Towards Modeling and Measuring Information Literacy in Secondary Education

Completed Research Paper

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Abstract

The networked information and media society provides us increasingly with digital information and knowledge. However, the effective and efficient use of information requires a high level of information literacy (IL), i.e. adequate capabilities to deal with information. Despite of its growing importance, IL has been considered only sporadically in information systems research and education. There is a lack of a scientifically proven model to operationalize and measure IL. The paper contributes to fill this gap by providing a synthesis on existing research related to definition, conceptualization and measurement of IL. Applying the proposed framework through a survey with 86 high school students, we find relatively poor skill levels for the objective IL for most of the students, while the self-assessed IL is distinctly higher. In addition, our study shows that individual differences in IL can be explained by the student’s grade, web experience and the comprehension of the curriculum.

Keywords: Information literacy, 7i Framework, Measuring of Information Literacy
Introduction

One major benefit of the information age is the availability of ubiquitous information and knowledge from various information sources at our fingertips. However, the effective and efficient use of digital media requires information literacy (IL), i.e. a proficient dealing with information (Stanoevska-Slabeva et al. 2015). For example, UNESCO considers IL as one major practical competence relevant for the 21st century networked society (UNESCO 2013). Other authors consider it a key competence that facilitates participation in society, a self-determined life as well as lifelong learning (e.g. Gapski and Tesker 2009). In general, IL refers to skills necessary to effectively and efficiently use information and is described as the ability to recognize problem-driven information needs, to select information sources, to access, evaluate and use information, and to reflect upon both the applied information searching and processing procedure and the information resulting from it (Stanoevska-Slabeva et al. 2015; Balceris 2011; Gapski and Tekster 2009).

IL research has a long tradition and originated from library science. Within the last years, it has been picked-up by other research disciplines as information science, educational science, as well as media and communication science. IL is becoming of increasing importance for the information systems discipline as well, but has only been sporadically taken in consideration in information systems research and education (Stanoevska-Slabeva et al. 2015).

In the information age, children and pupils are being exposed to and have to deal with digital media and information starting from early childhood (Gust von Loh and Henkel 2014). Thus, it is increasingly becoming important to promote and create awareness for IL as a necessary competence starting from early education. In practice, in order to enable development of competences for appropriate dealing with information from an early age, the development of IL is considered an important goal for schools (Argelagos and Piffaré 2012). However, empirical evidence demonstrates that this goal, to embed IL in schools, has not been achieved yet (see for example Jones-Kavalier and Flannigan 2006). Various studies show that adolescents easily adopt search engines and various information sources, but to some extent deal naïvely with the online information (see for example Miller 2013). This can be explained by the insufficient integration of IL as a learning objective in existing curricula. One reason for this is the lack of a scientifically sound and proven model to operationalize and measure IL (Stanoevska-Slabeva et al. 2015). Prevailing approaches applied to measure IL in practice are rather performed on a global scale (see for example the study of the International Association for the Evaluation of Educational Achievement (European Commission 2014)) and do not provide individual and regular feedback. The paper at hand contributes to filling this gap, by providing both a synthesis on existing research related to defining, conceptualizing and measuring IL and by proposing an empirically validated model for measuring IL that can be applied in secondary schools.

The main goal of the research presented in the paper at hand is the development and empirical validation of a model for the measurement of IL in secondary schools. In order to achieve this goal, first a systematic literature review is conducted. The findings from the literature research are applied for developing the 7i Framework for measuring IL by combining and extending existing models for conceptualization and measurement of IL. Finally, the model is empirically tested in five classes from a Swiss secondary school.

The content of the paper is structured as follows: the next section explains the applied research methodology; the third section provides an overview of the findings resulting from the literature analysis; the fourth section presents the 7i framework for conceptualization and measurement of IL based on the findings resulting from the literature analysis; the fifth section contains the empirical results; and the last section concludes the paper by discussing the results and providing recommendations for future research.

Research Methodology

The main goal of the research paper at hand is the development and testing of a model for measuring IL that can be embedded in curricula and teaching routines at secondary schools. Thus, the main research question is: How can IL be modeled and measured in secondary schools?

In order to achieve this goal a two-year research project has been established in cooperation with a secondary school in the German speaking part of Switzerland. The project is based on a methodological combination of literature analysis, model development and empirical model testing:
1. To get an overview of existing IL research a systematical literature analysis has been performed by focusing on the following research questions (see also Stanoevska-Slabeva 2015): “Which terms exist associated with IL and how is IL defined in the literature? Which are the salient conceptualizations and measurement models of IL? Which methods are applied in order to examine IL?”

2. Based on the findings of the literature research, and by combining and extending existing models, the 7i Framework for measuring IL has been created.

3. The 7i Framework for measuring IL has been tested in five classes at a Swiss secondary school.

The focus of the paper at hand is on the first empirical testing of the 7i Framework. The results of the literature analysis and model development are presented in detail in (Stanoevska-Slabeva et al. 2015). However, to provide a complete picture and to present the evolution of the 7i Framework based on its first application in practice, most important results from the literature analysis and model development are summarized in this paper as well.

Research Results

Results of the Literature Analysis

The literature analysis followed the approach proposed by Webster and Watson (2002), and vom Brocke et al. (2009). In order to allow for a broad and at the same time focused literature analysis the keywords “Information literacy”, “Internet”, and “Education” were selected together with related terms as “Media literacy”, and “Media competence”, and were then used to search two databases (see also Stanoevska-Slabeva 2015): EBSCO and Science Direct. As the goal is to test and apply the model in the German speaking part of Switzerland, all considered keywords and combinations of them were translated into German and applied to search for German publications within the same two databases.

The literature search resulted in a high number of articles: 1398 articles from the EBSCO database; and 189 Articles from Science Direct. The number of relevant papers has further been narrowed down by an analysis of the abstracts from the first selection of articles. By selecting only papers explicitly dealing with IL related to the Internet and within the educational context (for example IL as a topic in library studies was excluded), a more focused article base of 49 publications (without doubles) has been deduced.

