USING INTELLECTUAL CAPITAL TO EVALUATE EDUCATIONAL TECHNOLOGY PROJECTS

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ABSTRACT

Intellectual Capital has been used to measure the intangible assets of corporations. Intellectual Capital can also be used to assess and evaluate the outcomes of social projects, i.e., ones that do not have either a book or a market value.

This paper aims to present a framework to evaluate the intangible outcomes generated by the deployment of Informatics in education, measuring the Human and Innovation Capital associated with this enterprise.

The PROINFO, a Brazilian nation-wide program to deploy 100,000 computers in the public K-12 schools, is analyzed as a case study in order to apply the developed methodology.

Some conclusions are presented to policy-makers, educational researchers and practitioners in order to enable them to better understand the dynamics and the overall mechanism of a nation-wide intervention aiming to deploy information and communication technologies in education.

In addition, the paper shows the potential use of Intellectual Capital in social projects, rather than limited to for-profit companies.

KEY WORDS: Educational Technology; Project Evaluation; Human Capital; Innovation Capital; Not-for-profit Projects; Creativity
INTRODUCTION

Several changes are occurring in both the formal educational system and in companies’ training endeavours, in order to develop a workforce which can meet the increasing and complex demands of a new society and economy. The newly developed information and communication technologies (ICT) are enablers for radical changes in the current educational practice, conveying what is called Educational Technology (ET).

Some researchers and practitioners have argued that the use of ICT in a country’s training and education is a necessary condition in order to be a leader in the 21st century. Although developed and developing countries have undertaken several projects aimed at deploying ICT in the teaching and learning environment, the results have been ineffective.

Currently, there are justified concerns about the quality of these technological applications developed to add value in the teaching and learning process. The main question is not whether the technology must be used, but why and how, taking into account that the old processes must be innovated.

This paper analyses and evaluates the use of Educational Technologies (ET) in Brazil, specifically in the Espírito Santo State, in its Southeast region, as part of the National Program of Informatics in the Public K-12 Schools (PROINFO). It is managed by the Distance Education Secretariat (SEED) of the Brazilian Education Ministry (MEC). Figure 1 presents the Espírito Santo State (ES) within Brazil.

![Figure 1 – Espírito Santo State (ES) within Brazil](image)

The basic idea is to create an Intellectual Capital-based conceptual framework in order to help policymakers decide about the selection and use of modern Educational Technologies, within a context of flexible and open knowledge management.

The Educational Technologies can create a different environment in teaching and learning for a knowledge economy. There are ideas that ICT can help improve the quality of education, allowing new players to take part in this process as well as lowering the costs of effective education in comparison to the traditional methods (Joia, 1999).
Hence, new ways of exploring Educational Technology are necessary, conveying the need of a better understanding of how people learn and how an effective educational environment is created, as well as a better understanding of the strengths and weaknesses of each ICT.

One of the main challenges of the developed countries is how to incorporate ICT in schools as educational tools, so as to achieve an educational level of excellence on a cost-effectiveness basis.

This is not a simple matter, solved just with technology acquisition (Joia, 1997). Even in the developed countries, there is no consensus on how the use of ICT in education will lead to improvements in the education, in general, unless the processes are re-engineered (New York Times, 2000).

Therefore, this paper intends to contribute to a better understanding of the key success factors in the implementation of ICT in the education, measuring the performance of these projects. The PROINFO Program in the Espírito Santo State in Brazil will serve as the case study, and the Intellectual Capital as the theoretical tool.

**The Brazilian PROINFO Program**

The PROINFO Program – The National Program of Informatics in the Public Education – is an educational program that aims to start the process of universalization in the use of new technologies in the K-12 public Brazilian schools, so as to spur deep changes in the schools’ culture and practice.

The PROINFO encompasses a series of actions from the Education Ministry (MEC) and a set of actions derived from the 27 State Programs for Informatics in the Education (PEI), reaching all the Brazilian states. The purpose of the Program, as already noted, is to disseminate the pedagogical use of ICT in the K-12 public Brazilian schools.

The program started its activities, formally, in April 1997.

