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Temporal Issues in E-learning Research: A Literature Review

Barbera, B.[1], Gros, B.[1] and Kirschner, P.A.[2]

[1] eLearn Center, Universitat Oberta de Catalunya

[2] Centre for Learning Sciences and Technologies (CELSTEC), Open Universiteit

Abstract

Time plays an important role in all aspects of education from scheduling through certification. It is also one of the determining factors within institutions for distance learning where education is almost always time and place independent and for those learners and/or learning institutions making use of e-learning. Be tis as it may, temporal factors has not received much attention in educational research. This is strange since "lack of time" and "out of sync" are two of the commonest complaints encountered by learners in online educational settings.

To better understand how research deals with 'time' as a factor in learning and education, a systematic literature analysis of articles relating to 'time' was carried out in the *British Journal of Educational Technology*, a high impact educational journal. A total of 966 papers across a period of 11 years was analysed for the presence of time as a factor in the research published. The most important result of this literature analysis was that 'time' played almost no role as a variable in research on education and educational technology.

Temporal Issues in E-learning Research: A Literature Review

1. Introduction

The old saying goes "You don't have the time, you make the time". In this interconnected world where access to people and things are ubiquitous and instantaneous, time does not seem to be a factor in our work or our leisure. People are available 24/7 through a myriad of different tools and techniques. Strangely enough, however, this does not appear to be the case in education. Children and adolescents generally still go to school between 8 and 9 in the morning and get out at around 3 to 4 in the afternoon (with any number of variations on these times), often for lesson periods of 45-50 minutes, five days a week, for nine to ten months a year. Evenings are reserved for doing one's homework, studying, and cramming for exams. Teachers in primary schools in Spain spend an average of 880 hours per year teaching in 37 weeks (i.e., 23.78 hours per week) and Dutch teachers spend 930 hours teaching in 40 weeks (i.e., 23.25 hours per week). Different educational levels (e.g., primary, lower secondary, secondary, et cetera) and types (e.g., academic, vocational, et cetera) have a standard number of years for their completion and curriculums are based upon what can be taught in a school year. And if we leave 'traditional' bums-on-seats education and visit alternative, electronic forms of education – including online and/or distance education which often operate within the time constraints of traditional education - additional factors such as time zones, synchronicity and asynchronicity also play a role.

All of this would cause one to think that if time is so important for teaching and learning, that the temporal aspects of teaching and learning (i.e., the *time-factor*) would play an important role in research on education. To determine what role the time-factor plays within educational research, a review of research on education was carried out within the journal that should be considered one of, if not the most highly ranked journal, specialized in the field of the use of technology in education namely the *British Journal of Educational Technology*. Citing the web page of the journal itself:

> The British Journal of Educational Technology provides readers with the widest possible coverage of developments in international educational and training technology. BJET is a primary source for academics and professionals in learning technology.

> Articles cover the whole range of education and training, concentrating on the theory, applications and development of learning technology and communications. There is a particular interest in the application of new information and communications technologies.

> What follows is a review of what this journal has to say about how the time-factor in education has been researched.

2. Framework

Time is a critical factor in learning, but time is also a very complicated factor that has many facets. Time can be: time needed to prepare a course or lesson (i.e., for the instructor to gather materials and design/develop a course or lesson), time needed to follow a course or lesson (i.e., the planned, nominal study time that the institution allots for the learner in minutes and/or hours per day or the number of weeks per semester/year that the course encompasses), lifetime of a course (i.e., how long a course can be used before it needs to be revised and/or is out of date), time that a student needs for study (i.e., both in and out of class), time that an instructor needs and/or uses to teach a course (i.e., the number of hours per day both during and beyond the 'school' day for preparation, correction, feedback and marking of products and exams), 'transaction' time costs (e.g., the amount of travel time needed to attend a course or to log into an online course), and even time that a learner can make effective use of the knowledge gained (i.e., half-life of the information in a course). Time can also be seen as an effectiveness factor (i.e., the amount learned in a specific time period; learning more in the same time period is more effective learning) and/or efficiency factor (i.e., the amount of time needed to learn something; learning the same amount in less time is more efficient learning). Time can, finally - though we are sure this list is not exhaustive - can be seen as a solitary factor or as part of a temporal pattern in which other factors play a role such as work time, family time, down time, et cetera.

