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ICT Support assessment in primary school teaching and learning through AHP

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Abstract

The aim of this study is to analyse the importance of Information and Communication Technology (ICT) support at primary school. Applying the analytic hierarchy process (AHP) a decision model is proposed to reveal the effect of ICT system support in teaching and learning process performance at primary school. A case study is pursued involving private and state schools at a zone in the Metropolitan Region in Chile. First-hand data is gathered comprising different agents involved with education, primary schools and with academic experience. The outcome indicate the key aspects showing those schools who assigned priority to the ICT support had better results in the teaching and learning process.

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1. Introduction

The support that an information and communication technology system provides have been well recognized and incorporated to the education process at schools long ago. It has been expected that information technology (IT) should help the individual learning, stimulating the capacity in learning to learn. However, so far, most studies refer to the transformation of the way of teaching rather than substantiating the improvement of the scholarly results. The effect of ICT system usage on student accomplishment is still hard to measure although there have been many impact studies; this issue causes reasons for discussion up to now. In [1], the authors evaluate the impact of information and communication technologies on educational institutions through interviews and group discussions to reveal the challenges, demands and perceptions of teachers involved in this experience. According to [2] the authors, through a non-experimental research

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indicated that the attitude of middle school teacher is in advance stage of technology adoption. The competence level in educational network has been studied through an exploratory analysis including students and by their teachers in [3]. Also, an evaluation of the ICT usage and absorption has been explored for university education in [4]. Later, a model to capture perception of ICT system at primary school was presented by the authors in [5]. In [6], authors focus on ICT self-efficacy of primary school pupils and their ability to process digital information rather than direct measure of ICT competences. In a related attempt, it is of our interest to find out the critical ICT system to meet the basic tasks within the educational organization. Additionally, we are concerned to perceive the degree of contribution of an ICT system to teaching and learning quality, i.e. taking into account the academic performance obtained by the students. In this way we might be able to detect where to place efforts to train and develop the competencies in the use of ICT for each establishment and, thus, progress in their performance.

Provided that, in education come out conflicting goals when deciding: what, how, where and when to endorse new technology, a pilot study has been conducted applying a multi-criteria approach based on experts perspective for evaluating the implication of ICT support in the process of primary education. A decision model using AHP was carried out involving three types of primary schools to determine attribute, priorities and the most important activities that require ICT support. The results of this pilot study generates an opening to analyse the key aspects resultant as more significant for the primary teaching and learning process and would need to be reworked. The next section describes the problem situation in study. Following, in section 3 the application of AHP to design a model is presented. Section 4 delivers the result analysis, where in section 5 the conclusions are provided.

2. The Problem Situation

Regarding the incorporation of ICT's as a resource support in primary education in Chile, a question arises related to the degree of stimulus to the quality of primary education. In response to the question, the study is carried out from different perspectives, to learn about the diverse elements that have contributed to the success or the eventual failure of ICT's use. Actually, there are many factors that contribute to quality of education, [7, and 8]. Therefore, initially, in order to identify the facility of the ICT system provision in the quality of education [9], initially we have considered six influential factors for this study:

- the teaching quality determined by the pedagogic practice to achieve an effective learning;
- the number of students per course that favours an effective learning;
- the college infrastructure, which allows the innovation for the development of an efficient learning process;
- the result from first to fourth primary level in Chile of the National test (named SIMCE test) [10] that assess the validity of the current educational model and is performed every two years;
- The parents educational and socio-cultural level, which contributes to the motivation and the affectivity of the student; and
- ICT system that support the development of the educational process and the performance of students, teachers and administrators.

These six influential factors proposed are initially validated and evaluated by a group of experts, consisting of teachers' specialists, officials of the ministry of education and education consultants.

Figure 1 shows the evaluation results indicating that the teacher quality is the most important factor. However, the ICT support has been considered as important as the others factors.

Then, according to national government dependence, we have selected three types of primary schools: a city council college with national state financial support; a private school, with national state financial support; and private school without national state financial support for the case study. Having in mind that the actors of the selected schools (*students, teachers and administrative staff*) have different responsibilities and daily duties relying on ICT support, the essential technology required are to be regulated.

Hence, at this point, emerges the initiative to generate a decision making model to detect to what extent the importance of an ICT system is perceived for the activities they currently perform. The identification of priority

activities and aspects that contribute to teaching and learning will allow placing efforts to train and improve the competencies in the use of ICT to each establishment.

