Heuristics and Web Skills Acquisition in Open Learning Environments

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ABSTRACT

Web literacy refers to the skills and competencies people need in order to function in societies connected through the Internet. Many of the frameworks for understanding the components of web literacy are limited in value because they rely on conceptual definitions. They do not take into consideration the social practices governing the use and writing on the web. Nor do these frameworks take into account the open and participative nature of the Internet. With the aim of moving beyond this theoricist vision, we present an analysis of the relationship between the social practices of a group of university students in open learning environments and the acquisition of web skills. We proposed an alternative approach that is rooted in an understanding of social practices. In order to "operationalize" and facilitate an study of web skills, we relied on a specific type of analysis that allowed us to observe the consistency between the practices observed and the behavior reflected in the heuristic framework of web skills. The main elements of this alternative framework are explained, as is the link between the social practices of the students and the skills acquired. We also discuss other contributions to the field of Web Literacy and to the even larger field of Digital Literacy.

Keywords

Web skills, Web literacy, Digital literacy, Open learning, Non-formal learning, Heuristic approach

Introduction

The way digital skills are taught is a subject that has been studied since the late 1990s, when analog devices were beginning to be replaced by digital ones as a first-tier socialization factor. Since then, there has been a wide-ranging discussion on how the need to acquire web skills has had an impact on how people are trained to carry out ordinary daily tasks. Many studies have shown that there are substantial educational and psychological benefits to incorporating digital social media into education and work (Coward et al., 2014; Gasser et al., 2012; Junco, 2015). In addition, it is beneficial for professional careers. Therefore, it is necessary to provide citizens with the basic skills required to function in the information society. This is known as Digital Literacy Instruction. This concept appeared because of the accelerated changes that were taking place as a result of massive use of software and hardware connected via the Internet, and the fact that this new system was inaccessible to many people (Lankshear & Knobel, 2007).

The Web is currently the best forum for becoming digitally literate. This technology is part of the majority of mediation devices. Social environments can be created using the Web. This makes it an appropriate tool for facilitating all types of human activity and interaction. The Web is an emerging technology; therefore the approaches on how to teach the skills people need to use it have evolved over time (Belshaw, 2014; Hall & Tiropanis, 2012).

In the field of education, the development of Web literacy instruction has been greatly influenced by digital, media, and information literacy instruction. As with these other kinds of literacy instruction, research about Web literacy revolves around operationally identifying and classifying the skills that people need to acquire in order to be regarded as "literate." One key focus of these studies is to clearly map the skills related to handling browser software and programming languages. A second key focus is determining what distinguishes these skills from one another (European Committee for Standardisation, 2014; Dore, Geraghty, & O'Riordan, 2015). The Internet is different from other digital media and tools. As a consequence, the skills and competencies required and the mechanisms by which they are acquired, may be very different from other types of literacies (Ahtikari & Eronen, 2004; Lankshear & Knobel, 2013).

The existing approaches to studying these issues are either not specific enough, or ignore the participative nature of the Web. Here we introduce a new approach that focuses specifically on social practices in web environments and their relation to the development of digital skills. The reference framework used in this study is Web Literacy Map. This method for grouping skills was designed by Mozilla Foundation in conjunction with stakeholders with formal and informal education, as well as industry (Belshaw & Hilliger, 2015). The Web Literacy Map is used as heuristic model that reflects the skills required to read, write, and participate effectively

on the Web. The Web Literacy Map includes the skills that Mozilla users consider important for reading, writing, and participating on the Web. At the time of writing, the latest iteration was v1.1.

Web literacy and the skills and competencies needed to use the Internet

Web literacy instruction is a subset of the field of digital literacy instruction that shares some characteristics with other types of literacy instruction, such as media literacy, computational/algorithmic thinking, and computer science (Belshaw, 2013). From an educational standpoint, web literacy can be analyzed in a practical manner by dealing with the skills that a person needs in order to be considered "literate." However, most studies of digital skills are conceptual analyses of the types of knowledge to acquire and the skills themselves. That is, they focus on their definition and operationalization (Bawden, 2008; Beetham, McGill & Littlejohn, 2009; Ala-Mutka, 2011; Ferrari, 2012). The many types of web participation and the range of possible behaviors possible are not taken into account. These should be a fundamental part of the analysis. As a reaction to this deficiency, it has become more common to study these skills directly by observing the practices of people on the Internet. In these new types of studies, an analysis of people's interactions and what motivates them to participate in online forums is favored. The objective is to understand the skills that are developed and that are necessary to be able to participate in these forums, as well as the behavioral and socialization schemes that form part of daily social practices. The goal is to develop new methodologies for digital education that are more open and natural (Avila & Zacher-Pandya, 2012; Dominguez, 2006; Epstein, Nisbet & Gillespie, 2011; Hargittai, 2010).