Time is also used as a quality measure. Serdyukov and Serdyukova (2007) posit that time efficiency of both the instruction and of the learning process becomes a decisive factor in assessing a program or a course. In their eyes, colleges and universities who are now evaluated based upon the quality of their education will soon be selected and appreciated based upon the time needed for the learning to take place. With education budgets decreasing, but with the number of learners taking part in education and going further in their education increasing (in the Netherlands 39% of the population is now continuing through higher education as compared to 29% ten years ago[1]) innovative pedagogic and/or technological approaches that promise and/or demonstrate (i.e., evidence-based education) that learning and/or teaching time efficiency can be improved are welcomed and even required/demanded by governing bodies ranging from local school boards to national governments and ministries. Also, with drop-out rates remaining high (11% of the Dutch population between 18-25 years and 31% of the Spanish population left school before getting a qualification in 2009[2]), pedagogic approaches and technologies that increase involvement of the learner's intellectual and emotional capacities, and thus that the learner stays in the system and completes a diploma (i.e., time in school) that give admission to a profession are also demanded.

[1] http://www.trendsinbeeld.minocw.nl/grafieken/3_1_1_3.php

[2] http://www.cbs.nl/nl-NL/menu/themas/onderwijs/cijfers/overig/schoolverlaters.htm

Finally, with a chronic shortage of teachers, either due to a simple lack of teachers (as is the case in the Netherlands) or due to budget cuts increases the need for more effective planning of teaching and learning processes. A case in point:

National Public Radio - December 29, 2010[3]

In Franklin County, the faltering economy has meant longer school days, a shorter calendar, fewer teachers…As the economy continues to falter, many governors are already warning of more budget cuts. The single biggest expense for most states is public school funding, and districts across the country have been making drastic cuts to staff and programs…To save money, the district also cut 20 days from its calendar and lengthened the school day by 40 minutes.

Putting all of this together, we concur with Serdyukova and Serdyukov (2010), that these problems provoke "a question, can we, the educators, teach more effectively; can students learn more, better and in less time? The answer to this question can have profound social, economic and personal significance as it may affect learner's career and life style, societal attitude towards education, the rate of investment in education, and eventually the nation's well-being" (p. 255).

3. Methodology

The aim of the present research is to try to obtain empirical data on the presence, nature and content of variables related with temporal factors that researchers take into account in their research on educational technology and to determine whether either trends or omissions can be discerned that point to practical recommendations in this area.

For the systematic literature review we made use of the methodology proposed by Fink (2005, 2010) to identify, evaluate, synthesize, interpret and analyze research literature. Fink mentions that it is important for an efficient search to decide the criteria for including and excluding articles and to sort relevant and strong studies from others. The first screening was primarily practical in nature and was used to identify a broad range of articles that might, potentially, be usable. These articles were published in the *British Journal of Educational Technology*, a high-impact SSCI journal (Impact = 1.255) in the field of education, educational research and educational technology.

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[3] http://www.npr.org/2010/12/29/132408943/georgia-schools-offer-lesson-in-living-with-cutbacks

The first selection criterion was 'currency'. To this end, the review limited itself to research published from 2000 onwards (i.e., 58 issues and 966 articles without book reviews). The second criterion for identification and inclusion was that the article addressed the use of time in an educational context in either an implicit or an explicit way. In addition, emphasis was placed on research in the areas of the:

- teaching and/or learning process in e-learning (i.e., the pedagogy)

- organization, management and policies in e-learning (i.e., the organization)

- learning resources in e-learning[1] (i.e., the infrastructure)

The articles were reviewed firstly by title and abstract and finally by full text by three independent researchers, excluding at each step those articles which did not satisfy the inclusion and/or which satisfied the exclusion criteria. Exclusion and inclusion was to not only based upon the presence of 'time', but also on the relevancy of the use of words related with time-factors in the manuscripts. Example s of this are: (1) the use of terms connected with time coming from common language (e.g., the term "evolution" not meaning educational progress or change, but only for expressing the passing of time) and (2) the use of terms related with temporal factors for mere description (e.g., referring to a "4?month course"). Once a selection by title was made, each abstract was read and a choice was made for inclusion – based upon the aforementioned criteria – or they exclusion if they did not, It must be noted that abstracts vary considerably in content and descriptive qualities and, for example, some fail to state important information such as the research paradigm used or the level and type of education studied. Based upon this procedure, 893 articles were excluded from the analysis since they failed to meet the stipulated criteria. As a result, 73 articles[paul1] (7.56% of the originally selected abstracts) were analysed to determine whether the studies fell into the areas mentioned.