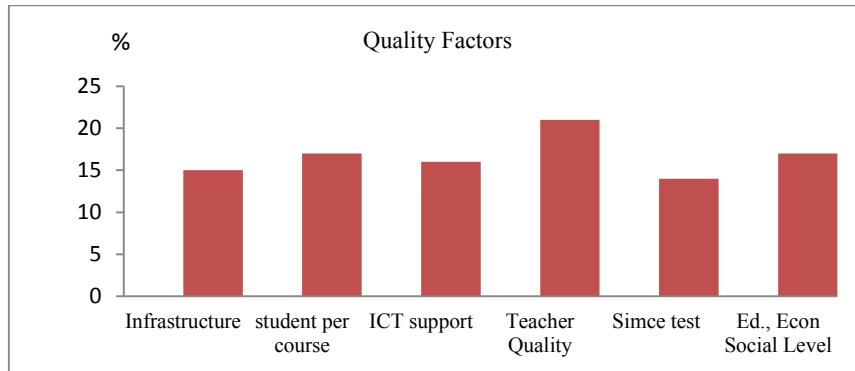


Fig. 1. Proposed quality factors assessment in education

3. The Case Study

The methodology involved three stages. The first stage is concerned with the identification of decisive factors and attributes that actors (*students, teachers and administrative staff*) consider important for evaluating the ICT provision at primary school operations. However, individually each participant has different expectations about the system and will request many diverse characteristics. Empirical data was collected from the selected schools. The common school the activities declared by the representatives of the three institutions type are depicted in Table 1.

Table 1. Actors, activities and description

Actors	School Activities	Description
Teacher	Evaluations	Regulation design to grade students
	Student Grading & administrative duties	Grading records
	Communication and Provide information	Transmit and share information, students, parents, and administrative staff.
	Lectures	Preparing and teaching lessons
Students	Study and Information search.	Study and search
	Homework and tests	Homework and study lessons preparation
	Presentations	Design and prepare presentations
Administrative staff	Data Exchange,	Data sharing and exchange
	Data transfer	To transfer data
	Student Enrolment Control	Students enrolment records
	Finance	Financial records.

Most of these activities are supported by ICT tools. Planning and managing a school IT infrastructure is a difficult and complex task. It is of interest to have an insight about the main tools is used at the moment to help to develop some of the pronounced activities. Table 2 summarizes the ICT tools provision.

Table 2. ICT tools provision

Main tools	Services	Provision
Network		
Telephone	Fix & mobile Phones	School, home, Cyber Coffee shop
Web site	Internet	
Video and TV Documental	Information provided by Video & TV programs (CNN-History Channel,)	Television, School, home , Ministry of Education
Microsoft Office	Office Software (PowerPoint, Excel, Word)	Ministry of Education, School
Private Software	Other private software	Personal facility
Library on line	On line catalogue, electronic collection	Primary school, Ministry of Education, City library

3.1. Structuring the problem situation

Practically the aim of the analysis is to examine the ICT support in the process of primary education. The problem situation is examined from the actors' perspective by means of the proposed approach using AHP methodology [11] to generate a decision model. The AHP has been proposed in literature as an emerging approach to large, dynamic, and complex real world multiple criteria decision-making problems [12-14]. This method provides the structure and the mathematics for helping decision-makers (DMs) make rational decisions. AHP orders, structure the problem in study, formulate a hierarchy and follow a comparison procedure to examine and prescribe a course of action helping DMs to find the alternative that best meets the needs identified. The method is used to state criteria and rank user's preferences. The application of AHP to the problem situation allows integration of the diverse judgements and preferences and therefore to obtain an overall result. This practice allowed us to specify the criterion and to structure the problem situation constructing a hierarchy structure.

3.2. Expert panel

It follows that, efforts are oriented to create a team of experts[15] comprised with representatives from each of the three types of schools and educational experts .This interdisciplinary team included thirty people related to primary education and the three types of schools. Accordingly, for this study, the agents are initially arranged into three groups of representatives: (*students, teachers and administrative staff*). The next step, the critical tendency of undertaking certain activities is identified. Experts expressed their judgment according to their own expertise and knowledge.

3.3. Basic Hierarchy

One of basic principles of AHP is the hierarchy representation and decomposition where a hierarchy is a representation of a complex problem in a multilevel structure whose first level is the goal followed successively by levels of factors, criteria, and sub criteria, and so on down to a bottom level of alternatives The object of a hierarchy is to assess the impact of the elements of a higher level on those of a lower level or alternatively the contribution of elements in the lower level to the importance or fulfilment of the elements in the level above. This type of assessment is usually made by paired comparisons responding to an appropriately posed question eliciting the judgments. The mathematical definition of a hierarchy is given in Saaty's Book [11-14].