The Ministry of Education (MEC) through the SEED – Distance Education Secretariat – set up the followings objectives for the period 1998-1999 (PROINFO, 1997):

- Acquisition of 105,000 computers, 100,000 of them for the schools and the remaining 5,000 for the NTEs – the State Centres of Educational Technology.
- Implementation of the CETE – Centre of Research in Educational Technology, in Brasília, and 200 NTEs across the Brazilian states, besides the implementation of 6,000 laboratories of informatics in the K-12 public schools.
- Training of 1,000 teachers trainers to be engaged in the NTEs, via *lato-sensu* graduate courses in Educational Technology, given in partnership with Brazilian universities.
- Training of 25,000 teachers to use the ICT resources in the classroom, through the use of teacher trainers in the NTEs.
- Training of 6,600 support technicians in ICT for the NTEs and the schools, at least three for each NTE and at least one for each school to provide technical support.

The PROINFO requires that each school must apply the program through the presentation of a pedagogical project on how to use computers in its daily activities. This project must be approved at the state level and by the PROINFO’s National Committee. PROINFO has the right to remove equipment from schools which are not trying to accomplish their pedagogical aims. Besides, there is a covenant between the State and the schools chosen to receive equipment that investments in infrastructure will be undertaken to receive the ICT Lab, such as air conditioner, tables and chairs, safety devices, electrical network and civil works.

Hence, the Program has established that the MEC (Federal Government) is in charge of the hardware (servers, PCs clients, printers, scanners, etc.), basic software (MS Windows and MS Office), some other material for some months (printers toners, floppy disks etc.) and the training of human resources. The States must offer infrastructure conditions for the computational learning environments, and providing teachers to be engaged in the training process with the time and resources so as to act as teacher trainers in the future. In a further stage, the States will be in charge of supplying the required disposable material, as well as acquiring educational software.
The main actions of the PROINFO have been:

- Sensibilization for the Program.
- Training of Human Resources.
- Implementation of the NTEs.
- Definition of the Technical Specification and Management of the equipment and services bidding process.
- Program’s Monitoring and Evaluation

As a ripple effect, the PROINFO intends to increase the technical collaboration among the states so as to enable them to implement their own projects; define a national policy to spur the educational software development in order to assist the schools’ needs; and implement a deeper collaboration with the universities to facilitate Educational Technology as part of their curriculum in their Education Faculties.

The NTEs are decentralized structures, technically subordinated to the State Coordination of Informatics in Education, aiming to support the implementation of the ICT in the K-12 public schools. Among their duties are the teacher training process, as well as the technical and pedagogical support in the use of ICT in the classroom. Besides, they are supposed to monitor and evaluate their teacher trainers' activities.

The 200 planned NTEs were distributed strategically across the country, according to the State Project of Informatics in Education (PEI) of each state. It is foreseen that nearly 50 schools will be linked to each NTE, according to their characteristics, such as: number of students, geographical dispersion, accessibility and ease of communication.

Each NTE consists of teacher trainers (called multipliers), ICT technicians and of a suitable set of computer systems.

It is also planned to link the NTEs with the RNP – Brazilian Research National Network, so as to become information hubs. The plan intends to link the NTEs with the CETE in Brasília, which will centralise all information in the network, through a database.

**Main Accomplishments and the Current Status of the Program in the Espírito Santo State in Brazil**

The PROINFO started in the Espírito Santo State, Brazil, on February 1998, with the implementation of two NTEs (Vitória and Colatina). Now, there are four NTEs implemented (Vitória, Colatina, São Mateus and Cachoeira do Itapemirim), linked via Internet through 64 kbps, and 33 schools with ICT Laboratories, all of them belonging to the Vitória NTE’s area. Of these 33 schools, just one has a link of 19,200 bps to the Internet.

The PROINFO at the Espírito Santo State has trained 23 multipliers (360 hours of training given by the Espírito Santo Federal University), 99 facilitators or Lab Co-ordinators (160 hours of training given by the multipliers) and 351 teachers qualified with a training of 80 hours given by the multipliers in the NTEs. A total of 473 teachers have already been trained in different levels of expertise.

The Figure 2 presents the cascade methodology applied to train the teachers (the multipliers, the facilitators and the subject content teachers) in a large-scale basis.

