“Assessing Impact of ICT on the quality of education”

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Objectives

- To understand some of the weakness of the design, implementation and evaluation of ICT in educational settings

- Propose a conceptual model to create ICT for education programs

- Discuss applications for public policies
ICT in education

**History**

- Significant evaluation studies
- Uses of ICT on education & Research topics
- Technological development

Years
ICT in education

**History**

Significant evaluation studies

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**Uses of ICT on education & Research topics**
- Educational software
- Use of ICT in universities
- Subject-based drill & practices programs

**Technological development**
- Microprocessors
- Interactive computers
- INTERNET / ARPANET
- Miniaturization of electronic components

ICT in education

History

Significant evaluation studies

Uses of ICT on education & Research topics
- Widespread use of computers in schools
- LOGO
- Spreadsheets / word processors software

Technological development
- World wide web
- Windows
- IBM–PC / Apple Macintosh

1980–90
ICT in education

History

Significant evaluation studies

- SITES M1
- ImpaCT2
- ImpaCT

Uses of ICT on education & Research topics

- Theories about educational change
- Need of resources for teaching with ICT
- Widespread use of ICT in schools

Technological development

- Personal Digital Assistants
- Interactive whiteboards
- Classroom Projectors
- Laptop computers

1991–99
ICT in education

History

Significant evaluation studies

Uses of ICT on education & Research topics

Technological development

Silicon Valley vs Silicon Glen
SITES M2
On-line courses and assessment
Conflict between productivity and educational software
Wireless network massification
Learning Virtual Environments
Internet massification

2000–04
ICT in education

History

Significant evaluation studies

Impact Report (European Schoolnet)
Uses of ICT on education & Research topics
Impact on standardized tests
Digital Literacy

Technological development

Web 2.0

2004–07
**ICT in education**

### History

#### Significant evaluation studies
- Evaluation of “Computadores para educar” (Colombia)
- Evaluation of “Enlaces” network (Chile)
- Effectiveness of Reading and Mathematics Software Products II (USA)
- Effectiveness of Reading and Mathematics Software Products I (USA)
- SITES 2006

#### Uses of ICT on education & Research topics
- 21st Century skills
- CSCL
- 1:1

#### Technological development
- Kindle, Ipad
- OLPC, Netbooks
- YouTube, Facebook, Twitter

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2008–10
What affects the impact of ICT on education?

What we know

- ICT was not designed for educational purposes
- Technology is put before pedagogy
- Existing educational research was not applied to ICT programs
- ICT generally implemented without valid theoretical support
- ICT competes with the needs of the system, measured by standardized tests
- Lack of adequate ICT monitoring initiatives, to learn from experience
Evaluation of the impact

**What we know**

- No accepted standard methodologies for measuring the impact

- Evaluation weakness are:
  - What to measure
  - What to measure with
  - How to measure
Evaluation of the impact

What we know

• What to measure:
  - Identifying the effects of ICTs
  - Identifying how the ICT design and its curricular implementation affect students’ attainment
  - Teachers’ pedagogical approaches
Evaluation of the impact

*What we know*

- **What to measure with:**
  - Assessment instruments don’t match the defined aims
  - The instruments that measure educational results are rarely sufficiently investigated, as far as reliability and validity
How to measure:
- It is difficult to isolate the role technology plays in experimental studies carried out in real educational settings
- There are substantial differences between the design and actual implementation of ICTs in education
- Lack of explanation regarding results
- Relevance of findings
Conceptual model

**Concepts & background**

- Efficacy, effectiveness, efficiency
- Formative and summative studies
- Investigation methods: “Design research”
- ICT for education program
- Experimental design
Conceptual model

*Concepts & background: 3E*

- **Efficacy**: when in *controlled environments*, technology is evaluated to determine if it *can* improve students’ results.

- **Effectiveness**: when in *real educational settings*, technology is evaluated to determine if better results are *really* obtained.

- **Efficiency**: considers program costs to effectiveness, measuring its practical applicability and replicability.
Formative studies are carried out to improve learning environments while the program is being developed.