For analysis, 36 articles (49.31% of the remaining articles) were included for the teaching and learning process area; 7 (9.58%) in organization, management and policies and 30 (41.11%) in learning resources. For the analysis of the reliability of this selection process, we randomly selected approximately 10% of the total number of the original abstracts (i.e., 100) for analysis by two researchers. The inter-rater reliability for selection and classification of the papers of the three researchers' judgments with the fourth researcher was quite high (Kappa coefficient = .79).

---Insert table 1---

4. Results

The articles were analyzed both quantitatively and qualitatively. The quantitative results include a basic analysis of variables involved and their place in the research such as explicit/implicit attention to time as a factor within the research, level of education studied, type of education studied (i.e., academic, vocational), nature of time as a variable (i.e., whether time was the independent, dependent or mediating variable), et cetera. The qualitative results were obtained through content analysis based upon the traditional structure of reporting research. Moreover, the three areas of analysis distinguished previously (i.e., pedagogy, organization, infrastructure) were also used as a discriminating variable to determine the uniformity of research within an area.

4.1. Quantitative results: Variable analysis

The results on this section can be seen in Table 2. The analysis shows that though time is generally more often an explicit element than an implicit one, it is not frequently the focus of the research. Although temporal issues are not usually at the core of most research, the time-factor is frequently a controlled variable understood as a part of the teaching and learning process. The research reported tends to primarily address the time-factor in formal educational settings, and specifically in undergraduate higher education.

---Insert table 2---

Most of the research analysed was quantitative in nature, with a tendency towards the study of the following instructional elements: communication and interaction, materials and resources, instructional design and teaching, learning and assessment. Brough to a higher level of aggregation, the main general topics related to time were: participation time, perception of time and time personalization.

4.2. Qualitative results

The qualitative analysis focuses on what was studied, how it was studied and the main conclusions of the corpus of research.

4.2.1. Description of the studies

a) Research question addressed

The first aspect of the qualitative analysis was to capture how the research question was framed with respect of time. Overall, it can be said that studies proposed several types of questions:

- What conditions are needed to implement technologically mediated pedagogies? In this case, the focus is mainly on the knowledge and skills needed by teachers and

students, student perceptions of ICT, or broader aspects of the educational reality (institution, culture, economic constraints, et cetera).

- What is the impact of implementing technologically mediated pedagogies on the teaching and learning process, and what is the impact on the institutions?

- How do students manage their time in relation to their participation in technologically mediated educational activities?

Most of the research was comparative in nature, namely comparing "electronic" materials with "traditional" materials. For example, textbooks vs. on line material, paper based testing vs. computer based testing. In the studies where time was the main focus, the research questions were related to how online students develop strategies regarding time management, student experiences in taking electronic examinations and time pressure.

With respect to the management and organization studies, the most frequent research questions dealt with effectiveness of ICT implementation and how technology has impacted the teaching and learning process. In these studies, the role of time seems to be treated as secondary.

b) Methodology

From a methodological point of view, studies use and combine different techniques such as questionnaires-surveys-interviews, pre and post-tests, quantitative analysis of log files, content analysis of synchronous or asynchronous conversations, or qualitative observations of processes.

The techniques used in the studies focus on time analysis are mainly tracking data to analysis time spending on line, frequency of Internet use, and questionnaires based on time perception. The main point focus on management is the time to adopt and implement new technology.

4.2.2. Analysis of the results

With respect to problems, the implementation of technologically mediated pedagogy has been found to be time consuming, imposing an extra workload on participants due to their lack of knowledge, skills and familiarity with ICT tools. This is compounded by institutional structure constraints as well as the fact that time advantages of implementations are not initially visible because of the long cycle time that most implementations require. For these reasons, the success of these implementations is related to the historical moment of the organization and also on the institutional support that they receive.