Along with this first approach towards the active and applied component of web skills, the analytical concepts that underlie our study are the following:

- *The user is active on the web.* Web literacy is not only about "reading" the Web, but also "writing" on the Web. This includes reading, using the medium, and constructing online spaces where social practices take place. This does not mean that everyone must become a Webmaker, but it does mean that literate people should have the basic skills for connecting with others in order to interact both with and on the Web (Belshaw, 2013).

- *Skills and competencies.* A skill is a controlled activity that a person has learned to do. There are generic skills as well as specific ones. For example, a generic skill could be understanding how code is structured. A specific skill could be knowing how to use a diverse set of HTML elements. Skills have objective thresholds: they can be confirmed via evidence indicating that a predetermined skill level has been reached in a particular field. A competency, on the other hand, is a group of skills required for a predefined purpose. In spite of appearing objective, assessments of competencies are subjective by nature. These assessments require the prior definition of the criteria for considering a person "competent" in a particular subject and context (Belshaw, 2012).

- *Social web skills.* We were primarily interested in the access and use of the Web through browsers. There are "beginner" skills, such as identifying the web browser's address bar, using functions like copy/paste, and directly including a site's URL instead of searching for the page with a search engine. There are also "advanced" web skills, such as understanding code review workflow or server technologies. Both beginner skills as well as advanced ones lie outside the scope of this study.

Heuristic frameworks and human behaviors on the Web

We present a point of view that differs from classic conceptual approaches used to studying the world of web skills. It involves explicitly considering the heuristics and linking the practices of individuals using the web and the skills they develop from these practices.

The reasons for using a heuristic approach are twofold. First, the ability of subjects to act has expanded as a consequence of the massive use of digital technologies. This, in turn, has overrun the analytical frameworks that have traditionally explained the acquisition of technological skills as an isolated process. The frontiers between web literacy and social literacy are becoming more diffuse, as the digital realm massively permeates the rules of social conduct and shapes a model of network connectivity (Rainie & Wellman, 2012). It is becoming inappropriate to speak about digital competencies in education as something specific. The social practices of students who are connected daily through social network sites must also be considered (Ellison & Boyd, 2013).

Second, advances in the behavioral sciences have opened up new paths for researching how skills related to daily tasks are mastered. Notably, rationality theories have moved away from formal models towards action and an attempt to explain people's decisions about the actions they will carry out. These theories explain that, in natural settings, there are many variables affecting the decision-making process. Under these circumstances, people apply mechanisms, termed heuristics, to adapt to environmental requirements and exploit them for their own benefit (De Neys, 2015; Evans, 2006; Gigerenzer & Gaissmaier, 2011; Goldstein, & Gigerenzer, 2002; March, 2002).

In this study, the characterization of heuristics is based on the concept of bounded rationality (Gigerenzer & Selten, 2001; Gilovich, Griffin, & Kahneman, 2002; Kahneman, 2003; Klaes & Sent, 2005) which lies within the field of cognitive science (Hutchins, 1995). According to Gerd, Gigerenzer & Reinhard Selten (2001), under the system of bounded rationality, actions are rational in proportion to the ability of the individual to exploit the structure of the action in which they find themselves, while at the same time taking into account the contextual and informational restrictions in which the action is carried out. Heuristics are "cognitive shortcuts" that allow individuals to evaluate a situation based on one or more basic rules. Using these, an individual can avoid carrying out costly, exhaustive evaluations of a varied and complex group of options. At the same time, the individual can pay attention to the circumstances that arise in that context. The advantage of bounded rationality and heuristics is that both theories elegantly explain how people can find suitable options in a way that is quick, successful, and a function of their environment. When a subject uses a heuristic he/she saves the effort of looking, identifying, and evaluating all the possible options in a context where these options are not readily apparent (Robles, 2007).

In education, heuristics have frequently been used as a methodological resource in disciplines that demand a high cognitive and meta-cognitive capacity (e.g., as applied to mathematics: Chavez, 2007; Hoon, Kee & Singh, 2013). Learning theories usually rely on analytical models and frameworks as a way of "operatizing" the variables related to a subjects' behavior and explaining how these variables function in specific situations. For example, in the specific field of connected and online learning, heuristics and frameworks have been used on many occasions to analyze and interpret the processes and pathways governing the behavior of students in digitally mediated scenarios (Aparicio, Bacao & Oliveira, 2016; Conole, Galley, & Culver, 2011; Garrison & Anderson, 2003; Hirumi, 2002; Hwang et al., 2010; Wang, Chen & Anderson, 2014; Wang, Han & Yang, 2015).

