THE CHANGING ROLE OF INFORMATION LITERACY SKILLS IN HIGHER EDUCATION

TRENDS OF INFORMATION LITERACY EDUCATION AND ITS INTEGRATION INTO PROBLEM-BASED LEARNING AT MAASTRICHT UNIVERSITY

Maastricht University
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Foreword

This paper has been written in the context of the Library-EDLAB project "Learning in a changing information landscape", which contributes to vision, policy and projects in this rapidly changing learning environment. It entails a narrative literature review, discussion points and recommendations as a foundation for further projects related to teaching and learning at UM. An important element in the assignment was to identify, assess and select a suitable framework, which defines relevant 21st century information literacy skills for students and teachers in a PBL setting and in alignment with the UM CORE Strategy.

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Executive Summary

The aim of the present paper was to examine the current developments of information literacy skills in higher education and how to integrate these skills within and/or complementary to the curricula in a problem-based learning (PBL) setting. Systematic searches were performed in multiple databases and more than 50 selected academic sources were reviewed.

The Changing Information Landscape

Digital (e.g. Web 2.0) and technological (e.g. Artificial Intelligence) developments result in an abundance of information and change the way users have access to information. These disruptive developments provide quick and easy access to a wealth of online information sources that can serve as learning resources. This is in turn might lead to students being less dependent on the library. The increased amount of information also has its drawbacks. These sources create an information overload, and a considerable number of studies show that students continue to lack relevant skills to deal with information.

ACRL Framework

Given the significant changes in the information landscape since the adoption of the predominant Information Literacy Competency Standards for Higher Education in 2000, the Association of Research Libraries (ACRL) announced in 2016 their new *Framework* to bring the existing standards into alignment with contemporary information creation and use. Based on six threshold concepts (e.g. Information has Value), the ACRL Framework organizes various approaches and ideas about information, research and scholarship. In addition, the ACRL Framework adds a pedagogical, cognitive and attitudinal dimension to the traditional definition of information literacy. Worldwide, academic libraries collaborate with faculties to implement the ACRL Framework into their curriculum and adapt their academic skills support services accordingly. Integrating the ACRL Framework requires a contextualized approach to the frame. In other words, educational institutes face the challenge to adapt the ACRL Framework into their educational philosophy and disciplinary context.

PBL and Information Literacy Skills

Information literacy plays a major role in PBL because students deal more independently with information compared to traditional-teaching education. Particularly, during self-studying periods, students require an advanced level of self-regulation to identify their information needs and evaluate the information relevant to their learning issue. The tutor can support students in effectively searching and dealing with information by asking reflection prompts about where students found information, why they chose the sources, and how they assessed the quality of these sources.

Constructive Alignment of Information Literacy Skills education

To prepare students for the rapidly changing information landscape, faculties and academic librarians invest greater effort in aligning information literacy skills instructions constructively with their learning activities and assessments to stimulate students to properly engage with (digital) information. In other words, it is advised to effectively address these skills in the intended learning outcomes (ILOs), teaching and learning activities (TLAs), and in both formative and summative assessments. Ideally, information specialists, instructional designers, and teachers collaborate to situate and align the proposed ACRL Framework into their programme and course structure.

Recommendations for Maastricht University

- The library and faculties are advised to follow evidence-based information literacy education driven by quantitative and qualitative analysis of data. Qualitative methods such as focus groups could address the perceived benefits in constructively aligning information literacy within the curriculum. An in-depth quantitative analysis could reveal insights that help in understanding where students struggle in terms of their information literacy knowledge and skills.
- Building a real partnership between the library and faculties and identifying and connecting existing information literacy practices at Maastricht University.
- This literature review recommends the integration of the ACRL Framework in current and future information literacy activities and to harmonize it with the academic skills education in faculties.
- Gradually reformulating fixed reading lists and making the search for literature an integral part of the regular PBL sessions could encourage students to develop creative and critical approaches when faced with complex information problems.
- It is advised to either develop information literacy instructions that are linked to course assignments and learning goals, or by directly embedding information literacy skills within the programme curriculum or course syllabus.
- Academic librarians are encouraged to familiarize themselves with the ACRL Framework and further professionalize their pedagogical understanding and teaching.

Introduction

Higher education institutions (HEIs) worldwide discuss on how to best prepare students and teaching staff for the rise of digital developments and a rapidly changing information landscape (van Laar, van Deursen, van Dijk, & de Haan, 2017). Web 2.0 including social networking sites (e.g. Facebook), video sharing sites (e.g. YouTube), wikis and blogs affects the digital contribution to education (Luo, 2010; Newman, 2017). These and other digital changes (e.g. massive open online courses, open access) influence the storage of information, and also the search and the gain of accessibility to information by users (Lamptey & Corletey, 2012). Next to digital developments, the advancement of technologies (e.g. cognitive computing power, intelligent algorithms) result in a growth and variety of information. These digital and technical developments are often cited as *the changing information landscape*. The changing information landscape has provided quick and easy access to wealth of online information sources that can serve as learning resources making students less dependent on the library. The increased amount of information has also its drawbacks. These sources create an information overload, which confronts individuals with diverse, abundant information choices.

In a century in which information and knowledge are transient and contradictory, 21st century skills are critical for entering the labour market and participating effectively in society (Siddiq, Gochyyev, & Wilson, 2017). Across countries, HEIs have embedded 21st century skills in their curriculum (Siddiq et al., 2017). Important components of 21st century skills comprise searching, accessing and assessing information, solving problems, sharing information and creating ideas in a digital context (Siddiq et al., 2017; van Laar et al., 2017). The growing body and complexity of (digital) information demand HEIs to increase their efforts to teach students the complex 21st century skills in order to actively and effectively participate in the current and upcoming changing information landscape (Van Laar et al., 2017).

