

A NEW MULTIDIMENSIONAL MODEL FOR QUALITY EVALUATION OF GRADUATE-LEVEL EDUCATION IN NUCLEAR TECHNOLOGY

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ABSTRACT

Educational institutions have been highly concerned about the quality of products offered to the society, in order to obtain better results they need to provide a high degree quality service. The exclusive approach of this study is the development of a Multidimensional Model for the Educational Quality Assessment, named *MULTQUALED*, based on quality standards and models used in other economic sectors. This model was developed to support the decision process, concerning the strategic actions for improving the quality of the graduate courses. Four data collection instruments were created, comprehending dimensions such as pedagogical, human resources and facilities regarding qualified and quantified actions for the continuous improvement of educational quality management process. The study was applied to the Nuclear Technology *stricto sensu* Graduate Program from the Instituto de Pesquisas Energéticas e Nucleares, IPEN-CNEN/SP.

1. INTRODUCTION

The context in which institutions of higher learning are inserted require profound changes in its secular mission of production and dissemination of knowledge. Currently, these institutions are called to perform an important social role in the training of men and women prepared for the critical exercise of responsible citizenship and professional development (Peters, 2003).

To Tachizawa and Andrade (1999, p.37), “like any other organization, the educational institutions are designed to meet the primary needs of its customers”, and they also add that these institutions should offer “learning services, research and extension of quality.” This offer should occur in terms of ideal teaching-learning conditions, taking into account the physical dimensions for equipment and facilities, the pedagogical-didactic structure with updated menus and themes, and, finally, the human-resources, observing the capacity, degrees and experience of faculty and technical assistance for production and publication of knowledge.

In today’s world, quality management should cooperate to make the institution's senior management set the policy of quality required. Moreover, quality management can be

established as a process of definition, implementation, monitoring and evaluation of policies, as Paladini said (2004).

For Campos (1992), models of quality management applied in administrative environments within organizations enable quality assurance in the provision of goods or services.

It has been observed that most graduate programs in search of excellence with the goal of attracting new customers, improving their marketing concept and spreading the relevant and, even, the exceptional results of their search, from scientific research, thus spreading the knowledge achieved.

The actions to be taken by such programs need to be properly prepared, planned and implemented, so that the commitment to quality and excellence is maintained through a constant evaluation of their processes. Because of these factors, higher education has been the object of study and discussions between practitioners, where the urgent challenge is to rethink teaching to ensure its social relevance, scientific and technical quality (Peters, 2003).

Due to the need to create models that can be applied to educational institutions, Aranda (2003) notes that there is a lack of work on operational strategies that enable the improvement of performance of the institution in line with the real attributes set and defined by its target audience.

According to Schwartzman (1997), higher education as a production process depends on good inputs and good management like any other service or product. Thus, both the organizations and the educational institutions that effectively apply the basic principles of quality provide good services.

Mezomo (1997) states that each day the educational institutions discover its social character and assume that they need to conquer, by the effectiveness, fully the credibility and legitimacy in the environment in which they operate. Hence, this is the meaning and the main reason of the evaluation performance, to ensure the quality of their products and services, full care of the needs and legitimate expectations of its customers.

The unprecedented nature of this study was the creation of a Multidimensional Model for the Evaluation of Educational Quality of the model from Parasuraman, Zeithaml and Berry (SERVQUAL); Spanbauer (1995); Cheng and Tam applied to education; the European model of quality management (European Foundation for Quality Management - EFQM), the principles of the American Society for Quality - ASQ; of standards ABNT NBR ISO 9000/9001, presented by Lundquist and Valls, and criteria and indicators of CAPES (2008). The purposes and official purposes of the Institute of Energy and Nuclear Research - IPEN should coincide with the goals offered by those who compose the offer of the service analyzed, ensuring the quality level, and fully attending the market in their areas. Thus, the guarantee of improved quality in education is derived from the management capacity of available resources and how they use media.

The decision to develop the *MULTQUALED* for the Graduate Program *stricto sensu* of IPEN, has found support in the need of continuous improvement of the quality management of educational institutes in order to maintain and expand the concepts of excellence achieved.