Then, for this study, a three level hierarchy structure model is considered upon the information specified by the experts. Each level has multiple nodes against which the alternatives on the next level will be compared.

Figure 2 shows the basic structure model.

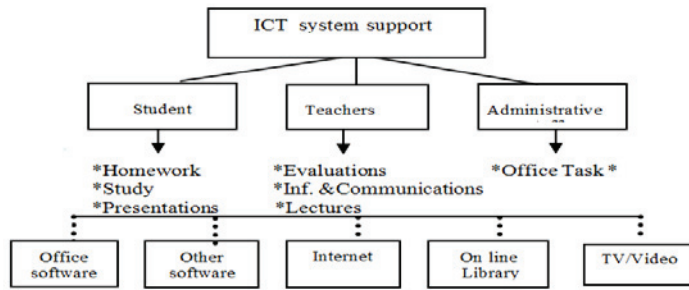


Fig. 2.Hierarchy structure for assessing the ICT support in primary education

The first level is concerned with the global objective it is desired to obtain. For the situation problem, it is to evaluate the level ICT support for the related declared activities. The other levels and nodes represent the decision factors that contribute to attain the goal. In this case the main actors or users of the system and the main activities they perform supported by the provision of ICT tools. The second level takes into consideration the implicated actors’ perspective, where the next level comprises the main activities performed by the actors and would have an effect on each of them. The last level consists of the alternative ICT system tools that each activity depends on.

3.4. Priority discrimination

Setting priorities in a hierarchy requires that we perform measurement throughout the structure. We must then synthesize these measurements to obtain priorities for the bottom level alternatives. The AHP is based on ranking activities in terms of relative ratio scales. In the paired comparison approach of the AHP, one estimate ratios by using a fundamental scale of absolute numbers in comparing two alternatives with respect to an attribute, one uses the smaller or lesser one as the unit for that attribute.

To estimate the larger one as a multiple of that unit, assign to it an absolute number from the fundamental scale. This process is done for every pair. Thus, instead of assigning two numbers w_i and w_j and forming the ratio w_i / w_j we assign a single number drawn from the fundamental 1-9 scale to represent the ratio $(w_i / w_j) / I$. The absolute number from the scale is an approximation to the ratio w_i / w_j . The derived scale tells us what the w_i and w_j are.

This is a central observation about the relative measurement approach of the AHP and the need of a fundamental scale. The scale of absolute values for judgments is shown in table 3, [11-14].

Table 3. The Fundamental Scale

Importance Intensity	Definition
1	Equal Importance
3	Moderate Importance
5	Strong Importance
7	Very strong or demonstrated Importance
9	Extreme importance
Reciprocals of above	If activity i has one of the above nonzero numbers assigned to it when compared with activity j , then j has the reciprocal value when compared with i

3.5. Pairwise comparison

In agreement with the described basic hierarchic structure, a pairwise comparison is made, in such a way that all the elements of a same level are compared and weighed to each other. The expert panel went through the hierarchical structure and derived a priority matrix for each level.

Let W be a matrix (1) whose row elements are ratios of the measurements w_i of each of n items with respect to all others.

$$W = \begin{bmatrix} w_1/w_1 & \dots & \dots & w_1/w_n \\ w_2/w_1 & & & w_2/w_n \\ \dots & & & \dots \\ w_n/w_1 & \dots & \dots & w_n/w_n \end{bmatrix} \quad (1)$$

The numbers in the matrix express the intensity dominance of the criterion in the column heading over the criterion in the row heading. The ratio scale of the matrix is reciprocal, the numbers which are symmetric with respect to the diagonal are inverses of one another, $a_{ij} = 1 / a_{ji}$. In general, $n(n-1) / 2$ comparisons are needed if n is the number of elements being compared in the triangle above the diagonal ones.

The team of experts judgements are entered in the matrix in response to the question: How much more important is one element or criteria on the left side of the matrix compared with another at the top of the matrix? In this case it refers to the decisive factors to rank the ICT support to primary school related activities.

This is done to justify a fair decision selection. In this way, we will be able to observe if activities that move the organization are developed with the help of technologies. Once all the pairwise comparisons of the expert team group are completed, a scale of relative priorities is derived from them. The final step involves applying the weights to the measured attributes of each activity to derive a ranking about the value of ICT support for each activity that would bring about a service improvement. This procedure is repeated for all the elements of the structure, obtaining a ranking, reflecting user perception.

In addition, it was possible to detect inconsistencies when experts emitted judgments. Under such situations, it was necessary to review them until obtaining an acceptable index. In general, the ratio should be in the neighbourhood of 0.10 in order not to cause concern for needed improvements in the judgments.