In accordance with the overall research goal, the resulting body of literature has been analyzed with respect to three dimensions (see also Stanoevska-Slabeva 2015): 1) IL definitions; 2) approaches and models for conceptualization and measurement of IL; and 3) methods used to assess and examine IL. Regarding the definition, a code was assigned for each definition found in a paper. The coding was conducted by two of the primary researchers. To ensure high homogeneity and consensus in coding, the two researchers closely worked together and precisely coordinated the coding pattern. Overall, this led to 28 codes describing a wide range of definitions associated with IL and related constructs. In order to gain insight into the utilized theoretical frameworks, published conceptualizations and measurement models developed or/and applied in the literature were analyzed and aggregated. With reference to the method, we assigned a code for each method applied at least in one of the selected papers which resulted in six different codes. As the case study design was one of the most frequently used methods, six additional codes have been added to make a further differentiation of the methods used for evaluating the assignments.

Information Literacy Definitions

The origin of the IL research and its consideration in education policy goes back to the 1970s. At the beginning IL was considered in library sciences and the meaning of the term IL was clearly related to the use of knowledge available in classical libraries (Grafstein 2002). Since then, the landscape of available information sources and information has changed radically. With the appearance of Internet many new information sources emerged, such as online libraries, online encyclopedia, open government data, social media and many others. The meaning of IL had to be constantly adjusted to account for the increasing availability of online information in various forms and the required capabilities to deal with it (see also Stanoevska-Slabeva 2015). At present the meaning of the term IL is again challenged by social media. While previous information sources were mainly used in a search, read and use manner (Jones-Kavalier and Flannigan 2006), social media provide information environments where information is not only
searched and used, but also co-created, presented and shared (Livingston, Van Couvering and Thumin 2005). Overall, driven by the dynamics of Internet developments and by different perspectives of the various fields of research considering IL, to date, no explicit definition has been established that precisely unveils IL in all its facets (Balceris 2011; Cope and Flanagan 2013). Not only definitions, but also terms to denote skills necessary to deal with information vary considerably (for a detailed overview see Stanojevska-Slabeva 2015).

The literature analysis reveals that newer articles rarely define IL (see also Stanojevska-Slabeva 2015), and if they do, they refer to existing definitions that serve as a starting point for deriving new, diverging definitions (see for example Kimmons 2014; Markless 2009; Lin et al. 2013; Vanwynsbergh and Verdegem 2013). Papers considering IL in context of social media, introduce new terms for denoting competences to deal with information from social media. In this context, the terms new literacies and new media literacy appeared in 7 out of 15 papers considering IL within the context of social media (Cope and Flanagan 2013; Fahser-Herro and Steinkuehler 2009; Greenhow and Gleason 2012; Jenkins et al. 2009; Kimmons 2014; Lin et al. 2013; Mackey and Jacobson 2011). In addition, the terms critical (information) literacy and critical media literacy were used in 4 out of 15 social media related papers (Burnett and Merchant 2011; Dunaway 2011; McLeod and Vasinda 2008; Vanwynsbergh and Verdegem 2013).

Another term for IL that has been introduced in literature in recent years is digital literacy. In the corpus of 49 papers, the term appeared in three articles (Badilla Quintana et al. 2012; ChisăliŃă 2013; Mackey and Jacobson 2011). Digital literacy has been defined as "the ability to use technology applications, and use technology to meet personal and collective needs" (Erstad 2009: 30). While IL focusses on broad information environments that necessarily include a range of technologies, digital literacy rather refers to technological environments (Jones-Kavalier and Flannigan 2006). Information-literate individuals attain the ability to understand information using different forms of technology (Mackey and Jacobson 2011).

Besides the above mentioned terms used to denote capabilities necessary to deal with information, even more remarkable is the fact that there are a vast number of other different terms that typically appear only in one of the examined 49 publications. This variety of terms contributes to the confusion with respect to IL, while the distinctions and commonalities between the terms remain unclear. However, many of these terms did not attract broad attention. Furthermore, some of the terms found in the literature are used to describe the literacy of technology rather than of information. As the aim of the research presented in this paper is to analyze the necessary capabilities to deal with online information in a competent manner, the technological aspect of literacy goes beyond the scope of this study and will not be further discussed.

Besides newly introduced terms, the findings of the in-depth literature analysis reveal that IL is still by far the term most often used to denote capabilities considered as necessary to deal with information in a competent way. From 49 evaluated papers, 17 used the term IL (see for example Ali et al. 2010; Burke 2010; Jeffrey et al. 2011; Shankar et al. 2005; Scott and O’Sullivan 2000; Pinto and Sales 2008). Additional 13 articles used the term “Informationskompetenz” – the German equivalence for IL (see for example Blum 2007; Freimanis and Dornstädt 2010; Gorski 2008; Prander 2013; Hapke 2007). Thus, in total, 30 out of 49 papers use the term IL. Given the wide spread of the term IL, as well as its clear reference to information, this term has also been kept in the research presented in the paper at hand with the aim to denote capabilities to deal with digital information of any kind. However, the meaning of the term was clearly defined and adjusted by refining, combining and extending existing definitions for IL.

The analysis of prevailing definitions for IL shows that IL is considered to be a complex phenomenon that consists of several components or sub-competences necessary to deal with information. The analysis also shows that the meaning of the term as well as the number of sub-competences and their meaning has been changing during time to reflect the changing environments in which information is searched and used. Older definitions (Kuhlthau 1987; American Library Association 1989; Breivik and Gee 1989; Bruce 1992; Doyle 1992) focus on the following components of IL: identifying information needs, finding (locating), evaluating and using information. Newer definitions reflect the bigger variety of digital information environments with varying quality of information by introducing additional sub-competencies of IL such as the selection of relevant information sources (Rader 2003; Livingstone et al. 2005; Chaka 2009; Association of College and Research Libraries 2010), as well as the evaluation of information sources and of the information resulting from them. Definitions stemming from papers discussing IL in context of social media furthermore refer to the ability to present information as an additional necessary component of IL (Argelagos and Pifarré 2012; Jones-Kavalier and Flannigan 2006; Lin et al. 2013).
Despite the differences, there are some common elements that during time have remained part of all IL definitions. One such common element is the problem orientation or problem embeddedness of IL (see for example Breivk and Gee 1989; Bruce 1992; Livingston et. al. 2005). Other common aspects are the problem-driven identification of information needs as well as finding, accessing, evaluating and using information. Some papers also consider the ability to constantly reflect upon the applied information search and processing procedure and upon its outcomes as well as the ability to learn from the reflection an important component of IL in a dynamically changing environment (see for example Kuhlthau 1987 or Marshall 2006).