2. STRUCTURES OF REFERENCE FOR THE *MULTQUALED* MODEL

Models of quality management that are developed and adapted for operational routines in organizational environments, taking into account the characteristics of these environments, are found in the literature. The adaptation of these models of quality management in the educational area becomes possible as the existing techniques can be used as proposed for the development of the proposed model.

SERVQUAL model: One of the most known and used contributions is the SERVQUAL model, developed by Parasuraman, Zeithaml and Berry (1985) that provided a break in the process of services evaluation (Sampaio, 2004) and requires an overall services assessment, comparing the experience with their customer's expectations. The model is based on five factors: tangibility, reliability, responsiveness, security and empathy. The SERVQUAL contributes significantly to a better understanding as to measure the quality of services. The authors seek to measure the perceptions experienced by consumers because of intangibility, which in most cases, is present in services. (Parasuraman, Zeithaml and Berry, 1985). According to Araújo (1996), the SERVQUAL model has proved robust in education as an instrument of measure of the quality of provision of educational services.

American Society for Quality - ASQ (2003): The characteristics defined in the book of the American Society for Quality - ASQ demonstrate a clear statement of eight principles for elementary and high American school (K-12-Kindergarten-12th grade), in order to manage and implement a quality management system. These principles are: Information and Analysis, Case Management, Leadership, Student Focus, Involvement of Teachers and Employees; Society; Continuous Improvement Process and Briefing Program.

Spanbauer (1995): Spanbauer studied the educational institutions the U.S., using quality and productivity methods commonly used in industrial enterprises. The author argues that the process can improve the quality management system and operation of educational institutions, contributing to the learning and achievement of students. From this method, the author applied the technique to the design of matrices curriculum, control of schedules and routines education, saying that "the techniques and processes of quality and productivity can be transferred successfully to the education. The models of enterprises and sectors can be used in designing the curriculum, the schedules and the provision of education.

Cheng and Tam (1997): Multi-model of quality applied to Chinese educational institutions and is composed of seven different models: specifications and objectives Model; input resources Model; process Model; Model of satisfaction; legitimate or real model; Lack of problems Model and Model of organizational learning. This multi-model for quality education can be applied, taking into consideration the idea of design or quality of the institution, terms of use, and indicators for evaluation. For these authors, the quality in education is a multidimensional concept that can not be easily accessed through a single indicator, so you should evaluate the quality of education through different models for a process of continuous improvement.

European Foundation for Quality Management - EFQM: Saraiva et al. (2003) using the methodology of the European model of quality management: European Foundation for Quality management-EFQM, known and widely used to achieve excellence in traditional organizations, implementing the necessary procedures for the effective pursuit of excellence in a case study in Portuguese schools. The EFQM model is a flexible tool, and usually used to

achieve levels of excellence in business that can be applied to large and small organizations, from either the public sector as the private sector. The model here is not prescriptive and can be used to measure and achieve the progress in the organization of a course of sustainable excellence in all aspects of performance. It is based on nine criteria, and in the following premise: the excellent results in what refers to Performance, Customers, People and Society are achieved through Leadership in the conduct of policy and strategy, which is transferred through the people, the Partnerships and Resources, and Processes.

Certification ISO 9000/9001: Lundquist (2003) and Valls (2004) present models of quality based on NBR ISO 9000 certification (2000a) and ISO 9001 (2000b), applied to education at high level, highlighting the importance of those certificates to quality assurance. To Morejón (2005) the NBR ISO 9000 is basically a proponent method of a model of quality systems implementation, applicable to any company, anywhere in the world. It is a tool that has a focus on quality assurance, creating a consistent and uniform set of procedures, components and requirements.

Criteria and indicators of CAPES (2008): The Coordination of Improvement of Higher Education Personnel - CAPES has assessed post-graduation *stricto sensu* courses using a methodology applied from criteria established in accordance with the programs, faculty, research activities, training, student body, intellectual and scientific production, and other related factors. This body ends up publicizing the situation of the institution and programs in a ranking with the maximum score achieved after an evaluation visit in loco. It is not always that this way shows loyalty to the process as a whole, since it does not take into account certain particularities of each institution and its programs.

