

# “Interdisciplinary Evaluation” Using the Model of Education of the IPN in Automotive Manufacturing Classes in Mexico

Israel Ibarra Solís\*, Raymundo Jimenez Zavala, Yazpik Hernandez Vargas,  
Maria Eugenia Santana Bastida, Nancy Martinez Campos, Ubaldo Gil Cruz

Instituto Politécnico Nacional (UPIIG-IPN), Department of Specific Formation, Guanajuato, Mexico

---

**Abstract** At the present article a follow up was made of the technics used to evaluate interdisciplinary classes in automotive manufacturing engineering, based in a method proposed by the Instituto Politécnico Nacional (IPN). The method is related to the evaluation through competency-based learning, although is not a new method worldwide, in the engineering education specifically in Mexico is gaining popularity. The evaluation method of the IPN is center in the flexibility, the continuous education, and the professional formation of the student by working in a lab of manufacturing processes. The conducted follow up of the method deals with the performance of students working in small teams, and the way the students are evaluated using equipment. The results were obtained through observation, and analysis of the methods used to evaluate, and making comparisons with the method of competency based learning proposed by the IPN.

**Keywords** Multidisciplinary evaluation, Interdisciplinary, Competency-based, Assessment

---

## 1. Introduction

The purpose of the following paper is to make an analysis and a follow up of the method proposed by the IPN (Instituto Politecnico Nacional) which is call a “New Educational Model”. The method deals with evaluation technics that are centered in the pillars of UNESCO, to form individuals in the competencies needed to develop skills required in the life and in the work field. Observations and Interviews were conducted in order to get the data from two different subjects that are taught in the Automotive Manufacturing career that is offered by the IPN, both subjects deal with interdisciplinary evaluation thus making possible an analysis of the techniques applied and compare the results obtained with those proposed by the IPN.

### 1.1. Background of Evaluation in Mexico

Evaluation through competency based learning for undergraduate education in Mexico started in 1995. It was strengthened and monitored by creating the National Center for Higher Education Assessment (CENEVAL), in order to design and implement standardized methods to measure the learning and the competency of the students. In the period 2001-2006 (PRONAE) [18] The National Education

Program recognized that the external evaluation and accreditation of higher education was a fundamental mean to encourage the improvement of academic fields. Therefore, the federal government encourage higher-level institutions to strengthen their self-evaluation processes, to boost the diagnostic evaluation, promoting external assessment of students at the entry and completion of the university programs through the application of standardized tests.

Within the scope of competency assessment. The National Association of Universities and Institutions of higher Education (AUNIES) [1], was focused primarily on the high school level education where it was implemented a national program to train teachers in assessing competency. This program was called PROFORDEMS [23], the teacher education program for high school in the periods of 2007 to 2012. In which 20,000 teachers from public and private schools throughout Mexico were trained.

The ANUIES started preparing teachers of higher level education on September 19<sup>th</sup> 2008, and to this date it has not yet been given a timely monitoring program that reveals the results of the program, however most of the reports resulted in competency assessment to credited senior level students in high school with the right competencies to get into a higher level education. According to the Education Based Competency [1] it aims to link the education sector with the productive sector, in order to raise the potential of individuals, facing the contemporary society [6]. The ANUIES sees that, through the combination of knowledge,

---

\* Corresponding author:

iibarra@ipn.mx (Israel Ibarra Solís)

Published online at <http://journal.sapub.org/edu>

Copyright © 2016 Scientific & Academic Publishing. All Rights Reserved

abilities and skills in performing a job. This can result in a good persuasion by the companies that are interested in hiring young graduates. As it was mentioned before this is not a new concept since it was expressed long ago by the pillars of UNESCO, but in Mexico the authorities of education (SEP) are taking the competency based level education seriously to be implemented throughout the country.