After a process of comparison, systematization and matching of both the different definitions for IL and their components, the following generic definition of IL has been extracted in accordance with (Stanoevska-Slabeva 2015): IL is defined as the ability to recognize problem-driven information needs, to select information sources, to access, evaluate and use information, to present information and to reflect both the applied information searching and processing procedure as well as the information resulting from it. This definition serves as basis for further research presented in this paper, as well as for extraction of a measurement model for IL. Furthermore, it provided the basis for evaluation of the completeness of published models for measurement of IL.

**Information Literacy Conceptualizations and Measurement Models**

The second goal of the literature analysis was to provide a comprehensive overview of existing conceptualizations and measurement models of IL. Two types of papers were discovered (for more details see also Stanoevska-Slabeva 2015): papers providing only a theoretical and conceptual discussion on IL without empirical validation (Eisenberg 2008; Pinto and Sales 2008; Shenton 2009; Witch and Jasiewicz 2011), and papers covering all aspects from conceptualization to empirical validation. The second category of papers is summarized in Table 1. For each paper the basic definition providing the starting point for the conceptualization is given, followed by the conceptualization approach and the method applied for measuring IL.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Definition</th>
<th>Conceptualization</th>
<th>Method</th>
<th>Context of the Measurement</th>
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<tbody>
<tr>
<td>Mackey 2005</td>
<td>ALA</td>
<td>- Knowing</td>
<td>Case study Questionnaire</td>
<td>Case study Questionnaire</td>
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<td>- Identifying</td>
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<td>- Using</td>
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<td>Shankar et al. 2005</td>
<td>Doyle 1992</td>
<td>- Starting</td>
<td>Case study Software program</td>
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<td>- Chaining</td>
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<td>- Monitoring</td>
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<td>- Extracting</td>
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<tr>
<td>Marshall 2006</td>
<td>ALA</td>
<td>- Identify a topic</td>
<td>Instrument development and quantitative survey</td>
<td>Test of the model with two different population. The two tests revealed good reliability and validity of ICAI as approach to measure IL from a self-assessment perspective</td>
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Table 1. Overview of IL Definitions, Conceptualizations, and Methods (adjusted from Stanoevska-Slabeva 2015)

<table>
<thead>
<tr>
<th>Study</th>
<th>Framework</th>
<th>IL Abilities</th>
<th>Methodology</th>
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</table>
| Klein et al. 2009                        | ACRL      | - Detect Information  
- Locate effectively and efficiently  
- Evaluate and manage critically  
- Obtain new findings  
- Understand and recognize implications | Quantitative survey  
ACRL questionnaire |
| Thirion and Pochet 2009                  | ALA       | - Concept Identification  
- Search Strategy  
- Document Types  
- Search Tools  
- Use of Results | Quantitative survey |
| Ali et al. 2010                          | ACRL      | - Concept Identification  
- Search Strategy  
- Document Types  
- Search Tools  
- Use of Results | Case study  
Questionnaire  
Citation analysis  
Developed a questionnaire containing 20 questions to measure IL at Canadian University  
In 2009 Thirion and Pochet used this questionnaire for their study aiming to objectively describe the level of IL in higher education institutions in the French speaking community of Belgium |
| Balceris 2011                            | ALA; Breivik and Gee 1989; Bruce 1992; Chaka 2009; Rader 2003 | - Information needs  
- Information source selection  
- Information access  
- Information evaluation  
- Information use  
- Reflection of the information process and findings | Instrument development and quantitative survey |
| Miller and Barlett 2012                  | ALA       | - Net-savviness  
- Critical evaluate techniques  
- Diversity | Quantitative survey |

The table above outlines the various definitions, conceptualizations, and methods used to measure information literacy (IL) across different studies. The methods include both qualitative and quantitative surveys, with some studies employing case studies or questionnaire-based research. The data highlights the multifaceted nature of IL, encompassing diverse factors such as information detection, effective locating, evaluation, and understanding implications, as well as the use of mass media, presentation of information, learning from feedback, and applying to other projects.
As the overview in Table 1 shows, the definitions and conceptualizations of IL proposed in the literature vary in the overall scope and in the number and granularity of IL components contained in them. Another source of differences in the proposed definitions is the different naming of the various components of IL. As a result, there is a lack of suitable standardized conceptualization and measurement methods to capture IL holistically. Most of the proposed approaches merely provide insight into partial aspects of IL (Balceris 2011). Compared with the definition proposed in the previous section, only three approaches (one conceptual and two providing empirical evidence) seem to reflect the definition in a comprehensive manner. These are: the concept of Eisenberg and Berkowitz (2008), also known as the Big6 product (http://www.big6.com/); the concept of Marshall 2006 and the concept of Balceris (2011). The latter two have been empirically tested in different settings.

The concept of Eisenberg and Berkowitz (2008) conceptualizes IL with six components: task definition, information seeking strategies, location and access, use of information, synthesis, and evaluation. However, it seems that this model rather focuses on teaching IL along the 6 dimensions and less on systematic measurement and assessment of IL. Beyond a mere conceptualization, Marshall (2006) developed and tested the Information Competency Assessment Instrument (ICAI). The ICAI evaluates IL from a self-assessment perspective and involves ten aspects that Marshall considered of common importance for an individual to be information literate: (1) identify a topic, (2) determine source requirements, (3) know how to search for needed information, (4) how to locate and retrieve information, (5) evaluate the information, (6) synthesize and organize the information, (7) understand ethical, legal and socio-political issues of the information, (8) appropriately use mass media for information, (9) present the information, and (10) learn from feedback and apply to other projects. Beyond the mere conceptualization, Marshall (2006) empirically tested ICAI with two different populations at two different points of time. The two tests revealed good reliability and validity of the ICAI as an approach for measuring IL from a self-assessment perspective.