Students' competences to access, process, and assess information are formulated as essential 21st century skills in a changing information landscape (Todd, 2017). The ability to create structure, meaning, and purpose within the wider field of information refers often to information literacy (IL).

"Information literacy is the set of integrated abilities encompassing the reflective discovery of information, the understanding of how information is produced and valued, and the use of information in creating new knowledge and participating ethically in communities of learning."
(Association of College & Research Libraries Board, 2016).

As defined here, information literacy encompasses a set of complex and integrated skills (e.g. critical thinking, information processing, problem solving, and digital skills). These skills enable students to access and process information (i.e. understanding how data and information is produced and valued), and to critically assess (i.e. reflective discovery of) information. This definition also refers to the synthesis of information to create knowledge and the ethical (e.g. following legal guidelines in using information, cautious use of data) engagement in learning communities (Ferguson, 2017). Further definitions consider information literacy skills as a part of learning, which is understood as the constant search for meaning by the acquisition, reflection, engagement and active application of information in multiple contexts (Bent & Stubbings, 2011; C. Bruce & Hughes, 2010; C. S. Bruce et al., 2017).

Information literacy skills are recognized as an important outcome of higher education and often described as fundamental to students' learning process (Bruce & Hughes, 2010; Bruce et al.,

2017; Maybee, Bruce, Lupton, & Rebmann, 2016). Several accrediting agencies of various disciplinary associations in Australia, Canada, the United Kingdom and the United States have adopted elements of information literacy (Maybee et al. 2016). At the same time, a considerable number of HEIs struggle to integrate information literacy skills in their curriculum. This is due to a lack of awareness of the importance and also due to difficulties to implement them properly (Frerejean, van Strien, Kirschner, & Brand-Gruwel, 2016). Furthermore, Frerejean et al. (2016) criticized the assumption that students automatically develop a complex set of skills to find and process reliable (online) sources and make relevant use of them. A considerable number of studies underpin this misconception and indicate that students continue to lack information literacy skills, while overestimating their own abilities in this area (Chen et al., 2011; Erlinger, 2018; Frerejean et al., 2016; Mahmood, 2016; Peter, Leichner, Mayer, & Krampen, 2017). Thus, putting greater emphasis on fostering students' information literacy in 21st-century higher education appears to be indispensable (Peter et al., 2017).

Information literacy as an integral part of PBL

Information literacy plays a major role in problem-based learning (PBL) because students deal more independently with information compared to traditional teaching education (Dodd, 2007; Santharooban & Premadasa, 2015). PBL is an instructional approach that is adopted by many universities worldwide (e.g. Maastricht University, Lund University, McMaster University) (Dolmans et al., 2016). All formats of PBL are based on a real-life problems, which are discussed in small groups in a self-regulated and student-centred manner (Rovers, Clarebout, Savelberg, & van Merriënboer, 2018). In the PBL process, students start defining a problem drawing on their prior knowledge. In the discussion, students come up with learning goals, which represent missing information and understanding to solve the defined problem.

To fill this gap, students spend time selecting and studying (academic) sources that are relevant to the learning goals generated, as well as preparing the next tutorial meeting. After this period of independent self-study, students share and critically evaluate their located information, elaborate on knowledge acquired, and have an opportunity to clarify misunderstandings. The whole process takes place under the guidance of a tutor who stimulates the discussion, provides students with relevant content information if needed, evaluates the progress, and monitors the extent to which each group member contributes to the group's work (Loyens, Magda, & Rikers, 2008). During these PBL steps, students identify information needs, as well as locating, using and evaluating information and synthesize it with the information provided by other group members (Carbery & Hegarty, 2011; Diekema, Holliday, & Leary, 2011; Santharooban & Premadasa, 2015). This process can be difficult, producing more questions, requiring students to seek out additional information to solve the problem. In such a process, students must be self-regulated and reflective in their information seeking (Fulkerson, Ariew, & Jacobson, 2017).

During self-studying periods, students require an advanced level of self-regulation to identify their information needs and evaluate the information relevant to their learning issue (Chen et al., 2011; Rovers et al., 2018). Self-regulated learning (SRL) refers to "the extent to which learners are metacognitively, motivationally, and behaviourally active in their own learning process." (English & Kitsantas, 2013). One can assume that students need to be educated in how to select and evaluate proper information to self-regulate their learning while studying (Dolmans et al. 2016). In her quick scan into examining information literacy at Maastricht University, Ferguson (2017) reported that bachelor's students often receive fixed and recommended literature lists. In later stages of their studies, students might not be prompted enough to perform independent literature searchers in their self-study periods. Ferguson (2017) further argues that little incentives for independent research

might hinder students to actively search information resources and thereby do not take a critical approach to their research question. In a similar direction, Frerejean (2016) indicates that learners from all ages experience problems with formulating questions and evaluating search results and processing of information. A lack of developing self-regulated and information literate students most likely reduce the efficiency of PBL because students will face difficulties in searching and using information independently (Dodd, 2007; Ferguson, 2017; Santharooban & Premadasa, 2015; Saliba et al., 2017).

In most university settings, information literacy instructions follow a 'one-shot' model which typically refers to a one or two hours lecture-based instruction offered by the library (Wenger, 2014). Several scholars raise concerns about 'one-shot' library instructions as the only intervention to develop information literacy skills (Chen, Lin, & Chang, 2011; Frerejean et al., 2016; Hoffman, Beatty, Feng, & Lee, 2017; Salisbury et al., 2012). General drawbacks to lecture-based instructions are a lack of student motivation and difficulties to maintain students attention. In addition, traditional library instructions and generic tutorials delivered online often overemphasis generic information literacy skills (e.g. information retrieval techniques), which may leave students without a deeper understanding of research as an ongoing, iterative process (Wenger, 2014). Another disadvantage is that while students may acquire new skills in these tutorials they often need help to make the link between generic information literacy skills and the application to their own discipline (Salisbury et al., 2012).