However, technologically mediated pedagogies have also been found to deliver important advantages on the temporal aspects of teaching and learning. The most often named advantage for students is the possibility of more immediate and continuous feedback, especially in assessment. Technology, often in the form of tools have also been found to be advantageous for teachers in that they can decrease the time needed for instructional design or by decreasing the amount of time needed for providing feedback thanks to automated feedback possibilities.

The implementation of ICT implies more time spent both by students and by teachers, whereas also difficulties for the institution schedules. Organization of time and schedules has implications on the students' educational experience. An e-learning modality, which permits a large temporal flexibility, has positive implications on this issue. At the same time, the mediation of ICT in learning and teaching processes offers the possibility of more immediate and continuous feedback. This fosters more students' participation and engagement to learning tasks.

The literature reviewed also identifies some lines of improvement for technologically mediated tasks:

- In some cases, assistance service for the technological tools is not 24 hours available, so although in theory the tool may not be time constrained; this constraint exists in practice if participants needs assistance in the use of the tool.
- The immediate nature of feedback is highly valued, but this feedback is usually only summative and not formative. Without formative feedback, students need to spend a great amount of time in order to solve the task.
- On-line exams demand more time spent by students than traditional exams. This is due to several reasons: Because if each question corresponds to one screen, then to change the question implies more time and more cognitive load than in a face-to-face exam; Because students may not be familiarized with the on-line exam situation; Because technical problems may be frequent and because the time needed for answering questions depends on the typewriting speed of students, which can be very different among them.

Possibly the most often found result is that ICT mediation in the learning and teaching process offers the possibility of receiving/giving more immediate and continuous feedback. This has been found to foster student participation and engagement.

ICT implementation in educational organizations implies a long cycle time and, thus a relatively long time before the effects of implementation are seen and felt. Consistent with this is that although professionals perceive potential gains in time and work load for their activities when

ICT is implemented, the implementation process itself requires spending more time and imposes a higher work load than maintaining the status quo. This leads to resistance and loss of motivation.

This perception of more time spent and higher workload has been found to be related to a lack of knowledge of and abilities with respect to ICT for teachers and administrators. The lack of knowledge means that more time than needed is spent on both using the ICT (i.e., learning while doing) and in explicit training on how to use ICT (which is often carried out "on top of" normal teaching responsibilities). Finally, implementation often also requires the assistance of colleagues who have more knowledge and/or skills, leading to an "unfair" increase in workload for those users.

With respect to the literature on learning tools, ICT implementation has been shown to permit important improvements in time but also present time problems. The main time advantages of tools are the following:

- The immediate feedback that some tools permit is highly valued by participants, especially in on-line assessment. On-line assessment permits teachers to have more time for direct interaction with students, and permits students to gain quality immediate feedback when they need it.

- Video games are positively valued for improving children's speed of computation, and also for improving the ADHD children attention.

- Tools of design support for teachers permit a higher integrity of pedagogic implementations over time and also a decrease of time needed for carrying out the instructional design tasks.

Some time problems of technological tools are:

- The fact that on-line assessment typically offers only summative feed-back, but not formative, implies more time needed for task resolution by students.

- Often, assistance on the use of technological tools is continuously available, so though the tool, in theory, may not be time constrained, this constraint exists in practice if participants need assistance in tool use.

- Tool appropriation and implementation in an educational setting often takes a long time and is initially extremely time consuming. Using the tool, thus, involves increased time investment by participants than not using of the tool.

6. Discussion and Conclusions

Judging by the small percentage of articles dealing directly with time as a factor in the *British Journal of Educational Technology*, it is clear that the time factor in e-learning research has for the most part been neglected even though time is one of the most commonly heard requirements of

and complaints about teaching and learning in general and the use of ICT is often touted as a solution to the problems voiced. Whether it is due to methodological difficulties or because time is considered to be an invariable reality, temporal factors appear to have been poorly explored.

According to its exploratory aims this study indicates that there is a low percentage of articles explicitly related with time and there is weaknesses on e-learning research concerning to the temporal treatment of the methodology employed. The study also points out several ascertains that opens new challenging questions that need to be corroborated in a larger scenario.

