The Effectiveness of E-Learning: An Explorative and Integrative Review of the Definitions, Methodologies and Factors that Promote e-Learning Effectiveness

Signe Schack Noesgaard[1,2] and Rikke Ørngreen[2]
[1]Kata Foundation, Sønderborg, Denmark &
[2]ResearchLAB: IT and Learning Design, Dep. of Learning and Philosophy, Aalborg University, Copenhagen, Denmark
ssn@learning.aau.dk
rior@learning.aau.dk

Abstract A structured search of library databases revealed that research examining the effectiveness of e-Learning has heavily increased within the last five years. After taking a closer look at the search results, the authors discovered that previous researchers defined and investigated effectiveness in multiple ways. At the same time, learning and development professionals within public and private organisations are increasingly being asked to prove the effectiveness of their learning and development initiatives. This paper investigates the effectiveness of e-Learning through an integrative review. The paper answers the following research questions: How is the effectiveness of e-Learning defined? How is the effectiveness of e-Learning measured? What makes e-Learning solutions effective? The authors discovered 19 distinct ways to define effectiveness, the most common of which is 'learning outcome', appearing in 41 % of the articles examined in the literature review. Moreover, the most common way to measure effectiveness is quantitatively with pre- and post-tests. This paper includes an empirical study of an e-Learning solution for science teachers (K–12) which serves as a valuable addition to the findings of the literature study. The study suggests that it is difficult to use e-Learning to improve teaching performance, as participating teachers can apply several strategies to avoid substantially changing their work-related practices. Furthermore, the study shows that only using the fulfilment of pre-defined learning objectives as an effectiveness parameter does not allow developers and researchers to see unexpected and unintended changes in practice that occur as a result of the e-Learning program. Finally, the research provides insight into the validity of self-assessments, suggesting that participants are able to successfully report their own practices, provided certain qualitative survey approaches are used. In this paper, a model for understanding the relationships of the key factors that influence effectiveness is developed. The model categorises these factors from three perspectives: the context in which the e-Learning solution is used, the artefact (the e-Learning solution itself) and the individuals that use the artefact. It was found that support and resources, the individuals' motivation and prior experience and interaction between the artefact and the individuals that use it all influence effectiveness. Finally, this paper discusses whether e-Learning and traditional face-to-face learning should be measured according to the same definitions of and approaches to effectiveness, ending with a call for learning designers and researchers to target their measurement efforts to counting what counts for them and their stakeholders.

Keywords: effectiveness, e-Learning, adult learning, literature study, definition, measurement

1. Introduction

Research examining the effectiveness of e-Learning has increased in recent years. This is primarily due to the increased possibilities for IT and learning as well as increased political and organisational attention to 'what works' in learning. Figure 1a shows the 761 papers relevant to this research, and Figure 1b shows 111 intensively coded abstracts of the 761 papers (which are described in further detail in the methodology section below). There are fewer papers published in 2013 than in any other year because the structured search took place in October 2013.

In the following analysis, the authors investigate the research into the effectiveness of e-Learning. The paper is structured around three research questions: How is the effectiveness of e-Learning defined? How is the effectiveness of e-Learning measured? What makes e-Learning solutions effective? The aim of the literature study is to organise similar research in order to better understand the characteristics and tendencies as well as connections between the applied concepts.
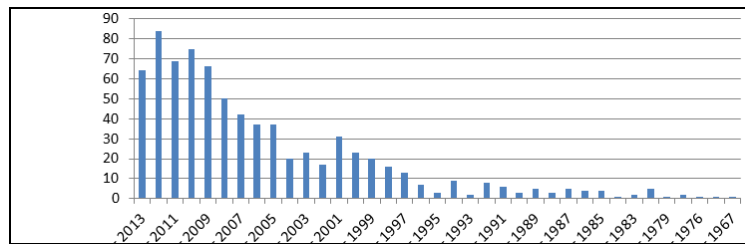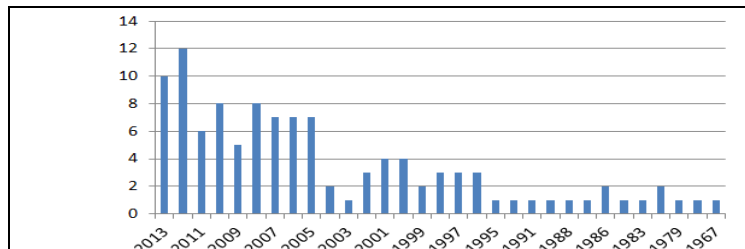
Figure 1a: Number of published papers per year

Figure 1b: Number of published papers with coded abstracts per year

1.1 Literature study - methodology

Several systematic reviews and meta-studies on the effectiveness of e-Learning are considered within the context of health care or language learning. These reviews primarily include quantitative studies based on certain criteria, such as sample size (Veneri, 2011), transparency of statistical information (Grgurovic, Chapelle and Shelley, 2013; Means et al, 2013) or homogeneity of the respondents and predefined outcome measures (Rosenberg, Grad and Matear, 2003). Only one relevant meta-review, which included both qualitative and quantitative studies in an integrative review evaluating the outcome of distance learning for nursing education, was found (Patterson, Krouse and Roy, 2012).