4. Pairwise Results

The methodology results indicated the degree of importance on having ICT systems for helping to develop the actors' activities and for who is more relevant. For this study it is possible to appreciate the overall prioritization results for the actors at level 1, showed in table 4. Students and teachers indicated the priority for ICT support.

Table 4. Actors Overall Priority

Actors	Priorities
Students	30,4%
Teacher	57,5 %
Administrative Staff	12,1%

We have noticed that previously the student and teachers had revealed to have the same relative priority regarding the importance to have ICT support. [5]. However, in the last study, the teachers' priorities have increased over the time. Now, in regards, to the alternative ICT tools that actors consider essential for developing their daily task Table 5 shows the overall priorities.

Table 5. Overall Priorities for ICT system

ICT systems	Priorities
Internet	52,5%
Office software	18,2%
Library on Line	16,7%,
Other software	7,3%
TV/Video	5,3%

Taking into account that this is a global result for the present situation, from tables 4 & 5 it is possible to visualize that the support of the computer assisted system (internet, e-mails, web, etc.) have more significance for the students and teachers. Although, when we evaluate schools separately we found some differences. Independently of the type of school the administrative staffs gave minimal importance to the ICT in relation to the importance given by the students and teachers.

4.1. Student's perspective

Through Figure 3 we can appreciate the overall relative importance of the ICT support for student activities where we can observe that students declare that is more relevant for learning and studying.

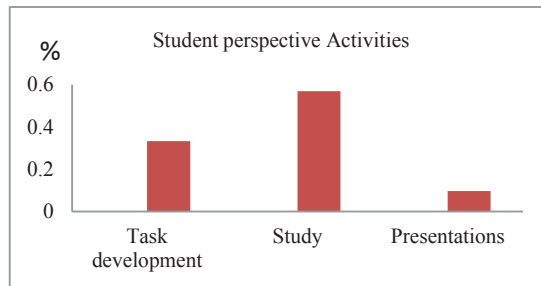


Fig. 3. ICT support for student activities priority

With a view to recognize the possible variants in preferences, through figure 4 we can observe the gradient sensitivity. If the present conditions prevail and the ICT support for task development increases in importance, the necessity for library online would increase. However the tendency for internet would decrease.

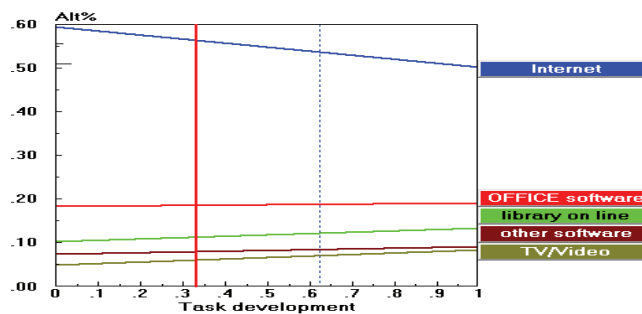


Fig.4 Gradient Sensitivity related to ICT tools priority for student task development

Now, if we compare the results from the three types of schools. Figure 5 shows the ICT support priority for each type of schools

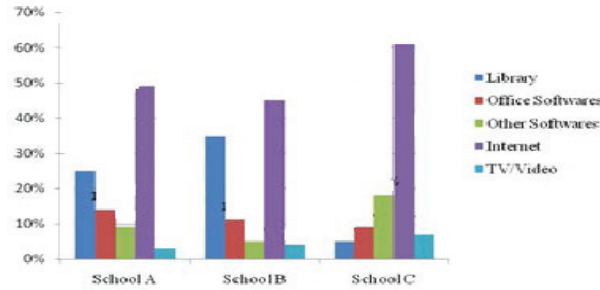


Fig. 5. Relative priority for ICT support associated to student activities

Where, School A refers to private school with partial state financial support, School B represent city council school with total state financial support and School C private school without state financial support.

4.2. Teacher’s perspective

Teachers, depending on the type of college give greater or lesser importance to the ICT, for the activities they perform. In the private schools and in the state subsidized private schools gave the greatest importance for ICT support to the communications, while in the municipal schools gave it to teaching and preparing lectures. In figure 5 we can appreciate the relative importance for teacher activities and in figure 5 the relative importance of ICT support for developing their activities.

