

# Opinions on Future Research Themes for Technology-Enhanced Learning: A Delphi Study.

Christine PLESCH<sup>a\*</sup>, Malte JANSEN<sup>a</sup>, Anne DEIGLMAYR<sup>a</sup>, Nikol RUMMEL<sup>b</sup>,  
Hans SPADA<sup>a</sup>, Nina HEINZE<sup>c</sup>, and Ulrike CRESS<sup>c</sup>

<sup>a</sup>*Institute of Psychology, University of Freiburg, Germany*

<sup>b</sup>*Institute of Education, Ruhr-Universität Bochum, Germany*

<sup>c</sup>*Knowledge Media Research Center, Germany*

\*plesch@psychologie.uni-freiburg.de

**Abstract:** In this paper we present first results of a Delphi study on technology-enhanced learning (TEL). The study is carried out as part of the European Network of Excellence STELLAR (Sustaining Technology Enhanced Learning Large-scale multidisciplinary Research). In the 1<sup>st</sup> Delphi round an expert survey was conducted to identify future trends in TEL research: Forty-one European TEL researchers answered open-ended questions concerning future key societal demands and technological developments, and concerning research themes that could respond to these demands and developments. Answers were coded and categorized using a qualitative approach. To conclude this article we give an outlook on the next steps of the STELLAR Delphi study.

**Keywords:** Delphi study, technology-enhanced learning, STELLAR, future research trends

## Introduction

As the prevalence and the capabilities of digital devices in educational settings increase rapidly, the research community's interest in the potential of information and communication technologies (ICTs) for learning is growing. Researchers in the field of technology-enhanced learning (TEL) are exploring how ICTs can be used to support learning in various educational settings [1]. In the past few years there have been a number of attempts to identify future trends in learning and technology such as the annual Horizon Report by the New Media Consortium [2]. The aim of the present study was to identify trends and challenges in TEL by gathering experts' predictions of emerging research themes, relevant societal challenges, and future technological developments. To do so, we used the Delphi method. In general, Delphi studies aim at identifying emerging trends and future developments in a given field [3]. They involve several rounds of consecutive surveys among experts. The results of each round are analyzed and transferred into materials to be processed and evaluated by the survey participants in the subsequent round. For example, the Japanese National Institute of Science and Technology Policy (NISTEP) [4] carried out a prominent large-scale Delphi study on scientific and technological developments.

The Delphi study that we present in this paper is carried out as part of the European Network of Excellence STELLAR (Sustaining Technology Enhanced Learning Large-scale multidisciplinary Research) [5]. One of the final goals of the work of STELLAR in general and the Delphi study in particular is a catalogue of recommendations for TEL research on the European level and beyond. The Delphi method allows us to involve a large number of international researchers and experts from various disciplines in the iterative process of co-constructing visions for future research in the field of TEL.

The focus of this paper is on the 1<sup>st</sup> Delphi round, which constitutes the starting point of the 5-round process of the STELLAR Delphi study. In the 1<sup>st</sup> Delphi round, we encouraged all researchers within the whole STELLAR network to provide their opinions on future TEL research. The STELLAR experts' input is discussed and extended in consecutive Delphi rounds, employing a larger international panel of experts. The 1<sup>st</sup> Delphi round was completed at the end of 2009; the subsequent rounds are already under way.

## 1. Methodology

### 1.1 Sample of Experts

The sample of the 1<sup>st</sup> STELLAR Delphi round consisted of 41 researchers working in the field of TEL from nine European countries. All participants of this round were members of the STELLAR program. The experts' professional background was almost equally distributed between educational technology/computer sciences (N = 23) and social/educational sciences (N = 18).

### 1.2 Questionnaire Design

In answering an online questionnaire, the experts stated predictions concerning the future of TEL and made recommendations for a future research program (see Figure 1). The questions were open-ended, that is, they allowed for written answers in text fields. The findings that we present in this paper refer mainly to the question asking for experts' forecast of future research themes (Figure 1; question 1); we do, however, also make connections to two other forecasting questions concerning technological developments and societal challenges (Figure 1; question 2 & 3).