Two technicians are under training in Rio de Janeiro, in a course of 424 hours given by a private company to support PROINFO’s technical activities. A similar course is under negotiation. Another initiative has been developed to train pupils to assist the facilitators in the Lab in their spare time.

The Vitória NTE has its own Website (http://www.proinfo.es.gov.br) which contains all of the information about the State program of Informatics in Education, Laws and Directives that formalised the PROINFO in the state and the role of the multipliers, along with some projects already developed by the schools and NTEs.
Besides the national PROINFO’s discussion list, there is a state discussion list where the multipliers, facilitators and teachers can exchange information and discuss themes related to the use of ICT in schools, as well as to externalise their feelings, expectations and hurdles they are having to face.

**RESEARCH METHODOLOGY**

The main objective of this research is to generate a *heuristic frame* so as to help the policy-makers and governments in their decision processes, addressing how to train teachers and how to select and use Instructional Technology to generate an open and flexible environment for the learning and knowledge management.

The *heuristic frame* concept developed by S. Winter (1987) in his article “Knowledge and Competence as Strategic Assets,” is heavily used, being the model proposed in this research.

As Winter says:

“A heuristic frame corresponds to a degree of problem definition that occupies an intermediate position on the continuum between a long and indiscriminate list of things that might matter at one end and a fully formulated control-theoretic model of the problem at the other. Within a heuristic frame, there is room for a wide range of more specific formulations of the problem - but there is also enough structure provided by the frame itself to guide and focus discussion. On the other hand, a rich variety of different heuristic frames may represent plausible approaches to a given problem”, Winter (1987, pp. 172-3)

Some studies have been developed to measure the Intellectual Capital of both a company and a project (Edvinsson & Malone, 1997), (Roos et al., 1997), (Joia, 2000). The Intellectual Capital addresses the intangible assets of a company and how to measure them. Usually the Intellectual Capital is divided into Human Capital, Customer Capital, Process Capital and Innovation Capital (Joia, 2000).

Most of research analyses the variation of the Intellectual Capital, rather than its absolute value, and compares this variation with the variation of the market/book value of the company or the ROI (Return on Investment) of the project. In the educational realm, this can not be done. Usually a qualitative approach is developed through the triangulation technique which is very common in case study analysis.
Different data and information sources are analysed, outcomes coming up from distinct players within the analysed intervention impact area are collected, and they are compared altogether. However, our target is to develop a quantitative approach based on the Intellectual Capital theory in order to measure these intangible outcomes.

The methodology used consists of the following steps:

1. Development of the heuristic model for the quantitative analysis of the project.
2. Development of the tools to gather data and information from the project so as to develop the quantitative approach.
3. Visit to the Espírito Santo State’s schools and NTEs to collect data and information.
4. Analysis of the data and information gathered, using the heuristic frame (quantitative approach).
5. Analyses of the results so as to develop conclusions and a final evaluation of an educational technology intervention.

The Heuristic Model for Intellectual Capital Rating of the PROINFO at the Espírito Santo State, Brazil

The qualitative analysis based on the triangulation method is too common for case studies addressing educational interventions (Taschereau, 1998), the same can not be said regarding quantitative analysis. Based on Edvinsson & Malone (1997), Roos et al. (1997), the NCT’s Kellog School of Business at the Northwestern University (Stewart, 1997), Sveiby (1997), Klein (1998) and Winter (1987) an Evaluation Triangle for ICT interventions in the Education was constructed, hereinafter named the “Intellectual Capital (IC) Triangle.”

Figure 3 depicts the IC Triangle taxonomy:

Figure 3 depicts the knowledge leverage process along an ICT intervention in the Education realm.
The Physical Capital is compounded by:

- The hardware and its maintenance and technical assistance.
- The LAN – the Local Area Network that links all the PCs of a school’s lab.
- The Internet links among the NTEs and schools.
- The basic and educational software used in the PROINFO Program.

