

# The Impact of Research and Information Technology Solutions in the Context of Tertiary Educational Institutions

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## Abstract

*While there is rapid growth in the use of information and communications technologies in education, there has been little assessment of the effect of IT on graduates' outcomes. This study performs an analysis of existing and current research concerning the implementation of IT solutions to support education achievements in the tertiary educational institutions in Europe. This research is two-fold, consisting of a literature review and numerous in-depth, structured interviews. The authors performed a literature review of published and unpublished works regarding the educational implication of IT solutions. Interviews were administered to a wide range of IT academics, researchers, managers, and designers of IT solutions. The interviews were used to examine the development, accomplishment and evaluation of current IT solutions in education and to develop strategies in the implementation of IT solutions for tertiary educational institutes particularly with regard to future research, IT effectiveness, influence, and return on funding.*

**Key words:** IT solutions; strategies; education achievement; and effectiveness.

## 1. Introduction

This research investigates the impact of research development and information technology on students' learning in a tertiary educational institution context. The evidence provided in the research is supported by an evaluation of the impacts of information technologies (ITs) on

student learning outcomes in tertiary educational institutions. Little is known about and few experiments that exist in this field, leaving important matters unsettled regarding the educational merits of IT involvement on learners. Considerable detailed information on, and assessments of, projects integrating ITs in educational learning settings in advanced economy learning do exist (for example, Crawford et.al., 1998). Some of the ITs impact approaches used in the tertiary educational institutions in USA, described by Briggs et. al. (2001) and Biggs (2001) as breaks down of tasks into parts that enables students' learning to undergo step-by-step constructive learning and then evaluate their learning outcomes (Dick et. al., 2001). This approach has been critiqued by practitioners like Gordon and Zemke (2000), who claim that it is not suitable for life-long learning. However, context for learning in Europe and North America is different due to the economic, social, and cultural environments often found within learning communities in tertiary educational institutions in these regions.

Figure 1. The impact of information technology to students learning outcomes

This research investigates the possibility that many IT-driven challenges are accepted based on untrustworthy evidence rather than scientific research. This work will show that many IT attempts, while well aimed and seeking to find practical solutions, have been initiated with limited empirical research. Much of the conducted research discussing the impacts of integration of ITs with learners is from advanced courses in engineering (National Statistical Institute, 2010). Research performed in tertiary educational institutions is little to none. Many assessments of the impact of ITs to learning (Linden et al., 2008) in tertiary educational institutions are based on linking designs to research where relationships are sought between variables and case or qualitative study methods are used. Such methods produce a detailed understanding of the ways in which ITs may be utilized within learning settings to enhance learning outcomes, but they not assess whether the expected learning outcomes are achieved over time. There is a continuous debate on the ways to determine and quantify impact in this area, creating a considerable barrier to research and developing equivalent evaluation designs. Trials also exist at the research performance level.

## 2. Literature review

Web-based searches of educational databases and recommendations obtained from in-depth qualitative interviews conducted with developers, practitioners, and users of ITs form the basis of the literature review. Existing literature on the development of research and impacts of integration of ITs can be grouped into four categories: (i) empirical and qualitative research on IT impact in the US and other advanced economies (Cox and Marshall, 2007); (ii) empirical and qualitative research on ITs impact in developing countries (Arnold et al., 1999); (iii) theoretical reviews on the relevance of research and utilization of ITs in the education (Hepp et al., 2004); and (iv) analyses of the cost effect of research and IT impacts (Entwistle and Tait (1990).

<b>Existing Literature on ITs impact on learning</b>	<b>Findings</b>
Empirical and qualitative research on IT impact in the US and other advanced economies	Enhancement of content and delivery. Emphasis on knowledge-transfer approach. Online facilitation. Enhancement of cognitive apprenticeship (Dennen, 2000).
Empirical and qualitative research on ITs impact in developing countries	Slow in meeting the growing learner demands. Slow adoption of ITs in academia. Need to consolidate governmental support to utilization of ITs in education. Need for cooperation between developed and developing countries in IT education and research settings to increase economic growth in developing country.
Theoretical reviews on the relevance of research and utilization of ITs in the education	Need of extension the access for educators in IT education. Lack of institutional leadership for instructors to obtain proper support to implement changes in the teaching process. Need to provide ITs tools for innovative teaching and learning.
Analyses of the cost effect of research and IT impacts	The adoption of ITs for administrating tertiary education institutions is considered as one principal source of cost efficiency in the this sector. Sustainable cost-efficient models for ITs learning are critical.