3. IMPORTANCE OF THE TYPE AND CONTRIBUTIONS *MULTQUALED*

According to Ribeiro and Kaloustian (2005), understanding its strengths and weaknesses, an institution is able to intervene to improve their quality according to its own criteria and priorities.

The subject of educational processes are the more intellectual and professional authorities, to evaluate the activities and results of educational practices. This means that teachers, researchers, students and technical and administrative are primarily responsible for evaluation, since its design philosophy, development of resources, implementation of practices, to the interpretation of information and the actions of correction and improvement. Thus, the more extensive, qualified, organized and intense, the better the chances of an evaluation be useful and produce the desired results (Dias Sobrinho, 2005).

The *MULTQUALED* is useful for the following reasons:

1. Allow a self knowledge in relation to the activities and processes that affect the quality of the educational program of Graduate and therefore the institution;
2. Promote a clear understanding of what is being executed and the results generated;
3. Identify the dimensions where the problems occur relating to quality education;
4. Pointing out the aspects that require actions to improve quality education.

MULTQUALED allows to the leaders of an educational institution:

1. Identify the activities, processes and its quality levels;

2. Discover the problems related to quality;
3. Identify the causes for the problems of quality;
4. Propose actions to improve quality continuously.

The *MULTQUALED* provides the following objectives:

1. Consolidate a culture of assessment, identifying strengths and weaknesses, opportunities and threats in improving educational quality;
2. Diagnose, monitor and improve aspects related to the Didactics – Pedagogics dimension , promoting improvement in quality of activities and processes related to teaching, research and extension;
3. Diagnose, monitor and improve aspects related to human resources dimension, promoting improved quality of activities and processes related to performance and teacher, student and technical-administrative recovery;
4. Diagnose, monitor and refine aspects related to infrastructure, promoting improvement in quality of activities and processes related to facilities such as classrooms, laboratories, library, equipment and other facilities;
5. Reassessing the educational administration, taking strategic decisions to increase the educational quality continuously.

To improve the educational quality it is needed to consider the cultural characteristics, flexibility and institutional autonomy, avoiding conflict in the organizational environment, seeking a cooperative participation of all who make up the functional structure. In the working course of an educational system, a process can be improved from the information obtained after its execution, being indispensable an evaluation as a way to measure, so that the right decisions are made if they are necessary. With an appropriate data collection through the application of assessment tools, and its analysis, the decision making is based on results and helps all in the perception of their mistakes, favoring the overcoming of obstacles on the continuous improvement of educational quality.

Dourado, Oliveira & Santos (2007), argue that studies, evaluations and researches contribute to the understanding that educational quality is a complex phenomenon, comprehensive, that involves multiple dimensions. The contribution of *MULTQUALED* model must occur in the use of measures that aim the transformation and evolution of didactic-pedagogic dimensions of human resources and infrastructure, contributing in the graduate training and the processes of knowledge generation, as final product.

4. DEVELOPMENT OF MODEL *MULTQUALED*

The model developed is called Multidimensional Model for the Evaluation of Educational Quality-*MULTQUALED* by having a structure composed of three elements: didactic-pedagogic, human resources and physical infrastructure. This organized structure widely ranks and evaluates determinants and indicators of educational quality of programs for Post-graduation *stricto sensu*, to a process of continuous improvement.

Figure 1 shows the orderly flow of actions for the development and application of *MULTQUALED*.