Heuristics are not "a priori" constructions. Their identification emerges from practices that are often carried out daily in different situations. In the case of the Web, these practices occur in the context of situations such as identifying where to write a search term in a browser or learning how to edit information using an online word processor. These skills are considered prerequisites for developing competencies such as "Search Engine basics" and "Browser basics." As a result of this decanting process, the heuristic that is linked to web literacy may consist of a series of competencies such as "Browser basics," "Search engine basics," and "Web mechanics." By implication, the more highly-literate users will be those who automate their behavior on the Internet by relying on these competencies.

Open and non-formal learning practices

Open online education is a combination of the use of resources and tools under open licenses and the application of social media to promote learning. In a bottom-up model, like the one presented in this study, web skills are defined based on people's practices in online spaces. Within these models, open learning contexts are considered a favorable forum in which to develop these skills.

In the social sphere, open learning has progressed due to the generalized adoption of the Internet by large, self-organized communities of civil society. These communities share resources and apply management methods based on connectivity. These communities serve different purposes (Carfagna, 2014). In the field of education, advances in open learning networks are facilitated by social media platforms, Massive Open Online Courses (MOOCs) and the Open Educational Resources movement. These advances place open education within a wider movement that drives the dissemination of knowledge in a way that is open, scalable, and capable of reaching large groups of society (Farrow et al., 2015; Weller, 2014; Wiley, 2014).

Open education projects allow any person to participate (within limits) regardless of their origin, location, or credentials. As in the case of traditional non-formal education, these projects challenge the notion of formal certification by "experts." In these forums, new methods for evaluating learning outcomes in open online communities are utilized. Examples of these methods are the use of peer evaluation, the management of

reputation, complex meritocratic arrangements, and the measure of social capital within the community (Schmidt et al., 2009).

The open education approach challenges the way we think about education, educational institutions, and the certification of knowledge (Iiyoshi & Kumar, 2008). A "learning environment" no longer means a classroom or delimited digital zones, but rather encompasses many other wider spaces on the Internet. These spaces are distributed, connected without being limited by time and space (Gil-Jaurena & Dominguez, 2012).

The theory of Connected Learning specifically analyzes these situations and posits that, in connected environments, it is the students, who construct pathways to learning in a self-directed way. They do this by appropriating the resources that are most suited to their needs (Ito et al., 2013; Ito et al., 2015). Our research is consistent with this richer vision of learning. In this vision, it is possible for students to access the web and gain knowledge (Buckingham, 2007; Collins & Halverson, 2009; Williams, Karousou & Mackness, 2011). What matters is the ability of each individual to develop competencies through their own social behavior on the web. By applying these competencies in other situations, they achieve a level of web literacy (Dominguez & Trillo, 2014).

It is advantageous to use behaviors in open spaces as a model for understanding how Internet skills are acquired. According to Latchem (2014), there is still much to be learned about open education and how best to validate these skills using the existing evaluation and certification systems. The aim of this study is to understand this topography better by collecting information about those who develop competencies for web mastery through their practices in open spaces. Our objective is not to construct a model of competencies in order to create a standard for non-formal students. This approach has been criticized as lacking in empirical support. Categorization would also not be possible without prior research into how these skills are acquired by non-formal students. Categorization would require specifying the objectives of their behaviors and what processes and learning styles develop during skill acquisition (Coffield et al., 2004).

Research context and methodology

In order to validate the approach, a specific analysis was performed on data from a research study on the practices of university students in open learning spaces. Based on this research, a meta-analysis of the linkages and groupings between the student practices in these spaces was carried out in terms of the Web Literacy Map framework. We considered how they used the web and the skills they acquired from these practices.

The benchmark research consisted of two phases. The first phase was a case study of 40 university students enrolled in Communication Sciences (at the Complutense University of Madrid, Spain) and Social Education (at the National Distance Education University, UNED, Spain). The participants were offered an opportunity to take one of the open courses indexed in the Open Education Consortium website (www.oeconsortium.org/). This group was divided into five focus groups whose participants talked about their practices on the Web.

The second phase was an attempt to give the data greater representativity. The sample was widened to include 451 students with characteristics similar to members of the pilot group. The students were enrolled at the following universities: Granada University (Spain), Oviedo University (Spain), Vigo University (Spain), Complutense University of Madrid (Spain) and National Distance Education University (UNED, Spain). They completed a questionnaire-based survey that was organized in two dimensions. This was based on a contrast between the theoretical-conceptual aspects of the study and conclusions from the focus groups: (1) Generic Web Practices (9 items), (2) Learning Practices on the Web (10 items).

