



Integral schema for Monitoring and Evaluation of ICT Inclusion, Use and Appropriation in Education

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Abstract. Problem: Taking global Frameworks of ICT4E for developing M&E (Monitoring & Evaluation) research: ¿How to compose an integral schema to assess the state of inclusion, use and appropriation of ICT4E in institutions at Tunja, Colombia? **Objective:** Design an integral M&E schema of Inclusion, Use and Appropriation of ICT4E. **Methods:** The Evaluation schema was designed by correlation of Core Indicators of 7 educational Frameworks. The Monitoring scheme is composed of the steps for evolution assessment. Final assessment was performed to the 14 official institutions. **Results and Conclusion:** Public Educational Institutions at the city of Tunja are in the second stage of evolution, called Use. Individual Frameworks' scores supports the data behavior. It's the first time the institutions of the municipality are assessed about their ICT4E skills, so the given information should be taken as a preamble for further assessments; these should line up with national policies and goals.

Keywords: ICT4E · M&E · Educational Frameworks · Assessment · Indicators

1 Introduction

After more than 30 years of research on the field of integration of ICT in education, we understand that ICT are tools to deliver contents and implement better educational practices [1,2,3,4,5,6,7]. So a main goal for developed countries is the integration of ICT with the technical capabilities of teachers, technical support, maintenance and modernization, pedagogical skills, preferences and capabilities of teachers, availability of resources, skills and motivations of students to build a more dynamic educational environment. This is known as ICT for Education (ICT4E) [8].

Among investigations it's accepted the Technology-Enhanced Learning (TEL) concept [9]. However, other studies argue that only by providing infrastructure and computing resources to the institutes is not enough for a true integration of ICT in school practice [10].

a. ICT4E Frameworks

To guide ICT4E practices, organizations like UNESCO and nations such as South Africa, Australia, United States and the Netherlands, have designed Frameworks to set a benchmark of needed skills for its effective implementation, use and appropriation in educational environments [11,12,13,14,15,16].



b. M&E Schema

In order to assess the state of inclusion, use and appropriation of ICT of the official institutions of primary and secondary education at the municipality of Tunja, it's proposed a Schema of Monitoring and Evaluation (M&E) of ICT4E.

The schema is built from identifying indicators, which are the ways in which each selected framework delivers a state, trend or warning on ICT in the educational environment [17]. The indicators of each studied Framework cover topics such as implementation, monitoring, design plans, policies and custom models. Also are clearly and effectively categorized, so they can be correlated through the Core Indicators to be considered in any study of monitoring and evaluation of ICT for Education [18]. Based on this input the selected frameworks were correlated by their categories and their Stages of Evolution to ensure an effective measurement [19].

The schema is run through the survey *Assessment of the level of inclusion, use and appropriation of ICTs*, applied to the 14 official institutions in the municipality of Tunja.

• Frameworks and Indicators

In [19], 7 frameworks were identified for possessing outstanding progress reports and status of the implementations. Then they were analyzed based on the *Stages of Evolution* and the *Categories of Indicators*, and their most relevant indicators were extracted.

The selected Frameworks are:

- UNESCO ICT Competency Standards for Teachers, with 63 indicators.
- ICT-enhanced Teacher Standards for Africa, with 48 indicators.
- ISTE: National Educational Technology Standards for Teachers (NETS-T), with 84 indicators.
- Australia: ICT Competency Framework for Teachers, with 58 indicators.
- ICT-tools for a balanced use of ICT in the Netherlands, with 36 indicators.
- Metas Educativas 2021, with 4 indicators.
- Competencias TIC para el desarrollo Profesional Docente, with 45 indicators.

Metas Educativas 2021 is not really a framework but it is included because it's an unanimously accepted proposal by the Ministers of Education meeting at El Salvador, on the XVIII Ibero-American Conference; a joint commitment to meet the challenges of their people through an education program.