### 1.2. The Four Elements of Competency Based Learning

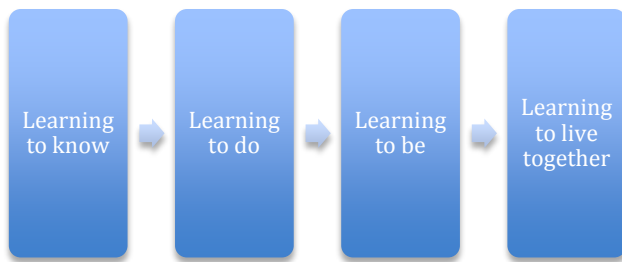
The four pillars of learning are fundamental principles for reshaping education [24]:

**Learning to know:** to provide the cognitive tools required to better comprehend the world and its complexities, and to provide an appropriate and adequate foundation for future learning.

**Learning to do:** to provide the skills that would enable individuals to effectively participate in the global economy and society.

**Learning to be:** to provide self analytical and social skills to enable individuals to develop to their fullest potential psycho-socially, affectively as well as physically, for a all-round 'complete person.

**Learning to live together:** to expose individuals to the values implicit within human rights, democratic principles, intercultural understanding and respect and peace at all levels of society and human relationships to enable individuals and societies to live in peace and harmony.



**Figure 1.** According to UNESCO, the four pillars of education. [1]

In Fig. 1 we can see the four pillars of education that are according to UNESCO, in which they are the basis for the overall development of students, to help them integrate successfully into a workplace. Many companies consider that the skills that students are receiving should go beyond transmitting theoretical knowledge and manual skills [13]. It should seek to increase the capacity of people to solve difficult situations. Also an important factor to consider is the cultural, social and attitudinal aspects as ANUIES aims to build a competency-based curriculum that holistically seeks:

- A constant link of the productive sector with the educational system, which can not be separated from the national and the international regional context.
- An education linked to national goals and the productive sector of the country [10].

- A link through education skills in the different levels of education such as; the primary, secondary, and upper middle with the higher education to ensure consistency and coordination.
- An important role to detect the needs of the productive sector [20].

The validation of the skills is important, because competencies describe normative behaviors, behaviors the organization wishes to promote and develop to enhance organizational effectiveness [12] Regarding the competency assessment test, it is important to mention that each university of the public sector in Mexico, focus on the characteristics of vocational students receiving the appropriate methods to learn. It is also important to notice that the industry plays an important role in this regard because the education sector prepares students with skills that are determined by them [15]. According to the ANUIES, it is important to strengthen the institutional field of school so that they can give education based level competencies [1].

## 2. The Method of the IPN

In the IPN we have a program that is called "New Educational Model" which is basically an ideology that focuses on competence-based learning [7]. This program is handled by the university as a new scheme for all its students and teachers, although is not mandatory, encourages teachers to implement the methodology in their classrooms continuously. Through the new educational model IPN aims to be an educational institution of innovation, flexibility and focused on teaching higher technical level competencies, fulfilling its role as leader of public technology education in Mexico. (Fig.2) gives a glimpse of what involves the Educational Method of the IPN.

The new educational model focuses on training practical processes, rather than theoretical levels of study. As we can see in (Fig.2) the process of learning is flexible and innovates. Also it mainly highlights the ongoing training in labs, a comprehensive institutional vision that takes the experience of teachers and learning approaches from the industry. Most universities can make their students familiar with basic concepts of knowledge but seldom deliver the knowledge which shall be implemented in on-the-job contexts [21], and at the same time adapting in training systems based on teaching methodologies to prioritize innovation, creativity and the use of information technology and communication [3].

From the New Educational Model emanates several trends that are considered to promote in learning. The teacher plays an important role in these methodologies because according to the New Model for Education, the teacher must leave its traditional role to guide and advise students and adopt a completely different role to merely be

a guide of the self learning process in the students. The individual success of students is determined by the frequency and quality of feedback on the learning achievement, the amount of time allowed and the need for learning, the relationship between teaching and learning strategies as well as the standards of self-regulated learning and motivation [14]. The teacher must have an integral connection with the educational model and must be updated in the field of his/her specialty.