	Lower fixed capital cost. Cost-effectiveness of the ITs impact in tertiary education depends on business model, number and profile of students, that is well aligned with numerous undergraduate science classes (Harley, 2003).
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Table 1. Literature on development of research and integration of ITs impacts to learners

Policy-driven reviews about the use of technology in education and institutional programs were used in the literature review to support the evaluation of the impact of ITs in education (Thiele et. al., 2006). This study presents only existing assessments of ITs on learning outcomes within tertiary educational institutions.

### 3. Methodology

This study is unique because it focuses on research conducted within tertiary educational institutions in an attempt to better grasp an understanding of the way to improve effectiveness and tackle challenges to ITs impacts and research. The authors contacted 15 experts in the field of IT including practitioners and academic researchers, working in Eastern Europe. Developers, researchers, and users of IT solutions were involved in the study. Of these 15 people, 7 agreed to telephone interviews. In Bulgaria, this is a considerably new element not found in traditional research studies.

The task was to ask for unpublished reports and work done on the impacts of IT in the field of education and to collect first-hand reports of the effectiveness and challenges related to developing, carrying out, and assessing the impact of ITs in tertiary educational institutions. Interview questions were based on the expertise of the interviewee that generally consisted of both (i) questions to developers and researchers and (ii) questions to users of ITs such as:

Questions to developers and researchers:

- *In your opinion, what is the forthcoming value of use of IT devices in the field of education in tertiary educational institution contexts?*
- *Is there a universal demand for these sorts of ITs solutions?*

- *Is there a need for modifications, if any, to the utilization and development of ITs solutions in the field of education?*
- *What is your view of the challenges to incorporate ITs solutions in tertiary educational institutions?*
- *In your opinion, what would be effective considerations in planning process of and use of IT in education?*

Questions to users of IT:

- *What sources are available and what more do you still need?*
- *What are the challenges to employing these sorts of IT devices?*
- *Which ITs solutions are you most receptive about?*

The research is divided into two parts: qualitative assessment using case study methodology, and experimental assessment. This study aims to recap the challenges that exist in assessing these impacts in the tertiary educational institutions in Bulgaria and compares this situation to that which exists in a developing country (United States). The study also discusses the lessons learned from successes and failures in Bulgarian tertiary education during the past decade, all associated to utilization of IT in education.

### **3.1 Qualitative analysis using case methodology of the assessment of impact of ITs solutions**

Data was obtained through structured telephone interviews and the data were much more qualitative than quantitative in nature. Hence, qualitative data analysis methods are primarily used in this study. Such methods can supply descriptive data and information, and provide an in-depth investigation of complex hypotheses in a manner that quantitative data analysis methods cannot accomplish. Quantitative data cannot describe the problems related to a specific goal or investigate the context in which learning is discussed (Thiele et. al., 2006). Quantitative data helps researchers understand better the development of pre-determined objectives, as described by Thiele et. al., (2006).

There is little or no existing research in Bulgaria using quantitative and mixed-research methods to assess the impact of IT on student's outcomes in tertiary educational institutions. There were a limited number of case studies or qualitative assessments on these topics in Bulgaria. A field study completed by a team of IT researchers from ICT Media in Bulgaria was designed to enhance education in secondary (not tertiary) schools in that country (National Statistical Institute, 2010); an assessment of IT models to integrate in tertiary educational institutes in Bulgaria (National Statistical Institute, 2011). This field study included both a set of digitized instructional materials that can be downloaded for free for instructors and learners to use for teaching, learning and research education, and a field study discussing the impact of IT in academia in Bulgaria (National Statistical Institute, 2010). This is an on-going, longitudinal study and has not as yet issued findings.

Two qualitative assessments of educational impact of ITs in Bulgaria were reviewed for this study. These assessments were chosen because they present a diversified set of methods and methodological cogency within the qualitative analysis. The first is a study that incorporated mobile technologies in mathematics and engineering enrichment classes in Bulgaria. Data for this case study was gathered from two classes of mathematics and engineering courses at the Technical Institute of Sofia that was facilitated by Krasteva (2011). The demographic data and results are presented in Table 1. This was a semester long pilot project operating in mathematics and engineering classes at tertiary educational institution in Bulgaria. The project involved the use of hand-held technologies such as mobile graphic calculator and wireless portable networking devices to increase the efficiency of course delivery employing online instructions in the engineering and mathematics courses. This project was launched with the purpose to improve the retention of learners in senior math and engineering, and to increase the learners' achievement in these classes. The instructors in math and engineering were appointed as the course facilitators in their respective classes. Their objectives were focused on learners' ability to connect with each other and with their worldwide counter partners, to increase students' learning and completion of tasks, and to evaluate students' learning outcomes.