Hence, it is advisable to train and support the practice of information skills throughout the university curriculum and explicitly align information literacy skills development to subject learning outcomes, learning activities and assessment (Ferguson, 2017; Salisbury et al., 2012). Constructive alignment is a holistic curriculum design approach requiring optimal coherence between the three elements intended learning outcomes (ILOs), assessment methods, and teaching and learning activities (TLAs) (See *Figure 1*). Constructive alignment provides a model for ensuring that information literacy efforts are I) not detached from the curriculum, II) could be embedded within course-contents in a way that is meaningful for students and III) could result in measurable student learning outcomes (Biggs & Tang, 2011; Salisbury et al., 2012).
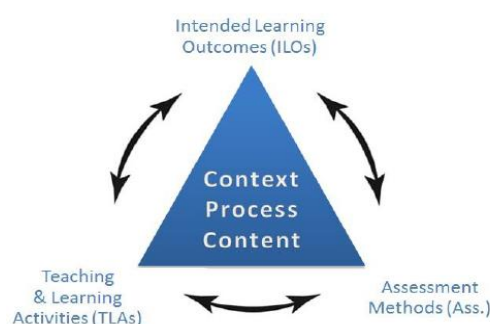
Figure 1, Dijkstra et al., 2016

Given the aforementioned changing information landscape, it is important to understand the shifting paradigm of information literacy skills. Especially, in a PBL environment that aims to educate students in becoming independent and critical 21st century citizens. Constructive alignment within curriculum and course design is necessary to connect information literacy skills to students' academic development and discipline context. Therefore, it is of pivotal interest to examine the following research question:

What are current developments of information literacy skills in higher education and how to constructively align these skills within and/or complementary to the curricula in a PBL setting?

Literature Review

Method

The review is part of a larger project that investigates the changing role of learning in a growing information landscape and aims to provide practical recommendations for vision, policy and education at Maastricht University. The purpose of this paper was to perform a literature review of articles published from 2008 that address the recent developments of information literacy, focusing in particular on research in a PBL setting. Given the research question, the review further aimed to find literature on the integration of information literacy skills into the curriculum, with a special interest on constructive alignment. This review will serve as the foundation for a project proposal, which draws a roadmap for information literacy education and training at Maastricht University in the future.

For this traditional literature review, we decided to perform systematic searches (see Appendix 1) to narrow the search and systematically address the initial research question. The items included in this review were gathered through a process of database searching, bibliography mining, usage of thesaurus, and the inclusion of known items. A series of nine main searches was carried out using Google Scholar, ERIC (EBSCO) and Web of Science (WOS). The searches included different combinations of several terms (see Appendix 1 for detailed search terms), representing the concepts of information literacy, PBL and constructive alignment, respectively.

Shifting role of information literacy in higher education

Early developments of information literacy

The widely-used *ACRL Information Literacy Competency Standards* for Higher Education outline five Standards about the access, selection, processing, and evaluation of information (ACRL, 2000). The *ACRL Information Literacy Competency Standards* describe an information literate student as being able to 1) determine information needed, 2) access the needed information effectively, 3) critically evaluate information and its sources; 4) use information to accomplish a specific goal, and 5) understand economic, legal, and social issues that affect the use of information. These skills-centered ACRL Standards have been adopted by HEIs to develop and validate information literacy instructions and pedagogical efforts (ACRL, 2000; Maybee, 2018).

Notably in the US, accrediting bodies increased their standardization efforts of information literacy and require HEIs to demonstrate how information literacy is embedded within the curriculum (Mudave, 2016). For example, the American Association of Colleagues and Universities (AACU) established an information literacy rubric (see Appendix 2c and 2d) to direct institutional efforts (Maybee, 2018). The rubric's scale covers five broad constructs of information literacy, ranging from "novice" to "expert". For instance, an expert in the information literacy concept 'evaluate information and its sources critically' would be able to "communicate, organize and synthesize information from sources to fully achieve a specific purpose, with clarity and depth". A novice would be able to 'communicate information from sources but information is fragmented and/or used inappropriately such as misquoted or incorrectly paraphrased'. As a tool, the rubric was designed for the institutional levels to evaluate and discuss students' acquisition of information literacy skills, not for grading (Wiebe, 2016; Rhodes, 2009).

Recent developments of information literacy

The ACRL board officially adopted the *Association of College & Research Libraries (ACRL) Framework for Information Literacy* in January 2016, after a two-year process of reviewing. Given the significant changes in the information landscape since the adoption of the *Information Literacy Competency Standards for Higher Education* in 2000, the *Framework* emerged of a need to bring the existing Standards into alignment with modern information creation and use (Schulte & Knapp, 2017). According to the ACRL Board (2016), in the past decade students obtained a greater role in actively constructing knowledge and being able to use information, digital tools, and data both ethically and critically. To prepare students for these new conditions, teaching staff members are expected to put greater effort in aligning information instructions constructively with their learning activities and assessments to stimulate students to properly engage with (digital) information (ACRL Board, 2016). Furthermore, an analysis of information literacy documentation at HEIs revealed that information literacy education, which applied the *ACRL Information Literacy Competency Standards*, often focused on procedural skills (e.g. using bibliographic management systems) (Maybee, 2018). This conventional skill-focused view of information literacy has been criticized for reducing an integrative and iterative set of learning processes into a simplified list of skills and learning outcomes (Kutner & Armstrong, 2012).