The teacher should motivate students towards the participatory education [2] using the following areas:

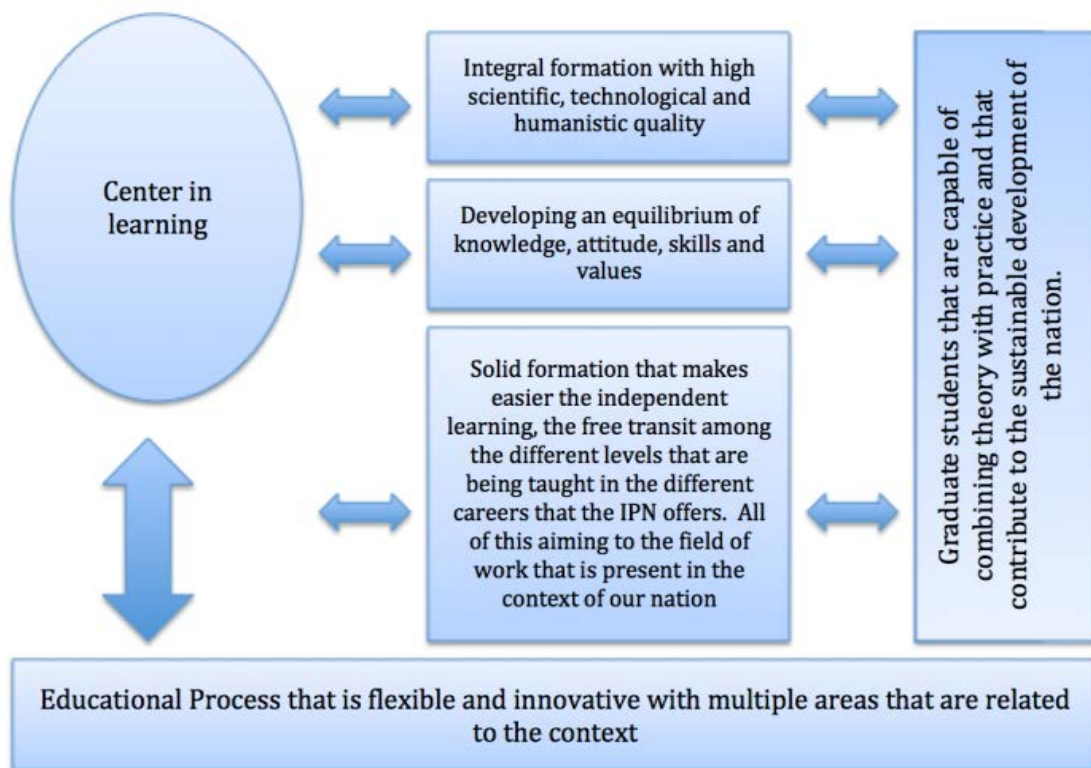
- 1) Organize the contents of the curriculum through interaction with other disciplines or real problems.
- 2) Recognize the individual and group work learning, considering the following aspects:
  - a) The purposes of education,
  - b) The role of teachers and students
  - c) The role of the institution
  - d) Economic, political and ideological and the cultural environment.

In these aspects the teachers must become familiar with the basics of their actions, cognitive and affective characteristics and in response to their students. To be able to start this teaching process it needs to be supported by:

- a) The student's previous knowledge.
- b) The objectives of the course and
- c) The learning strategies

This will give the teacher a better role in the student learning process, also it can help to plan their classes better. The New Model for Education in the IPN provides what is called Strategic Teaching. This methodology allows you to create and perform interventions with the student. Through this model, the teacher should consider the student in cognitive and affective means, speaking to motivate. The teacher must be aware of the perception of the students and their ability to overcome any academic obstacle [17], teachers must understand the difficult objectives, to ensure the success.

The method of the IPN was taken in consideration to make this research, due to several aspects being two of them very important in the educational field in Mexico. The ideology of competency learning has a great impact in all basic levels of education in Mexico, but there is little research done in the higher education. Another reason is that all the teaching processes generally is done through theoretical methods and the evaluation goes in the same way. This research is focused in obtaining information that deals with practical teaching and evaluation.