Another attempt to measure IL in a comprehensive and empirical way was made by Balceris (2011). In his work, he also conflated a wide range of definitions, concepts and standards including those from the ALA, ACRL, ANZILL, Breivik and Gee (1989), Bruce (1992), Chaka (2009), Doyle (1992), and Rader (2003). After a comprehensive evaluation of the literature, Balceris (2011) developed and tested a measurement instrument for IL containing six stages: (1) information needs definition; (2) information source selection, (3) information access, (4) information evaluation, (5) information use, and (6) reflection of the applied information search and processing procedure and of the resulting findings. Balceris’ framework is nearly identical to the Big6 framework proposed by Eisenberg and Berkowitz (1995, 2008). However, compared to Balceris (2011), the framework of Eisenberg and Berkowitz (1995, 2008) does not contain information evaluation as a sub-competence of IL that considers the evaluation of found information before it is used. In the later framework, evaluation is considered only at the very end of the process. On that account, the framework of Balceris is seen as more suitable, as the evaluation of information before it is used is considered an important component of IL in particular with respect to online information sources.

**Methods Applied to Measure Information Literacy**

The third goal of the literature analysis was to provide an overview of applied methodology to measure IL. The resulting findings are summarized in the 4th column of Table 1, which contains all papers out of the body of selected 49 papers that describe approaches applied to empirically measure IL. The analyzed body of literature revealed a mixed picture: 3 studies used qualitative methods (data collection and data analysis), 10 studies used quantitative methods, and 16 studies were based on case studies out of which 11 case studies used either qualitative or quantitative methods, and the remaining 5 case studies used a mixed method approach (combination of qualitative and quantitative methods). The case studies involved different assignments for the participants. For analyzing the participants’ assignment results and by that also their level of IL, various quantitative and qualitative approaches have been applied. Quantitative assessments involved surveys after the assignments (applied in 8 of the 16 case studies), and test evaluations (used in 4 of the 16 case studies). The qualitative assignment analysis involved various qualitative methods such as: content analysis of homework, essays, project work, or papers (applied in 6 of the 16 case studies), analysis of the Internet search strategy recorded by a software program that captures the screen (applied in 5 of the 16 case studies), participant observation (used twice), and focus groups (also used twice).
The literature analysis of applied methods to measure IL reveals that there is no consensus among the described studies. There is also little empirical verification of proposed conceptualizations and operationalization of IL. Most of the described approaches aiming to measure IL are not described in detail and it is difficult to replicate them. This holds in particular for the studies based on qualitative methods and situation specific IL related assignments.

However, only two authors proposed a comprehensive solution for measuring IL in a replicable generic manner including a quantitative measurement model for IL, an instrument to collect measurement data and empirical validation. These two authors are Marsh (2006) and Balceris (2011). Both authors merge crucial aspects of frameworks and conceptualizations of IL presented in literature. It can be concluded that Marsh’s and Balceris’ work has closed a gap in research by conflating different approaches to two measurement instruments that assess IL from two complementary perspectives: the ICAI model of Marsh from the perspective of self-assessment, and Balceris’ model from an objective perspective based on defined generic tasks for each of the relevant IL competences identified in his model. However, both models propose a different perspective on IL, conceptualize IL differently, and propose different number of sub-competences for IL. Thus, they can only be compared in limited manner and an overall generic measurement model for IL is still missing. However, the two models provide a good starting base for developing a combined model for measuring IL.

Towards a Measurement Model for Information Literacy

The two complementary models for measuring IL proposed by Marsh (2006) and Balceris (2011) served as foundation for development of the 7i Framework on IL that is based on a combination of both. Table 2 provides an overview of the IL components (sub-competences) considered in the frameworks of Balceris and Marsh, and how they have been combined and extended into the new integrated 7i Framework.

<table>
<thead>
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<th>Table 2. Comparison and merging of IL Frameworks into the 7i Framework</th>
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<td>Information needs</td>
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<td>Information source selection</td>
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<td>Information access</td>
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<td>Information evaluation</td>
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Table 2. Comparison and merging of IL frameworks into the 7i Framework (adjusted from Stanoevska-Slabeva 2015)

The proposed 7i Framework is shown in Figure 1. It contains seven sub-competencies comprising knowledge, skills and attitudes: (1) Information needs; (2) Information sources; (3) Information access and seeking strategy; (4) Information evaluation; (5) Information use; (6) Information presentation; (7) Information process & finding reflection.

In an earlier version of the 7i Framework presented in Stanoevska-Slabeva 2015, the sub-competencies were named phases and were considered to form a straight sequence. However, teachers and pupils, who applied the 7i Framework during the first empirical evaluation described in later sections of this paper, besides adhering to the proposed overall sequence of the framework components, also frequently switched in an interactive manner back and forth among the sub-competences before moving to the next sub-competence in the sequence. For example, if the evaluation of the found information (sub-competence 4) reveals that more information is needed, than the process was rather started from the beginning in order to refine the information needs (sub-competence 1) or went back to refine the
information access and retrieval strategy (sub-competence 3). Based on these and similar observations, and the feedback from teachers and pupils, who applied the 7i Framework, the numbered “phases” were renamed to numbered sub-competences (SC) and each of the seven sub-competencies refers to a certain skill part of IL.

Thus, according to the 7i Framework, the student who is information literate knows (Stanoevska-Slabeva et al. 2015):

**SC 1:** ... how to determine information needs in the context of a given problem, i.e. to determine information needs in a problem-driven manner.