The second layer is compounded by the training process. In the Espírito Santo State three different players have taken part in the PROINFO Program:

- Multipliers, working at the NTEs, who undertook a 360-hour course in Educational Technology, given by the Federal University of Espírito Santo (UFES).
- Facilitators, working at the Schools’ Labs, who undertook a 160-hour course, given by the Multipliers, on how to use ICT in the Education and operate a Laboratory.
- Teachers, working with contents, who have received an 80-hour course, also given by the Multipliers, on how to use ICT in a pedagogical way, related to their subjects.

After this training, in our model, it is paramount that the trainees master the technological use of Informatics, i.e., ICT as a tool in the teaching and learning process (3rd layer). After having expertise in how to adequately use the technological tool, can the teachers use ICT in a pedagogical way (4th Layer)? And finally, innovation in the educational process can only be expected if all the skills worked out in the lower layers are consolidated and mastered by the trainees. In this way we can achieve the highest level (the 5th layer) – the Innovation of the Educational Process, and new ways of performing the teaching and learning activities.

The bottom level of the Program rests upon STEP – Social, Technological, Economic, Political Issues – as its influence is mandatory for the results delivered by this Model. The PROINFO State Co-ordination has no control on the STEP forces. Some of these forces have great influence on the success or failure of the entire Program.

As an analogy with the formal Strategy Models (Hax & Majluf, 1991), the context can be compared to the Environmental Scan Stage of any strategic analysis. On other hand, the IC triangle represents the strengths and weaknesses of the Program, and can be compared to the Internal Scrutiny Stage in any formal strategic analysis (Hax & Majluf, 1991). The Environmental Scan gives us the opportunities and threats, and all we can do is to adapt our strategy to this external scenario, which is out of our control. Yet, the Internal Scrutiny which leads us to the weakness and strengths, shows us what can be done to better develop our strategy. It can be said that the IC Triangle corresponds to the Program’s Value Chain.

The arrow at the right side of the Figure 3 shows that all these stages are linked in a cause and effect relationship. It is hard to reach the innovation level if there are deep problems at the training level. In a broad sense the Innovation Capital depends on the Human Capital, which itself depends upon the Physical Capital. Analysing the collected data and information, we can create a broad picture of what is happening in the PROINFO Program at the Espírito Santo State.

The methodology applied is designed to address all the stakeholders related to this intervention. The stakeholders taken into account were:

- The PROINFO National Co-ordination.
- The PROINFO Co-ordination at the Espírito Santo State.
- The Multipliers, mainly the ones at the NTE in Vitória (Espírito Santo State capital) – the first to be trained.
- The Facilitators (also named Lab Co-ordinators).
- The teachers in the schools.
- The schools’ principals.
- The pupils.
PROJECT EVALUATION – A Quantitative Analysis based on Intellectual Capital

According to the Research Methodology presented in this paper, we have used an adapted version of the Model for Valuing Intangible Outcomes for an ICT intervention in Education, as proposed by Roos et al. (1997), Edvinsson & Malone (1997), Stewart (1997) and Joia (2000).

The following indicators were defined and collected:

- **Physical Capital**
  - % Equipment that can be used, on average, in the Lab.
  - % Time the LAN works.
  - % Time Internet works.
  - % Educational SW/Total SW available

- **Human Capital**
  - % Teachers in the school that use the Lab.
  - % Time the Lab has teachers dealing with subjects in the curriculum.
  - % of their time in the school the Teachers use the Lab.
  - % Teachers in the school with ICT Technical Skills.
  - % Teachers in the school with Pedagogical Skills to use ICT as a tool.

- **Innovation Capital**
  - % of Interdisciplinary Projects/Total Projects.
  - % Projects involving the Community/Total projects.
  - % Time the Lab is used by the Teachers for R&D.