The quantitative meta-reviews aimed to document the effectiveness of e-Learning by consolidating the data of a number of quantitative studies. The mixed-method meta-review mentioned above describes the state of the research, explains how the studies evaluate different outcomes and discusses different aspects of learning effectiveness. This is somewhat similar to the present paper, which also applies a mixed-method methodology in an integrative manner. However, many more research articles are considered in this paper due to broader selection criteria. Hence, this paper is not concerned with re-investigating how effective e-Learning is, but rather with understanding the definitions, measurements and factors promoting e-Learning effectiveness.

The authors aimed to obtain a broad foundation of high-quality papers, from which a large but not pre-defined number was chosen for further investigation. Papers were chosen using a strategic randomised approach based on a purposive sample size, then analysed based on the concept of theoretical saturation (that is, the point at which new data no longer provide further insight into the subject at hand). In this integrative review, data analysis, data reduction and data displays are equally important (Whittermore and Knafl, 2005).

The authors conducted conventional subject searches in 30 academic databases (J-stor, Scopus and Proquest, which includes 28 databases) to discover articles examining the effectiveness of e-Learning within the context of adult learning (see Table 1). All fields of research were included in the searches, as e-Learning can be used to support any subject. The searches only included articles in English, and where possible, only peer-reviewed journals. The chosen synonyms for 'effectiveness' include 'transfer' and 'application', which may have resulted in an overrepresentation of articles that define effectiveness as the application of learning content into work practices.

The searches resulted in almost 1000 articles. Articles clearly irrelevant to the subject were excluded, diminishing the number to 761. If an article contained an empirical study on the effectiveness of e-Learning and the solution under investigation was targeted at working professionals or students, then the abstracts were carefully coded and analysed in great detail using Nvivo 10. When doubts about the relevance or coding of the abstracts surfaced, the two authors discussed the abstract, decided on the best coding and documented what was learned from the discussion in a shared document.

Table 1: Applied search string

effect* OR transfer* OR applica* OR impact OR outcome*(search title)
AND
"e-Learning" OR e-Learning OR online OR web-based OR "web based" OR technology* OR WBT OR WBL OR blended OR Internet OR Distance OR CBT OR CBL OR distance OR Computer OR mobile OR simulation* OR "social media" OR "community of practice" OR game* OR gamification* (search title)
AND
learning OR training OR education OR development OR "competence development" (search title)
AND
adult OR "competence development" OR lifelong OR profession* OR employee* OR worker* OR "further education" OR master OR business* (search abstract)
NOT Children OR Child OR kids OR Youth OR "Technology transfer"(search anywhere)

Before the coding began, a rough coding scheme was created based on the research questions, which entailed parent codes (named 'nodes' in NVivo) such as 'definition of effectiveness', 'research question', 'research methodology', 'subject area', 'audience', 'theories applied', 'technology applied', ' key findings' and so on. The detailed coding tree was created through in vivo coding, a grounded approach in which codes are added as the analysis reveals relevant factors by using the original statement of the source as a code name (Harry, Sturges and Klingner, 2005). New sub-nodes were continuously created as new definitions, new factors of effectiveness and new technologies were discovered in the abstracts.

As mentioned, the purposive sampling led to a strategic randomised approach for selecting papers from the large collection. The papers were not investigated in alphabetical order. Rather than analysing from A to Z, a variety of letters in the alphabet was chosen, as there tend to be surnames, and henceforth letters, which are used more in some regions than others. Though the aim was not to obtain an even global distribution of papers, the authors, newerthless, tried to accumulate the broadest scope of information possible.

Of the 224 abstracts that were carefully read, 111 fulfilled all the criteria and were coded in detail using the above-mentioned method.

1.2 Empirical study – bringing context into the literature study

The empirical study aimed to discover if, how and why an e-Learning program would be successful in improving science teachers' work practice in Danish elementary schools. Thus, the empirical study lives up to the criteria of the literature study, as it focuses on the effectiveness of e-Learning for working professionals. It also explores some of the challenges highlighted by the literature study.

The solution and learning design focused on developing competent teaching methods for natural science. In this project, effectiveness is understood as the transfer of learning, which positively impacts teaching practices. The e-Learning was investigated thoroughly from February to June 2014 as a possible solution for 7 teachers at three Danish elementary schools.

The data gathering method included extensive in-class video recordings and observations. The researcher recorded teaching methods using a mobile ethnographic approach; the teachers had small camcorders attached to their necks, which enabled the researcher to view the classroom from the teachers' perspective. The data consisted of approximately 120 hours of in-class video recordings and 100 pages of observation notes. The researcher also had reflection sessions with the teachers before and after the introduction of e-Learning. These sessions were inspired by the mind tape and retrospective interview methodologies (as in Kumar, Yammiyavar and Nielsen, 2007). The teachers' interactions with e-Learning, including their preparation for classes, were recorded by Camtasia, a software program that can record the screen, mouse movements and a picture-in-picture setting of the user. Here, the think-aloud approach was applied (Nielsen, Clemmensen and Yssing, 2002). The data consisted of approximately 25 hours of video recordings and 40 pages of observation notes of teachers' interactions with e-Learning. The teachers responded to a satisfaction survey immediately following the conclusion of the e-Learning, as well as a pre-survey shortly before initiating the e-Learning and a post-survey approximately one month after completion of the e-Learning. The latter was repeated 6 months after completion. This final data consists of 28 responses to the surveys, which each had approximately 20 questions.