### Elements of the model of Education IPN

Figure 2. Educational Method of the IPN. [9]

### 3. Discussion

In the academic unit (UPIIG-IPN) campus Guanajuato, the new model of evaluation has been a good option among teachers. Particularly in a project that is presented in the 8<sup>th</sup> semester of the bachelor in automotive systems engineering. This project is a multidisciplinary project because it is work between two academic subjects. The two subjects are “Tool Design” and “Robotics”. The two subjects developed a project together as an interdisciplinary process to evaluate and it is based on the knowledge that was acquired in the class by the students. We selected these two subjects as a good way to interpret their styles of evaluation using the method of the IPN and to make an analysis to determine if there was a positive outcome by using the method. A positive outcome will be acquiring the knowledge and the competency to do the activities in the lab using the equipment given.

#### 3.1. Techniques Employed

Observations were made both in the classroom and in the laboratory production cell using two techniques one of them being Ethnography and a second technique was the moments of evaluation to get a holistic view of the processes of teaching and evaluation. The data were collected through a punctual registration of the events that were happening in the classroom, and also through the exams and the final project that was presented.

Generally, the observations were taken in classes by writing notes of the things that were happening between the students and the teachers. A video recorder was also used for a closer look of the classes both in the classroom and in the laboratory. A strong problem was, the excessive noise that was in the lab as the class shared space with other laboratories, generally they used tools and machines that produced a lot of noise. The observations were given for a period of four months and a half, later culminating in a presentation of the project in the laboratory (Fig.3), where all the students presented their work. Information was gathered belonging to 18 weeks where the group usually received an average of 3 lessons per week of 1½ hour each session as we can see in (Table 1). One group of students was selected to give a timely follow.

The access to the classes for observation was relatively easy because according to Woods [22], it is necessary to build a sense of trust between students, teachers and the person who will be watching for all that happens in a natural way. We spoke with teachers and students to get their permission to be observed and they all agreed.



**Figure 3.** (Manufacturing Lab-UPIIG-IPN)

According to the New Educational Model of the IPN, the following processes should be addressed; diagnostic evaluation (initial), continuous assessment, and final assessment evaluation. Integrating these three time points, we can embrace the ideologies of summative evaluation and qualitative evaluation that are present in the Educational Model of IPN.

The Educational Model of IPN says that the evaluation should be agreed between the students and the teacher to thereby determine the percentage of grade considered fair in each discipline or modality evaluated. In the subjects both “Tooling Design” as in “Robotics”, negotiation between student and teacher was not performed, however a negotiation between the teachers who taught the subjects was performed. For each subject an agreement was reached on issues that needed to be considered within the overall project that was proposed as an evidenced of learning process, see (Table 2). At this point the evaluation negotiation was not done completely as the educational model implies.

**Table 1.** The schedule of the subjects shown

Group (8SM1) Subject	Practice (Lab)	Theory	Laboratory location	Classroom area	Schedule
Tooling design	1.5 Hrs. per week	3 Hrs. per week	CNC Lab	Building 5-2	Tuesday, Wednesday and Friday from 11:30 am to 13:00hrs
Robotics	1.5 Hrs. per week	3 Hrs. per week	Manufacturing cell	Building 5-2	Monday, Wednesday and Thursday from 8:30am to 10:00am

Referring to the process of multidisciplinary evaluation it can be seen that teachers planned a method to evaluate previous knowledge which they refer to as “diagnostic testing”. However, we have to differentiate what kind of knowledge is required for the proper functioning in the subjects. On the one hand we have knowledge of academic nature (theoretical) and on the other, we have the practical knowledge of nature. In the two subject teachers gave importance to the skills as each of them considered the practical learning required for the proper handling of equipment and thus avoid complications.