In turn, Mozilla's Web Literacy Map was used as the heuristic around which the skills could be organized. The Web Literacy Map consisted of three dimensions, "Explore," "Connect" and "Build." However, the "Build" dimension and "Privacy" item of the "Connect" dimension were discarded because they only apply in the context of using the Web for learning purposes:
Explore — Reading the Web

- *Navigation.* Using software tools to browse the Web.
- *Web Mechanics.* Understanding the Web ecosystem and Internet stack.
- *Search.* Locating information, people and resources via the Web.
- *Credibility.* Critically evaluating information found on the Web.
- *Security.* Keeping systems, identities, and content safe.

Connect — Participating on the Web

- *Sharing.* Providing access to Web resources.
- *Collaborating.* Creating Web resources with others.
- *Community participation.* Getting involved in Web communities and understanding their practices.
- *Open practices*. Helping to keep the Web democratic and universally accessible.

Data analysis and interpretation

The meta-analysis began with a descriptive statistical analysis. This was followed by an exploratory factor analysis contrasting the relationships between web practices and the skills acquired. These skills were organized in a heuristic framework. The goal was to find parallelisms between the internal structure of the practices and their agreement with the heuristic of the Web Literacy Map. Therefore, we aimed to study the existing correlation between the structure of the factors derived from the practices and the structure of the Web Literacy Map.

Dimension 1 - Generic web practices

The structure of the items in this dimension is dichotomous. Its content matches the skills that fall into to the "Explore" and "Connect" dimensions of the Web Literacy Map (see Table 1).

Table 1. Descriptive statistics, dimension: Generic web practices

Generic web practices	No (%)	Yes (%)
Community participation	24.4	75.6
Navigation	25.3	74.7
Open practices	39.3	60.7
Sharing	42.8	57.2
Search	45.8	54.2
Web mechanics	59.7	40.3
Collaborating	60.6	39.4
Security	62.5	37.5
Credibility	74.2	25.8

Given this descriptive data, an exploratory factor analysis was applied. A KMO value of 0.78 was calculated. The Bartlett's Test of Sphericity resulted in a score of 658. The significance level of 0.000 indicated the adequacy of the dimension reduction model. The variance explained by the four first factors was 68%. This resulted in the following groupings (see Table 2):

Table 2. Factor analysis, dimension: Generic web practices

	Rotated component matrix*			
	Component			
	1	2	3	4
Navigation	.101	.054	.156	**.914**
Open Practices	.057	**.902**	-.018	.044
Security	**.713**	.020	.010	.228
Sharing	.359	.176	**.707**	.091
Credibility	**.835**	.138	-.031	-.027
Collaborating	.526	.465	.308	-.161
Community Participation	-.269	-.170	**.817**	.083
Web Mechanics	**.537**	.430	.032	.260
Search	.412	.465	-.176	.385

Note. *Rotation converged in 6 interactions. Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization.

When assessing the variable factor saturations the factors listed here were revealed. These factors were consistent with the dimensions of the Web Literacy Map framework:

- The first factor was a general one related to practices of "Security," "Credibility," and "Web mechanics." All of these were practices that formed part of the "Explore" dimension of the framework.
- The second factor was "Open Practices," which fit into the "Connect" dimension of the framework.

- The third consisted of the practices of "Sharing" and "Community Participation," in the "Connect" dimension of the framework.
- The fourth contained "Navigation," of the "Explore" dimension of the framework.

Dimension 2 - Learning practices on the Web

The items structure in this dimension was designed in the form of a Likert-type scale with five levels (see Table 3).

Table 3. Descriptive statistics, dimension: Learning practices on the Web

Generic web practices	N (%)	R (%)	S (%)	F (%)	A (%)
Social media	14.8	5.3	11.9	24.0	44.0
Chat	19.4	8.1	10.3	22.1	40.2
Leisure	19.0	9.7	16.4	24.1	30.8
Email	20.8	9.3	15.8	17.2	37.0
Search of Non-academic Information	20.9	13.9	24.1	21.8	19.3
Exchange of Notes	53.4	14.5	15.2	9.7	7.1
Search of Academic Information	39.5	18.3	18.4	14.6	9.3
Readings	50.4	16.4	17.1	9.0	7.2
Performing Group Work (e.g., Skype)	64.9	15.8	8.6	4.1	6.6
Study tasks	57.2	23.9	9.8	4.9	4.3

Note. N = Never; R = Rarely; S = Sometimes; F = Frequently; A = Always.