The approach to gathering empirical data was specifically designed to capture some of the complexity, possibilities and challenges of teaching practices, both expected and unexpected. In the following section, the preliminary results of the empirical study are included when they contribute to answering the research questions of this paper.

2. How is the effectiveness of e-Learning defined?

Approximately one-third of the abstracts in the literature study were coded. From these, as many as 19 different ways to define effectiveness have been identified. These definitions are listed in chronological order below, in Table 2, with the most commonly used definition at the top. The table includes 92 papers of the 111 coded. The remaining abstracts did not state the target audience and are therefore not included in this table. The actual number of papers from which the 19 definitions were obtained is 170, not 92. This is because a *set* of definitions is often used to investigate the effectiveness of an e-Learning solution; for example, several papers use both 'learning outcome' and 'satisfaction' as definitions for effectiveness (Harrington and Walker, 2009; Jung et al, 2002; Maloney et al, 2011). The number of papers in this list would of course change if the remaining abstracts were coded, but the author's find that the most common definitions are expected to stay relatively stable, as they have not significantly changed in recently reviewed abstracts.

Table 2: Definitions of effectiveness organised by the context of adult learning

	Higher education	Work-related learning	Total
Number of papers:	52	40	92
Distribution of papers:			
Learning outcome	29	9	38
Transfer (application to practice)	3	15	18
Perceived learning, skills or competency	11	6	17
Attitude	8	3	11
Satisfaction	8	3	11
Skills acquired	5	5	10
Usage of product	4	5	9
Learning retention	4	4	9
Completion	0	5	5
Motivation and engagement	3	2	5
Organisational results	0	5	5
Application to simulated work practice	0	4	4
Self-efficacy	0	4	4
Confidence	1	2	3
Cost-effectiveness	1	2	3
Connectedness	1	1	2
Few errors	2	0	2
Raised Awareness	0	2	2
Success of (former) participants	1	0	1
Undefined effectiveness	10	2	12

Of the papers reviewed, 57 % (52/92) examined effectiveness within higher education, in which context the most prominent definition of e-Learning effectiveness was 'learning outcome', with 56 % (29/52) of these papers applying this definition. Within work-related learning, the most common definition was 'transfer (application to practice)', with 38 % (15/40) of the papers applying this definition.

'Learning outcome' occurs when participants acquire new understandings as a result of the e-Learning initiative. This is a broad definition, but in the abstracts of papers examining higher education, the definition is often clarified in terms of measurements; for example: 'Student learning measurements included: pre-test, final examination (post-test) and final letter grade' *(Boghikian-Whitby and Mortagy, 2008).*
Within the field of work-related learning, the ability to apply the content or processes of the e-Learning

solution is essential. For example, in a study on teachers' technology competencies, it was not 'knowing about', but rather the actual 'integration of computer activities with appropriate inquiry-based pedagogy in the science classroom' that determined effectiveness (Angeli, 2005).

It is, however, interesting that 'transfer (application to practice)' is sometimes evaluated through the participants' self-assessments: 'Outcomes were measured across levels 1 to 3 of Kirkpatrick's hierarchy of educational outcomes, including attendance, adherence, satisfaction, knowledge and self-reported change in practice' (Maloney et al, 2011) and 'A follow-up questionnaire showed that two-thirds of those who viewed the program had subsequently reviewed the performance data for the initial wire they were using and 20 % had changed it' (Marsh et al, 2001). This brings to light the discussion of whether or not it is possible for learners to assess their own transfer (i.e. if people accurately report their actions, or if researchers, managers, peers or learning professionals must observe and report).

Since learning literature often focuses on engagement and motivation as necessary factors for knowledge gain and learning transfer, it is surprising that only five papers include these aspects in their research (Table 2).

Some papers investigated the interrelatedness of more aspects of effectiveness, such as the relation between learning outcome/retention and behaviour. For example, Hagen et al (2011) found that '…the effects of the intervention on security awareness and behaviour partly remains more than half a year after the intervention, but that the detailed knowledge on information security issues diminished during the period.' Such a study challenges the idea that behaviour changes can be measured through learning retention.

Table 2 also shows that the abstracts dealing with higher education operated with few definitions other than 'learning outcome', while the abstracts dealing with work-related learning generally applied a greater variety of definitions. This could be because universities work with performance requirements that primarily focus on examination grades and completion rates, causing effectiveness to be measured by cognitive knowledge indicators. In a work-related setting, however, effective learning is much broader, including aspects that are not bound to individual or group projects, such as the application of learning to work contexts, organisational results and cost-effectiveness.

It became clear in the analyses that many abstracts and a number of papers did not state their definitions of effectiveness; 13 % (12/92) of the abstracts left effectiveness completely undefined.

2.1 Why is this important?

Having multiple ways of understanding the effectiveness of e-Learning allows professionals and researchers substantial flexibility in defining, measuring and determining the effectiveness of an e-Learning solution. However, the broadness of the concept does present challenges. Leaving the concept of e-Learning undefined may lead to misunderstandings, and the aspects of effectiveness that are of most value to participants and stakeholders may not be considered. Illuminating the many definitions of effectiveness can lead to reflection and inspiration for appropriately utilising the concept of effectiveness, thus enabling learning professionals to better align their expectations and target their measuring efforts towards what is important to them and their stakeholders.