Summative studies aim to show its impact once it is completed.
Hypotheses Based upon Observation and/or Existing Theories

Experiments Designed to Test Hypotheses

Theory Refinement Based on Test Results

Application of Theory by Practitioners

Specification of New Hypotheses

Analysis of Practical Problems by Researchers and Practitioners in Collaboration

Development of Solutions Informed by Existing Design Principles and Technological Innovations

Iterative Cycles of Testing and Refinement of Solutions in Practice

Reflection to Produce “Design Principles” and Enhance Solution Implementation

Refinement of Problems, Solutions, Methods and Design Principles
Conceptual model

Background: ICT4E program

- ICT for Education (ICT4E) Program:
  - Pedagogical Model (what is installed)
  - Intervention (how it is installed and monitored)
  - Transference (training for intervention)
Conceptual model

Background: ICT4E program

Transference

Implanter

Teacher

Intervention

Implementation Process

Student

Pedagogical model

Empowered teacher

Results on Students' attainment
To find rigorous evidence (BEE, WWC) of the impact of technology on students’ attainment, key are:
   - Experimental design
   - Sample size
   - Interpretation of results

Effect size and statistical significance must be interpreted together (Fan, 2001)

When effect size ($\delta$) is measured, type I ($\alpha$) and type II ($\beta$) errors have to be controlled
   - These 3 elements are related with the sample size:
     - $\alpha = 0.05$
     - $1 - \beta \geq 0.8$ (Fox & Mathers, 1997)
     - $\delta \geq 0.25$ (Agodini et al. 2003).
   - Effect size diminishes with larger sample sizes (Slavin & Smith, 2009).
Background: sample size

Total sample size and statistical power necessary to measure a given effect size of two independent means (two groups)

2 tails, equal size samples, \( \alpha = 0.05 \)
Conceptual model

- Decomposes the problem of designing, implementing and evaluating ICT4E programs in stages:
  - **Efficacy**: studies the impact in laboratory and real educational environments focusing on the pedagogical model
  - **Effectiveness**: studies the impact in real educational environments focusing on the pedagogical model and intervention
  - **Efficiency**: studies the impact in real educational environments focusing on the pedagogical model, intervention, transference and costs of the solution.

- Ensure the effectiveness of the ICT4E programs before performing expensive summative evaluations.
Conceptual model

Scale of implementation

Pertinence
Assumptions on which it is based
Learning environment
Literacy in the ICT environment

Impact on students’ attainment

Pedagogical Model

Efficacy

Initial design

Final outcome of the stage

Iterative cycles of design, testing and refinement performing formative and summative evaluations

Duration of the cycle

(sample size of summative evaluation on each stage)
Conceptual model

- Context
- Intervention
- Fidelity of the implementation
- Impact on students’ attainment
- Relationship between variability of the implementation and results

- Scale of implementation
- Duration of the cycle

Intervention
- Effectiveness
- Efficacy

Pedagogical Model

Duration of the cycle
Conceptual model

- Impact on students’ attainment
- Relationship between the variability of the intervention, implementation, and results
- Fidelity of the intervention
- Fidelity of the implementation
- Total cost of the program

Transference
Efficiency
Effectiveness
Efficacy

Scale of implementation
Duration of the cycle
Conceptual model

Final product: ICT4E Program

Duration of the cycle

Scale of implementation

Stages of the design and development process with their respective emphasis

- Transference
- Intervention
- Pedagogical Model
- Efficacy
- Efficiency
Conceptual model

An example

Collaborative activities without technology

Primary education (1st and 2nd grades)

Collaborative learning (Dillenbourg, 1999)

Pedagogical Model

Duration of the cycle

weeks

1 school

Efficacy
Conceptual model

**An example**

Collaborative activities with technology

- Primary education (1st and 2nd grades)
  - Mobile Computer supported Collaborative learning (Zurita & Nussbaum, 2007)

**Efficacy**

1 school

**Pedagogical Model**

- Duration of the cycle
  - weeks

- 1 school
Conceptual model

*An example*

Collaborative activities *without* technology
Conceptual model

An example

Collaborative activities with technology
Conceptual model

An example

- **Intervention**
  - Secondary education (9th and 10th grades)
  - 5 schools

- **Effectiveness**

- **Duration of the cycle**
  - 2004
  - Months

- **2004**

- **5 schools**
Conceptual model

An example

2005–2006

Secondary education (9th and 10th grades)