Imagine a large international TEL research program to be carried out from 2014 till 2020 is planned:

1. What should be 2-3 central research themes and questions to be covered by this program?
2. What future key technical developments (e.g. increasing use of mobile devices) should be accounted for in the research program? (Please name 2-3)
3. What future key societal demands and challenges (e.g. aging society) should the research program live up to? (Please name 2-3)

Figure 1: Questionnaire 1<sup>st</sup> Delphi round – Forecasting Questions.

### 1.3 Data Analysis

The goal of the data analysis was to create thematic clusters for each of the three forecasting questions from the experts' textual input. Our analysis approach was twofold consisting of an open coding process [6] and a categorization of the experts' answers: Coding segments were chosen based on units of meaning. Categories were developed from the experts' answers in a bottom-up approach suitable for the explorative nature of the 1<sup>st</sup> Delphi round. In a second step, topics and subtopics were developed from these codes. Two independent coders developed their own hierarchical systems, which were then combined in one final version. Table 1 shows an extract from the resulting coding system for the question on future societal challenges that TEL research should live up to (Figure 1; question 3).

Table 1: Example for the category system developed for the open-ended answers on future societal challenges.

Topic	Subtopics	Sample expert quotations
Social justice	TEL for the inclusion of diverse groups of people	“ICT inclusion for elder people and ICT marginalized people“; „technology must not longer exclude certain classes of population“; ...
	Reducing the digital divide	“danger of increased digital divide. “; ...

## 2. Results – Future Trends in TEL Research

Table 2 lists the most important topics and subtopics that were mentioned for each of the three forecasting questions (future research themes, future technological developments, and future societal challenges; see Figure 1) along with the frequencies of each topic. Our discussion of these results in the following will focus on the experts’ predictions of future research themes, but also connects them to the future technological developments and future societal challenges identified by the experts.

Overall, the experts named *ubiquitous and contextualized learning and technology* as the most important focus of future TEL research. The importance of this research theme has to be seen in the light of the demands that the modern knowledge society poses on formal education (societal demand: *knowledge society and its demands for education*). Ubiquitous technology satisfies the need for permanent access to the latest information in a time where knowledge is the most valuable resource and where knowledge is changing quickly and dynamically. Ubiquitous technology provides the possibility to access information and tools on the fly. The combination of mobile and location-based learning offers the possibility to instantly equip learners with context-related information; for instance, a learner could inquire the name of the architect of the cathedral he/she is just looking at. Furthermore, mobile devices bear the potential to improve formal learning by bridging across informal learning settings (e.g. a visit to the zoo) and formal learning settings (e.g. a biology class). Another field of application for *ubiquitous and contextualized learning and technology* can be seen in mastering the societal challenge of *lifelong and workplace learning*, which is especially important for an aging society. Learning on the job opens new horizons for continuing education in organizations and thereby contributes to the higher goal of organizational learning. Due to contextualized learning designs learning events can be embedded in the daily working routine.

The second most often mentioned topic for future TEL research was to *improve formal education*. A large cluster of expert statements focused on improving educational practices and education systems. For example, an expert statement illustrating the subtopic *teaching of TEL-skills* was:

“Teaching of TEL-skills, e.g. computer-literacy, collaboration skills, learning skills, reading skills, information evaluation skills...: What skills are needed, how do they influence each other? How can they best be taught?”

Within the goal of *improving formal education* a key societal challenge is to adapt formal education to the changing demands caused by the *knowledge society*. According to the experts, this may include teaching media literacy and information literacy as well as adapting to new generations of students, i.e. digital natives who grew up with ICTs as part of their daily life. To meet these challenges successfully TEL tools need to be integrated in formal education, as suggested in this research question by one expert:

“How to best integrate computer-based/computer-supported learning activities with regular face-to-face, teacher-to-students learning arrangements, in school and universities settings, but also in adult learning settings (e.g. vocational education, training on the job)?”

This statement also points out that future educational challenges may not only be met by adapting formal education as we know it, such as school systems and universities, but that the connection between formal education and *informal learning* as well as *lifelong and workplace learning* will need to be redefined.

Table 2: Most important topics and corresponding subtopics of the Forecasting Questions.