All the Frameworks were analyzed by two proposed factors: *Stages of Evolution* and *Categories of Indicators*. Although other studies as [20,21] developed M&E models, each Framework has its own way to assess and supervise [22,23,24,25,26,28]. So the work took on with the correlation of these factors to develop an integrative result. These proposed definitions determine how is evaluated and monitored the progress:

- The *Stages of Evolution* help to score the evaluated subject or entity at a performance level. Fig. 1 shows how each Framework measures progress. For the integral schema, this work proposed 3 stages: the lowest level was defined as Inclusion, intermediate level as Use and advanced as Appropriation. This allows to set quantitative scores on scales from 0 to 3 or 0 to 4, depending on the Framework.
 - The defined *Categories of Indicators*, used to assess the particular approaches.

FRAMEWORK	STAGES OF EVOLUTION			
	Inclusion	Use	Appropriation	
1. UNESCO ICT Competency Standards for Teachers	APPROACHES TO TEACHING			
	Technology Literacy	Knowledge Deepening	Knowledge Creation	
2. ICT-enhanced Teacher Standards for Africa.	Stages			
	Emerging	Applying	Infusing	Transforming
3. ISTE: National Educational Technology Standards for Teachers (NETS-T)	RUBRICS			
	Beginner	Medium	Expert	Transformer
4. Australia: ICT Competency Framework for Teachers	Phases			
	Phase 1	Phase 2	Phase 3	
5. ICT-tools for a balanced use Of ICT in the Netherlands	Expertise/Vision			
	Teacher-Driven Learning	Autonomous Learning	Self-Organized Learning	
7. ICT Competencies for the Professional Development For Teachers	Levels			
	Exploration	Integration	Innovation	

Fig. 1. Stages of Evolution of the Frameworks (Source: WOSC 2014, p. 124)

Each Framework is briefly described below:

a. Category of Indicators

At the design of the M&E Schema, was proposed a list of 7 *Category of Indicators* to have a general reference among all frameworks: ICT, Learning environments, Teacher Professional Learning / development, Pedagogy Assessment, Curriculum and Educational Policies. The states of evolution are quantified in Table 1.

Table 1. Qualification levels by category: Category of Indicators.

Evolution State	Qualification
Inclusion	0 \geq 1
Use	1 \geq 2
Appropriation	2 \geq 3

b. UNESCO ICT Competency Standards for Teachers

This UNESCO project provides a comprehensive framework for "capacity building" and "e-learning". Its primary aim is creating inclusive knowledge societies through information and communication [22].

It has 3 stages of evolution called *Approaches for Teaching*, quantified in Table 2. It groups the indicators into 6 categories called aspects of teachers' work: 1. Understanding ICT in Education (UN-1), 2. Curriculum and Assessment (UN-2), 3. Pedagogy (UN-3). 4. ICT (UN-4), 5. Organization and Administration (UN-5), 6. Teacher Professional Learning (UN-6).

Table 2. Qualification levels by category: UNESCO ICT Competency Standards for Teachers.

Approaches for Teaching	Qualification
1 Technology Literacy	0 \geq 1
2 Knowledge Deepening	1 \geq 2
3 Knowledge Creation	2 \geq 3



c. ICT-enhanced Teacher Standards for Africa

ICT e TSA was conceptualized and launched in 2009 by the UNESCO International Institute for Capacity-Building in Africa (IICBA), as one of the strategies for capacity building to strengthen the development of teachers in Africa [23].

It has 4 stages of evolution called *Stages*, quantified in Table 3. It groups the indicators into 6 categories called Areas: 1. Engage in Instructional Design Processes (AF-1), 2. Facilitate And Inspire Student Learning, Innovation And Creativity (AF-2), 3. Create and Manage Effective Learning Environments (AF-3), 4. Engage In Assessment and Communication of Student Learning (AF-4), 5. Engage In Professional Development Model And Ethical Responsibilities (AF-5), 6. Understand Subject Matter For Use in Teaching (AF-6).

Table 3. Qualification levels by category: ICT-enhanced Teacher Standards for Africa.

Stages	Qualification
1 Emerging	0 >= 1
2 Applying	1 >= 2
3 Infusing	2 >= 3
4 Transforming	3 >= 4

d. ISTE: National Educational Technology Standards for Teachers (NETS-T)

The text contains six standards with performance indicators, designed to be appropriate for state, universities or district guidelines. This performance indicators provide specific outcomes that are measured during the development of tools for assessing them [24].