At the core of the *ACRL Framework* are conceptual understandings that organize many other concepts and ideas about information, research and scholarship. The ACRL Framework contains six frames, each centred on a 'threshold concept' reflecting an integral element of information literacy (ACRL, 2016). These 'threshold' concepts are grasped over time and students have to pass through a passageway before arriving at an 'aha moment', meaning that one is expected to reach a deeper understanding of each of the information literacy concept to be considered as information literate (Oakleaf, 2014). The six information literacy threshold concepts are:

Authority is Constructed and Contextual
Information resources reflect their creators' expertise and credibility, and are evaluated based on the information need and the context in which the information will be used.
Information Creation as a Process
Information in any format is produced to convey a message and is shared via a selected delivery method. The iterative processes of researching, creating, revising, and disseminating information vary, and the resulting product reflects these differences.
Information has Value
Information possesses several dimensions of value, including as a commodity, as a means of education, as a means to influence, and as a means of negotiating and understanding the world. Legal and socioeconomic interests influence information production and dissemination.
Research as Inquiry
Research is iterative and depends upon asking increasingly complex or new questions whose answers in turn develop additional questions or lines of inquiry in any field.
Scholarship as Conversation
Communities of scholars, researchers, or professionals engage in sustained discourse with new insights and discoveries occurring over time because of varied perspectives and interpretations. **Continued on next page…**

Search as Strategic Exploration
Searching for information is often nonlinear and iterative, requiring the evaluation of a range of information sources and the mental flexibility to pursue alternate avenues as new understanding develops.

The ACRL Framework is organized into six frames, each consisting of a threshold concept central to information literacy, a set of knowledge practices, and a set of dispositions. Knowledge practices are activities that learners can undertake to increase their understanding of relevant information literacy concepts. A knowledge practice for the information literacy concept 'Authority is Constructed and Contextual' would be about defining different types of authority, such as subject expertise (scholarship), societal positon (public office), or special experience (involvement in a historic event). Dispositions describe ways in which to address the attitudinal and valuing dimension of learning (e.g. maintain an open mind and critical perspective when encountering conflicting perspectives) (ACRL, 2016). Overall, the ACRL Framework provides a broader definition of information literacy, adding the pedagogical, cognitive and attitudinal dimension to the information literacy concepts (Booke & Wiebe, 2017).

In addition, the ACRL Framework draws significantly on the concept of *metaliteracy*, coined by Mackey and Jacobson (2014). Metaliteracy focuses on the impact of Web 2.0 and social media on the way we access, use, and interact with information (Kutner & Armstrong, 2012). Social media allows learners to become active consumers and creators of information who are able to generate and share information with their fellow students beyond the classroom (ACRL Board, 2016; Todd, 2017). According to Jacobson and Mackey (2016), metaliteracy upgrades the concept of information literacy. They argue that metaliteracy widens the scope of information literacy and encompasses information literacy as the central part of an integrated set of other literacies (e.g. visual literacy, digital literacy, news literacy, and data literacy). This integrated set of literacies becomes increasingly important in a changing information environment where information become transient and participatory such as a Facebook post or tweet. Metaliteracy is a multidisciplinary concept, which empowers students to engage as critical and adaptive learners in a technology and digital-mediated information environment (O'Brien et al., 2017). Furthermore, this concept supports metacognitive reflection as an empowering practice for learners (see metaliteracy model in Appendix 2a).

Digital developments in the classroom

Students increasingly create information themselves and participate in digital and informal learning communities due to the simple and intuitive connection via social media and online networks (O'Brien et al., 2017). This collaborative and participatory nature of new technology and digital tools asks students to use a set of integrated skills. In a collaborative research project, a number of scholars and institutions showed that students frequently use informal learning strategies, such as learning by doing, problem solving and imitating, while learning new digital skills (Scolari, 2018). Students self-taught their digital skills while immersing themselves in social media (e.g. Facebook, Instagram, YouTube, blogging) outside the classroom. This research project revealed the informal and proactive character of learning in students' development. It highlights a need to centre information literacy related learning activities and assessments to students' behaviour within and outside the classroom. The findings from this research project call upon higher education to consider digital activities students do outside their institution. They describe students' informal learning behaviour (e.g. using

Facebook and Blogs to gather information) in information literacy education and stress the need for the redesign of academic skills courses and library instructions accordingly.

Role of information literacy within PBL

The relevance of information literacy in PBL

In a traditional PBL approach, teaching staff no longer delivers information to assist the learning process but support students in independent information gathering. One basic principle of PBL is that students should be able to identify and retrieve relevant information according to their needs (Dodd, 2007). In the self-study phase, students have to identify what additional information they need to solve the problem, where to go to find information, as well as how to evaluate information to solve the problem (Dolmans, Loyens, Marcq, & Gijbels, 2016; Wenger, 2014). One can assume that during the self-study period students are encouraged to autonomously identify and evaluate relevant literature to define and solve the problem. Contradictory, in a study conducted at Maastricht University, Ferguson (2016) reported that most Bachelor's students received fixed literature lists for their self-study periods. The results of the study illustrate that in several courses, students were not expected to search for additional literature and sources. The fact that students not have to regularly and consistently search for sources on their own might negatively affect students ability to independently search and critically assess (academic) information. A lack of these skills can lead to insecurity in dealing with information, which creates a barrier to seek and use information for academic purposes (Olufemi, 2016). In a PBL environment that aims to foster active and self-directed student engagement, failing to train students to deal with (academic) information hampers the quality of education and increases level of uncertainty to work with information (Frerejean et al., 2016).

The role of information skills and self-regulation in self-studying phases

Research indicates that PBL applied by several universities has become less effective over the years because students and teaching staff seem to skip important elements of the problem-solving process (Rovers et al., 2018). One reason is the finding that little attention paid by teaching staff to support students in their self-study phases (de Bruin & van Merriënboer, 2017; Rovers et al., 2018). Learners with higher self-regulated learning abilities and information literacy skills know how to use various tools and strategies to gather and critically assess relevant information to answer their initial problem and thus have better control over their learning process (de Bruin & van Merriënboer, 2017). Presumably, students who control their learning process will face less problems (e.g. anxiety, information overload) in self-study periods.