The grading agreements which were reached for the two subjects were:

**Table 2.** Assessment policies presented

Period of evaluation	Written exam	Project percentage	Evidence of learning
1	40%	20%	40%
2	40%	50%	10%
3 (final)	40%	50%	10%

The grading described in table 2, applies to the 2 different subjects that were being taught because that was the agreement. It is noteworthy that it is given more grade percentage to the project that is delivered by the students rather than the theoretical exam itself. According to the New Educational Model of IPN students must show the competence acquired and at the same time it should be

assess by using rubrics and checklists. In subjects that we followed up, they came up with rubrics to evaluate the projects and some tasks given by the teachers

#### 4. The Process of Evaluation

The project that the students did, was focused on 2 different subjects but related through the system of assessment and the delivery of the final product which was that students work on two fronts that gave meaning to their project. The two main aspects that have been detected were teamwork and the competency to use the previous acquired knowledge, as the project required that students used metrology techniques and knowledge of conventional manufacturing skills that they had learned in previous semesters.

The educational model of IPN requires to evaluate the student's previous knowledge (Fig. 4) so in this way it can be diagnose the level of each student specifically, once having this information, teachers can make adjustments to planning and so if there is some lag in skills, they can be met timely and level according to the diagnosis [11]. The diagnostic exam was created between the two teachers that were involved in the project. The questions were focused on equipment knowledge rather than previous theoretical knowledge, as the main point of the course according to teachers was to teach the skills needed to operate the tools and machinery of the labs.

Diagnostic Exam
1. What do you understand by automotive tooling? mention an example.
2. What is the purpose of a clamping tool?
3. Explain the operation of a die?
4. What kind of molds are commonly employed in the manufacturing of auto parts, mentions an example?
5. What are the main characteristics of a cutting tool?
6. How do you consider your domain as a percentage of the following tools ?:
CAD
CAM
Operation of conventional M-H
Operation Lathe Milling and CNC
7. What is the difference between a drawing and one set definition, when used each?
8. What is the dimension string that has impact in the manufacture of a product?
9. What is the importance of a standardized dimension?
10. Explain what these settings tree - hole?

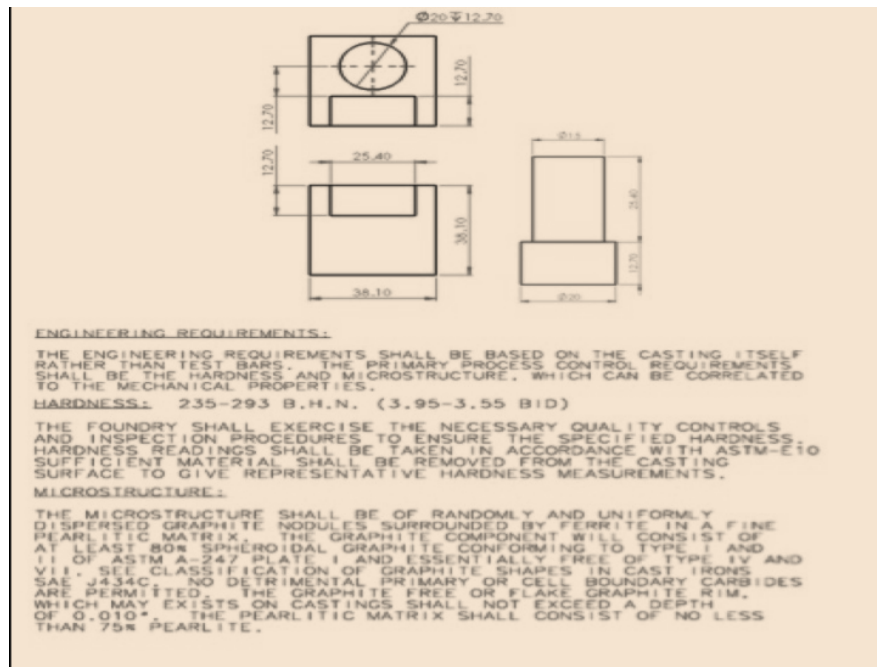
**Figure 4.** Diagnostic Exam

**Table 3.** Evaluation Portfolio

Team 1							
reduction of .5 for each observation							
expected points	evidence	esthetics	critical characteristics	functioning			Final grade
3	Base		ok				3
2	Pin		ok				2
5	Pallet		ok				5
	paperwork		observations		reduction		
2	Piece design		ok				2
5	Pallet						
5	Methodology		ok				5
5	Gripper methodology		ok				5
3	Gripper Design		ok				3
2	Conceptual Base machining		check document				2
2	Conceptual Interchange		check document				2
29							29