3. How is the effectiveness of e-Learning measured?

The previous section broadens the understanding of the definitions applied within research examining the effectiveness of e-Learning. But how are these definitions investigated in the various studies? How do the researchers measure effectiveness, and what consequences result? Of the 111 abstracts coded in detail, 63 abstracts identified their research design.

Table 3: Research study methods

	Mixed	Qualitative	Quantitative
All abstracts coded with…	9	5	37
Comparative studies applying…	0	1	18

The first row of Table 3 shows the distribution of research studies coded as mixed, qualitative and quantitative studies. In addition, 30 comparative studies were found, 11 of which do not describe in the abstract whether

they are conducting qualitative, quantitative or mixed methods research. The distribution of the rest is shown in the second row. Nearly 73 % (37/51) of the studies are quantitative. Almost half of these are comparative studies, which compare e-Learning with traditional face-to-face and/or blended learning. The vast amount of comparative quantitative studies may be due to policy makers' interest in this research (Grgurovic et al, 2013).

The literature study reveals that the most common way to measure effectiveness is through quantitative pre- and post-testing. To come to an understanding of which definitions of effectiveness are most used in particular kinds of studies, the effectiveness code was correlated with the research methods applied. This correlation showed that 'learning outcome' was used more frequently in quantitative studies (18 papers) than qualitative (2 papers) and mixed methods studies (1 paper). More quantitative studies were identified than qualitative studies, but the quantitative studies' use of 'learning outcome' is still significantly higher.

It might be assumed that qualitative studies would use several definitions of effectiveness, but this was not the case. Instead, these studies tended to use only one or two of the 19 definitions, whereas quantitative studies used significantly more. This could be because qualitative and mixed methods studies aim to explore a single concept in dept, and the intentions are often to understand the 'why's' of such a concept, which requires a significant amount of time and resources. On the other hand, quantitative research uses definitions as a set of variables constituting effectiveness, thus necessitating the use of several definitions.

The reason for the distribution of research methods in this literature study could be due to both a publication and policy bias. Writing thorough descriptions of the 'why's of qualitative research requires more space than reporting means and standard deviations. Very few journals allow for such prolonged papers, and quantitative papers also tend to be in higher demand, in line with what Grgurovic (2013) calls a 'publication bias' (i.e. the tendency to only publish studies with statistically significant findings).

3.1 Why is this important?

As stated, most research into the effectiveness of e-Learning focuses on measuring if and/or which e-Learning solutions are effective using quantitative measures. The aim of the empirical study examining an e-Learning program for science teachers was to understand the complex approaches used, when attempting to change teaching practices using e-Learning. The solution uses an on-the-job learning approach, including in-class practice, and a facilitated team-based competence development setup. It was shown that great effort is needed to use e-Learning to improve teaching performance.

The qualitative analysis of the teachers' interactions with e-Learning (Camtasia recordings) shows three prevailing strategies that the teachers use to avoid substantial changes to their work practice:

1. Finding statements to reject content, which means that the teachers seemed to be searching for single statements in the e-Learning content that they could use to prove that application to practice was not possible. Some stated that they preferred to teach as the e-Learning suggested, but their work context would not allow for it.
2. Modifying content to make change less demanding, which means that the teachers consciously or unconsciously modified the content to work similarly to their current practices, allowing them to state that they were already teaching this way, or changing the content to become easily applicable. This finding is in line with Bransford and Schwartz (1999), who discovered that people often modify a transfer situation until it becomes similar to something they know (Lobato, 2006).
3. Pinpointing content that can be easily implemented, which means that the teachers used elements of the content that they could easily apply to their teaching without changing it fundamentally.

For the quantitative and qualitative surveys, the teachers were asked to evaluate their application of the program's learning content to the lessons that were observed by the project researcher. This enabled the researcher to compare the teachers' self-assessments of transfer and transfer-related concepts (motivation, knowledge and self-efficacy) with the observation material. This led to the conclusion that all teachers following the program made noticeable changes to their teaching practice, largely using the third strategy mentioned above.

This research design (see 1.3) also enabled the researcher to discover unintended and unexpected transfer. For example, one teacher became so fond of her new way of posing questions to the pupils that she now uses the method when teaching history as well. On the other hand, her co-worker was insecure with the new teaching methods, which negatively affected her teaching. Research examining learning transfer shows that the traditional notion of one-to-one transfer from learning to practice must be challenged (see Lobato, 2006). A challenge often faced when evaluating effectiveness is that unexpected transfer, which can have both positive and negative impacts on performance, may not be analysed if only known and a priori concepts are investigated. Thus, if only quantitative survey data was gathered, the empirical study would have presented a misleading view of the transfer of learning. In addition, the teachers generally overestimated themselves in both pre- and post-testing. However, by including the qualitative elements of the survey (e.g. teachers describing their actions during the lessons in their own words), most discrepancies between self-assessment and observation were clarified, and the responses could be accepted or corrected. The amount of pure quantitative research in the literature study was also of concern. Results relying solely upon rating scales and multiple-choice tests can easily become misleading. Openness to participants' own unframed understandings, even if only part of a survey, can potentially result in more valid and usable answers regarding the effectiveness of e-Learning, regardless of its definition.