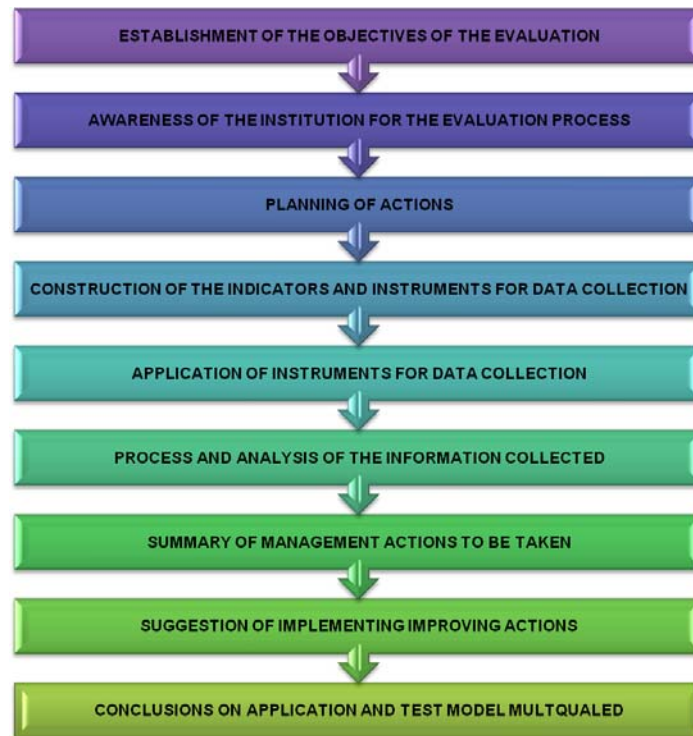


Figure 1 - Flowchart of Activities for Development and Implementation of the Model

Quality education is defined by the engagement between the material and human resources, and the relationship that occurs in the institution in its processes management, teaching and learning, in the disciplines, in the performance of the students, in the satisfaction of teachers and mentors, in professional achievement of employees. Thus, the quality is the relationship between *inputs, processes, outcomes and outputs*. The flow of this information can be seen in **Figure 2**.

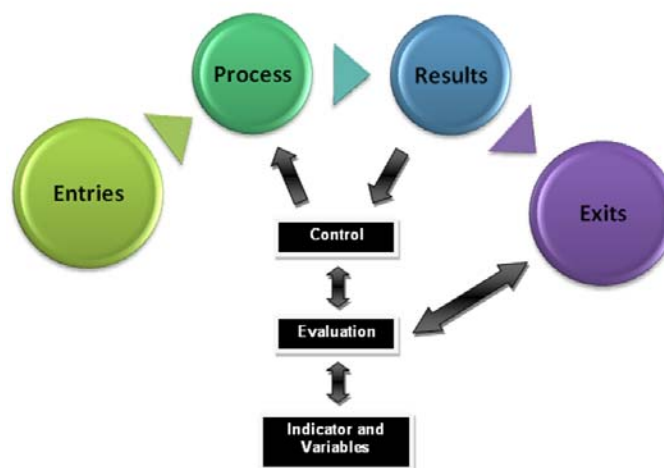


Figure 2 - Flow of Information Model *MULTQUALED*

Thus, every operating system must be subjected to assessment procedures and control as a manner of reorientation of the actions to the continuous improvement of educational quality.

The **entries** are represented by students of the Graduate Program of the *stricto sensu* IPEN, incorporated by the dimension of the didactic-pedagogic organization, human resources and infrastructure, translated as inputs.

The **cases** are represented by the activities of work developed by technical and administrative teachers, where all the procedures are ordered and inter-related, standards and actions, with a beginning, middle and end, to achieve the mission and goals established by the program.

The **results** are translated to fulfill the services offered by the institution and received by the student (customer).

The **outputs** are represented by the students formed after full compliance of the requirements of the program. This is the final product of the institution that characterized its mission, translated into knowledge. Therefore, the real product is knowledge transmitted and based on critical thinking, which enables the student to decision making and problem solving, forming it as professional and citizen.

The **control** occurs by the analysis of the data collected during the evaluation, referring to procedures correction actions if necessary. The control exists to determine the quality levels achieved by indicators and variables that make the tools of evaluation.

The **evaluation** is the tracking of results received phase, where the data collection instruments are used, consisting of quality indicators and variables.

Figure 3 can be seen that steps up the process of evaluation of the multidimensional model proposed.