It has 4 stages of evolution called *Rubrics*, quantified in Table 4. It groups the indicators into 6 categories called Standards Areas: 1. Technology Operations and Concepts (NS-1), 2. Planning and Designing Learning Environments and Experiences (NS-2), 3. Teaching, Learning, and the Curriculum (NS-3), 4. Assessment and Evaluation (NS-4), 5. Productivity and Professional Practice (NS-5), 6. Social, Ethical, Legal, and Human Issues (NS-6).

Table 4. Qualification levels by category: ISTE: National Educational Technology Standards for Teachers (NETS-T) .

Rubrics	Qualification
1 Beginner	0 >= 1
2 Medium	1 >= 2
3 Expert	2 >= 3
4 Transformer	3 >= 4

e. Australia: ICT Competency Framework for Teachers

The Framework articulates the competency standards for teachers working in government schools at Western Australia. It defines competency rules to describe the different degrees of effectiveness in which teachers demonstrate efficacy applying their professional knowledge, skills and attributes in the specific teaching context [25].

It has 3 stages of evolution called *Phases*, quantified in Table 5. It groups the indicators into 6 categories called Dimensions of Teachers' Work: 1. Facilitating Student Learning (AU-1), 2. Assessing and Reporting Student Learning Outcomes (AU-2), 3. Engaging in



Professional Learning (AU-3), 4. Participating in Curriculum Policy and Other Program Initiatives in an Outcomes-focused Environment (AU-4), 5. Forming Partnerships within the School Community (AU-5).

Table 5. Qualification levels by category: Australia: ICT Competency Framework for Teachers.

Phases	Qualification
1 Phase 1	0 \geq 1
2 Phase 2	1 \geq 2
3 Phase 3	2 \geq 3

f. ICT-tools for a balanced use of ICT in the Netherlands

This Framework aims to support the effective and efficient use of ICT in primary and secondary education at institutions of the Netherlands. It was designed by the ICT-OP [26].

It has 3 stages of evolution called *Expertise/Vision*, quantified in Table 6. It groups the indicators into 3 categories called Infrastructure/Content: 1. Instruction and Practice (4B-1), 2. Adaptive Learning Material (4B-2), 3. Personal Learning Environment (4B-3).

Table 6. Qualification levels by category: ICT-tools for a balanced use of ICT in the Netherlands.

Expertise/Vision	Qualification
1 Teacher-Driven Learning	0 \geq 1
2 Autonomous Learning	1 \geq 2
3 Self-Organized Learning	2 \geq 3

g. Metas Educativas 2021

It is a unanimously welcomed proposal by the Ministers of Education meeting at El Salvador in the XVIII Ibero-American Conference; a joint commitment to meet the challenges of their people future as an update through an educational program leading to a more just society for all [27].

The paper presents indicators to assess progress of the program until 2021. There were identified 4 indicators related to the implementation of technology in education: Indicator 16 (ME-16): Computer's use frequency at school by students for learning tasks, Indicator 20 (ME-20): Ratio of students per computer, Indicator 23 (ME-23): % Design of Technical and Professional Careers, Indicator 24 (ME-24): % Practices at enterprises.

h. ICT Competencies for the Professional Development for Teachers

This document is intended to provide guidelines, criteria and parameters for those who design and implement training programs for teachers and practicing managers, and teachers willing to take on the challenge of developing and training on the educational use of ICT. Was designed by the Educational Innovation Office, from the Ministry of Education of Colombia. [28].



It has 3 stages of evolution called *Levels*, quantified in Table 7. Groups the indicators into 5 categories called Competencies: 1. Technological (CP-1), 2. Pedagogical (CP-2), 3. Communicative (CP-3), 4. Management (CP-4), 5. Investigative (CP-5).

Table 7. Qualification levels by category: ICT Competencies for the Professional Development for Teachers.

Levels	Qualification
1 Exploration	0 >= 1
2 Integration	1 >= 2
3 Innovation	2 >= 3

- **Schema of Monitoring & Evaluation**

The evaluation scheme is integrated from the correlation of all Frameworks' categories, they will deliver the state scores. This correlation is achieved by extracting the most relevant and immediate indicators for the Implementation, Use and Appropriation of ICT in each case, also is identified their correspondence with the group of *Core Indicators* which it belongs. For such purpose is proposed an integrative frame called Category Indicators, the final correlation is shown in Fig 2.