Using this descriptive data, the exploratory factor analysis resulted in a KMO value of 0.82 and a value of 1069 on the Bartlett's Test of Sphericity. The significance level was 0.000. These results suggested a dimension reduction model. This model consisted of three factors that accounted for 68% of the variance (see Table 4).

Table 4. Factor Analysis, dimension: Learning practices on the Web

	Rotated component matrix*		
	Component		
	1	2	3
Study Tasks	**.789**	.122	.075
Readings	**.791**	.132	.092
Search of Non-academic Information	.098	.449	**.729**
Chat	.195	**.807**	.047
Social Media	.081	**.873**	.130
Exchange of Notes	**.754**	.208	.152
Email	.254	.637	.332
Search of Academic Information	.304	.131	**.823**
Performing Group Work	**.757**	.088	.236
Leisure	.107	**.661**	.392

Note. *Rotation converged in 5 interactions. Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization.

Evaluating the factor saturations of the variables the following factors were found, which were consistent with the dimensions of the Web Literacy Map framework:

- The first factor was related to the use of the Web in academic activities, such as "Study tasks," "Readings," "Exchange of Notes," and "Performing Group Work." These were typical of the "Connect" dimension of the framework.
- The second factor was related to leisure and social interaction activities. These included "Chat," "Social media," and "Leisure." These practices fit into the "Connect" dimension of the framework.
- The third includes the practices of "Search of Academic & Non-academic Information." These practices fit into the "Explore" dimension of the framework.

Discussion

The current results should be interpreted keeping in mind that this was an analysis of students' practices in open learning situations on the Internet. It is also important to consider that the Internet is a medium that provides

access to new knowledge without restrictions from the physical world. In this forum, the student's autonomy comes first. How well students shape their own educational environment is a subject for debate. This is especially true considering the emergence of social media and MOOCs. For example, Turkle (2011) has argued that young people who show over-confidence in social media are moving away from the meaning of social norms and the significance of conventional socialization. Other studies suggest that participation in digital media, especially multitasking, correlate with a reduction in sustained and reflective thought (Bauerlein, 2008; Baron, 2008; Carr, 2010; Greenfield, 2009; Pea et al., 2012). However, defenders of connected learning and new forms of endoculturation via digital media have argued in favor of types of learning that are highly-participative and that offer resources for digital self-literacy (Boyd, 2014; Jenkins, Ito, & Boyd, 2016). For example, Ito et al. (2008; 2013) analyzed the ways in which young people integrate diverse technologies into their lives for personal, social, and educational purposes. This group concluded that different groups of skills, literacies, and social relationships are needed in the connected world in order to prosper and be successful. These skills are acquired in open online environments.

Meanwhile, in accordance with bounded rationality theory, the intelligent use of heuristics can be utilized to adapt to the structure of the environment and exploit its resources in a way that favors certain behaviors. Application of this theory has given verifiable results in the fields of economics (Gilovich et al., 2002) and health (Thaler & Sunstein, 2008). Our work took these advances into consideration. We propose their application in the area of learning. Heuristics should be used as frameworks to guide methodologies in educational processes for web literacy. Still, what applications the heuristics model is appropriate is controversial subject. The definition of heuristics is not a deductive process, but rather an inductive one. Having to define the psychological mechanisms governing an individual's rational actions complicates the task. This is the reason why bounded rationality is still not a complete and coherent corpus, but rather a "robust grouping of micro-theories" (Robles, 2007). The inclusion of experimental techniques in bounded rationality has led to advances in the field (Gigerenzer, 2015). Nevertheless, it is necessary to use empirical methods more often.

Data collection in non-formal environments is also discussed in the methodological section. There were unique challenges in the sampling and validation steps. This was due to the difficulties related to verification. In order to validate this type of methodology, Cohen (2007) conducted a multi-dimensional analysis of the research literature published in the areas of non-formal and formal education. He concluded that the usual qualitative and quantitative tools already available to researchers, such as interviews, observation, surveys, etc., are useful and appropriate for the study of non-formal education. He also concluded that the new tools and approaches were not needed to produce significant results. Although it can be scarcely found in the scientific literature, some evidence coming from analysis of the various research studies underscores the central role of non-formal and informal education. This evidence supports its relevance as a field of study in research of this kind (Latchem, 2012; Latchem, 2014).

Conclusions

The classical approach to digital literacy is the reference framework for web literacy. This approach assumes that digital skills are useful in order for people to be capable of selecting, analyzing, processing, organizing, and transforming information into knowledge based on context and personal and social needs. We believe that this approach is excessively instrumental. This is because it does not take into account the new competencies the web offers for people to be active in constructing new pathways for social participation and, especially, learning. In addition, incorporating a group of skills related to reading and writing on the web into the web literacy scheme is recommended. This group of skills should be included taking into account the Mozilla Foundation´s Web Literacy Map, used as the heuristic framework in this research.