**SC 2:** ... which information sources apply best to the identified information needs.

**SC 3:** ... which methods and search strategies suit best to access the selected information sources.

**SC 4:** ... how to evaluate whether the sources and information are valid and reliable.

**SC 5:** ... how to use the information appropriately in order to solve the problem.

**SC 6:** ... how to present the information geared to a specific target group.

**SC 7:** ... how to reflect the applied information search and processing procedure and the information resulting from it and to learn for future information search processes.

Based on the 7i Framework the 7i Questionnaire was constructed (Stanoevska-Slabeva et al. 2015) by combing both assignments (adapted from Balceris 2011) and questions for self-assessment (derived from Marshall 2006). Based on this combination, the 7i measurement model results in two different scores of IL: one objective score based on generic assignments, and one, rather subjective score, based on self-assessment. The part of the questionnaire based on IL tasks is made up of 23 assignments, one to four covering each of the seven phases. Potential participants of an IL measurement study will be asked to solve assessment tasks and receive one point for each correctly completed task. To assess the overall IL level, the individual responses are scored across all the assessment tasks. Thus, a participant’s overall score on the test may range from 0 to 70 points. One example for measuring the objective IL phase 1 is the following task:

**Imagine your friend is calling you in the afternoon and asks you: “Could you help me with my research on Michael Porter? I have to give a presentation on him tomorrow.” You agree to help him. What would you most likely say to your friend to help him with his problem? Please choose only one answer.**

a) “What have you found out so far?”

b) “I will just find out some information about Michael Porter on the Internet and call you back immediately.”

c) “What is your presentation about?”

d) “Let us just look together for information on the Internet.”

According to Balceris (2011), answer c) is correct.

*Figure 2: Example IL Assignment Task of the 7i Framework (Stanoevska-Slabeva et al. 2015)*

The 2nd part of the questionnaire is based on Marshall (2006), and consists of 27 statements, three to four covering each of the seven phases. Potential participants in the survey are asked to rate their feelings concerning each statement along a five-point Likert-scale ranging from 1 (strongly disagree) to 5 (strongly agree). To allow a better comparison with the task-based score, the self-assessed score is recorded by starting as well at 0 points. The summing up of the possible scores of the Likert scale, results in a total score with a range from 0 to 108 points. The self-assessment questions are illustrated below on the example of the questions for the phase 1 of the 7i framework:

- “I feel confident determining what topic I need to research.”
- “Sometimes I feel lost because the topic I want to research is not very clear to me.”
- “I can take a complex topic and break it down into more useful, simpler items.”
- “Confused’ is probably the best term to describe me when starting a project.”

*Figure 3: Example Self-assessment Question Part of the 7i Framework (Stanoevska-Slabeva et al. 2015)*
Overall, the 7i Framework enables different approaches to measure IL: 1) the objective and self-assessed IL, 2) the separate measurement of the competence level for each of the seven single sub-competencies, 3) the interrelationship between the objective and self-assessed IL, 4) the impact of antecedents on IL.

Empirical Results

Methodology and Descriptive Data Analysis

The empirical validation of the proposed model was conducted in cooperation with a Swiss high school. Data was collected from five high school classes of business and law through an online-based survey during February and March 2015. Overall, 86 high school students completed the online questionnaire. The questionnaire asked respondents about their web experience (including years of Internet use, access to the Internet at home, and frequency of information related Internet use), motivation and proficiency in the school subjects economics and law (including pleasure and comprehension in the subjects as well as the previous semester’s grade in the subjects), objective IL, and self-assessed IL. The dataset was received by end of March 2015. A subsequent analysis of the participants’ objective and self-assessed IL levels and their relationships with the factors that were assumed to explain individual differences in IL has been carried on.

The sample contained 54.7% male and 45.3% female students. About two-thirds of the participants attended 10th grade, the other third composed students from 11th grade (19.7%) and 9th grade (16.3%). All participants were born between 1996 and 2000. Thus, the students were aged between 14 and 19 years.

To assess the internal consistency of the instruments, Cronbach’s alpha (α) was calculated and was found to be above the required criterion values: For the objective IL, Cronbach’s alpha was 0.75, for the self-assessed IL 0.70.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective information literacy</td>
<td>28.21</td>
<td>4.85</td>
<td>0 – 70</td>
</tr>
<tr>
<td>Self-assessed information</td>
<td>65.59</td>
<td>9.91</td>
<td>0 - 108</td>
</tr>
</tbody>
</table>

Table 3. Means and standard deviations of objective and self-assessed IL

The measured objective IL proved to be rather low with a mean score of 28 points compared to the maximal possible score of 70 points. In the sample, the score ranged from 18 to 42 points. The fact that the maximum measured score lays only slightly above half of the obtainable points shows an alarming picture. It implies that the vast majority of students have a low level of IL. When the IL level is considered for each of the seven sub-competencies separately, on average, the highest scores are detected for the sub-competence 5 (information use), while sub-competence 2 (information sources), sub-competence 3 (information access and seeking strategies), and sub-competence 6 (information presentation) reveal the lowest scores.

The self-assessed IL of the students was - with a mean of 65.59 points - distinctly higher than the objective literacy. The respondents scored from 36 to 91 points in the self-assessed IL, where theoretically a range from 0 to 108 points was achievable. This result suggests high levels of self-assessed IL as most of the students' scores are in the upper half of the score. The results of self-assessed IL for each of the seven sub-competences were also high and do not differ remarkably.