The data consolidated and inserted in this model leads us to the following results (Table 1):

<table>
<thead>
<tr>
<th>SCHOOL</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>AVERAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment works</td>
<td>80</td>
<td>100</td>
<td>95</td>
<td>95</td>
<td>90</td>
<td>90</td>
<td>91.67</td>
</tr>
<tr>
<td>Time LAN works</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.83</td>
</tr>
<tr>
<td>Time Internet works</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Educ. SW/Total SW</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.83</td>
</tr>
<tr>
<td>PHYSICAL CAPITAL (%)</td>
<td>22.5</td>
<td>25</td>
<td>23.8</td>
<td>23.8</td>
<td>22.5</td>
<td>23</td>
<td>23.33</td>
</tr>
<tr>
<td>Teachers use Lab.</td>
<td>50</td>
<td>80</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>88.33</td>
</tr>
<tr>
<td>Time Lab. has Teachers</td>
<td>20</td>
<td>10</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>71.67</td>
</tr>
<tr>
<td>Time Teachers use Lab.</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>11.67</td>
</tr>
<tr>
<td>Teachers with Technical Skill</td>
<td>40</td>
<td>25</td>
<td>80</td>
<td>10</td>
<td>10</td>
<td>25</td>
<td>31.67</td>
</tr>
<tr>
<td>Teachers with Pedagogical Skill</td>
<td>5</td>
<td>30</td>
<td>90</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>24.17</td>
</tr>
<tr>
<td>HUMAN CAPITAL (%)</td>
<td>25</td>
<td>31</td>
<td>77</td>
<td>46</td>
<td>45</td>
<td>49</td>
<td>45.50</td>
</tr>
<tr>
<td>Interdisciplinary Projects</td>
<td>0</td>
<td>0</td>
<td>70</td>
<td>15</td>
<td>0</td>
<td>10</td>
<td>15.83</td>
</tr>
<tr>
<td>Projects involving the Community</td>
<td>0</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.33</td>
</tr>
<tr>
<td>Time spent by Teachers in R&amp;D</td>
<td>0</td>
<td>2</td>
<td>15</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>4.50</td>
</tr>
<tr>
<td>INNOVATION CAPITAL (%)</td>
<td>0</td>
<td>4</td>
<td>31.7</td>
<td>5</td>
<td>1.67</td>
<td>5</td>
<td>7.89</td>
</tr>
<tr>
<td>No. of Projects</td>
<td>15</td>
<td>20</td>
<td>30</td>
<td>15</td>
<td>20</td>
<td>6</td>
<td>17.67</td>
</tr>
<tr>
<td>Time (Months)</td>
<td>5</td>
<td>9</td>
<td>6</td>
<td>10</td>
<td>5</td>
<td>3</td>
<td>6.33</td>
</tr>
<tr>
<td>Projects/Month</td>
<td>3</td>
<td>2.22</td>
<td>5</td>
<td>1.5</td>
<td>4</td>
<td>2</td>
<td>2.79</td>
</tr>
</tbody>
</table>

Table 1 – Capital Indexes for PROINFO in the Espírito Santo State
As it can be seen, the school number 3 (the poorest one) has developed 5 projects/month, most of them interdisciplinary ones. They are very innovative and have the highest Human and Innovation Capital score. By the other hand, the richest school has developed only 1.5 projects/month and has the lowest Innovation Capital score.

The next step is to analyze the influence of the Physical Capital (infrastructure) in the Human Capital. The statistical correlation between the former and the latter Capital is 0.04, almost zero. This shows that the Human Capital, till now, is almost independent of the Physical one (Infrastructure). For example, with support problems, the teachers are striving to leverage their Human Capital, not only through a hands-on approach, but also via training which they are paying for themselves, mainly to fulfill the technical gap derived from their training. Besides, the technical support is perceived as bad, but has not hindered the use of the Lab yet and, by consequence, the creation and development of the other Capitals.

As it can be seen, the Physical Capital Average among the visited schools is 23.33%, with a standard deviation of 1.05% and a variation coefficient of just 4.5%. This very low value leads us to conclude that all these schools are having the same kind of problems regarding their infrastructure. Naturally a continuous poor Physical Capital will jeopardize the Human Capital, leading to its depreciation (Argote et al., 1990).

On other side, the statistical correlation between the Human and the Innovation Capital is nearly 0.9 (almost 1.0), showing that innovation is derived from Human Capital. This result agrees with the Innovation and Creativity theories. The Innovation is a function of: (Sternberg et al., 1997):

- knowledge: knowing what is new, not just reinvented.
- intellectual abilities: generating, evaluating and executing ideas.
- thinking styles: a preference for thinking in novel ways of one’s own choosing.
- motivation: making a move, having fun.
- personality: personality and persistence in overcoming obstacles.
- environment: one that supports the investment game and spreads the risk.

