scholarships to its teaching staff, upon their request:

- Unpaid leave;
- Paid leave; and
- Scholarships to support their post-graduate and post-doctorate improvement.

The President could award him/her a support scholarship, the amount of which will be determined case by case based on the type of studies and the scholar's performance.

The University will cover the costs of tickets and/or travel expenses –in exceptional cases, justified and approved by the University Council.

❖ International Academic Mobility

Likewise, the possibility of having diverse experiences in foreign universities is essential for updating our teachers. The departments have a fund that allows them to cover part of the costs created by this type of activity. The policy on this issue is determined by each unit; therefore, the chance of receiving or not receiving complementary support shall be consulted to each department.

It is worth mentioning that the Engineering Department covers the travel costs of professors attending international

congresses as lecturer. The Department covers this type of costs. The Mining Section also has a variable fund for trips inside the country.

PUCP funds

The Office of International Cooperation (OCI) of the Academic Director's Office of Institutional Relations (DARI) is the area in charge of managing the opportunities offered through international cooperation, and aims to link the PUCP academic and scientific demand with the offer of human, technical and financial resources, destined to promote the development of Higher Education. This office aims at promoting the exchange of knowledge, experiences and technology, and it intends to create and maintain spaces for interinstitutional exchanges and cooperation.

The programs offered by the Office of International Cooperation promote the international academic mobility of our professors and researchers through:

- Management of agreements for post-graduate (doctorate) studies
- The allocation of its own funds for post-graduate and post-doctorate studies
- Promotion and management of agreements for the teaching academic exchange
- Search for international funds for the visit of foreign teachers to strengthen the academic grid and the development of joint projects
- Allocation of funds (scholarships) from international cooperation for post-graduate studies and research.

The OCI manages its own funds and funds financed together with international institutions, which has created the following academic education and research programs:

- a. Economic aid program for stays in post-doctorate Higher Education Institutions (IES) abroad: The objective of this program is to promote the post-doctorate research and education of our faculty; therefore, four economic aids have been assigned to professors-doctors to make a post-doctorate in any foreign IES for three months. This aid covers the tickets, sustenance and travel insurance.
- b. Economic aid program to obtain a Doctor's Degree in Higher Education Institutions (IES) abroad: This program considers four economic aids to fund the trips of PUCP professors who are part of the jury of doctorate thesis presentations; and two economic aids to fund short stays that convey to progress of the doctorate thesis in a foreign institution.

PUCP funds under the method of co-financing with foreign institutions

- a. KAAD – PUCP: This agreement allows to study in Germany with the co-financing of the PUCP and the Katholischer Akademischer Ausländer-Dienst (KAAD),

institution that belongs to the German Catholic Church, funded in 1958. Its mission is to support students and researchers in Latin America, Asia, Africa, the Near East, the Middle East and Eastern Europe. The KAAD materializes this aid by granting post-graduate and research scholarships in Germany, in various university disciplines.

- b. Fulbright Commission – PUCP – Scholar: This agreement allows to finance a scholarship for professors of our university, with the co-financing of the PUCP, the Fulbright Commission and the scholar to make post-graduate studies in universities in the United States.
- c. Embassy of France – PUCP, Paul Rivet Program: Two full scholarships to make doctorate studies in France under the co-supervision and co-direction method. The "sandwich" model of doctoral scholarship includes a stay of four months a year in France for a total of three years –which is what the doctoral program lasts– and includes the corresponding linguistic training before the first stay.

Programs for foreign academic visits

- a. PUCP - Embassy of France: This program allows to receive a specific number of French professors for a week to perform various academic activities. The activities arising through this program shall be based on the strategic objectives of the development plans of the PUCP units and shall aim to strengthen the contents of an undergraduate, Master's or Doctor's course.
- b. PUCP - Fulbright Commission: This program allows to annually host the visit of two US professors or researchers to develop activities such as the lecture of specialized seminars, contribute to the design of curricula, prepare teaching material, among others, for a period of two to six weeks.

5) Students

Students can also access funding scholarships.

- a. Fondo Ulises: Is a competitive fund accessible to all the post-graduate programs of the University. Its main objective is to strengthen the internationalization of Master's and Doctor's programs by financing systematic and institutionalized activities. Thus, it contributes to the PUCP's positioning abroad as a quality Education Center and research.
- b. Fondo Marco Polo: This is a competitive fund that promotes research among the students of the PUCP post-graduate programs by supporting the academic mobility through research stays with co-counselors from universities or research centers abroad, and their participation as lecturers in national and international academic events.
- c. ICALA: This a non-profit association financed by the episcopal action ADVENIAT since 1969 and dedicated

to promoting Latin American and German post-graduates. Its aim is to promote –together with the Christian faith– the scientific reflection on men and society, on the economy and education.