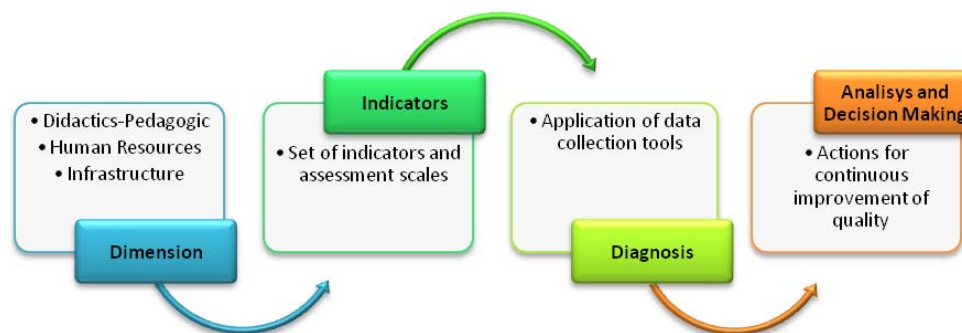


Figure 3 - Stages of the Evaluation Process that Composes the Model

The **dimensions** are represented by three areas: Organization Didactics-Pedagogical (teaching activities, disciplines, menus, bibliographies, forms of assessment), human resources (teachers, students, technical-administrative, its functions and activities) and infrastructure (facilities, materials and equipment: classrooms, laboratories, library and other dependencies).

The **indicators** are represented in a set of variables for size, which scales are used to measure the levels of quality.

The **diagnosis** occurs by the application of instruments for data collection questionnaire type, which includes the size and number of indicators with their respective variables and scales.

From these results **analysis** are made for **decision making**, promoting readequacies and corrections of the processes for continuous improvement of educational quality. We prepared four (04) tools for data collection questionnaire type consisting of a number of variables that make up a set of quality indicators that enable the collection of evaluative reviews of faculty advisors, students and administrative staff in the three dimensions mentioned.

In the three questionnaires answered by the three faculty advisors, students and administrative staff two scales of responses that represented two levels of assessment were used: *importance and degree of perceived satisfaction*, characterizing as multidimensional scales: the first is an ordinal increasing scale of five(5) points which determine the level of importance allocated for statements (variables), thus defined as: No Importance (1); minor importance (2); Average Importance (3) Important (4) and Very Important (5), the second is an ordinal scale of the semantic differential Likert-type of five (5) points where each assessor mark their level of agreement or disagreement/satisfaction or dissatisfaction and/or occurrence with respect to the same statements (variables), and well defined: Totally Disagree/Very Dissatisfied/Never (1); Disagree/Dissatisfied/Rarely (2) Neither agree nor disagree and/Neither Satisfied nor Dissatisfied/In Media (3); Agree/Satisfied/Almost Always (4) Totally agree and/Very Satisfied/Always (5).

The fourth questionnaire answered by students was used after the end of the disciplines offered in the Program, in order to measure levels of satisfaction and performance of students in relation to the discipline given, to the teaching and infrastructure support. In this questionnaire, it is used in an ordinal scale of evaluation by increasing gradation of opinion with five (5) points thus represented: Never/Very Bad (1); Rarely/Bad (2); In Average/Regular (3); Almost Always/Good (4), and Always/Very Good (5).

In the questionnaire 1 applied to guiding teachers are included three dimensions of evaluation of the program: didactic-pedagogic organization (with 24 variables), Human Resources with a self-evaluation of teacher performance (with 25 variables), and infrastructure facilities with evaluation of physical, the library, officials of the division of education and institutional site (with 23 variables).

In the questionnaire 2 answered by students it is also provided three-dimensional evaluation of the program: didactic-pedagogic organization (with 21 variables), Human Resources with a self-assessment of student performance (with 18 variables), and infrastructure facilities with evaluation of physical, the library, officials of the division of education and institutional site (with 23 variables).

In the questionnaire 3 applied to technical and administrative staff, the dimensions evaluated are two: Human Resources with a self-evaluation of technical and administrative performance (with 27 variables), and infrastructure with assessment of physical facilities and institutional site (with 09 variables).

The questionnaire 4 answered by students evaluates specific disciplines and contains three dimensions: Didactics-pedagogic organization evaluation with the program content (10 variables), methods of use (05 variables) and material (05 variables), evaluation of Human

Resources performance of teachers (18 variables) and student self-assessment (15 variables), and evaluation of infrastructure (07 variables).

In **Figure 4** it is presented the Model *MULTQUALED*, portraying the process and flow of information, which is observed on one side the students (customers) with their wishes and needs, and on the other side, after the process of interaction with the program chosen, your level of satisfaction.