<b>Demographic data for students in mathematics course</b>	<b>Web-based course</b>	<b>Traditional face-to-face course</b>
Total enrollment	16	30
Female	12	14
Male	5	16
First year	0	17
Second year	2	6
Third year	9	17
Fourth year	7	8
Students view of online knowledge	3.04	2.86
Use of mobile devices in online course	1.91	1.94
Student Grade Average Points	3.00	3.2

Table 1. Demographic data and results for case study 1.

The second is a comparative study of Web-based education programs at the Technical Institute (a tertiary educational institute) in Bulgaria. Data for the second case study was gathered from two classes of mathematics and engineering courses at the Technical Institute of Sofia. The study was performed using the same methodology and tools as explained in the first study. The purpose of the study was to validate the first study and to present a longitudinal research of the matter. The demographic data and results are presented on Table 2. Based on observed learning outcomes, authors of this research have found different results and trends for success related to Web-based learning (Van Rossum and Shenk (1984). The learners' proficiency were equally evaluated in both online and traditional face-to-face classes.

The authors (2011) researched on computing engineering students who took a mathematics course in the Technical Institute in Bulgaria and found that there were no wide range differences between the average exam grades of students taking a web-based and traditional face-to-face courses. In 2011, Krasteva reported that students in a Web-based bachelor of science (in engineering) program obtained considerably higher score on the final examination than the students in the traditional face-to-face course. She also stated that students in a Web-based programming course obtained a higher grade than students in a similar traditional face-to-

face course. And that the Web-based courses showed higher learning outcomes than in traditional face-to-face courses. While these studies cannot be used for final conclusion, they may suggest of an existing opportunity for learners to achieve comparative or enhanced learning outcomes in Web-based courses. The results of these qualitative studies are mixed, indicating both positive and negative impacts on student learning outcomes, while lacking a quantitative validation of the results.

<b>Demographic data for students in engineering course</b>	<b>Web-based course</b>	<b>Traditional face-to-face course</b>
Total Enrollment	33	35
Female	18	20
Male	15	16
First year	0	0
Second year	5	4
Third year	22	20
Fourth year	9	12
Students view of online knowledge	3.04	3.11
Use of mobile devices in online course	2.16	2.04
Student Grade Average Points	3.18	3.25

Table 2. Demographic data and results for case study 2.

A combination of both qualitative and quantitative methods are likely to provide a more complete assessment of ITs impact.

### **3.2 Experimental analysis of the assessment of the impact of ITs solutions**

There have been a small number of experimental assessments done on the impact of ITs on student outcomes in tertiary educational institutions. Few randomized controlled trials (RCT) have been conducted and as a result, relevant questions about the impact of ITs on student learning outcomes are unanswered. For example, which IT impacts are more efficient than others and which elements enhance the effectiveness of IT impact? The utilization of the RCT approach

enables researchers to extrapolate research findings beyond the study sample group of participants.

By administering experiments, researchers can try to create cause-and-effect relationships and consequently establish the types of positive and negative impacts that can result. Although the variables can be controlled, causal relationships are difficult to determine within complex social situations (Mertens, 2005). Within this research project, the authors examine several experiments directed by Krasteva (2011) and her colleagues who tried to evaluate the results of computer aided learning on student achievement in Bulgaria. Additionally, the authors analyze an assessment of the World Links Initiative, intended to create worldwide educational online communities for teachers and students in secondary schools (Kozma, 2004).

The final set of experimental studies reviewed include an assessment of the Bulgarian tertiary educational institutions (BTEI) contain a set of educational reforms prescribed to increase the quality of education in Bulgaria through the use ITs (Shoikova, 2010). While there are limited number of studies in this field, those studies have a mixed set of methods, and show mixed findings of both positive and negative results on student learning outcomes. There is a need for a focused observation within the length (duration) of IT impact assessment. For example, Krasteva (2011) stated that one weakness in the assessment of the BTEI program was an absence of formative research methods to repeatedly measure the IT impacts of the student learning outcomes. This is a common challenge that researchers are facing and it will carry on throughout this and other research.

#### **4. Barriers to evaluation of ITs impact in education in tertiary educational contexts**

The impact of ITs in education which is about integration of ITs into the traditional face-to-face classroom and online learning environments encounters barriers in tertiary educational contexts compared to those taking place in ordinary educational institutions with native English such as social, cultural, and economic factors to reflect on the ITs impact educational programs and the varying consequent outcomes (Horton and Mackay, 1999). Well established and quality assessment to evaluate if and any IT solutions work and apply in educational settings are of the

paramount significance given rivalry for insufficient resources available within tertiary educational institutions.