III. RESULTS

The results of the activities carried out within the framework of the continuous improvement plan are detailed below:

TABLE V
LIST OF ORGANIZED CONFERENCES.

SPEAKER	TOPIC	COMPANY
Eng. David Dextre	New trends in Mining: Startup Electronic Systems	Davey Bickford International Company
Dr. Eng. Willem Viveen	Evaluation of the tectonics during the last stage of the Cenozoic in the Hercínica region of the NW of Spain.	PUCP
Eng. Victor Guimaraes	Experiences in the Planning and Operation of Open Pit Mines	Río Tinto Minerals
Dr. José Valle	Peruvian Regulation in Mining Occupational Health and Safety, identifying dangers and evaluating risks.	ISEM Mining Safety Institute
Mr. Roberto Nowak	Risks in Underground Mining: "Main risks and solutions available in the market to minimize them".	Dräger
Geologist Pilar Hernández	Talk: "Hydrochemistry and Identification of Water-Rock Interaction Processes in Active Fault Areas in the Eastern Sector of the Baetic System (Spain)".	University of Granada (Spain).
MSc. Eng. Fortunato Ramirez	Evolution of a Mining Project	Hochschild Mining
Eng. Carlos León Ojeda	Mining Production Process: "From Exploration to Distribution".	Hoschschild Group
Eng. José Zeballos	Input information for the fleet estimation as part of the Strategic Planning process of the production of "La Granja Project".	Río Tinto Minerals



Fig. 2 Technical Conferences organized.

• Leadership Workshops

In coordination with the Lidera Program of the Student Orientation Office and the Psychopedagogical Service, two Leadership and Teamwork Workshops were carried out, where the Mining Engineering students worked in soft abilities, such as assertive communication, teamwork abilities, identification of resources and the application of contents to achieve an objective in the academic environment, as well as in the work field in the mining industry (Figure 3).

These workshops favor the personal development of the students of the School of Science and Engineering because they allow them to recognize their weaknesses in some personal aspects, as well as their strengths, favoring the

• Training Talks, Workshop, Seminars

As part of the Continuous Improvement Plan, different professionals of the mining industry were invited to give training talks, workshops and seminars to the undergraduate students (Figure 2). These talks were organized by the Accreditation Office in coordination with the faculty and the representatives of the mining industry (Table V). They were carried out on Thursdays and Fridays, taking into account the students' academic schedules.

complete development of the PUCP student according to the mission and vision of the Institution.

Developing the integration and teamwork abilities in the Mining Engineering students contributes to the improvement of their leadership ability in multidisciplinary works.



Fig. 3 Active participation of students in the Leadership Workshop organized as part of the Continuous Improvement Plan

• Meeting with full-time and part-time professors

The goals for this meeting were the following:

- Presentation of the progresses of the ABET accreditation process (processes, model, benefits and importance).
- Collecting opinions on the academic progress of the courses monitored for the accreditation.

- Continuous Improvement Plan based on the Student Outcome.
- Presentation of qualitative and quantitative data of the Mining Engineering Student Outcomes - PUCP in the courses observed.
- Gathering information regarding the knowledge, technical abilities and personal competences currently required by the industry of a Mine Engineer.

A participatory methodology combining oral presentations, conversation, reflection and discussions around the proposed thematic focuses, was used (Figure 4). The general organization and direction were in charge of the Accreditation Coordination Office of Mining Engineering.

The faculty proposed, discussed and supported the following personal competences which a Mine Engineer should have:

- Professional updating
- Communication skills (active listening, negotiation).
- Empathy, emotional intelligence and assertiveness.
- Personal security and self-esteem.
- Teamwork and leadership.
- Problem-solving.
- Tolerance to criticism.
- Conflict solution.

Furthermore, it was agreed that the companies should promote guided visits to encourage internships in the students of the last semesters. Among the technical competences a mine engineer should have, the following were mentioned:

- Proficiency in the English language.
- Mining management.
- Research and innovation.
- Technical topics: hydrogeology, tunnel engineering, geostatistics.