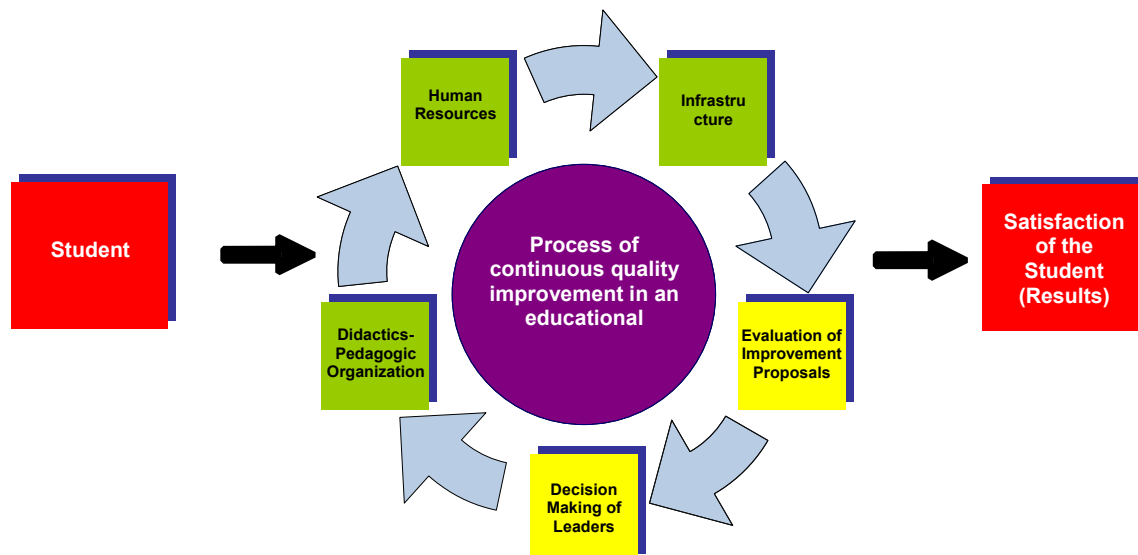


Figure 4 - Multidimensional Model for the Evaluation of Educational Quality-*MULTQUALED*

The *MULTQUALED* was applied at the Instituto de Pesquisas Energéticas e Nucleares, IPEN-CNEN/SP, located in São Paulo, Brazil, associated for the purpose of teaching the University of São Paulo-USP and maintained by the National Nuclear Energy Commission-CNEN, had by the sample the Graduate Program *stricto sensu* in Nuclear Technology, master's and doctorate in supply areas: Nuclear Technology-Materials, Technology and Nuclear Reactors, Nuclear Technology, Applications.

The Graduate Program in August 2008, had 125 (one hundred twenty five) student guiding teachers of master and / or PhD credentialed. The students regularly enrolled totaled 420 (four hundred and twenty), and the Division of Education, there were 12 technical and administrative employees in effective performance responsible for operation of the program.

5. APPLICATION OF MODEL

The minimum sample of teachers and students were defined by a probability sample of the type of group, i.e. from the total universe to be studied in groups of faculty mentors (125) and students (420), the respondents were randomly chosen to complete the minimum number set for a confidence level of 95.5%, with maximum allowable error of 5% to 95 teachers and 205 mentors students regularly enrolled, and students collected in 215 questionnaires. Regarding the total number of employees (12) all responded to the evaluation instrument used. The data collection began in August and was closed at the end of October 2008.

The form of data collection was through a printed questionnaire, where respondents were invited to participate in the study for evaluation of the program. After explanation of the purpose of the research and the acceptance of the respondent was handed the questionnaire, and subsequently collected in an envelope with no identification, the average time to answer a questionnaire was 15 minutes.

In the case of teacher researchers there were 144 responses to questionnaire, distributed in three dimensions, where for each variable were requested two responses related to assessment of the importance and the satisfaction.

For the students there were 124 responses in a questionnaire, distributed in three dimensions, and for the staff there were 72 responses of questionnaire, distributed in two dimensions. The personal delivery system in printed form helped meet the sample set.

6. RESULTS

After application of the model, the main weaknesses identified in the dimensions assessed, are presented in **Table 1**, reflecting the evaluation of teacher's mentors, students and administrative staff of the Program of Graduate study. These variables indicated represent the highest level of dissatisfaction found by analyzing data collected in each category of respondent, deserving special attention of the leaders of the program. In contrast many strengths contributed to the excellence of the program.