In their research paper, de Bruin and van Merriënboer (2017) explained a SRL model (*see Figure 2*) by illustrating a situation of a student dealing with information. The authors note: "when a student reads, e.g., a textbook chapter (the object level), she may experience less confidence in her understanding of the information (the meta-level). Insecurity can lead her to decide to restudy that information so as to improve her knowledge (control)." This example emphasizes the relevance for students to reflect (meta-level) on the way information is used to support learning (control). Finally, when the student recognizes the improved understanding of the chapter when restudying it, the acquisition of knowledge and skills can be further optimized (monitoring). Given the example, one can assume that students who are able to self-regulate their learning process while understanding the role of information in their learning can significantly enhance the self-study phase.
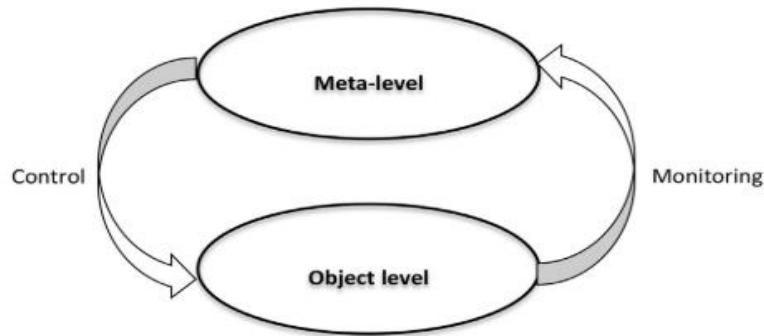
Figure 2, de Bruin (2017)

Often it is assumed that students are naturally capable of acquiring relevant information literacy skills due to their ability to browse through Google and other digital tools (Frerejean et al., 2016). Yet, with little information literacy instructions, the risk of high disparity between the students ability to independently study with information raises concerns (Frerejean et al., 2016). Some students perform much better in independent research and this might lead to a structural disadvantage for some students. In their research about information problem solving, Frerejean et al. (2016) concluded that students lack relevant information literacy competences for their studies and tend to overestimate their abilities to self-regulate their information processing skills. The authors noted that students particularly struggle in dealing with complex information (e.g. reasons for the global warming) because students will need to find, evaluate, and process information that can differ greatly in terms of credibility, bias, or can contain contradictory information.

Mahmood (2016) made similar observations in his systematic review examining information skills in 53 English language studies. The findings reported that in the majority of studies (64%) students overestimated their information skills in self-assessments compared to their actual skills (actual skills were measure differently, e.g. expert grading of searching tasks, and information related assignments). More dramatically, the outcomes implied that individuals with below proficient skills are unlikely to seek help because they are unaware of their skills gap, meaning that students with a lack of information literacy skills will most likely not be motivated to join information literacy instructions, or they may be disengaged from classes. In sum, assuming that students naturally adopt information literacy skills and self-regulated learning strategies becomes concerning, especially due to a growing body of misinformation (Erlinger, 2018; Peter et al., 2017). Instead, a greater focus on stimulating self-regulated learning and information literacy skills throughout the curriculum continues to be warranted because it supports students in effectively self-studying and taking responsibility for their learning process.

Constructively aligning information literacy within the PBL curriculum

Coined by Biggs and Tang (2011) constructive alignment provides a framework for ensuring information literacy efforts could be aligned with subject intended learning outcomes, learning activities, and assessment tasks. It clarifies what the student needs to learn, how to develop information literacy skills further, and how this learning will be assessed (Erlinger, 2018; Salisbury et al., 2012). Furthermore, a constructively aligned model for information literacy ensures the alignment between these skills with the subject content. Scholars indicate that curriculum integrated information literacy education results in deeper understanding of the subject content because it guides students in how to gather, evaluate and apply the information needed to complete the

coursework (Dodd, 2007; Maybee, Bruce, et al., 2016). Therefore, the next step of this literature review is to integrate information literacy theory into the constructive alignment framework, which is deployed across faculties at Maastricht University.

Intended learning outcomes

ILOs are an important component of teaching and learning. They define what students will be able to do as a result of instruction and provide measure for the success of that instructions (Hosier, 2017). Biggs and Tang (2011) describe ILOs as "a statement describing what and how a student is expected to learn after exposure to teaching." In order to embed information literacy skills within the curriculum it should reach the standards of effective learning outcomes – namely being specific, achievable and possible to assess (Biggs & Tang, 2011). A learning outcome for information literacy is phrased in student-centered language and include verbs. Verbs are the key for effective learning outcomes, because If ILOs do not call for an observable behavior (e.g. distinguish, recognize) they result in outcomes that are not assessable. An example learning outcome for information literacy skills might be, "Students will be able to *distinguish* popular and scholarly sources" (Oakleaf, 2009).

The *ACRL Standards for Information Literacy for Higher Education* provided educators with a set of defined learning outcomes which could be used to measure whether students had mastered the skills needed to be considered information literate (Hosier, 2017). By contrast, the ACRL Framework provides teaching staff with a set of framworks including threshold concepts, knowledge practices, and dispositions but no learning outcomes. Instead educators need to define learning outcomes themselves based on the conceptual outline of the ACRL Framework but also according to their own environment and needs. Defining learning outcomes based on the ACRL Framework, which considers learning as a journey with various directions is challenging because educators need to translate the ideas of the Framework into the accepted language of the current educational landscape.