The research data links students' web practices skills developed via these practices. The organization of these practices is consistent with a heuristic framework that is based on the user's behavior. The heuristic approach was applied in order to group the skills that were revealed while observing people's web practices. Heuristics are constructed according to behavioral patterns. Heuristics are useful because grouping the practices seen in the observed behaviors facilitates the performance of complex tasks. This approach was used in this study to identify groups of web practices that have factors in common. In addition, these groups of practices are consistent with the skills defined under the framework of the Web Literacy Map. This framework is also a kind of heuristic model that is primarily defined on the basis of practices.

In conclusion, this practices-based-approach presents an alternative to classical web literacy instruction, which is primarily based on the conceptualization of a set of skills that need to be developed. The framework of this

research might also be useful for analyzing the field of web literacy and for composing educational proposals that take into account this practical dimension of social interactions.

References

Ahtikari, J., & Eronen, S. (2004). *On a journey towards web literacy —The Electronic learning space Netro* (Unpublished doctoral dissertation). University of Jyvaskyla, Finland.

Ala-Mutka, K. (2011). *Mapping digital competence: Towards a conceptual understanding*. Sevilla, Spain: Institute for Prospective Technological Studies. Retrieved from http://ftp.jrc.es/EURdoc/JRC67075_TN.pdf

Aparicio, M., Bacao, F., & Oliveira, T. (2016). An e-Learning theoretical framework. *Educational Technology & Society, 19*(1), 292–307.

Avila, J., & Zacher-Pandya, J. (2012). *Critical digital literacies as social praxis: Intersections and challenges*. New York, NY: Peter Lang.

Baron, N. (2008). *Always on: Language in an online and mobile world*. New York, NY: Oxford University Press.

Bauerlein, M. (2008). *The Dumbest generation: How the Digital age stupefies young Americans and jeopardizes our future*. New York, NY: Tarcher.

Bawden, D. (2008). Origins and concepts of digital literacy. *Digital literacies: Concepts, policies and practices, 30*, 17-32.

Beetham, H., McGill, L., & Littlejohn, A. (2009). *Thriving in the 21st century: Learning Literacies for the Digital Age (LLiDA project)*. Retrieved from http://www.caledonianacademy.net/spaces/LLiDA/uploads/Main/LLiDAreportJune09.pdf

Belshaw, D. (2012, July 12). On the important differences between literacies, skills and competencies [Web log post]. Retrieved from http://dougbelshaw.com/blog/2012/07/12/on-the-important-differences-between-literacies-skills-and-competencies/

Belshaw, D. (Ed.) (2013). *Mozilla Web literacies white paper*. Retrieved from https://wiki.mozilla.org/Learning/WebLiteracyStandard/Legacy/WebLiteraciesWhitePaper

Belshaw, D. (2014, December 1). A Brief history of web literacy and its future potential [Web log post]. Retrieved from http://dmlcentral.net/a-brief-history-of-web-literacy-and-its-future-potential/

Belshaw, D., & Hilliger, L. (2015). *Mozilla Web literacy map (v.1.1)*. Retrieved from https://wiki.mozilla.org/Learning/WebLiteracyStandard

Boyd, D. (2014). *It's Complicated: The Social lives of networked teens*. New Haven, CT: Yale University Press.

Buckingham, D. (2007). *Beyond technology: Children's learning in the age of digital culture*. Cambridge, UK: Polity Press.

Carfagna, L. B. (2014). *Beyond learning-as-usual: Connected learning among open learners*. Irvine, CA: Digital Media and Learning Research Hub.

Carr, N. (2010). *The Shallows: What the Internet is doing to our brains*. New York, NY: W. W. Norton & Company.

Chavez, J. A. (2007). Enlivening problems with heuristics through learning activities and problem solving. *Learning Science and Mathematics, 2*, 1-8.

Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). *Learning styles and pedagogy in post-16 learning. A Systematic and critical review*. London, UK: Learning and Skills Research Centre.

Cohen, E. H. (2007). Researching informal education: A Preliminary mapping. *Bulletin of Sociological Methodology/Bulletin de Méthodologie Sociologique, 93*(1), 70-88.

Collins, A., & Halverson, R. (2009). *Rethinking education in the age of technology: The Digital revolution and schooling in America*. New York, NY: Teachers College Press.

Conole, G., Galley, R., & Culver, J. (2011). Frameworks for understanding the nature of interactions, networking, and community in a social networking site for academic practice. *The International Review of Research in Open and Distributed Learning, 12*(3), 119-138.