● **Coaching Workshop for the Faculty**

The Coaching Workshop for the Faculty of the School of Science and Engineering was performed. It was directed by a Professional Certified Coach International Coach Federation (Figure 5). The purpose of this workshop was to develop the basic notions and competences of Coaching, which would allow the professors to strengthen communication and assertiveness in their relationship with the students.

Among the specific objectives were:

- Developing the behavior management ability to perform the necessary improvements.
- Developing the ability to have an assertive and effective communication with other people, in the personal as well as in the work environment.

The topics discussed were:

- Fundamental notions of Coaching
- Coaching as a learning process

- Communication and interpersonal relationships
- Development of emotional competences
- Coach Professor

The proposed methodology is directed to strengthening changes in the participants, not just at a behavioral level, but at an attitude level, based on the self-observation exercises, reflection, dynamics and coaching practices.



Fig. 4 Meeting of the Mining Engineering Program Faculty.



Fig. 5 Engineering Professors participating in the Coaching Workshop.

● **Technical visits**

A series of technical visits to different mining operations were organized as part of the course activities.



Fig. 6 Technical visits to mining companies.

- **Tutoring Program**

Tutoring is part of the education and learning process of the Mining Engineering students and offers to the student an academic and professional orientation space.

Through tutoring, the tutoring professors promote the development of competences (group of knowledge, techniques and abilities of the student) and offer through their experience and good judgment, orientation to the students, allowing them to expand their reference framework, expectations and opportunities, so they can continue and finish effectively their university life. The Tutoring Program Objectives were:

- Cooperating with the development of the quality of the higher education taught in Mining Engineering - PUCP.
- Contributing to the comprehensive development of the students.
- Promoting and improving the relationship between the faculty and the students.
- Directing the students' learning process.
- Promoting an attitude of responsibility, autonomy, commitment, collaboration and interest for the degree.
- Encourage students to reflect in the face of their professional project.

- **Cause-Effect Workshop with the Undergraduate Students**

The purpose of the workshop was to identify the main difficulties the students have in the achievement of the Student Outcomes at the end of the professional degree, using the Ishikawa Method. This method consists of preparing a diagram taking into account the problem to analyze. In this case, the problem was the low average in the evaluation of rubrics of the criteria in the monitored courses (Figure 7).

The workshop was very rewarding because the students presented the problems they have in some courses and at the same time, they proposed solutions for the different situations taking place in the teaching-learning process. Table VI shows a summary of the problems detected by the students during the feedback meeting.

TABLE VI
SUMMARY OF THE CONTRIBUTIONS OF THE PROGRAM STUDENTS DURING THE FEEDBACK MEETING

COURSE	PROBLEM	SOLUTION
Fundamentals of Dynamics	Course with methodological approach to Civil Engineering.	Restructure the contents and methodology with a geological and mining vision.
Rock Mechanics	Theoretical Course	Improve the laboratory practice sessions. Schedule more field visits.
Drilling and Blasting	Loss of contact hours due to nonattendance	Increase the number of contact hours.
Underground Mining	The contents of the course are not in agreement with the current environmental impact difficulties.	Improve the curriculum.



Fig. 7 Program students participating in the Cause-Effect Workshop.

- **Informative Talk**

It was directed to all the undergraduate students of the Mining Engineering Program (Figure 8). The importance of the Accreditation with ABET was made known, as well as the preparation of the self-study where the support of the entire university community will be necessary: students, faculty, administrative and maintenance personnel.



Fig. 8 Informative conference about the Accreditation.

- **Accreditation Training for the Administrative Personnel**

As part of the Self-study process for the Accreditation of the Mining Engineering Program, an Orientation Seminar for the administrative personnel was carried out (Figure 9). The purpose of the seminar was to train the administrative personnel working (secretaries, assistants and laboratories teaching assistants, among others) in the Mining Engineering Section.



Fig. 9 Administrative personnel participating in the accreditation informative meeting.

IV. CONCLUSIONS

It is possible to implement a continuous improvement process for an academic engineering program. The activities must be developed in collaboration with the different actors: teachers, students, alumni, administrative staff.

The active participation of students in feedback workshops is essential to propose improvements in the curricular plan.

Coaching workshops for teachers will allow them to develop and enhance their soft skills.

The program must have the financial support of the institution to ensure the maintenance and renewal of equipment, acquisition of new specific computer licenses, recruit new teachers, conduct field visits to mining units.

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