In one example, Hosier (2017) discussed the revision of learning outcomes for an online information literacy instruction at the University at Albany drawing on the ACRL Framework. The research project evolved after a meeting with the Student Library Advisory Board where students expressed their desire to learn more about scholarly articles and their role in the research process. Hosier (2017) picked up the students' request and decided to redesign the content of an existing online tutorial using the ACRL Framework as a lens. Based on the needs of the students, three ILOs were formulated and later revised translating the threshold concept "Scholarship as Conversation" into practical learning outcomes. The premise of the formulation of ILOs was to support students in learning about scholarly articles and their role in the research process. The learning goal "students will be able to identify the role of a scholarly article in the research proccess" was enlarged by the following learning goal. "Students will be able to describe the scholarly article as a piece of an ongoing scholarly conversation in which a variety of perspectives may be represented and meaning must be negotiated." The revised learning goal emphasised that scholarly articles are part of a larger conversation, representing the perspectives of disciplinary experts. The revision in turn enhanced the content of the instruction, because the online course instruction addressed the understanding of the nature of a scholarly article in more depth. Hosier (2017) concluded that the ACRL Framework asks for strategies for adapting the broader threshold concepts (e.g. Scholarshop as Conversation) into learning outcomes that can be applied to day-today instruction.

Teaching and Learning activities

ILOs articulate the level of understanding i.e. explain, apply, reflect and evaluate related to a subject matter or skills level. Teaching and learning activities (TLOs) aim to help students meeting these ILOs (Briggs & Tang, 2011). Such learning activities vary greatly from pre-readings and discussions (i.e. explain) to reflective diaries (i.e. reflect) and the usage of digital tools such as blogging to write a critical post about a selected topic (i.e. evaluate). Recent studies drawing on the relation between information and learning suggest to view information as a medium that helps students to better understand the subject content (C. S. Bruce et al., 2017; Maybee, Bruce, et al., 2016; Maybee, Doan, & Flierl, 2016). The perspective, that information is an integral part of learning is often referred as *informed learning* (C. S. Bruce et al., 2017).

In his book, Maybee (2018) describes various examples of informed learning initatives at the PURDUE University. He mentions for instance the redesign of a introductory technology course, reflecting on the usage of information as part of each learning and teaching activity. Students were supposed to learn five steps of a design thinking process 1) definition, 2) articulation, 3) ideation, 4) evaluation, and 5) communication. Within the course students identified a topic and started their investigation. For example, students investigated issues related to food service at the campus. Students collected and analysed data from interviews and other sources to define the problem, explored scholarly literature, and formulated a solution. At the end of the course, students presented their design solutions in the class. The course design built on different levels of ILOs and combined it with learning activities that involved information literacy skills on each step. *Table 1* outlines students' information use to understand the subject content (i.e. design process). Students engaged in information by building up on existing knowledge (e.g. analyzing data) and newly learned content (design process) to evaluate their collected (academic) information. Finally, students presented their design solution to the class.

ILO Verb	Information Skills	Learning Activities
Explain	Finding and Searching information	Becoming familiar with the design process, Reading scholarly articles, technical reports
Apply	Engaging with information and build up on previous knowledge	Analyzing data and scholarly information, conducting interviews
Reflect	Organizing and Relefecting on information	Synthesizing resources and information to formulate a solution
Evaluate	Presenting information	Formulating solution based on theoretical model and presenting it to peers

Table 1, adopted from Maybee (2018)

Another trend in designing TLAs for information literacy education is linked to technology-supported teaching and the application of digital tools to stimulate learning. Chen et al. (2011) argue that blended learning, i.e. combining online information literacy instructions with classroom teaching has a greater effect than conventional classroom instruction. Especially one-shot sessions held by a librarian benefit greatly when the course is supplemented by online materials. Providing information literacy instructions online also tackles the challenge of just-in time availability because students can complete online courses at their own pace and according to their needs (Peter et al., 2017). Furthermore, blended formats such as flipped learning, where students individually watch online lectures prior to class and then engage in classroom learning activities interacting with peers and instructors can maximize students information literacy education experience (Lee, Lim, & Kim, 2017).

Meyers, Erickson, and Small (2013) mentioned a set of different cognitive and social network tools to facilitate students learning. Tools such as concept mapping (i.e. mind mapping) support students to develop learning goals because they stimulate the structured use of information and concepts. To reflect on their learned content, students could engage in forum discussions, in which the tutor posts prompting questions to retrieve the information learned. A study, performed by Bye, Smith, and Rallis (2009) showed that students reflection in a forum discussion had a greater effect on their study outcomes than offline reflection. Creating digital content (e.g. writing blog posts) help students to move away from only seeing themselves as digital information consumer towards engaging in the activity of digital information creation (Meyers et al., 2013).

Assessment

Information literacy assessment allows educators to evaluate the success of their teaching activities related to information literacy and adapt their lessons to gaps in students knowledge, therby improving the efficacy of future sessions (Anderson, 2015; Pinto & Fernández-Pascual, 2017). Assessment in itself can be considered as a learning tool that helps students to understand course content and improve the retention. The choice of an instrument for information literacy assessment, as well as combining different instruments depends on the type of assessment to be made, the available time, and the cost of implementation (Erlinger, 2018). In a review of the literature on information literacy assessment, Erlinger (2018) outlines various approaches for assessing performance in information literacy. According to Erlinger (2018), surveys, authentic-, objective tests, focus groups, and rubrics are all instruments used to measure students information literacy performance. Most of these assessment instruments are grounded in the *Information Literacy Competency Standards for Higher Education*. As noted previously, the ACRL Standards were recently replaced by the ACRL Framework, which focuses on higher-level concepts instead of a list of specific skills. As the transition from the Standards to the Framework is relatively recent, few published scholarly litature on information literacy assessment consider the six threshold concepts of the ACRL Framework (Erlinger, 2018; Rosman, Mayer, & Krampen, 2015).

Oakleaf (2014) was one of the first authors who introduced the assessment of information literacy skills according to the ACRL Framework. As stated by Oakleaf (2014), the ACRL Framework is very well suited to learning outcomes and assessment, as long as assessment allows the use of authentic assessment approaches, emphasizes the indvidual pace of learning, supports metacognition and links learning and grading in a meaningful way. Authentic tasks are asssessed in a real-world setting (e.g. on a computer with access to biliographic databases) and ask students to demonstrate meaningful application of essential knowledge and skills. According to Oakleaf (2014), the ACRL Framework once more put emphasis on the application of pedagogical concepts (threshold concept) to design validated and reliable information literacy assessment instruments.

