Models of study for ICT-supported educational programs, applications, and generalization to the non-ICT field

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EIPPEE Conference 2012
The Hague, Netherlands
May 10th 2012
Problem definition:

*ICT impact in Education*

Frameworks to study ICT in education

*ICT4E programme & EDM*

Implications for policy making

*What is next?*
Problem definition

ICT impact in Education

• ICTs in schools: to “transform” teaching and learning processes for better educational attainment

• But, there is still no conclusive answer about their impact

• Why ICT did not have the expected effects?
Dimensions affecting the impact of ICT:

1. Design and implementation in real settings
2. Evaluation of impact
3. Scaling-up
4. Cost-effectiveness
1. Design and implementation

• **Design:**
  – ICT was not designed for educational purposes
  – Technology is put before pedagogy
  – Previous educational research was not used

• **Implementation**
  – Without valid theoretical support
  – Competes with the needs of the system, measured by standardized tests
  – Lack of adequate ICT monitoring initiatives, to learn from past experience
2. Impact evaluation

• No accepted standard methodologies for measuring the impact

• Evaluation weakness are:
  – What to measure
  – What to measure with
  – How to measure
1. ICT impact in Education

2. Impact evaluation

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

**What to measure with**
- Assessment instruments don’t match the defined aims
- Reliability and validity of assessment instruments

**How to measure**
- It is difficult to isolate the impact of ICT in real educational settings
- Differences between the design and implementation
- Lack of explanation regarding results
- Relevance of findings
2. Impact evaluation

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

2 tails, equal size samples, $\alpha=0.05$

- $\delta = 0.25$
- $\delta = 0.35$

Power ($1-\beta$ err prob) of t-test
• It has not been studied in depth: tendency to try and repeat what worked locally, everywhere

• Dimensions of scalability:
  – **Depth** (changes needed in classroom practice)
  – **Sustainability** (how to maintain these changes over time and under what conditions)
  – **Spread** (diffusion of the innovation to large numbers of classrooms and schools)
  – **Shift in reform ownership** (school’s adoption of the programme)
Very few rigorous, quantitative studies of the real cost of ICT in education have been conducted.

The required investment in ICT cannot be easily calculated and compared between different countries and schools.

Even less is known about the cost-efficiency of ICT, particularly in developing countries.
Frameworks to study ICT in education

- ICT for Education (ICT4E) programme:
  - What we understand by an educational programme based on ICT?
  - How and why a Technology Enhanced Learning environment works?
  - What do teachers and students need to perform new teaching and learning practices?
  - How can we calculate the total cost to compare it with other educational programmes?
• **Evolutionary Development Model:**
  
  – How can we design, implement and evaluate ICT4E programmes?
  
  – How can ensure the effectiveness of the ICT4E programmes before performing expensive summative evaluations?
ICT4E programme

Activities timeline

Settings

- Transference
- Intervention
- Implementation

Elapsed time

- External
- School
- Classroom

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Monitoring plan for adoption indicator

Assessment 1
- Teachers and students start using ICT4E program (expected evolution according to experience)

Assessment 2
- Remedial actions are required

Assessment 3
- Remedial actions performed

Elapsed time

Expected outcome of indicator

Deviation from plan

Adoption indicator
- Adoption indicator (expected evolution according to experience)
- Adoption indicator (actual evolution)

Possible evolution without remedial actions

Intervention

Implementation

Teachers and students start using ICT4E program
Evolutionary Development Model

Description

- Decomposes and studies the problem of designing, implementing, evaluating and scaling-up ICT4E programmes in 3 stages:
  - Efficacy
  - Effectiveness
  - Efficiency

- Ensure the effectiveness of the ICT4E programs before performing expensive summative evaluations.
Iterative cycles of design, testing and refinement performing formative and summative evaluations.

Evolutionary Development Model

Efficacy → Implementation

- Pertinence
- Assumptions on which it is based
- Learning environment
- Literacy in the ICT environment
- Impact on students’ attainment

Initial design → Final outcome of the stage

Scale of implementation (sample size of summative evaluation on each stage)

- Laboratory,
- Few classrooms

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Effectiveness → Intervention

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

Evolutionary Development Model

Effectiveness
- Few classrooms, some schools, a district

Implementation
- Laboratory, few classrooms

Intervention

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Evolutionary Development Model

Efficiency → Transference

- 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
  - Schools
  - District
- Effectiveness
  - Few classrooms
  - Some schools
  - A District
- Efficacy
  - Laboratory
  - Few classrooms
Evolutionary Development Model

Result: an ICT4E programme

- **Transference**
  - Schools
  - District
  - State

- **Intervention**
  - Few classrooms,
  - Some schools
  - A District

- **Implementation**
  - Laboratory,
  - Few classrooms

- **Efficiency**
- **Effectiveness**
- **Efficacy**

Scale of implementation:
- Nationwide

Process specification and documentation:
- Development of a monitoring and evaluation scheme
Evolutionary Development Model

An example: efficacy

Primary education (1st and 2nd grades)

Collaborative activities without ICT

Collaborative learning (Dillenbourg, 1999)

Implementation

Efficacy

1 school

Scale of implementation

Duration of the cycle

weeks

Primary education (1st and 2nd grades)
Evolutionary Development Model

An example: efficacy

Collaborative activities supported with ICT

Mobile Computer supported Collaborative learning
(Zurita & Nussbaum, 2007)