Thus, comparing the self-assessed IL score to the objective IL score displays a discrepancy in the two measured forms of IL: while most of the students evaluate themselves as competent, the objective literacy is considerably lower. Furthermore, in the self-assessed test, the students averagely hold high scores for all of the seven sub-competences, whereas the objective test unveils substantial differences among the seven sub-competences. Interestingly, there was no significant correlation between the objective score...
Factors that may Explain Individual Differences in Information Literacy

As increasingly more people use the Internet to communicate, retrieve information, and contribute content, the discourse concerning the frequently discussed topic of the digital divide is shifting from a digital gap between those who do and those who do not have access to digital technologies (e.g. Hoffman and Novak 1998; Katz and Aspden 1997; Van Dijk 2005), to a digital gap between those who fail to make effective and purposeful use of digital opportunities and those who use the Internet productively. In other words, the focus is shifting from a simplistic and binary conceptualisation of Internet access to a more advanced and complex approach that involves the width and depth of Internet usage (Dholakia et al. 2004; Livingstone and Helsper 2007; Van Dijk 2005; Wei et al. 2010). Thus, Internet usage is not equally experienced by everyone. Based on these findings, two factors are considered to have an impact on the students’ IL scores: 1) the students’ web experience, 2) the motivation and proficiency in the subjects of economics and law in which IL is addressed in the study at hand. To explore the impact of web experience, motivation, and proficiency on IL, multiple linear regression analysis has been applied. Figure 4 shows the proposed research model.

Web experience: Prior research posits that web experience affect ICT use. Experience plays an important role in the secondary digital divide that describes the gap between those who fail to make effective and purposeful use of digital opportunities and those who use the Internet productively (Dholakia et al. 2004; Livingstone and Helsper 2007; Van Dijk 2005; Wei et al. 2010). In this context, the degree of experience and the level of confidence in using IT emerge as significant factors (Brown and Czerniewicz 2010). Since web experience constitutes a formative learning experience (Shankar et al. 2002), this experience is considered to help individuals achieve the information competency required to fully utilize the potential of the Internet. Based on the insights described above about user experience, the following three hypotheses are proposed:

H1a: The years of web experience are positively related to IL.
H1b: Number of personal computers is positively related to IL.
H1c: The frequency of information related Internet use is positively related to IL.

Motivation and proficiency in the school subjects of economics and law: Motivation builds a driving force behind all the actions of an individual. The individual’s needs and desires both strongly influence the direction of their behaviour. Motivation is based on emotions and achievement-related goals such as reaching success and achieving aspirations in life (Rabideau 2005). Achievement motivation is a constant drive to improve an individual’s level of performance (McClelland 1961) and an important psychological predictor of students’ future success or failure (Kolodziej 2010). Prior research has shown that school achievement is highly related to motivation: a positive relation between achievement motivation and school performance was found by Greene et al. (2004); Martin and Liem (2010); McEwan and Goldenberg (1999); Meijer and Wittenboer (2004); Steinmayr and Spinath (2009). Considering these findings, it is expected that high motivation and proficiency in both subjects of economics and law will increase the probability of using the information about economic and legal topics appropriately. Based on the insights described above, the following two hypotheses are proposed:

H2a: Pleasure in the subjects of economics and law is positively related to IL.
H2b: Comprehension in the subjects of economics and law is positively related to IL.
H2c: The grade in the subjects of economics and law is positively related to IL.
Modelling and Measuring Information Literacy

Methodology and Descriptive Data Analysis

To assess the relationships between the different indicators, multiple linear regression analysis has been applied. The variable “years of web experience” was operationalized by asking how old the participants were when they first used the Internet. The answer was then matched with the current age to receive the number of years of web experience. One measure was used to gauge access to the Internet at home: the respondents were asked whether they have access to the Internet at home, and if they do, how many personal computers (including laptops and tablets) they possess. To assess the impact of Web experience on IL, the frequency of information related Internet use was introduced as a third measure. This measure addresses the familiarity with the Internet as an information medium. It is based on an additive index comprised of seven indicators: frequency of 1) searching online, 2) watching school related videos, 3) watching or reading the news, 4) visiting a social media profile, 5) visiting a school relevant forum, 6) doing homework online with other students, 7) writing a blog or online diary. In order to differentiate between higher and lower experience, an additive index of the included items has been created. The maximum value is 21 and mirrors high experience of information related Internet use and the minimum value is 0 which reflects no experience.

The motivation in the school subjects of economics and law was measured with two scales derived from Kuhn (2008). The first scale measured the dimension pleasure in the subject (Cronbach’s alpha: 0.79), while the second stands for the dimension comprehension of the subject (Cronbach’s alpha: 0.83). For the regression analysis, for each dimension the item with the highest factor loading (pleasure item: 0.848,
comprehension item: 0.900) has been considered. The wording for the item measuring interest and joy was “Economics and law lessons are fun.” For the comprehension item, the statement was “The subject matter of economics and law is comprehensible to me.”

Finally, proficiency in economics and law was operationalized by asking the participants what grade they got in economics and law last semester. In Switzerland, grades range from 1 to 6, with 6 representing the highest level of achievement. Table 4 shows the means and standard deviations of the examined variables.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years of web experience</td>
<td>7.88</td>
<td>2.65</td>
<td>0 – 15</td>
</tr>
<tr>
<td>Number of personal computers</td>
<td>1.43</td>
<td>0.72</td>
<td>0 - 3</td>
</tr>
<tr>
<td>Frequency of information related Internet use</td>
<td>9.43</td>
<td>3.07</td>
<td>0 - 21</td>
</tr>
<tr>
<td>Pleasure in the subjects of economics and law</td>
<td>2.47</td>
<td>1.03</td>
<td>1 - 5</td>
</tr>
<tr>
<td>Comprehension of the subjects of economics and law</td>
<td>2.17</td>
<td>0.92</td>
<td>1 - 5</td>
</tr>
<tr>
<td>Grade in the subjects of economics and law</td>
<td>4.60</td>
<td>0.58</td>
<td>1 – 6</td>
</tr>
</tbody>
</table>

With regard to the factors that may explain individual differences in IL, the data reveals the following picture: on average, the students are highly experienced by using the Internet for 7.88 years. With the exception of one student, all students have access to the Internet at home. Most of the students own one personal computer, laptop or tablet computer. The created index measuring the frequency of information related Internet use reveals an average value in the central portion (9.43 on a scale from 0 to 21). This indicates an intermediate frequency of information related Internet use. In terms of motivations and proficiency in the school subjects of economics and law, the data shows medium values that can be observed: on a Likert scale from 1 to 5, where high values denote higher agreement, the mean of the pleasure in the subjects of economics and law is 2.47. In turn, the comprehension of the subjects of economics and law, with 2.17, has a slightly lower mean. For proficiency, the average grade in the subjects of economics and law of the previous semester is 4.60.