The role of motivation in the creativity development is very well studied (Amabile, 1997) and is a function of the environment. It can be said that the State Coordination is very keen to have the project be successful. All the teachers recognize the efforts of both the State Co-ordinator and the Multipliers, and are prepared to win this challenge. This cultural side can not be disregarded, but rather is the glue that binds the teachers’ expectations, obstacles and feelings altogether.

Another very important correlation is between the level of pedagogical expertise on how to use ICT in the Education and the level of Interdisciplinary projects in the school. This value is almost 0.92, showing that rather than the technical expertise, the teacher must understand what to do with the tool to develop a new educational process.

![Figure 4 – Capital Rating for the PROINFO in the Espírito Santo State](image-url)
Figure 4 and Figure 5 show that there is still a long and winding road to travel. But the performance of school number 3 – the one located in the poorest region in the bigger Vitória – depicts that the more the students and their parents know that computers at school are something they can not afford at home, the more they are committed with the success of the endeavour.

It is very important to understand that these ratings are just relative figures, compared with the maximum of 100%. So, the Human Capital has been well developed and the Innovation Capital has drawn on the Human Capital, even though time is necessary to achieve a better score, according to the “Time Lag Trap” developed by Joia (2000). The Physical Capital is low but not enough to spoil the Program till now. Nevertheless, to go further in innovating and leveraging the Human Capital above the calculated level, it is necessary to fix the problems already pointed out.

Therefore, we can present a graphic consolidating all the facets of this evaluation (Figure 6):
CONCLUSIONS

This research is a snapshot in time. We have spent three months analysing the project. This is the reason why more research is needed in order to track and verify whether the conclusions and recommendations drawn on the data and information collected and consolidated are still pertinent.

The PROINFO in the Espírito Santo State, Brazil, is a reality and more teachers are becoming involved, trying not only to leverage their personal and professional skills, but also improve the educational arena where they live. There are great problems related to the current infrastructure, mainly the ones related to technical support, but teachers have understood that ICT is a technical tool to transform and change the teaching and learning process. These changes are based upon the Piagetian constructivism, and are being made real through the development of interdisciplinary projects.

There is a great energy between not only the multipliers, Lab Co-ordinators and teachers, but also the pupils. This energy and a new práxis, where the teacher has to learn together with the student, are the main drivers for all this process.

Regarding some of the most important issues analysed in this case study, we can conclude:

Physical Capital

Physical Capital is the major problem, not only during the training sessions, but also mainly in the Labs. There is not a sufficient team to assist all the NTEs and schools. The equipment supplier is not giving the necessary attention. Till now, as the process is at the beginning, the teachers are using ICT in their classes even with some problems. A serious twofold problem resides in the use of the LANs: the LANs are not working and the teachers were not well trained on using this resource. Therefore, unless an adequate support team is prepared and deployed, the process and by consequence the Program will be jeopardised. The State is training their students to work as assistants, but we can not expect they will be able to solve more complex problems. Some ex-multipliers were and are being trained in Rio de Janeiro (Brazil) to get the needed skills to solve the technical problems. The hope is that they can socialize their skill through a knowledge transfer process based on the knowledge transfer spiral (Nonaka & Takeuchi, 1997).

There are also problems related to the purchase of Educational Software and Internet links. Both problems are due to the Espírito Santo State, which seems to have no money to invest in the program, notwithstanding knowing exactly its due counterpart in the Project. Unless some Educational Software and Internet are deployed within a short time, the students will become tired of the same resources, as technological news is paramount to motivating them.

Finally, the lack of some kind of basic software is already creating problems that can become very serious in a very short time, e.g., the absence of anti-virus software. In this kind of environment it is very common for the appearance of a software virus, as well as the disappearance of the mouse's tracking balls. The latter problem has not turned up yet, but the same cannot be said regarding the former. All the project files where we have made a copy were infected by some kind of virus (mainly a virus of macro for MS Word). In the future, when the LAN is supposed to be working well, the virus can spread through the network very quickly, corrupting most of the files already created by the students.