Intervention

Effectiveness

5 schools

months

Duration of the cycle
Conceptual model

An example

Students’ attainment in Physics (10th grade) 2005–2006

(Rodríguez et al. 2010)
Conceptual model

An example

2007

Primary and secondary education

Transference

Efficiency

30 schools

Duration of the cycle

Years
Conceptual model

An example

2008

Primary and secondary education

Transference

Efficiency

30 schools

Duration of the cycle

years
Relative comparison of Eduinnova program using netbooks and multiple mice as hardware platforms

Cost (netbook=100)

δ MM 0.52 – 0.66
Applications
Applications

Incorporating cost-effectiveness to design

Efficiency

Effectiveness

Efficacy

ICT4E program

Cost-effectiveness ratio

Minimal effect size

Cost per student (estimated)

Initial design

Duration of the cycle

Duration of the cycle

Efficacy

Effectiveness

Efficiency

Initial design

Duration of the cycle

Cost per student (estimated)

Incorporating cost-effectiveness to design

Applications
Development of an ICT4E policy
Applications

Development of an ICT4E policy

- Efficiency
- Effectiveness
- Efficacy

Initial design

Final outcome of the stage

Duration of the cycle

Scale of implementation

Applications

Development of an ICT4E policy
Applications

Development of an ICT4E policy

Final product: ICT4E Program

Efficiency

Effectiveness

Efficacy

Cost per student

Duration of the cycle

Initial design

Final outcome of the stage

To educational system

Applications

Development of an ICT4E policy

Final product: ICT4E Program

Efficiency

Effectiveness

Efficacy

Cost per student

Duration of the cycle

Initial design

Final outcome of the stage

To educational system
Conclusions
Conclusions

Pros

- Develops ICT4E programs based on rigorous evidence of the real effectiveness of the pedagogical model, intervention and transference
- Gives the decision-maker tools to build a public policy for the development of ICT4E programs
- Provides guidelines for evaluating grant proposals, and the projects themselves
- Educational policies are defined based on the specific schools needs, diversifying the equipment in schools
Conclusions

Cons

- Formative and summative evaluation methodologies require long-term alliances between researchers, schools and politicians

- Public and/or private agencies must be prepared to support this process to achieve the expected results

- It can take more time and resources than initially expected
Conclusions

Challenges (i)

• Long term commitment: political and institutional viability to carry out this proposal

• Evaluation requires specific technical abilities: governments must collaborate with specialized institutions, such as universities and research centers

• Requires long term incentives for researchers which currently are rewarded mainly by publishing
Conclusions

**Challenges (ii)**

- Evaluation standards for each stage, which can be objectively and transparently applied

- Ethical issues regarding educational research in real settings

- Standards for the calculation of the total cost of the program, to calculate, compare, and make transparent the differences between several proposals
World experience

- (Some) key players:
  - Government and Research agencies (e.g.)
    - BECTA, Education.au, Enlaces, KERIS, LSL
    - FutureLab, Mathematica Policy Research, SRI International
  - Institutions: (e.g.)
    - Interamerican development Bank (IADB)
    - World Bank (InfoDev)
    - United Nations (CEPAL, UNESCO)
    - OECD
World experience

ICT in Education

The use of ICT in and for education is now seen worldwide as both a necessity and an opportunity.

UNESCO is giving a high priority to the use of ICT for more equitable and pluralistic development in education, aiming to expand the knowledge base about the issues.

The broad questions on which UNESCO focuses are:

- How can one use ICT to accelerate progress towards education for all and throughout life?
- How can ICT bring about a better balance between equity and excellence in education?
- How can ICT help reconcile universality and local specificity of knowledge?
- How can ICT help prepare individuals and society to benefit from ICT that increasingly permeate all realms of life?

Several points must be borne in mind as one pursues these questions. First, ICT are only a part of a continuum of technologies, starting with chalk and books, all of which can support and enrich learning. Second, ICT, as any tools, must be considered as such, and used and adapted to serve educational goals. Third, many ethical and legal issues intervene in the...
World experience

- (Some) specialized journals:
  - British Journal of Educational Technology
  - Computers and Education
  - Educational Evaluation and Policy Analysis
  - Education and Information Technologies
  - Educational Technology and Society
  - Journal of Educational Research
  - Review of Educational Research
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