**Linear Regression Analysis**

Based on the postulated hypotheses, the impact of the above predictors on IL has been analyzed with SPSS. In order to assess the premises of the research model, it has been tested for linearity, heteroscedasticity, autocorrelation, and multicollinearity. The validation revealed that the underlying assumptions of the calculation of the linear regression analysis are fulfilled: linearity is given, and the assumptions are not violated by heteroscedasticity, autocorrelation (Dubin-Watson-statistics: 2.079 for the objective IL regression analysis, 2.056 for the self-assessed IL regression analysis), and multicollinearity (mean VIF for both the objective and the self-assessed IL regression analysis: 1.252). Overall, the validation indicates a good fit for the model. The results of the analysis include the unstandardized and standardized coefficients, the standard error, and the total variance explained (R2) regarding the considered variables. These results are shown in Tables 5 and 6.
Table 5: Multiple Regression Analysis Predicting Objective IL (n=86)

<table>
<thead>
<tr>
<th>Predictors</th>
<th>B (unstandardized coefficients)</th>
<th>Std. Error</th>
<th>β (standardized coefficients)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1a. Years of web experience</td>
<td>-0.114</td>
<td>0.222</td>
<td>-0.068</td>
</tr>
<tr>
<td>H1b. Number of personal computers</td>
<td>-0.981</td>
<td>0.829</td>
<td>-0.156</td>
</tr>
<tr>
<td>H1c. Frequency of information related Internet use</td>
<td>0.038</td>
<td>0.209</td>
<td>0.025</td>
</tr>
<tr>
<td>H2a. Pleasure in the subjects of economics and law</td>
<td>-0.939</td>
<td>0.789</td>
<td>-0.214</td>
</tr>
<tr>
<td>H2b. Comprehension of the subjects of economics and law</td>
<td>0.354</td>
<td>0.919</td>
<td>0.078</td>
</tr>
<tr>
<td>H2c. Grade in the subjects of economics and law</td>
<td>3.649*</td>
<td>1.493</td>
<td>0.417*</td>
</tr>
</tbody>
</table>

F(2.023) = 4.38, p < 0.05, R² = 0.199, R² adj. = 0.100

Table 5: Multiple regression analysis for web experience, motivation, and proficiency predicting the objective information literacy (n=86)

Table 6: Multiple Regression Analysis Predicting Self-assessed IL (n=86)

<table>
<thead>
<tr>
<th>Predictors</th>
<th>B (unstandardized coefficients)</th>
<th>Std. Error</th>
<th>β (standardized coefficients)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1a. Years of web experience</td>
<td>0.908*</td>
<td>0.450</td>
<td>0.258*</td>
</tr>
<tr>
<td>H1b. Number of personal computers</td>
<td>-2.019</td>
<td>1.679</td>
<td>-0.152</td>
</tr>
<tr>
<td>H1c. Frequency of information related Internet use</td>
<td>-0.688</td>
<td>0.423</td>
<td>-0.216</td>
</tr>
<tr>
<td>H2a. Pleasure in the subjects of economics and law</td>
<td>-1.108</td>
<td>1.597</td>
<td>-0.120</td>
</tr>
<tr>
<td>H2b. Comprehension of the subjects of economics and law</td>
<td>4.707*</td>
<td>1.861</td>
<td>0.493*</td>
</tr>
<tr>
<td>H2c. Grade in the subjects of economics and law</td>
<td>-1.986</td>
<td>3.024</td>
<td>-0.107</td>
</tr>
</tbody>
</table>

F(2.934) = 8.87, p < 0.05, R² = 0.264, R² adj. = 0.174

Table 6: Multiple regression analysis for web experience, motivations, and proficiency predicting the self-assessed information literacy (n=86)

The results of the multiple linear regressions show that the conveyed analysis only partly confirms the impact of the considered predictors on IL: only three of the hypothesized and estimated relationships were significant. Remarkably, the significant effects differ among the objective and self-assessed IL. With regard to the web experience predictors, the years of experience significantly affected the self-assessed (β = 0.258) but not the objective IL. Students with more years of web experience had higher self-assessed IL scores than students with less years of web experience. By contrast, more years of web experience did not lead to significant higher objective IL scores. In other words, the number of years of web experience is an antecedent of the self-assessed but not the objective IL. With respect to the other web experience indicators, both the number of personal computers and the frequency of information related Internet use did not show a significant effect on IL. These factors do not to perform a considerable role for neither the objective nor the self-assessed IL. Thus, individual differences in IL cannot be explained by these factors.

Furthermore, the motivation towards the subject has been presumed to be relevant in dealing with information and therefore it was expected that the pleasure in the subjects of economics and law would have an effect on IL. However, the pleasure in both subjects had no significant effect on both the objective and the self-assessed IL. On the other hand, strong support for the second motivation dimension has been noticed: the comprehension of the subjects of economics and law positively affected the self-assessed IL (β = 0.493) but not the objective IL. Thus, pupils with higher comprehension of economics and law showed higher self-assessed levels of IL than pupils with lower comprehension. The influence of proficiency in the subjects of economics and law, measured by a student’s previous semester’s grade, yielded a similar
pattern: The grade had a positive effect on the objective IL ($\beta = 0.417$), but the effect was not significant for the self-assessed IL. In total, the examined factors accounted for 19.9% of the observed variance in the objective IL and 26.4% of the variance in the self-assessed IL. Hence, the model at hand has a higher explanatory power for the self-assessed form of IL.