	CORE INDICATORS	CATEGORY OF INDICATORS	FRAMEWORKS' INDICATORS						
Inputs	1. Classroom ICT resources	1. ICT	UN-4	AF-1	NS-1	AU-1, AU-2, AU-3, AU-4, AU-5	4B-2	ME-20	CP-1
		2. Learning environments	UN-5	AF-3	NS-2		4B-3	N/A	CP-3, CP-4, CP-5
	2. Teacher training	3. Teacher Professional Learning/development	UN-6	AF-5	NS-1	AU-3	4B-1		CP-2, CP-3, CP-5
	3. Classroom pedagogy	4. Pedagogy	UN-3	AF-2	NS-3	AU-1	4B-1, 4B-3	ME-16	CP-5
Outputs	4. Student knowledge of School subjects	5. Assessment	UN-2	AF-4	NS-3, NS-4	AU-1, AU-2	4B-1	N/A	CP-4
	5. Student attitudes			AF-2	NS-3, NS-4, NS-5	AU-1, AU-2, AU-5			CP-2, CP-3, CP-4
	6. Student skills			NS-3, NS-4	AU-1, AU-2	CP-4			
	7. Systemic outcomes	6. Curriculum	AF-1	NS-3	AU-4	4B-3	ME-23		
	8. Teacher outcomes		N/A						
9. Long-term outcomes	7. Educational Policies	UN-1	AF-5, AF-6	NS-6	AU-4, AU-5	4B-1, 4B-2, 4B-3	ME-24	CP-4, CP-5	

Fig. 2. Indicators of the Frameworks (Source: WOSC 2014, p. 124).

Based on [29,30,31,32], was structured the assessing tool called *Assessment of the level of inclusion, use and appropriation of ICTs*, applied to the 14 official institutions in the municipality of Tunja.

The Monitoring schema was made from the steps to be followed to assess the state of inclusion, use and appropriation of ICTs across time and when is required. This process needs the Current State Assessment to make a quantitative review across time. The tasks in monitoring are: 1. Improvement Opportunities, 2. Setting Goals, 3. Action Plan Setting, and 4. Start Plan. The ideal frequency for measurement is annual due to amount of assessments made by the official institutions on this way, so adding this measurement to the summary of evaluations conducted facilitate its implementation. The scheme can be seen in Fig.3.

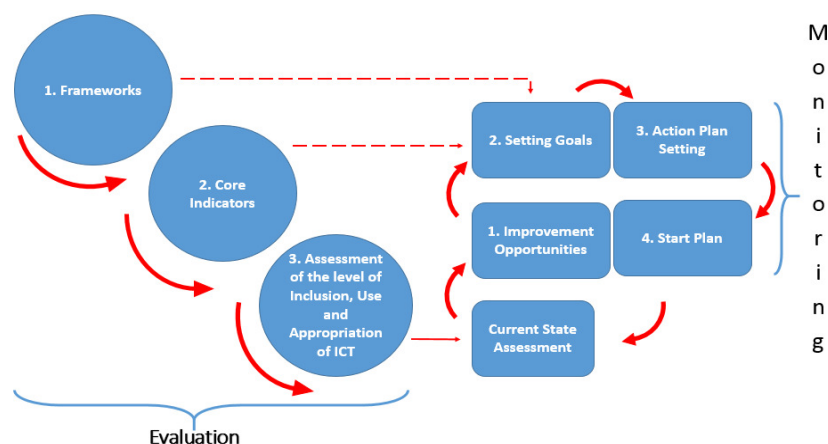


Fig. 3. M&E Schema (Source: The Authors)

• Results

The collected results were analyzed around the 7 selected Frameworks, plus the integrator frame *Category of Indicators*. Then, the current state of Inclusion, Use and Appropriation of ICT for Education in the official educational institutions in the municipality of Tunja is presented in Table 8.

Table 8. Evaluated Scores.