- **Lack of criterion for evaluation of structured impact of ITs in education**

A comprehensive evidence of the impacts of IT in education in tertiary educational institutions does not yet exist and is necessary to better explain the way that specific impacts will attain effectiveness which is to helpful in the decision making process of limited donor resources. Program assessment is a considerable element to the employment of effective educational impact of IT, especially the parties who use innovative technologies. Creating an assessment framework that is sufficiently adjustable to endure the myriad of resource barriers, as well as other social, cultural, and economic factors often discovered in tertiary education institutions, is a vital predecessor to creating a solid evidence indicating the impacts of ITs.

- **Limited training on assessment of IT impact in education**

Evaluators and researchers in tertiary educational institutions have substantial experience in empirical methods (qualitative and quantitative) in evaluation design. Frequently, researchers in local tertiary educational institutions require training in modern data gathering methods, recording and analysis.

- **Confusion between improvement with remodeling**

Given the scarce data availability that connects the impact of IT to students enhanced learning, why then are so many tertiary educational institutions following down this path? In fact, the literature review describes many decision-makers and stakeholders in tertiary educational institutions who were guided by their intuition, that by impacting ITs in the learning environments they assume they will be enhancing the teaching and learning that takes place in traditional classrooms. By only improving instructional materials, the way of utilization of the resources, tertiary educational institutions are not likely to carry out the longing of the remodeling traditional classroom instruction and undergraduates' learning.

## **5. Suggestions for Future Evaluations**

The construct of future assessments should capitalize on the lessons we have learned from evaluations of ICTs over the past few decades. Several suggestions are summarized below:

**Evaluate ITs impacts over time:** Generally the ingestion of ITs in tertiary educational institutions is a long process. It can take several for instructors to fully take over the technology and even longer to be able to essentially incorporate ITs into instructors' teaching process. Thus, research needs to look at the IT impact on learners over a period of time.

**Demonstrate understanding of scope:** The quantitative observation and impact data that has been gathered in these assessments centers on communication system such that functional impact of IT-driven hardware and software, as stated by Trucano (2005) that is easy to gather. Employing qualitative and quantitative techniques can help call researchers' attention on the set of existing effects and reasons for observed outcomes.

**Employ combination of research methods:** A combination of qualitative and quantitative methods could be used, although that a selection of purely qualitative or purely quantitative methods is an option (Day et.al. 2008). There is a reciprocal cooperative interaction between qualitative and quantitative methods such that one may use explanations in qualitative interviews with interviewees to be later developed on a wider range with assessment data or survey From the other point of view, there may be the option for the researcher to look into interesting trends that were found in assessment data or survey with in-depth interviews with particular interviewees.

**Investigate novel research questions:** Future research is to continue beyond the explanation to address development of efficient and relevant ITs impacts that consider the strengths of ITs in educational outcomes for learners.

## 6. Conclusion

A review of the lessons learned and future tendency were described in this research. Existing assessments using qualitative methods frequently depend on self-reported data, without proof of sources. This can turn to positive bias or inflation of the efficiency of ITs in tertiary educational settings.

There are several resources available describing the elements of an extensive and well-structured assessment strategy (Wagner et al., 2005) and presents a second lesson learned - that assessment is to call each phase of a project. For the purpose of constructing the scope and specific objectives of a study and complete its pattern, future assessment of ITs in the tertiary educational settings need to include a formative assessment during the impact development. Process assessments are a required element to extensive program evaluation that is taking place on a continuous basis throughout the course of the research. An efficient assessment to evaluate the effects of the IT impacts on recipients, including analyses of the intended objectives were completed for the purpose to understand the way an educational IT impact can become efficient and considerable.

A general method to construct and assess cannot be universally used. For each IT impact, researchers must account national educational objectives and that they suit the IT solutions within this policy frame. The impact of IT also dependent on factors, such as instructors and learners, training, management methods for classroom, and encouragement by institution leadership. Successful tertiary educational integration depends on efficient and collective leadership, professional development, and program content that is considerable to the interests of instructors and learners.

At last, a lesson learned is that it is relevant to know of the “glitches” of IT impact utilization in tertiary educational institutions. Important data can be gathered from these stories to enlighten planning of ITs in educational settings in tertiary educational institutions.

The impact of ITs in the tertiary educational settings is not a matter separated from educational reform efforts, but instead it is inseparably linked. This research reviewed significant literature that examines the ITs impacts on student learning outcomes and has underlined the questions that hinder demanding assessment of such impacts. Assessment is a critical process to assess the way the ITs are used in order to attain expected learning outcomes and to what level views and real facts align. There was limited number of methodologically valid studies about the impact of ITs in tertiary educational settings. From this point of view, this paper suggests that the impacts of ITs on learner outcomes oscillate whether towards positive, negative, or no impacts.

The stakeholders' view of ITs impacts is more positive and whether ITs can meet these goals is dependent on the implemented solutions.

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