**Discussion of empirical results**

To sum up, the issued quantitative analysis sought to identify the level of IL in secondary schools. It further intended to determine whether the experience with the Internet on one hand, and the motivation and proficiency in the school subjects of economics and law on the other hand, have positive effects on the high school students’ literacy. To examine IL, it has been distinguished between two specific forms: the objective and the self-assessed literacy. The objective IL was adapted from Balceris (2011) and measured the students’ literacy by means of assignments. In turn, the self-assessed IL referred to questions of self-assessment, derived from Marshall (2006). For the objective IL, the data indicated relatively poor skill levels for the vast majority of the students: on a scale from 0 to 70 points, the students scored on an average 28 points. In contrast, the self-assessed IL of the students was - with a mean of 66 points on a scale from 0 to 108 points - distinctly higher than the objective literacy. The findings imply that the students generally evaluate themselves as competent, while the objective literacy shows a different picture. The outcome of our study is in line with empirical evidence of other researchers: although students are active users of the Internet, prior research has observed that pupils often do not have sufficient web skills. Most of them lack adequate web searching skills, as well as the ability to process and critically evaluate web information (Pritchard and Cartwright 2004).

In order to determine how individual differences in IL can be explained, the influence of the factors 1) web experience and 2) motivation and proficiency in the school subjects of economics and law has been tested. The data showed some support for the considered predictors on IL. For the objective IL, the student’s grade in the subjects of economics and law is an important factor in explaining the level of the objective literacy. Accordingly, students with higher grades have higher levels in IL than students with lower grades. For the self-assessed IL, the years of web experience and the comprehension of the subjects of economics and law positively affect the self-assessed level. Students with more years of web experience and higher comprehension of economics and law perceive themselves as more information literate than students with less years of web experience and lower comprehension.

Overall, the hypothesis that web experience predicts IL, as derived from prior literature on the secondary digital divide (Dholakia et al. 2004; Livingstone and Helsper 2007; Van Dijk 2005; Wei et al. 2010), could only partly be confirmed. In the study at hand, Web experience does not play a key role for achieving IL required to fully utilize the potential of the Internet. Stronger support has been found for the achievement motivation line of argument that motivation affects school performance (Greene et al. 2004; Martin and Liem 2010; McEwan and Goldenberg 1999; Meijer and Wittenboer 2004; Steinmayr and Spinath 2009). In line with the quoted research, the study at hand shows that whether individuals intend to deal with information appropriately depends on their motivation and proficiency in economic and legal topics. This finding is also in line with the problem-orientation of IL as pointed out in most of the IL definitions.

**Discussion and Conclusion**

Information literacy is one of the major practical competences relevant for the 21st century networked society. It is considered as a key competence that facilitates participation in society, a self-determined life as well as lifelong learning. In practice, in order to enable development of competences for appropriate dealing with information from an early age, the development of IL is considered an important goal for schools. However, IL as newly required set of competencies in the digital age is a challenge for high schools to integrate it in their curriculum. To date, students lack competences for appropriate dealing with information, and the goal to embed IL in schools, in order to increase IL has not been achieved yet. Against this background, the paper at hand elaborated the 7i Framework to foster and measure information literacy as a process- and competency-oriented approach. The seven sub-competences of the 7i Framework aim to help pupils to manage their learnings, regarding both outcomes content (e.g. by using wikis, etc.), and process (e.g. by reflecting the information). The initial testing of the 7i Framework reinforce that broad educational support is required to foster the students’ IL. Therefore, the next step in
the research is to address the framework comprehensively in the curriculum. In cooperation with high school teachers, interventions on IL have been planned.

Overall, the paper provides three major contributions: an overview of current status of research on IL, a comprehensive and up-to-date definition of IL, and a new generic and empirically tested comprehensive framework for measuring IL. These results provide a significant scientific and practical contribution.

The literature review gives a scientific contribution by providing detailed insights into the current status of IL research and by identifying important research gaps. Another major scientific contribution is the 7i IL framework. It combines the two verified models found in literature and adjusts them to better meet the requirements of current developments of the information space. Compared to other approaches that measure IL, the 7i Framework is a generic framework and can be applied to measure IL in different settings. It furthermore enables a complementary perspective on IL from a self-assessment and objective perspective. Finally, the 7i Framework also introduces information presentation as a separate skill of IL.

With regard to the practical contribution, the proposed measurement instrument allows educators and teachers to easily estimate their students’ level of information literacy. As information literacy can be measured at various points of time, the instrument also enables capturing of the progress. Accordingly, the 7i Framework helps identifying whether IL increases over time. It further allows comparing the level of IL among classes and schools. Moreover, the instrument provides a sophisticated picture of IL as it not only reveals an overall score, but provides sub-scores for each of the seven phases. Thereby, educators and teachers can monitor which stages of information literacy cause pitfalls among the students and require further intervention.

Even though the results presented in the paper at hand provide a significant scientific contribution, the study has some limitations. In the quantitative analysis, only three of the twelve examined paths were significant. The influence that the factors web experience and motivation as well as proficiency in the school subjects of economics and law have over IL showed only little support. The results reveal that the variables chosen for the analysis are not important predictors for explaining individual differences in IL.

To gain a deeper understanding of the mode of action of IL, further research should identify and analyze other factors that might be more relevant than the factors considered in the current study. As outlined in the paper, we see great potential in the integration of IL in the school curriculum. The collected data indicates that students perceive themselves as competent in dealing with information even if they are not. Therefore, they do not realize that they could enhance their competence if they would process the information differently. It has been assumed that the actual IL level of students might increase if the topic would be comprehensively addressed in the curriculum, for which the pupils would receive critical feedback. In order to gain insight into the role of the school, in the next step interventions on IL in cooperation with high school teachers have been planned. Besides the influence of the school, other factors such as the role of the parents regarding their children’s online behavior should also be considered for future research. However, several other questions remain that provide the basis for future research.

First, the proposed 7i Framework needs to be further tested in practice with larger samples. Second, further research is necessary to explore if the proposed 7i Framework is sufficient to measure IL in social media environments as well. The rigorous changes of the Internet within the last years and the emergence of social media might require additional skills to reflect necessary social media literacy.

References


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