Framework	Categories	Abreviattion	Score
1 Category of Indicators	1.2 ICT		1,4
	1.2 Learning environments		0,9
	1.3 Teacher Professional Learning/development		1,4
	1.4 Pedagogy		1,9
	1.5 Assessment		1,6
	1.6 Curriculum		1,9
	1.7 Educational Policies		1,6
2 UNESCO ICT Competency Standards for Teachers	2.1 Understanding ICT in Education	UN-1	1,4
	2.2 Curriculum and Assessment	UN-2	1,8
	2.3 Pedagogy	UN-3	1,9
	2.4 ICT	UN-4	1,2
	2.5 Organization and Administration	UN-5	1,4
	2.6 Teacher Professional Learning	UN-6	1,3



3 ICT-enhanced
Teacher Standards for
Africa

3.1 Engage In Instructional Design Processes	AF-1	2,1
3.2 Facilitate and Inspire Student Learning, Innovation and Creativity	AF-2	2,6
3.3 Create and Manage Effective Learning Environments	AF-3	2,2
3.4 Engage In Assessment and Communication of Student Learning	AF-4	2,1
3.5 Engage In Professional Development and Model Ethical Responsibilities	AF-5	1,8
3.6 Understand Subject Matter for Use In Teaching	AF-6	2,2

4 ISTE: National
Educational
Technology
Standards for Teachers
(NETS-T)

4.1 Technology Operations and Concepts	NS-1	1,7
4.2 Planning and Designing Learning Environments and Experiences	NS-2	1,9
4.3 Teaching, Learning, and The Curriculum	NS-3	2,7
4.4 Assessment and Evaluation	NS-4	2,1
4.5 Productivity and Professional Practice	NS-5	2,2
4.6 Social, Ethical, Legal, And Human Issues.	NS-6	2,0

5 Australia: ICT
Competency
Framework for
Teachers

5.1 Facilitating Student Learning	AU-1	1,8
5.2 Assessing and Reporting Student Learning Outcomes	AU-2	1,7
5.3 Engaging in Professional Learning	AU-3	1,3
5.4 Participating in Curriculum Policy and Other Program Initiatives in an Outcomes-focused Environment	AU-4	1,7
	AU-5	2,6
5.5 Forming Partnerships within the School Community		

6 ICT-tools for a balanced use of ICT in the Netherlands			
6.1 Instruction and Practice	4B-1		1,8
6.2 Adaptive Learning Material	4B-2		1,5
6.3 Personal Learning Environment	4B-3		1,5
7 Metas Educativas 2021, 4 indicators.			
7.1 Indicator 16: Computer's use frequency at school by students for learning tasks	ME-16		6.8 Hours
7.2 Indicator 20: Ratio of students per computer	ME-20		1/3 Students per CPU
7.3 Indicator 23: % Design of Technical and Professional Careers	ME-23		64,3%
7.4 Indicator 24: % Practices at enterprises	ME-24		57,1%
8 ICT Competencies for the Professional Development For Teachers			
8.1 Technological	CP-1		1,4
8.2 Pedagogical	CP-2		1,8
8.3 Communicative	CP-3		1,5
8.4 Management	CP-4		1,8
8.5 Investigative	CP-5		1.2

• Findings and Conclusions

The scores were represented in radar charts to make easy comparative analysis between institutions for a detailed report. Though, the matter of this study was only centered on the general results as a performance metrics. The general results of this study shows that public institutions of primary and secondary education at the municipality of Tunja are in the second stage of evolution, called Use, this is shown in Fig. 4. The scores for each individual Framework were as follow:

- UNESCO ICT Competency Standards for Teachers: At second stage of evolution, called Knowledge Deepening. See Fig. 5.
- ICT-enhanced Teacher Standards for Africa: Reaching the third stage of evolution, known as Infusing. See Fig. 6.
- ISTE: National Educational Technology Standards for Teachers (NETS-T): Going through the transition from the second state of evolution called Medium to the third status, Expert. See Fig. 7.
- Australia: ICT Competency Framework for Teachers: At the second stage of evolution called Phase 2. See Fig. 8.
- ICT-tools for a balanced use of ICT in the Netherlands: At the second stage of evolution, called Autonomous Learning. See Fig. 9.

- ICT Competencies for Teacher Professional Development: The scores are distributed at the second stage of evolution, called Integration. See Fig. 10.
- About Metas Educativas 2021: The municipality has successfully accomplished the proposed indicators for 2015.