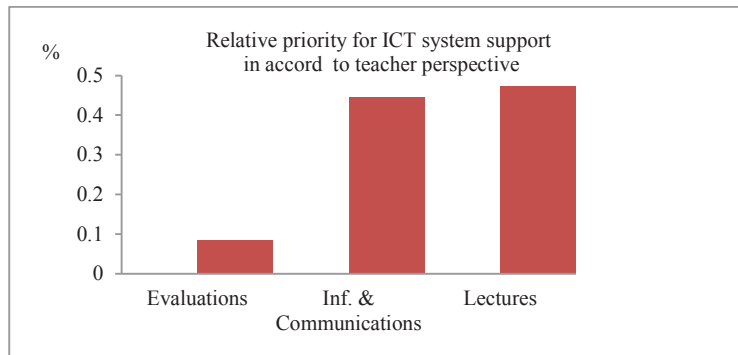


Fig.6.Relative ICT support priority from teacher perspective

Through figure 7 we can observe the gradient sensitivity for the importance of having support teachers’ lectures. If the present conditions prevail, the importance of ICT support for lecture development shows that the necessity for library online would tend to increase. However the tendency for internet would decrease in relative importance.

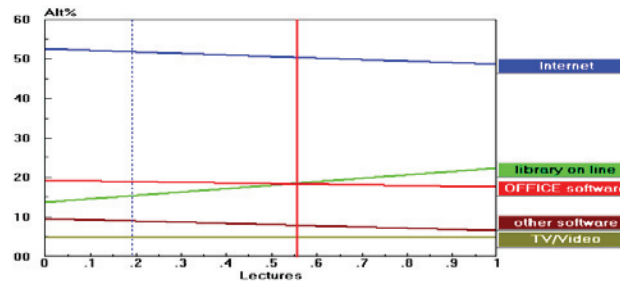


Fig.7 Gradient Sensitivity related to ICT tools priority for teachers lectures

4.3 Result analysis

Depending on the type of school, we could observe that the private and private state subsidized schools gave greater importance to the ICTs support for study activities and preparing lessons, while the municipal schools students give greater importance for developing homework.

Now, if we consider the results of the SIMCE test, through three stages, there have not been much changes and we could appreciate, as seen in figure 8, that the performance of the private schools (School C) are the ones that present the best scores, while the municipal schools (School B) obtain the lowest scores and private subsidized schools (School A) an average.

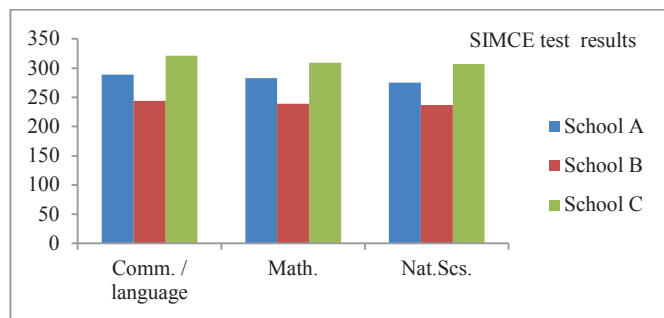


Fig.8. SIMCE test results for schools.

Associating these results with the study outcome implies that the type of school revealing to rely and perceive the great contribution of ICT system support, obtain a better performance. Therefore, it would be possible to correlate to the current use of internet and others. This is a matter for continuing investigation.

5. Discussion

Most of the studies related to the ICT in education have been oriented to post- primary education. The identification of priority activities and aspects that contribute to primary teaching and learning will allow placing efforts to train and improve the competencies in the use of ICT in each school.

Concerning to the teaching and learning process in primary education the results indicated that globally an ICT system support has a greater impact on the students and teachers. Teachers play an important role developing ICT activities for pedagogical aspects. And it has been detected that along time the interest and importance for the selection of ICT activities has increased. This could be considered in schools who would elaborate plans to support teachers to develop their skill to help children to obtain better performance.

Independently on the type of school, the actors identified five ICT tools that are commonly used in primary

education assigning the greatest importance to Internet. This indicates the necessity to provide with an ubiquitous ICT system for online applications that could facilitate the teaching and learning process.

The application of a scientific decision method, the AHP, was valuable to identify the high-priority dimensions of ICT support in primary education in Chile through a case study. The AHP helped the experts to identify advantages and limitations of the ICT support.

The expert team perceived that the outcome of the SIMCE test and the ICT support are significant factors for the quality of primary education. The investigation revealed that the results of the SIMCE test showed better result for those schools who assigned most importance to the ICT support demonstrating the existence of an inequality between those schools that assigned lower importance. However, ICT system is only one of the factors that have an effect in the quality of education, the results of this pilot study generates an opening to analyse the other key factors resultant as more significant for the primary teaching and learning process and to examine the critical aspects that would need to be reworked.

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