**Table 4.** Rubric for Final Evaluation

Team 1	Cont. Evaluation	oral exam	final exam	exam	project	final grade
Juan	8	1	1	15	15	64.5
Mario	6.6	1	1	15	15	68.5
Angelica	10	1	1	15	15	80
Teodoro	10	1	1	15	15	61.5
Cecilia	6.6	1	1	15	15	68.5



**Figure 5.** Work order from a potential customer

According to Sacristan [19]. The purpose of the continuous evaluation is to promote the improvement of knowledge for example: the process of the student's learning, a teaching strategy, an educational project, or the process of creating educational material. Within the class of "Tooling Design", in the field of continuous assessment two tests of theoretical methods were applied, this was in order to know the scope of the students in the skills being sought and transmitted simultaneously. A practical task was given to the students with the intention to guide them in an appropriate form of organization, design and product delivery to a potential customer (Fig.5), since the subject was established in a form in which there was a need from a company. In this way the students have the simulation of a real context work field, thus fulfilling the competency of practical knowledge.

In the project there was a check up between the team and the teacher, seeking to have control and supervision of the product that was being made as they were requested at the beginning and throughout the course. As mentioned before the educational model of IPN values the skills acquired in the different subjects being taught, the instrument used to measure the ability and the presentation of the project was the Assessment Rubric, instrument that was set by the Educational Method of the IPN to evaluate the academic subjects.

Final evaluation, according to Coll [5] has the purpose to determine whether students have met or not the level of requirements set by the educational objectives. At the end of any topic, or a set of topics in a course of a cycle, it may help to determine whether students have completed the prescribed learning objective before entering a new theme, a new thematic block, a new course or a new cycle. Clearly a summative assessment test only makes sense at the end of teaching / learning, since its purpose is to determine what the student has actually learned in relation to what was intended to learn [4].

With regard to the educational model of IPN, it seeks to have a holistic evaluation where students show knowledge acquired throughout the course. The educational model of IPN has different forms of summative evaluation to determine the success of teaching and learning. The IPN model proposes a set of instruments that must be used to ensure the final evaluation through competencies. One instrument is the portfolio of evidence (Table 3), which seeks students to show evidence of learning during the course. Within the portfolio, one can find endless work done in class, lab, and at home. The process of evaluating a portfolio is usually established at the beginning of the semester [8]. Another instrument used to check the acquired knowledge and competency is the use of the assessment rubric to evaluate a specific project globally. Within the subjects of Tooling design and Robotics. A rubric of evaluation was used to determine the competence and the realization of the project in a proper form, see (Table 4)

As we can see from the results of the evaluation and the approach of the teachers, the Model of Education of the IPN

is being put in practice. The results showed that students were evaluated in both subjects with the purpose to develop skills needed in the field work, but leaving behind the theoretical knowledge. The results of the different forms of evaluations show that the Method of the IPN works in a good way, however there is a lot more that deals with the Educational Model. The theoretical method.

## 5. Conclusions

The institutional educational model of the IPN presents a comprehensive and balanced formation of the four pillars of UNESCO knowledge, as it considers a humanistic, innovative and creative vision, considering theory and practice, as a thread of academic programs. Through out the evaluation method, it is to say that is focused on skills. The teachers made reflections on whether each student meets a variety of criteria, based on products obtained from various sources and its application to the peculiarities of the vocational training, and through an interdisciplinary project, which demanded team work, but also gave the opening to strategies and integrated learning [16]. All of this with the appropriate use of evaluation in three areas: diagnostic, formative or summative, can give us a positive result in the process of learning.