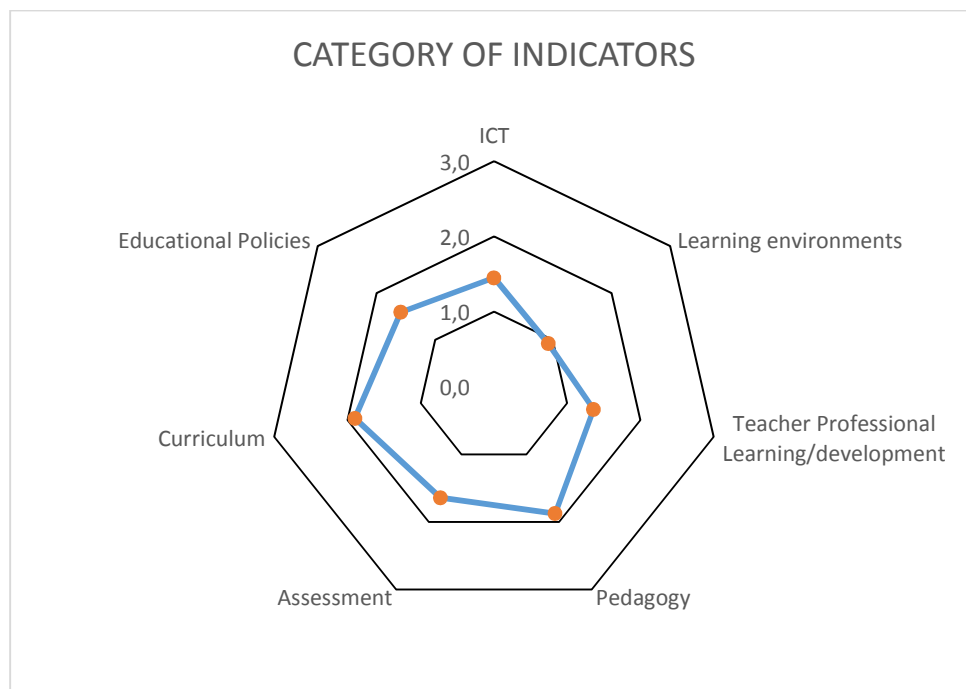


Fig. 4. Evaluated state according to Category of Indicators (Source: The Authors).

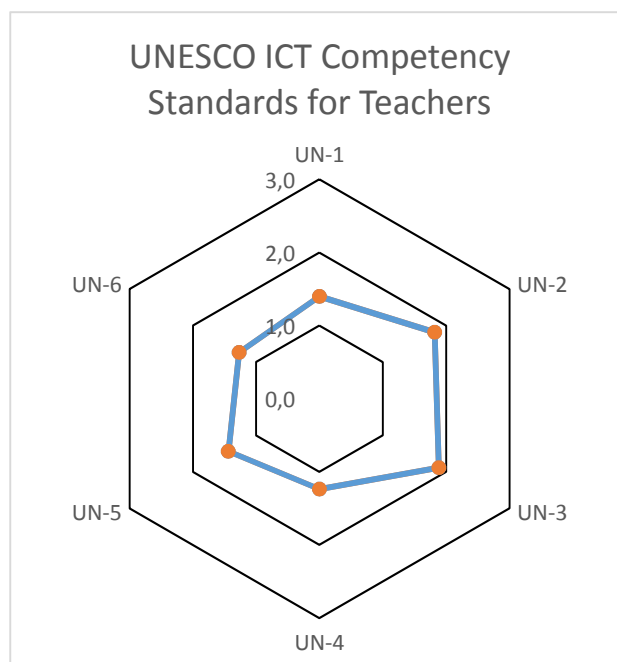


Fig. 5. Evaluated state according to UNESCO ICT Competency Standards for Teachers (Source: The Authors).