In an earlier paper, Oakleaf (2009) already explained the need for a comprehensive information literacy instruction outcomes assessment plan to guarantee instructional quality and successful student learning. Oakleaf (2009) described an information literacy instruction assessment cycle following a seven-step process reviewing learning goals, setting learning outcomes, creating learning activities, teaching to learning outcomes, gathering data to check learning, interpret that data, and enact decisions to close the loop (See Apendix 2b) (Carbery & Leahy, 2015). Combining such cycles with authentic assessment tasks are supposed to help identify the "stuck places" students encounter to grasp a threshold concept (Oakleaf, 2014).

Another assessment approach was put forth by Rosman et al. (2015). The authors claimed that assessment of information literacy skills should evaluate both how fast students master factual knowledge (i.e. "knowing what"), and procedural knowledge (i.e. "knowing how"). While factual knowledge can be achieved by memorizing facts, procedural knowledge includes knowledge about how to act in a certain situation. In terms of information literacy, factual knowledge would be about students' ability to distinguish between an empirical study and a literature review. Procedural knowledge would be about students ability to retrieve scholarly journals (e.g. using different databases) and other sources appropriate to the inquiry. Rosman et al. (2015) present different types, measurements, and methods of assessing students information seeking behavior that involve factual and procedural knowledge.

First, multiple-choice achievement tests can be applied for information literacy such as the Information Literacy Test (ILT). These measurements seem to primarily assess factual knowledge. For instance while working with the subscale *access* of the ILT, students are asked about the name of the database, which includes books from a specific library. Although these tests are easy to administrate they run the risk of generic assessment outcomes and are critizised for not testing higher-level skills (Chan, 2016).

A second method constitutes of information performance tasks, which fall under the umbrella of authentic assesment (Pinto & Fernández-Pascual, 2017). In information performance tasks, subjects are instructed to find a scientific article about a certain subject, and students search results are evaluated. For example, Frerejean et al. (2016) developed an online skills test to reveal student's level of performance. This test confronted students with seven situations that occur during a information problem (e.g. search information). The students had to answer several questions (e.g. Which search query would you type into Google?) related to the four information problem solving steps select, search, define, present. Information performance tasks as such are increasingly used in information literacy education because they measure procedural knowledge. However, it is noted that these assessments are difficult to administer and grade, because conducting extensive search tasks is time consuming (Rosman et al., 2015). In sum, Rosman et al. (2015) suggest to include assessments that test both factual and procedural knowledge to reflect the complex nature of information seeking.

4C/ID-model

The integration of information literacy skills into the curriculum can greatly benefit from contemporary instructional design methodologies that address the development of complex skills (Clarebout et al. 2017). The Four-Component Instructional Design model (4C/ID-model), in which authentic, real-world learning tasks are the method of choice, provides an extensive approach for developing instruction to teach complex skills (Frerejean et al., 2016; Van Merriënboer & Kirschner, 2017). Especially in the long term, students will likely benefit more from courses that combine authentic information-literacy tasks with students' coursework than from an extracurricular instruction session that conveys generic knowledge on how to use certain library services and databases (Artman, Frisicaro-Pawlowski, & Monge, 2010). Essentially, the 4C/ID-model is suggested to reduce cognitive load by scaffolding the support in learning tasks. It stresses the importance of built-in tasks support in cases where tasks are too complex for a learner to complete successfully. Built-in tasks support in many ways (i.e. with case studies, modelling and/or worked examples, inducing reflection, collaborative work, etc.) the acquisition of relevant information literacy skills.

Embedded Librarianship

In most academic settings, information literacy instructions follow a 'one-shot' model which typically refers to an one or two hours instruction workshop offered by the library. In recent digital developments new pedagogical concepts - such as blended learning and flipped classroom - lead to redesign of information literacy instructions (Hoffman et al., 2017; Peter et al., 2017). Frerejean et al. (2016) showed that even a 2-hour course intervention can have an significant effect on students information literacy skills. However, he also noted that if not aligned with further course teaching and assessments students tend to forget the lessons learned shortly after the instruction. As a consequence, practioners and scholars examine the evolvement form 'one-shot' information skills instructions to deep integration into faculty curriculum, combining traditional teaching activities with blended and technology-supported formats (Chen et al., 2011; Hoffman et al., 2017).

One study (Hoffman et al., 2017), investigated the expanding role of academic librarians as part of the instruction team to redesign a academic writing skills course. Findings illustrate that students felt more confident and prepared for course assignments due to the gained research and writing skills during the class. Members of the instructional team appreciated the richness of each other's expertise and inclusiveness. Teaching staff emphasized that the information specialist brought hands-on research and writing skills on the table. The case study, along others, emphasized the added value to redesign skills courses in collaborative and interdisciplinary manner involving instructional designers, information specialists, and course coordinators (Booke & Wiebe, 2017; Maybee, 2018). Hence, embedding information skills instructions into coursework while expanding the role of librarians can support students and teaching staff in further developing relevant information skills.

Discussion

Discussion Points of the Review

This review aims to answer the research question what the current developments regarding information literacy skills are in higher education and how these skills can be aligned within and alongside curricula in a PBL setting. The ACRL Framework redirects information literacy education from a standardized, discrete list of skills towards an integrated set of complex skills that is acquired over time reacting to a changing information landscape. Especially in a PBL curriculum, students require information literacy skills in all phases of their academic development (Diekema et al., 2011; Dodd, 2007; Santharooban & Premadasa, 2015; Wenger, 2014). One-time workshops and generic online tutorials provided by the library are not sufficient to develop such a complex set of skills (ACRL, 2016; Chen et al., 2011; Frerejean et al., 2016; Wenger, 2014). Constructively aligning information literacy skills with learning outcomes, teaching and learning activities, and assessments, can ensure that these skills are integrated in the curriculum (Ferguson, 2017; Hoffman et al., 2017; Santharooban & Premadasa, 2015). The application of evidence-based instructions and pedagogical models (e.g. 4C/ID model and information performance tasks) will further establish a systematic approach to train information literacy throughout students' academic path (ACRL, 2016; Frerejean et al., 2016). Furthermore, a greater collaboration between information specialists and faculty to institutionalize information literacy education will contribute to the development of self-directed and critical students at Maastricht University (Booke & Wiebe, 2017; Hoffman et al., 2017; Maybee, 2018).