4. What makes e-Learning solutions effective?

All the abstracts used in this study were coded for whether the e-Learning was effective, not effective or partly effective, provided this was stated or indicated in the abstracts. This was the case for 61 of the 111 abstracts examined. The distribution is shown in Table 4.

Table 4: Is e-Learning effective?

Effective	41
Not effective	6
Partly effective	14

Considering the challenges of e-Learning, the fact that only 10 % (6/61) of the studies are classified as 'not effective' questions the validity of the classifications. Taking a closer look at the abstracts, it became clear that many of the empirical studies on effectiveness were conducted by researchers who appeared to have a stake in the success of e-Learning. This issue of 'effectiveness bias' means that the literature study at this point does not support the investigation into which e-Learning solutions are particularly effective. Perhaps a future analysis of the papers in question is warranted. What this study can explore are the factors that influence e-learning effectiveness.

A qualitative view of the factors, which the researchers classify as either promoting or prohibiting e-Learning effectiveness across a spectrum of definitions, methodologies and e-Learning media, provides valuable additions to e-Learning design and research. Through in vivo coding, 34 factors were found and divided into the three categories: individual (subject), contextual scaffolding (context + object) and e-Learning solution and process (artefact). These categories are inspired by the concept of activity theory, as they relate to learning and the transfer of learning (in line with Engestrôm, Leont'ev, Vygotsky and Orlikowsky).

Table 5: Factors that influence effectiveness

E-Learning solution and process (artifact):	**Individual (subject):**	**Context scaffolding (context + object):**
Active learning	Age	Learning environment
Applicable to practice	Entrance scores	Support
Balance between asynchronous and	Experience in profession	Technological resources
synchronous activities	Language (second language)	available to user
Cognitive load	Learner characteristics	Time available to learn
Collaboration	Learner preferences	
Communication	Locus of control	
Computer playfulness	Motivation	
Design	Expected workload	
Instructional scaffolding	Perception of learning	
Interaction (learner – instructor and	Previous e-Learning experience	
peer2peer)	Previous training	
Learner control	Prior online experience	
Modeling		
Problem-based learning		
Practice (incl. case study, case-based		
learning, and simulation)		
Structure		
Technological constrains		
Usability		

The categorization of the factors shows an interesting distribution (Table 5). The papers examined in the literature study clearly prioritise factors related to the e-Learning solution and process, even though contextual factors may be more critical to e-Learning effectiveness (Noesgaard, 2014). The reason for this phenomenon may be that the contextual factors are perceived as too complex and changeable to investigate and control for research, and that they lay outside the responsibility of learning professionals.

As previously mentioned, the grounded approach uses the wording from the papers in the first round of analysis. This was also done for the factors listed in Table 5. In the second round of analysis, the authors found that the interconnectedness of the factors called for further categorisation. This categorisation into key factors is discussed further below and is illustrated in Figure 2.

Overall, in terms of the contextual factors, the key factors are quite clearly 'resources' (time, technology) and 'support' (from managers, IT personnel or peers) in the learning environment. These factors are essential for using e-Learning initiatives to improve performance and change behaviours.

With regards to individual factors, the papers generally agree that effectiveness varies according to individual differences (e.g. Armatas et al, 2003; Aydoğdu Karaaslan, 2013). Some papers refer to learner characteristics broadly and others discuss particular issues relevant to their study. Two mentioned characteristics are 'age' and 'previous online experience' (Table 5). One study suggests '…that adult students benefit more from taking online classes compared to traditional age students […] and that computer competency helped improve performance in online classes over time' (Boghikian-Whitby and Mortagy, 2008: 107). Sometimes, factors that are not mentioned can have an impact on effectiveness: 'However, although gender is a significant predictor in traditional classroom courses, its effect disappears in Web-based courses. There is evidence that Web-based courses can be conducive to the leaning process of technical knowledge for female students' (Lam, 2009).

The individual factors largely fit into two categories related to learner characteristics: 'experience' and 'motivation'.

It is not surprising that the experience of participants, in terms of previous relevant work experience and online experiences, affects the effectiveness of e-Learning. These factors seemed to determine the kind of attitude that participants 'go into the learning process with'; previous experience can be beneficial, if the previous work and online experiences correspond with the e-Learning (Boghikian-Whitby and Mortagy, 2008; Bennison and Goos, 2010; Haverila, 2010). What is intriguing is that, experience may either increase or decrease effectiveness. The authors have in previous empirical studies within higher education with students who study IT and educational design found that, when the definition of effectiveness was 'satisfaction', the

students' previous experience with a variety of e-Learning solutions left the students unimpressed; hence, decreasing effectiveness (satisfaction). In the empirical study discussed in this paper, the teachers had little e-Learning experience and were generally satisfied. Similarly, a learner with significant relevant work experience may perform well on tests and at work but have a low satisfaction score because the learning was not challenging. This underlines the importance of clarifying the definition of effectiveness and to discus the ways in which individual factors can affect effectiveness.