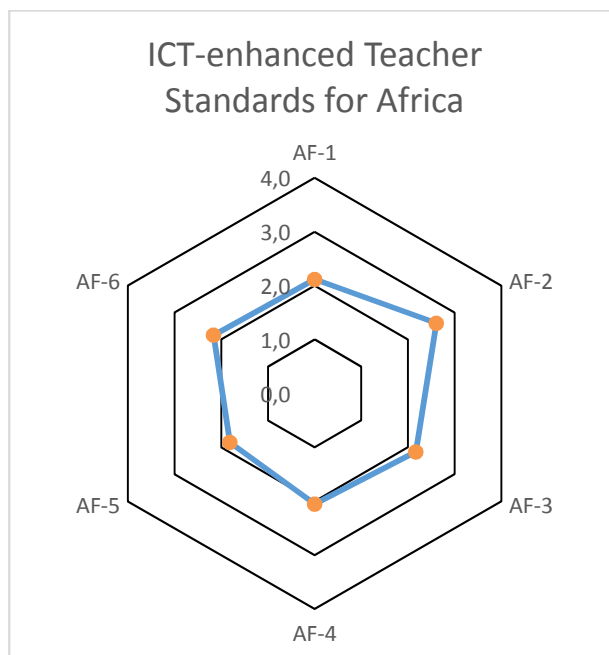


Fig. 6. Evaluated state according to ICT-enhanced Teacher Standards for Africa (Source: The Authors).

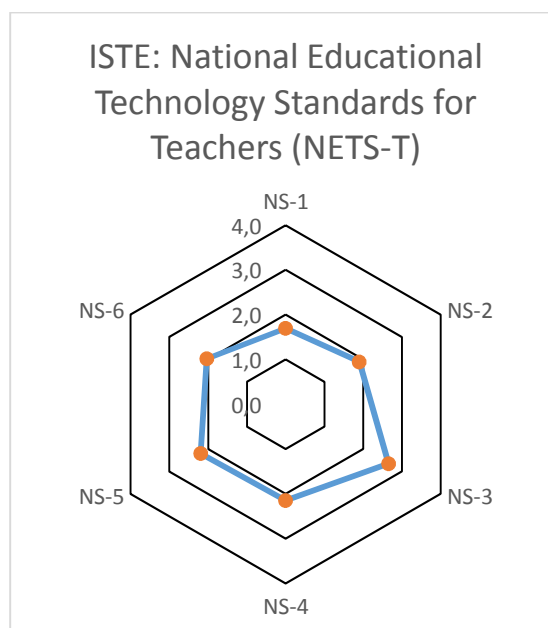


Fig. 7. Evaluated state according to ISTE: National Educational Technology Standards for Teachers (NETS-T) (Source: The Authors).

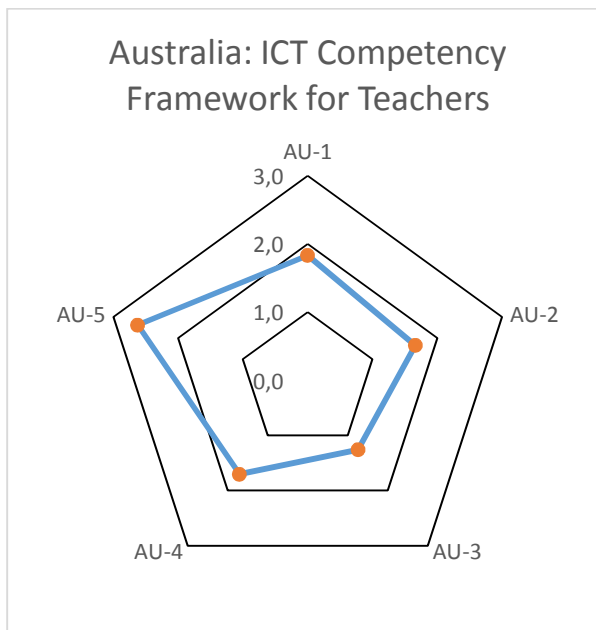


Fig. 8. Evaluated state according to Australia: ICT Competency Framework for Teachers (Source: The Authors)