Beyond trying to make a case for the explicit study of time as a factor in research on educational technology, there are a number of methodological issues (I.e., weaknesses) that have come to light in out study of the literature. Some weaknesses relate to the validity of the decisions made in the research process. These weaknesses are related to the unit of observation and analysis and/or aspects related to the methodology used for analysing the teaching and learning process. In the first case - the unit of analysis - the fact that the educational sequence that often is observed is a (formal) course which seems contradictory if the centre of attention is flexibility itself. A course might not be the best curricular format to select if we are interested in issues related to time; other formats need to be explored. In the second case, the methodology used is primarily quantitative in nature while the basic questions asked more qualitative in nature (e.g., quality of learning and/or teaching experiences, problems encountered inimplementation and use, solutions found for these problems). Also, because ICT implementation and use requires considerable periods of time for realisation and development, research about time should involve sequenced methodologies (e.g., episodes, behaviours,…) and not one-shot, moment related ones (e.g., questionnaires, surveys,…). In the scarce research that there is, we see that the majority – if not all – is superficial variable-centred and that there is, thus, a lack of in-depth longitudinal research to answer questions about the evolution of educational events across time.

Variables are attributes of fixed entities defined by measurement or by coding and counting procedures. But variables are not the only means to formulate and test hypotheses about time-dependent processes and data and possibly are not even the best way. There is a need to use events as units of analysis which not only allows qualitative research methods, but also augments quantitative methods including computational data analysis methods. Reiman (2009) suggests using stochastic modelling to process the data. This model is based on *event analysis*. Event analysis does not start by framing the world in terms of variables. Instead, it tries to conceptualize development and change processes as sequences of events that have unity and are coherent over time. What counts as an event is some kind of "actor", but the "actor" does not have to be a person; it can be a group, an organization, a technology, etc. An event-based view of the process and change would be an important addition to the variable-centred approach often used. While a variable-centred approach can be useful for answering research questions involving relationships

among variables, an event-centred approach can answer research questions pertaining to changes and processes.

A second issue is that there is a need to take time into account not only in micro level research but also in meso (i.e., curricular) level and macro (i.e., organisational) level. Understanding the impact of innovation on curricular and organisational change and how they affect each other is of the utmost importance. Research is needed to effectively improve methods that can provide evidence of growth over time and can support decision-making and policies with respect to ICT adoption and implementation.

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Table 1.

Research Line	n	%
a)Learning resources	30	41.10%
b)Organization, management and policies	7	9.59%
c)Teaching and learning process	36	49.32%
Total general	**73**	**100%**

Table 2. Variable analysis results

	Total general	
	n=73	
Time:		
a)Explicitly	40	54.79%
b)Implicitly	33	45.21%
Total	**73**	**100%**

Level of education:		
a) Primary/Secondary	16	21.92%
b) Undergraduate (Bachelor)	44	60.27%
c) Graduate (Master and PhD)	13	17.81%
Total	**73**	**100%**

Type of education:		
a) Formal (school, university,..)	72	99%
b) Non formal (workplace)	1	1%
Total	**73**	**100%**

Methodology:		
a) Qualitative	17	23.29%
b) Quantitative	39	53.42%
c) Hybrid	16	21.92%
Empirical	1	1.37%
Total	**73**	**100%**

Mediating variable		
a)Independent variable - as a requirement (i.e., key factor toaken for granted or needed in the progression of learning/teaching but explicitly, lack of time)	19	26.03%
b)Controlled variable - as a part of the process (i.e., how to manage time to be more effective)	34	46.58%
c) Dependent variable - as a result (i.e., doing X the students or teachers save time)	20	27.40%
Total	**73**	**100%**

	Total general
	n=73
Time category	
a) Time of participation (in forums, chats, during feedback, grading, individual study time, etc.)	37.97%
b)Time perceptions (participants experience, i.e., Are asynchronous students more positive about their experience than synchronous students?)	37.97%
c)Time conceptions (Personalization, the richness of the dialogue, the level of involvement of students and teachers in discussions and the different means of communication)	7.59%
d) Time personalization (rhythms, adaptive time, acceleration, etc.)	15.19%
e)Other categories: Evolving over time, Tutor marking time, Saving time	1.27%
Total	**100%**

Topic category:	
a)Materials/resources	25.61%
b)Formative Assessment	6.10%
c)Sumative Assessment	3.66%
d)Instructional Design	14.63%
e)Communication/Interaction	26.83%
f)Teaching/Learning	18.29%
g)Other categories: marking time, mobile learning, motivation, Team conflict	4.88%
Total	**100%**

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