Motivation to learn and engage with the e-Learning solution is key to effectiveness, especially when effectiveness is defined as the time spent using the product: 'Results suggest the importance of motivation to learn and workload in determining aggregate time spent in e-learning courses' (Brown, 2005: 465). However, when projects are defined as 'blended e-Learning', time spent may not always be a good indicator of whether learning took place: 'beyond the impact of extrinsic-related perceptions, social and personal motivations are important drivers of discussion forum usage in an e-learning context…[] … It is concluded that even for adult learners, social interaction with instructors and collaborative interaction with peer students are important in enhancing learning and active participation in online discussion' (Jung et al, 2002: 153). Therefore as in traditional learning, motivation is not only based on individual factors.

For the e-Learning solution and process, the key factors are 'interaction' and 'practice'. The importance of these factors was determined as a result of the coding of the factors that influence effectiveness as well as the codes including the reasons that e-Learning was or was not effective. Interrelated factors, such as 'instructional scaffolding', 'modelling' and 'support', were combined into a single factor, 'interaction'. Though e-Learning is often considered to be equally or more effective than face-to-face learning, interaction is generally considered to be critical to the effectiveness of e-Learning, as illustrated in the following papers: 'Students valued interaction with instructor as an important factor in online learning. New students had a better success rate in instructor-led online courses than in independent-study online courses. Adult students need modelling and scaffolding to be successful in an online environment' (Jiang, Parent and Eastmond, 2006); '…the supported training group had a significantly higher program completion rate than the independent group' (Bennett-Levy et al, 2012); and 'Results indicate teachers attributed improved student learning to technology use; online communication with peers and experts reduced teacher isolation, enhanced professional practice and gave access to perspectives and experiences otherwise unavailable; but the additional workload discouraged several teachers' (Hawkes and Good 2000). The last article also touches on the contextual factors as it emphasises the need to consider both the time available to the learners and the expected workload of the e-Learning (see also Noesgaard, 2014).

A recurring factor contributing to e-Learning effectiveness is 'practice'. The learner is given the opportunity or is required to practice the educational material presented via the e-Learning solution in case studies, simulations or actual work situations. The aim is to support learning retention and transfer to practice, as simulated practice provides a safe learning environment before the skills are applied in critical work situations: 'Intermediate-fidelity simulation is a useful training technique. It enables small groups of students to practice in a safe and controlled environment how to react adequately in a critical patient care situation. This type of training is very valuable to equip students with a minimum of technical and non-technical skills before they use them in practice settings' (Alinier et al, 2006).
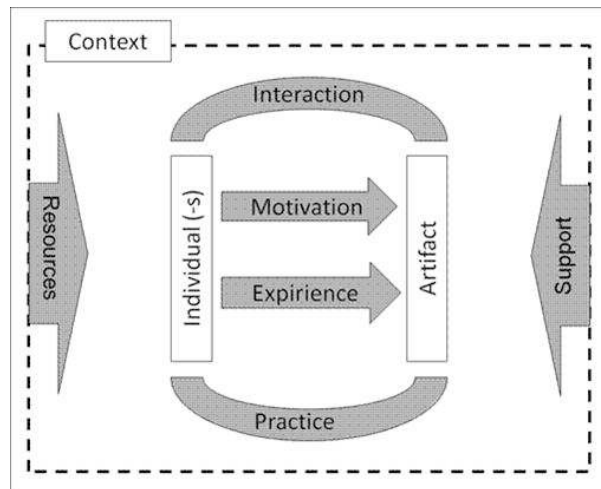
Figure 2: Key factors influencing effectiveness

The model in Figure 2 shows the key factors (in grey) that were identified by the review to influence the effectiveness of e-Learning (artefact) across the multiple definitions (Table 2). A supportive and resourceful learning environment (context) must be in place. The level of motivation of the individual(s) interacting with e-Learning (artefact) influences the time they spend using the product, and previous online or professional experience appears to have a largely positive impact on effectiveness. An e-Learning design that accommodates interaction between instructor(s) and peers and provides opportunities to practice the e-Learning material in simulated—or, when appropriate, real-life—work situations also promotes e-Learning effectiveness. As such, this model shows the interrelation of the key factors influencing effectiveness, but it cannot stand alone, as this abstraction like many papers in the literature review does not take the great variety of definitions into account. However, it is a good tool for starting discussions about effectiveness.

4.1 Why is this important?

Understanding the factors that are deemed critical for effective e-Learning in the context of adult learning can enable learning professionals to reflect on their priorities regarding learning design. The model and list of factors can be used as a checklist and a starting point for discussing how to ensure that the factors relevant to specific e-Learning participants, contexts and solutions are taken into account.

5. Critical reflections

Many of the studies analysed in this integrative review value e-Learning based on how well a given e-Learning solution accommodates for individual characteristics (experience and motivation) or the extent to which the solution provides opportunities for interaction and practice and to a smaller extent whether or not the necessary contextual resources and support are in place (Figure 2).