Coward, C., Caicedo, S., Rauch, H., & Rodriguez, N. (2014). *Digital opportunities: Innovative ICT solutions for youth employment*. Geneva, Switzerland: International Telecommunications Union.

De Neys, W. (2015). Heuristic bias and conflict detection during thinking. In B. Ross (Ed.), *The Psychology of Learning and Motivation* (pp. 1-32). Burlington, MA: Academic Press.

Dominguez, D. (2006). E-alfabetización y acceso a la formación virtual en la Universidad [E-literacy and access to virtual education in the university]. In R. Casado (Coord.), *Claves de la alfabetización digital* (pp. 315-334). Madrid, Spain: Ariel.

Dominguez, D., & Trillo, M. P. (2014). Learning competences in open mobile environments: A Comparative analysis between formal and non-formal spaces. *Open Praxis, 6*(3), 235-244.

Dore, L., Geraghty, A., & O'Riordan, G. (2015). *Towards a national digital skills framework for Irish higher education. Review and comparison of existing frameworks and models*. Retrieved from http://allaboardhe.org/DSFramework2015.pdf

Ellison, N., & Boyd, D. (2013). Sociability through social network sites. In William H. Dutton (Ed.), *The Oxford Handbook of Internet Studies* (pp. 151-172). Oxford, UK: Oxford University Press.

Epstein, D., Nisbet, E. C, & Gillespie, T. (2011). Who's responsible for the digital divide? Public perceptions and policy implications. *The Information Society, 27*(2), 92-104.

European Committee for Standardisation (CEN). (2014). *European e-Competence Framework 3.0. A common European Framework for ICT professionals in all industry sectors*. Retrieved from http://ecompetences.eu/wp-content/uploads/2014/02/European-e-Competence-Framework-3.0_CEN_CWA_16234-1_2014.pdf

Evans, J. (2006). The Heuristic-analytical theory of reasoning: extension and evaluation. *Psychonomic Bulletin & Review, 13*(3), 378-395.

Farrow, R., De los Arcos, B., Pitt, R., & Weller, M. (2015). Who are the open learners? A Comparative study profiling non-formal users of open educational resources. *European Journal of Open, Distance and e-Learning, 18*(2), 49-73.

Ferrari, A. (2012). *Digital competence in practice: An Analysis of frameworks*. Luxembourg: Publications Office of the European Union. Retrieved from http://ftp.jrc.es/EURdoc/JRC68116.pdf

Garrison, D. R., & Anderson, T. (2003). *E-learning in the 21st century: A Framework for research and practice*. London, UK: Routledge/Falmer.

Gasser, U., Cortesi, S., Malik, M., & Lee, A. (2012). Youth and digital media: From credibility to information quality. *European Journal of Open, Distance and E-Learning, 18*(2). doi:10.2139/ssrn.2005272

Gigerenzer, G. (2015). *Simplify rational: Decision making in the real world*. Oxford, UK: Oxford University Press.

Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic decision making. *Annual Review of Psychology, 62*, 451-482.

Gigerenzer, G., & Selten, R. (Eds.) (2001). *Bounded rationality. The Adaptive toolbox.* Cambridge, MA: The MIT Press.

Gil-Jaurena, I., & Dominguez, D. (2012). Open Social Learning y educación superior. Oportunidades y retos [Open social learning and higher education; opportunities and challenges]. *Revista Iberoamericana de Educación, 60*, 191-203.

Gilovich, T., Griffin, D., & Kahneman, D. (Eds.) (2002). *Heuristics and biases: The Psychology of intuitive judgment*. New York, NY: Cambridge University Press.

Goldstein, D. G., & Gigerenzer, G. (2002). Models of ecological rationality: The Recognition heuristic. *Psychological Review, 109*(1), 75-90.

Greenfield, P. M. (2009). Technology and informal education: What is taught, what is learned. *Science, 323*, 69-71.

Hall, W., & Tiropanis, T. (2012). Web evolution and Web science. *Computer Networks, 56*(18), 3859-3865.

Hargittai, E. (2010). Digital na(t)ives? variation in internet skills and uses among members of the "Net Generation." *Sociological Inquiry, 80*, 92-113.

Hirumi, A. (2002). A Framework for analyzing, designing, and sequencing planned elearning interactions. *Quarterly Review of Distance Education, 3*(2), 141-160.

Hoon, T. S., Kee, K. L., & Singh, P. (2013). Learning mathematics using heuristic approach. *Procedia - Social and Behavioral Sciences, 90*, 862-869.

Hutchins, E. (1995). *Cognition in the wild*. Cambridge, MA: The MIT Press.