7. CONCLUSIONS

The public educational organizations perform their activities based on models with bureaucratic actions in the vertical hierarchy of power that regulate the work, using conventional measures of performance rather than a tool to assist leaders in making decisions, taking aim at the maintenance of the concept of educational quality with practices in administrative decision making for results.

To carry out a process of continuous quality improvement in an educational institution the first requirement is that its leaders have a proactive vision, with an administration focused on customers and establish a conducive organizational climate transmitting security and freedom, where everyone will feel encouraged to cooperate, correcting flaws as a continuous improvement of institutional performance. The management of quality education will not happen by itself, it needs to be administered, managed, and this process involves the physical structure and all available.

Through the application of a self-reflexive, the model *MULTQUALED* was possible to perform a self diagnosis of the educational quality program for the IPEN post graduate *stricto sensu* and identify the information that revealed aspects and processes that need to be improved, and also reveal and strengthen the potential. The information obtained was passed to the Board of the Division of Education for acknowledge and decision making in the strategic planning of the evaluated program, contributing to continuous improvement of the quality of the educational program of post-graduation.

Table 1 - Identified weaknesses after Application of Model *MULTQUALED*

GUIDING TEACHERS	
Dimensions Evaluated	Weaknesses – Points which require improvement
1. Didactics-Pedagogic	<ul style="list-style-type: none"> • Use of techniques of teaching that facilitate learning. • Consistency between the concepts obtained by the students and learning effectively. • Integration between the disciplines offered in the Postgraduate Program. • Participation in courses and / or educational events to update. • The form of entry of students in the Postgraduate Program in Nuclear Technology. • The participation of teachers in the Postgraduate Program in Nuclear Technology.
2. Human Resources	<ul style="list-style-type: none"> • Analysis of evaluation results to refine procedures for teaching. • Maintain productivity with periodicals. • Relation between the content of the discipline given to other related disciplines. • Appreciation and recognition of the teaching staff. • The role as teacher in the Postgraduate Program in Nuclear Technology.
3. Infrastructure	<ul style="list-style-type: none"> • The bathrooms. • The parking. • Update of the acquis in particular areas of concentration. • Organization and efficiency of care (the Staff of the Division of Education). • Immediate resolution of questions (the Staff of the Division of Education). • The site on the IPEN Postgraduate does not meet its purpose in a coherent way.
STUDENTS	
Dimensions Evaluated	Weaknesses – Points which require improvement
1. Didactics-Pedagogic	<ul style="list-style-type: none"> • Use of techniques of teaching that facilitate learning. • Consistency in the evaluation system to stimulate the teaching and reasoning. • Review of assessments after disclosure of results. • Balance between theory and practice in the disciplines offered. • Integration between the disciplines offered. • The form of entry as a student in the Postgraduate Program in Nuclear Tech.
2. Human Resources	<ul style="list-style-type: none"> • Stimulation and attraction for the dynamism of the classes. • Stimulus to think about the issues. • Courage to share ideas and knowledge. • Consistency between the evaluation system and the content taught.
3. Infrastructure	<ul style="list-style-type: none"> • Organization and efficiency of care services (by the Staff of the Division of Education). • Accurate and reliable information (by the Staff of the Division of Education). • Immediate resolution of questions (by the Staff of the Division of Education). • The site on the IPEN Postgraduate does not meet its purpose in a coherent way.
TECHNICAL-ADMINISTRATIVE OFFICIALS OF THE DIVISION OF EDUCATION	
Dimensions Evaluated	Weaknesses – Points which require improvement
2. Human Resources	<ul style="list-style-type: none"> • Stimulation and motivation to perform tasks. • Participation in the discussion of goals and targets set by the Division of Education. • Courage to share ideas and knowledge. • Participation in training related to the area of performance. • Obtaining assistance in questions to better perform. • Consistency between the performance assessment system (DGS) and professional performance.
3. Infrastructure	<ul style="list-style-type: none"> • The bathrooms. • The kitchen. • The parking. • The safety on the premises. • The site on the IPEN Postgraduate does not meet its purpose in a coherent way.

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