Human Capital

The teachers’ Human Capital has increased greatly, both technically and mainly pedagogically. They understand that ICT alone will not solve the Brazilian education problem. They understand the new roles the students must develop to better face the knowledge society into which they will be inserted. Their approach corresponds with the current transition from an industrial economy to a knowledge-based one. They are developing as well as their students the abilities to learn to learn, learn to unlearn, and develop new mental models (schemata) that will be paramount for the digital economy.

Their pedagogical skills are better developed than the technical ones. They understand that children must create their own knowledge through an assimilation and accommodation process (Piaget, 1990). The increase in their Human Capital is creating for them a sense of importance and fullfilness long lost due to
the ‘bankruptcy’ of the Brazilian K-12 public system. This sense of ‘proudness’ is one of the key success factors for innovation. Even the students and the communities around the schools have acquired this feeling, too. So, a great energy can be felt not only in the Labs, but also in the NTEs and in the monthly facilitators meetings.

Another very important result is the very high statistical correlation between the Human Capital Index and the Total Number of Projects/Month in each school. The value of almost 0.9 (0.8916) shows that the higher the Human Capital of the Trained Teachers, the more the school is engaged in developing its own projects.

Table 2 presents the collected data for each visited school, as well as the average value of nearly three new projects being started each month per school:

<table>
<thead>
<tr>
<th>SCHOOL</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>AVG.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total No. of Projects</td>
<td>15</td>
<td>20</td>
<td>35</td>
<td>20</td>
<td>15</td>
<td>10</td>
<td>19.17</td>
</tr>
<tr>
<td>Interdisciplinary Projects</td>
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<td>0</td>
<td>20</td>
<td>3</td>
<td>0</td>
<td>1</td>
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</tr>
<tr>
<td>Time (Months)</td>
<td>5</td>
<td>9</td>
<td>6</td>
<td>10</td>
<td>5</td>
<td>3</td>
<td>6.33</td>
</tr>
<tr>
<td>Total Projects/Month</td>
<td>3</td>
<td>2.22</td>
<td>5.83</td>
<td>2</td>
<td>3</td>
<td>3.3</td>
<td>3.03</td>
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<td>Interdisciplinary Projects/Month</td>
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<td>0</td>
<td>0.3</td>
<td>0.66</td>
</tr>
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</table>

Table 2 – Developed Projects/Month

The Figure 7 depicts the Table 2 graphically:

![Figure 7 – Projects/Month](image)

**Innovation Capital**

Taking into account that the schools are using ICT during a period ranging from 3-10 months, it can be concluded that they are developing very innovative projects.

A very impressive statistics is the very high correlation (0.9) between the Innovation and the Human Capital. Besides, the results show that the poor infrastructure has nowadays almost no correlation with the Human Capital and, by consequence, with the Innovation one, showing that the technology is being used just like a powerful tool. Naturally, as the Project is still in its very beginning stage, the teachers are using few resources and so the technical problems are not so relevant. In a very near future, when the teachers start to use the LAN, the Internet and some educational software, the technical support will be absolutely relevant for increasing the innovation level of the teachers, together with their pupils.

Another very important result is the very high statistical correlation between the Innovation Capital Index and the number of interdisciplinary projects developed. The result (0.99) shows that the more innovative
the school is, the more interdisciplinary projects are developed, involving teachers in charge of different contents in the same arena.

Figure 8 presents the number of interdisciplinary projects per school visited (Table 2); the average number of these kind of projects starting each month is nearly 0.66 (more than one each two months):

Motivation, expertise and resources are the tripod where creativity and the respective derived innovation lie upon (Amabile, 1997). These three items are addressed in different scales in the PROINFO in Espírito Santo State. The Figure 9 depicts better what is happening in the PROINFO in Espírito Santo State:

Finally, creativity must be assessed not only based on the projects developed (mainly the interdisciplinary ones), but rather by the way teachers are using ICT to re-engineer the outdated educational assembly line we have practised in our schools. A new *modus operandi* is imperative for the knowledge society in which we are already living. So, the assessment and evaluation processes must make this as the key point to track PROINFO’s future results.
BIBLIOGRAPHICAL REFERENCES


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