Topic (Subtopics)	n
<b>Future Research Themes</b> (coded units of meaning: $n = 131$ ; experts: $n_e = 41$ )	
<b>Ubiquitous and contextualized learning and technology</b> (Contextualized learning and location-based learning/context-aware applications; Ubiquitous technology/learning; Mobile technology/learning)	19
<b>Improve formal education</b> (Improve formal education practice and formal education systems; Integrating technology into formal education; Teacher training; Teaching of “TEL-skills”)	18
<b>Characteristics of the research program</b> [This topic contains statements concerning the research program itself rather than research questions or themes] (Theoretical frameworks and objectives ; Methodology; Connecting researchers)	15
<b>Instructional methods and frameworks</b> (Instructional objectives and frameworks; Instructional methods and applications)	11
<b>Collaborative learning</b> (Analysis of cognitive processes on group level; Collaborative learning; Collective intelligence/wisdom of the crowds)	9
<b>Informal learning</b> (Connection between formal and informal learning; Informal learning)	8
<b>Personalization/individualization</b> (Personalization/individualization; Personal Learning Environments)	7
<b>Social justice</b> (Addressing the needs of all learners; Addressing the digital divide; Have third world countries benefit from TEL)	7
<b>Future Technological Developments</b> (coded units of meaning: $n = 102$ ; experts: $n_e = 38$ )	
<b>Ubiquitous &amp; contextualized learning and technology</b> (Mobile devices & ubiquitous computing; Contextualization, location-awareness and context-aware applications; Ubiquitous mobile connectivity; Mobile learning)	29
<b>New ways of human-computer interaction &amp; ambient computing</b> (Ambient intelligence/computing & sensor technology; “Intelligent” objects/furniture; New, more intuitive Interfaces)	18
<b>Future Societal Challenges</b> (coded units of meaning: $n = 102$ ; experts: $n_e = 40$ )	
<b>Social justice</b> (TEL for the inclusion of diverse groups of people; (Reducing the) digital divide)	16
<b>Knowledge society and its demands for education</b> (Adapt to new generations of students; Adjust education to the “knowledge society”; Teach media/information literacy; Quick/dynamic changes of knowledge; Information society)	15
<b>Demographic developments</b> (Aging society; Job market changes; Gap between young and old people)	14
<b>Improve formal education</b> (Adapt education to individual needs; Teacher Training)	12
<b>Lifelong learning &amp; workplace learning</b> (Lifelong learning; Connection between learning and working; Learning on demand)	11

Another important topic that was mentioned as a future research theme by several experts was also the most frequently mentioned future societal challenge: *social justice*. This topic reflects the idea that all learners (i.e. learners from different cultural and socio-economical backgrounds) should benefit from TEL. A related key future societal challenge for TEL mentioned by many experts is *reducing the digital divide* (subtopic of *social justice*) between people who have access to ICTs and know how to make use of ICTs and people who do not. The digital divide also refers to the divide between media-literate and

non-media-literate people in industrial countries, which may increase due to the *aging society* (subtopic of *demographic developments*). The experts suggest that TEL research may help to reduce this latter divide by developing easy-to-use TEL tools for elderly people:

„Handling of technological devices has to become easier, performance more reliable, and purchase cheaper to allow young children and old adults [...] to really profit from TEL“

According to the experts, social justice also includes addressing the technological and educational divide between industrial and developing nations, as mentioned in this statement:

“Social justice with a particular focus on countries in Sub-Saharan Africa -- Questions to include: How do we ensure access to technical resources is supported by access to human resources?“

### 3. Summary and Outlook

Our findings illustrate that the future of TEL and TEL research will be shaped by an interplay of technological developments, societal challenges and pedagogical advances. The experts who took part in our Delphi study did not only point out promising technological trends but also societal challenges that educational systems will need to meet. A trend towards interdisciplinary future research agendas that address multiple aspects of TEL is evident.

The 2<sup>nd</sup> STELLAR Delphi round was carried out from February to late April 2010 with the participation of 230 international TEL experts. This 2<sup>nd</sup> round aimed to further evaluate trends and developments that were identified in the first Delphi round. Results from the 2<sup>nd</sup> STELLAR Delphi round will be presented at the conference.

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