As discussed, approximately half the papers included in the literature review use a comparative methodology. This means that the effectiveness of e-Learning is largely defined based on how well the e-Learning performed, compared to traditional face-to-face teaching with the same content. Thus, the same definitions of effectiveness are used for both e-Learning and face-to-face teaching, and e-Learning must outperform face-to-face teaching in order to be considered effective. With this in mind, it becomes important to take another critical look at the key factors, since the comparative research methodology affects their perceived importance. This means that some of the factors like interaction and practice may have surfaced as critical during the review, because these factors illustrate the strong sides of face-to-face teaching. A given e-Learning solution must, therefore, entail these factors to be effective when compared to face-to-face teaching. But do we want e-Learning to be more like face-to-face teaching? Is the most effective e-Learning an online replication of the classroom setting? What would happen if policy makers and researcher stopped asking if e-Learning is as good as what we currently have with face-to-face teaching and instead started asking if we could get something better or different from e-Learning? Should different modalities have the same measures of performance, or should we consider e-Learning to be a unique learning process and thus use different definitions of effectiveness?

Within recent years, massive open online courses (MOOCs) have received profound attention within the field of e-Learning. MOOCs offer free courses, competence development and even certification. They are often considered to be the promised land of education, democratising education through scalable technology. As a stand-alone solution, MOOCs provide opportunities for reflecting on and constructing new knowledge, but often they entail a minimum amount of live interaction. Many MOOCs continue to be online replications of classrooms primarily consisting of video lectures, multiple-choice quizzes, Q&As and more informal after-class discussions in online discussion forums.

So are MOOCs ineffective because little interaction is provided compared to face-to-face teaching? And if not, is interaction not a key factor in e-Learning effectiveness? We argue that interaction is indeed essential to learning retention and learning transfer. An educational design applying collaboration and interaction with peers and a facilitator (the teacher or instructor) can provide a purposeful space for reflecting on the practice as well as an empathetic customisation of the subject matter, which no automatic process is capable of yet. Hence, when the overarching objective is to design e-Learning which increases learning retention and work performance, the effectiveness of e-Learning may very well be evaluated by the quality of the interaction provided. But what if the overarching objective is different than the definitions provided here (Table 2)? What if we, despite the vast number of definitions in this paper, are missing more e-Learning specific definitions that are independent of face-to-face teaching, such as democratization and scalability? And as a last mental exercise, what if we started evaluating face-to-face instructions on these objectives?

6. Conclusions

This paper has discussed the following research questions: How is the effectiveness of e-Learning defined? How is the effectiveness of e-Learning measured? What makes e-Learning solutions effective?

Through an integrative review, relying on both a literature review and an empirical study, this paper identified multiple ways to define effectiveness, with 'learning outcome' as the most prominent definition. The authors highlighted the benefits of reflection on and clarification of the way in which these definitions are used in research and practice. The paper discovered that the research is largely applying quantitative and comparative methodologies. In this regard, this paper suggests that applying purely quantitative measures to fulfil predefined learning objectives does not allow researchers and practitioners to discover unexpected and unintended transfers to practice and presents potential sources of error. Including open-ended qualitative questions in surveys can substantially improve the validity of such approaches; the empirical study and some of the analysed papers show that self-assessment can give researchers and designers quality feedback on the effectiveness of the e-Learning solution. To understand what makes e-Learning solutions effective, this paper analysed factors promoting the effectiveness of e-Learning. These factors were categorised according to the context in which the e-Learning solution was used, the artefact (the e-Learning solution itself) and the individuals that used the artefact. Subsequently, further categorization into key factors resulted in a model to guide e-Learning design.

One of the many questions raised in the discussion was the question of whether e-Learning and traditional face-to-face learning should be measured based on the same definitions of and approaches to effectiveness. To find appropriate answers to this question, the authors suggest that future researchers and designers critically consider the identified definitions, measures and factors when designing for effective e-Learning.

7. Limitations and further work

The literature study has certain limitations: First, the fact that the analysis is based primarily on abstracts, only including a few full papers, might have resulted in slightly different categorisations than had the full papers been analysed. Second, e-Learning is dealt with as a single concept, when in fact it consists of a great variety of delivery methods, technologies and learning designs. However, these variations are coded in the literature study, and the authors look forward to further exploring the concept of e-Learning. Third, the literature study considers a larger number of papers than most other literature studies. Still, the quantitative analysis will benefit from an increased number of coded abstracts since some of the findings are based on relatively small numbers (Table 2). However, as mentioned in the methodological section, the authors chose theoretical saturation over volume. Finally, both researchers were involved in discussions about the design of the e-

Learning solution tested in the empirical study and thus may be affected by effectiveness bias. The researchers will continue to explore these concerns as the study continues.

8. Recommendations

Based on the analyses in the previous chapters, the following recommendations are proposed:
- There are many understandings of e-Learning effectiveness. Be sure to clarify what would make your solutions effective. Consider using the list of definitions for inspiration (Table 2).
- Do not measure effectiveness simply for the sake of measuring. Know what measurements will give you the documentation your stakeholders require and the answers you need to continuously improve your solutions.
- When designing e-Learning, consider the key factors that impact e-learning effectiveness (Figure 2).
- Be critical and consider whether or not your face-to-face and e-Learning solutions should use different definitions of effectiveness (performance measures). Aim to compare your solution to other solutions using the same definitions of effectiveness.