Implementation

Primary education (1st and 2nd grades)

1 school

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Evolutionary Development Model

An example: *efficacy*

*Collaborative activities without ICT*
Evolutionary Development Model

An example: efficacy

Collaborative activities supported with ICT
Evolutionary Development Model

An example: effectiveness

Secondary education (9th and 10th grades)

2004

Scale of implementation

Duration of the cycle

Effectiveness

Implementation

5 schools

1 school

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Evolutionary Development Model

An example: effectiveness

- **Intervention**: Effectiveness
  - 5 schools

- **Implementation**: Efficacy
  - 1 school

Secondary education (9th and 10th grades)

2004

Duration of the cycle: months

Scale of implementation

Quantitative results:
There were no statistically significant differences
Evolutionary Development Model

An example: **effectiveness**

**Qualitative results**

**Educational contexts (inherent flaws)**
- Planning and use of class time
- Communication between teachers
- Mastery of subject

**Teaching orientation**: Changing roles is not automatic

**Technical problems**: connectivity and usability, logistics

**Research overhead**: constant external assessments overburn teachers

**Intervention**
- **Effectiveness**
  - 5 schools

**Implementation**
- **Efficacy**
  - 1 school

**Secondary education (9th and 10th grades)**

**Scale of implementation**

- 2004

**Duration of the cycle**

- months

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Evolutionary Development Model

An example: effectiveness

2005-2006

Secondary education (9th and 10th grades)

5 schools

1 school

Intervention
Effectiveness

Implementation
Efficacy

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Evolutionary Development Model

An example: effectiveness

Monitoring and evaluation scheme (M+E)

ICT management
Inside the classroom

Pedagogical practices of teachers in collaborative learning

Achievement (%)

Introduction
Training and coaching
Remote supervision
Autonomous implementation

Weeks

0 25 50 75 100

Evolutionary Development Model

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

An example: **effectiveness**

\[ d = 0.41 \]
\[ d = 0.32 \]
\[ d = 0.56 \]
\[ d = 0.45 \]

(Rodríguez et al. 2010)
Evolutionary Development Model

An example: efficiency

2007

Primary and secondary education

Scale of implementation

Duration of the cycle
years

Transference
Efficiency
30 schools

Intervention
Effectiveness
3 districts

Implementation
Efficacy
5 schools

1 school

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Evolutionary Development Model

An example: efficiency

Primary and secondary education

2008

Transference
- Efficiency
  
  30 schools

Intervention
- Effectiveness
  
  3 districts

Implementation
- Efficacy
  
  5 schools

δ MM 0.52 – 0.66

Duration of the cycle
- years

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Centro de Investigación Avanzada en Educación Universidad de Chile
Evolutionary Development Model

An example: *efficiency*

Comparative costs of MCSCL using Netbooks vs Multiple mice

![Graph showing comparative costs](image)

- **Netbook**
  - Hardware: 70
  - Teacher Training: 10
  - Technical Support: 20

- **Multiple Mice**
  - Hardware: 25
  - Teacher Training: 37

Cost (netbook=100)
Applications

- **ICT4E programme:**
  - Calculus of total cost and return of investment
  - Analysis of economic feasibility and cost-effectiveness
  - Specification of ICT projects for public funding
  - Assessment according to a standard of evaluation: Enlaces (Chilean Educational technology office)
  - Differentiate impact depending on adjustment to the definition
Evolutionary Development Model:

- **Roadmap** to create programmes both technically and financially feasible
- Works from **specific needs** and realities of the schools
- Can be used as base of a **system of grants** for each stage of the model:
  - Projects at the same stage are compared in terms of **cost-effectiveness** to determine if they will receive further funding
  - Rigorous evaluation standards for summative evaluations
- **Learn from failure**
Implications for policy making

How can policies benefit from this?

From where to start?

What do we need and what are our chances of being successful?
- School problems driven
- Alignment with current policies
- Innovators vs. followers
- Expectations about impact and costs

Diversification vs Intensification:
- Subjects, levels
- Beneficiary population
- Innovativeness profiles
Implications for policy making

How can policies benefit from this?

Which projects should continue?

Comparing ICT4E vs “traditional” initiatives
• Single or different tracks?

Selection criteria
• Cost-effectiveness of intervention including Monitoring and Evaluation
• Portfolio of projects:
  – According to risk
  – Innovativeness profiles
  – Infrastructure required
  – Sustainability
  – Scalability

Scale of implementation

Duration of the cycle
Implications for policy making

How can policies benefit from this?

Delivery and funding models
- Government purchase and distribute vs subsidies or private investment

Certification and quality assurance:
- Optimal relationship between cost and effectiveness across time
- Are desired effect achieved?

Technological issues:
- Obsolescence
- Emerging technologies (e.g. e-readers)

Transference to the educational system
Implications for policy making

Further Research questions

• What do happen if we remove the word “ICT” from these frameworks?
  – What is the relative impact between ICT4E and more “traditional” educational programmes?
  – There are some differences between the effectiveness of the programmes depending on specifics characteristics?

• How can policy-makers choose between educational programmes?
Thank you!