Hwang, G., Kuo, F., Yin, P., & Chuang, K. (2010). A Heuristic algorithm for planning personalized learning paths for context-aware ubiquitous learning. *Computers & Education, 54*(2), 404-415.

Iiyoshi, T., & Kumar, M. S. V. (2008). *Opening up education: The Collective advancement of education through open technology, open content, and open knowledge*. Cambridge, MA: MIT Press.

Ito, M., Gutiérrez, K., Livingstone, S., Penuel, B., Rhodes, J., Salen, K., Schor, J., Sefton-Green, J., & Watkins, S. C. (2013). *Connected learning: An Agenda for research and design*. Irvine, CA: Digital Media and Learning Research Hub.

Ito, M., Horst, H. A., Bittanti, M., Boyd, D., Herr-Stephenson, B., Lange, P. G., Pascoe, C. J., & Robinson, L. (2008). *Living and learning with new media: Summary of findings from the digital youth project*. Cambridge, MA: MIT Press.

Ito, M., Soep, E., Kliger-Vilenchik, N., Sheresthova, S., Gamber-Thomson, L., & Zimmerman, A. (2015). Learning connected civics: Narratives, practices, and infrastructures. *Curriculum Inquiry, 45*(1), 10-29.

Jenkins, H., Ito, M., & Boyd, D. (2016). *Participatory culture in a networked era*. Malden, MA: Polity Press.

Junco, R. (2015). What are digital literacies and why do they matter? In S. Cortesi & U. Gasser (Eds.), *Digitally Connected: Global Perspectives on Youth and Digital Media* (pp. 45-47). Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2585686

Kahneman, D. (2003). A Perspective on judgment and choice: Mapping bounded rationality. *American Psychologist, 58*, 697-720.

Klaes, M., & Sent, E.-M. (2005). A Conceptual history of the emergence of bounded rationality. *History of Political Economy, 37*(1), 27-59.

Lankshear, C., & Knobel, M. (2007). Sampling "the new" in new literacies. *A New Literacies Sampler, 29*, 1-24.

Lankshear, C., & Knobel, M. (2013). Introduction: Social and cultural studies of new literacies from an educational perspective. In C. Lankshear & M. Knoble (Eds.), *A New Literacies Reader: Educational perspectives* (pp. 1-19). New York, NY: Peter Lang Publishing.

Latchem, C. (2012). *A Quality assurance toolkit for open and distance non-formal education*. Vancouver, Canada: Commonwealth of Learning.

Latchem, C. (2014). Informal learning and non-formal education for development. *Journal of Learning for Development, 1*(1). Retrieved from http://www.jl4d.info/index.php/ejl4d/article/view/6/6

March, B. (2002). Heuristics as social tools. *News Ideas in Psychology, 20*, 49-57.

Pea, R., Nass, C., Meheula, L., Rance, M., Kumar, A., Bamford, H., Nass, M., Simha, A., Stillerman, B., Yang, S., & Zhou, M. (2012). Media use, face-to-face communication, media multitasking, and social well-being among 8- to 12-year-old girls. *Developmental Psychology, 48*(2), 327–336.

Rainie, L., & Wellman, B. (2012). *Networked: The New social operating system*. Boston, MA: The MIT Press.

Robles, J. M. (2007). Bounded rationality: A Realistic approach to decision making. *Theoria, 16*(1), 41-58.

Schmidt, J. P, Geith, Ch., Håklev, S., & Thierstein, J. (2009). Peer-to-peer recognition of learning in open education. *The International Review of Research in Open and Distance Learning, 10*(5). doi:10.19173/irrodl.v10i5.641

Thaler, R., & Sunstein, C. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. New Haven, CT: Yale University Press.

Turkle, S. (2011). *Alone together: Why we expect more from technology and less from each other*. New York, NY: Basic Books.

Wang, Y., Han, X., & Yang, J. (2015). Revisiting the blended learning literature: Using a complex adaptive systems framework. *Educational Technology & Society, 18*(2), 380–393.

Wang, Z., Chen, L., & Anderson, T. (2014). A Framework for interaction and cognitive engagement in connectivist learning contexts. *The International Review of Research in Open and Distance Learning, 15*(2). doi:10.19173/irrodl.v15i2.1709

Weller, M. (2014). *The Battle for open: How openness won and why it doesn't feel like victory*. London, UK: Ubiquity Press. doi:10.5334/bam

Wiley, D. (Ed.) (2014). *An Open education reader*. Retrieved from http://openedreader.org/

Williams, R., Karousou, R., & Mackness, J. (2011). Emergent learning and learning ecologies in Web 2.0. *The International Review of Research in Open and Distance Learning, 12*(3), 39-59.