Acknowledgements

References

Angeli, C. (2005) 'Transforming a teacher education method course through technology: Effects on preservice teachers' technology competency', *Computers & Education*, vol. 45, no. 4, pp. 383–398.
Alinier, G., Hunt, B., Gordon, R. and Harwood, C. (2006) 'Issues and innovations in nursing education: Effectiveness of intermediate-fidelity simulation training technology in undergraduate nursing education', *Journal of Advanced Nursing*, vol. 54, no. 3, pp. 359–369.
Armatas, C., Holt, D. and Rice, M. (2003) 'Impacts of an online-supported, resource-based learning environment: Does one size fit all?' *Distance Education*, vol. 24, no. 2, pp. 141–158.
Aydoğdu Karaaslan, I. (2013). 'The effect of banking personnel's access to E-learning opportunities on their professional achievement', *Turkish Online Journal of Educational Technology*, vol. 12, no. 2, pp. 269–280.
Bennison, A. and Goos, M. (2010) 'Learning to teach mathematics with technology: A survey of professional development needs, experiences and impacts', *Mathematics Education Research Journal*, vol. 22, no. 1, pp. 31–56.
Bennett-Levy, J., Hawkins, R., Perry, H., Cromarty, P. and Mills, J. (2012) 'Online cognitive behavioural therapy training for therapists: Outcomes, acceptability, and impact of support', *Australian Psychologist*, vol. 47, no. 3, pp. 174–182.
Boghikian-Whitby, S. and Mortagy, Y. (2008) 'The effect of student background in e-Learning—Longitudinal study', *Issues in Informing Science & Information Technology*, vol. 5, pp. 107–126.
Brown, K. G. (2005) 'A field study of employee e-learning activity and outcomes', *Human Resource Development Quarterly*, vol. 16, no. 4, pp. 465–480.
Buil, I., Hernández, B., Javier Sesé, F. and Urquizu, P. (2012) 'Discussion forums and their benefits for e-learning: Implications for effective use', Los Foros de Discusión Y Sus Beneficios En La Docencia Virtual: Recomendaciones Para Un Uso Eficiente, [English abstract only] vol. 22, no. 43, pp. 131–143.
Grgurovic, M., Chapelle, C. A. and Shelley, M. C. (2013) 'A meta-analysis of effectiveness studies on computer technology-supported language learning', *ReCALL*, vol. 25, no. 2, pp. 165–198.
Harrington, S. S. and Walker, B. L. (2009) 'The effects of computer-based fire safety training on the knowledge, attitudes, and practices of caregivers', *Journal of Continuing Education in Nursing*, vol. 40, no. 2, pp. 79–86.
Harry, B., Sturges, K. M. and Klingner, J. K. (2005) 'Mapping the process: An exemplar of process and challenge in grounded theory analysis', *Educational Researcher*, vol. 34, no. 2, pp. 3–13.
Haverila, M. (2010) 'Factors related to perceived learning outcomes in e-Learning', *International Journal of Knowledge and Learning*, vol. 6, no. 4, pp. 308–328.
Jiang, M., Parent, S. and Eastmond, D. (2006) 'Effectiveness of web-based learning opportunities in a competency-based program', *International Journal on E-Learning*, vol. 5, no. 3, pp. 353–360.
Jung, I., Choi, S., Lim, C. and Leem, J. (2002) 'Effects of different types of interaction on learning achievement, satisfaction and participation in web-based instruction', *Innovations in Education and Teaching International*, vol. 39, no. 2, pp. 153–162.
Lam, M. (2009) 'Effectiveness of web-based courses on technical learning', *Journal of Education for Business*, vol. 84, no. 6, pp. 323–331.
Lobato, J. (2006) 'Alternative perspectives on the transfer of learning: History, issues, and challenges for future research', *Journal of the Learning Sciences*, vol. 15(4), 431–449.

Maloney, S., Haas, R., Keating, J. L., Molloy, E., Jolly, B., Sims, J., … Haines, T. (2011) 'Effectiveness of web-based versus face-to-face delivery of education in prescription of falls-prevention exercise to health professionals: Randomized trial', *Journal of Medical Internet Research*, vol. 13, no. 4.

Means, B., Toyama, Y., Murphy, R. F. and Baki, M. (2013) 'The effectiveness of online and blended learning: A meta-analysis of the empirical literature', *Teachers College Record*, vol. 115, no. 3, p. 1.

Noesgaard, S. S. (2014) 'Supporting transfer of learning: Practice-based considerations on the applicability of transfer literature in online design', in the *conference proceedings from Designs for Learning*, Stockholm May 2014, pp. 1–5. Available: http://www.designsforlearning.nu/conference/program/pdf_webb/schack_noesgaard.pdf

Patterson, B. J., Krouse, A. M. and Roy, L. (2012) 'Student outcomes of distance learning in nursing education: an integrative review', *Computers, Informatics, Nursing*, vol. 30, no. 9, pp. 475–488.

Rosenberg, H., Grad, H. A. and Matear, D. W. (2003) 'The effectiveness of computer-aided, self-instructional programs in dental education: a systematic review of the literature', *Journal of Dental Education*, vol. 67, no. 5, pp. 524–532.

Veneri, D. (2011) 'The role and effectiveness of computer-assisted learning in physical therapy education: A systematic review', *Physiotherapy Theory and Practice*, vol. 27, no. 4, pp. 287–298.

Whittemore, R. and Knafl, K. (2005) 'The integrative review: Updated methodology', *Journal of Advanced Nursing*, vol. 52, no. 5, pp. 546–553.