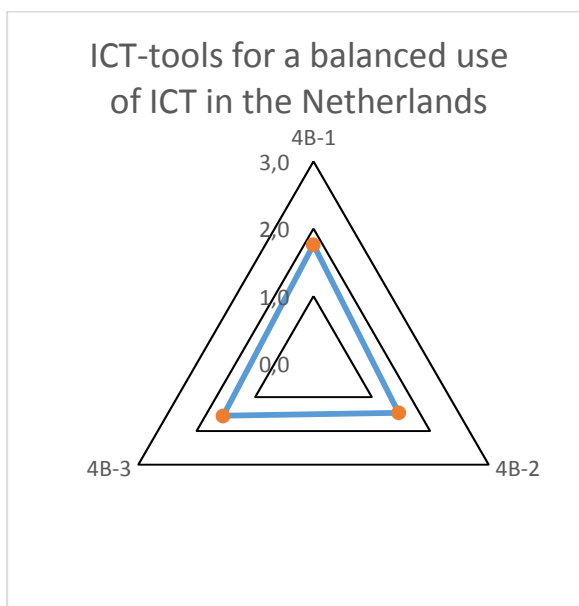


Fig. 9. Evaluated state according to ICT-tools for a balanced use of ICT in the Netherlands (Source: The Authors).

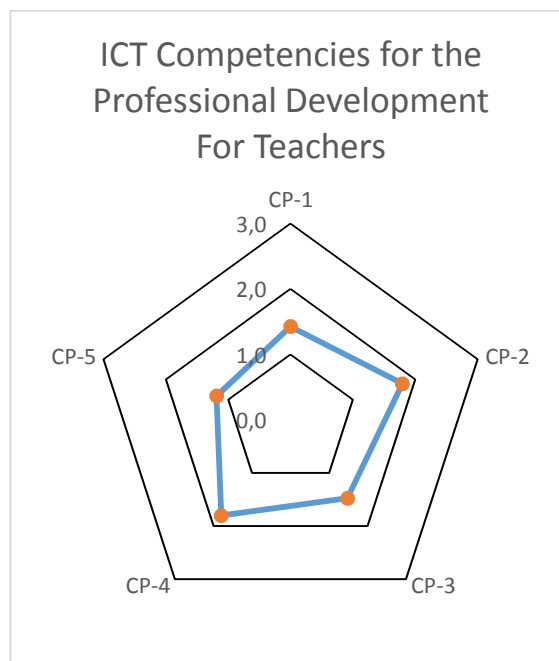


Fig. 10. Evaluated state according to ICT Competencies for the Professional Development For Teachers (Source: The Authors).

A significant remark of this study, is the capability to evaluate states and show the results according to different frameworks. This provide the institutions with numerous tools to overcome their weaknesses, work on their strengths and continue evolving in the educational exercise supported by ICT.

The second important contribution of the research is the data obtained with the evaluation schema. With the quantification of the state of Inclusion, Use and Appropriation of ICT at education, the Municipal Secretary of Education may establish new action plans, assessing and monitoring of the educational environment for improving it. It's also important to mention that as far as it's known, this study is first on its type at the region.

About the current state of Inclusion, use and appropriation of ICT: The scores show that the institutions of the municipality have strengths in skills such as administrative management, design curriculum, training and making associations of the school community and especially in pedagogy or teaching practice. The achievements in these areas should be used to support areas with more opportunities for improvement, as the development of curriculum policies to foster professional development and the evaluation/reporting of results in learning, making of adaptive resources and personal learning environments, and especially, with deepening on ICT for Education operational concepts and educational research.

- **Implications for Further Research**

This is the first time the institutions of the municipality receive an assessment of their skills related to ICT. The given information should be taken as a preamble for a deeper and detailed assessment work. The studies can be done individually for each institution so the M&E can be performed to attain specific interests and goals.

About Monitoring, even though is advised a yearly frequency, it also can be done by half-year or even on shorter terms. The objective is not only taking data, the measured scores must be improved, therefore it would be appropriate to conduct a study focusing on the techniques that can be used to improve the scores over the indicators and validate data using the monitoring and evaluation schema.



Finally, all the results and improvements made must line up with national policies and goals. For example: Newly, during the International Seminar on ICT, organized by Fedesarrollo, the Minister of Education launched the National Observatory of Educational Use of new technologies. This is an innovative tool that will measure the use and impact of ICT at the classroom. The Observatory will realize its work by publishing every year a National Report on Use of ICT in Education [33]. This kind of initiatives can provide new base data, and this schema can also contribute to MEN.

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