As can be observed, moments of assessment testing can be implemented within the interdisciplinary project generated thus obtaining the knowledge that was sought. The vast majority of teachers agrees that with the Educational Model of IPN, when the time comes to analyze assessment methods it can be quite complicated because represents a lot of work. Although some of the teachers are still evaluating in the traditional way like a written exam, others start to feel the necessity to implement a new methodology that shows a process of practical learning leading into a process of learning by competencies. We can infer that teachers seek to develop practical skills in students. The type of initial assessment both continuous and final shows that teachers find justifiable that students develop these skills because according to them it is necessary within the automotive industry which is pretty much where a student in automotive systems engineering will eventually work.

---

## REFERENCES

- [1] ANUIES. (2008). Bachelor level education in the century XXI. A proposal from ANUIES. México: ANUIES, 2008.
- [2] Bachelor, G. (2000). Formation of the scientific spirit. XXI CENTURY.
- [3] Bolivar, A. (2008). Citizenship and basic competencies. Sevilla: ECOEM Foundation.
- [4] Cabrerizo and Castillo, S. (2010). Educational evaluation of

- learning and competencies. Madrid: Pearson.
- [5] Coll, C. (1991). *The components of the curriculum*. Polity Press. International Commission on Education for the century X. (sf). *The education holds a treasure*. Compendium. UNESCO.
- [6] Comte, A. (1980). *Discourse on the positive spirit*. Madrid: Alianza.
- [7] Diaz Barriga (2001). *The era of evaluation in Mexican education*. Porrúa.
- [8] Diaz Barriga (2007) M. V. (XLVI). *Assessment: analysis of a notion " Mexican Magazine of Sociology, 175-204*.
- [9] IPN. (2015). [http://www.seacademica.ipn.mx/Documents/Pdf/e-academica/MPLR\\_I3BCD.pdf](http://www.seacademica.ipn.mx/Documents/Pdf/e-academica/MPLR_I3BCD.pdf).
- [10] Kuhn, T. (1962). *The Structure of Scientific Revolutions*. Mexico: Economic Cultural Fund
- [11] Martínez Rizo, F. (2000). *New challenges of higher education. Functions, actors and structures, Mexico* ANUIES.
- [12] Markus, L. (2005). *Confounded by Competencies? An Evaluation of the Evolution and Use of Competency Models*. *New Zealand Journal of Psychology* Vol. 34, No. 2, July 2005.
- [13] Mc Donald, and. C. (1995). *New perspectives on evaluation*. Paris: UNESCO.
- [14] P. Tóth. (2012) *Learning Strategies and Styles in Vocational Education*, *Acta Polytechnica Hungarica*, 9, 3, 2012, pp. 195-216.
- [15] Parsons, T. (1990). *The class as a social system*. *Education and society*.
- [16] Popper, K. (1999). *The Logic of Scientific Discovery*. Madrid: TECNOS.
- [17] Prigogine, Y. et. (1997). *The new alliance metamorphosis of science*. Madrid: Alianza.
- [18] Public, S. d. (2001). *National Education Program 2001-2006*. Mexico: SEP.
- [19] Sacristan, G. (1993). *Understand and transform education*. Madrid: Morata.
- [20] Sanchez, J. L. (2003). *Educating in and for diversity. towards an intercultural education approach*. Michoacan, Mexico: Academic Conference on the National Pedagogical University, Uruapan, Michoacan.
- [21] Szoboszlai, V. (2014) *Post-Experiential Education: from Knowledge to 'Knowing'*, *Acta Polytechnica Hungarica* 11(10), pp 235-247, Budapest, Hungary, 2014.
- [22] Woods, P. (1989). *The school inside: ethnography in educational research*. Madrid: Polity Press Iberian.
- [23] <http://www.copeems.mx/glosario/Glosario-1/P/Profordems-74/>. (24 de September de 2015).
- [24] <http://www.unesco.org/new/en/education/networks/global-networks/aspnet/about-us/strategy/the-four-pillars-of-learning/>.