Revision of ACRL Standards to Framework

The revision of the ACRL Standards to the ACRL Framework set a milestone in the evolvement of information literacy education. The ACRL Framework signalled a global shift from solely skill-centred standardization to a flexible and pedagogical centred approach, adoptable by universities to enhance information literacy education. The two concepts of *metaliteracy* and *threshold* that underpin the ACRL Framework provide a broader definition of information literacy referring to a set of complex and integrated skills that enable students to participate critically in a dynamic information environment (Maybee, 2018). The ACRL Framework also sparked a vivid discussion among scholars in the wider research field of information literacy. In a position paper, Beilin (2015) summarized the academic discourse on the ACRL Framework. The researcher and librarian noted that critiques are concerned with the practicality and implementation of the ACRL Framework, mainly because it is based on abstract threshold concepts, which are less prescriptive than clear learning outcomes.

In fact, as the transition from the Information Literacy Competency Standards for Higher Education to the ACRL Framework is still relatively recent, much of the literature on information literacy instruction is tied to the ACRL Standards. In addition, most practitioners stick to the well-established Standards within the university context. The challenge hereby is to apply the ACRL Framework to educational institutions. Importantly, the ACRL (2016) position their information literacy framework as a developmental and systematically integrated part of student's academic program, which is adaptable to a multitude of learning contexts. To that end, the ACRL Framework *for Information Literacy Sandbox* was developed as a repository of materials to assist librarians and academic staff with adopting and implementing concepts put forth in the ACRL Framework *(access via http://sandbox.acrl.org/about)*. The collection of resources and materials consists of I) ideas and examples for how to use the Framework, II) lesson plans and other instructional materials, III) potential collaborators for projects related to the Framework. This platform is an excellent venue for PBL-centred universities to share resources, examples, and studies that address the implementation of the ACRL Framework into an active learning classroom (Fulkerson et al., 2017).

Information literacy in PBL

This literature review presented numerous studies which indicate that information literacy skills are central to PBL-programmes as they enable students to become self-directed and independent learners (Dodd, 2007; Santharooban & Premadasa, 2015; Wenger, 2014). While information is present in the whole PBL process, Wenger (2014) described the seeking for answers to learning goals as the most information intensive process because students need to think critically about the information they find. When defining learning goals, students have to identify the skills they want to develop, evaluate the validity and relevance of the information found, incorporate the information into their existing knowledge base, and understand which knowledge was lacking and consequently bolster it. The tutor plays a significant role in providing right-in time support, i.e. guide this process by probing students where they found the information, why they chose the sources, and how they assessed the quality of these sources. Reflection cues as such help to stimulate the metacognitive usage of information. This goes in line with research on self-regulated learning suggesting that reflecting and monitoring the role of information in learning can optimize the acquisition of skills (de Bruin & van Merriënboer, 2017).

Reformulating the Provision of Reading Lists

Previous studies at Maastricht University outlined that in most bachelor courses independent search and acquisition of information are not indicated within the intended learning outcomes. For instance, the quick scan of Ferguson (2017) revealed that bachelor students mostly received fixed and

recommended reading lists. Another study at Maastricht University explained the reason for fixed reading lists. In an earlier paper, Moust, Berkel, and Schmidt (2005) argue that some staff members at Maastricht University do not believe that students are able to cover sufficient subject-content through independent learning. Therefore, they try to steer students' learning activities in various ways. Providing students with specific references can have negative effects on students' self-studying behaviour and students' abilities to become independent learners may be substantially hampered. Instead, providing students with fewer fixed reading lists and making the search for literature a more integral part of the regular PBL sessions could encourage students to develop creative and critical approaches when faced with complex questions (Ferguson, 2017; Moust et al., 2005).

Embedding Information Literacy Instructions

Literature suggests that students find it easier to navigate library databases than to understand what information they need, yet academic librarians often find themselves with barely enough time to teach the effectiveness of databases. Spending more time on the students' information needs, even if it allows less time for searching library resources, could prove very fruitful, especially for low-skilled students (Ferguson, 2017; Frerejean et al., 2016; Wenger, 2014). In the case of standalone workshops, students often fail to see the relevance of the information literacy instruction to their academic work or their personal lives, and the resulting low motivation creates obstacles to learning (Latham & Gross, 2013). Ferguson (2017) recommended tying information literacy skills courses into students' ongoing courses at Maastricht University while further improving the cooperation between the library, faculties and course coordinators. In such a collaboration, librarians with knowledge of pedagogy and experience with students' challenges with, and expectations of, the research process, could provide input into course structures and assessment designs (Hoffman et al., 2017). In the reviewed literature, several paper discussed the benefits of embedded librarianship. It is noted that many information literacy instructions lack formal assessments and therefore hardly prove their value in helping students to master their study work. At the same time, the dense and mostly procedural information provided in library workshops does not cover the full range and complexity of information literacy skills. A course-embedded approach could significantly improve information literacy education at Maastricht University (Hoffman et al., 2017; Saunders, 2012).

At Maastricht University, there seems to be little consensus about when, where and how information literacy skills can be developed throughout the curriculum. Some UM courses (e.g. *Writing Project: The Journal, Critical appraisal of a biomedical publication*) systematically address information literacy, whereas others articulate the need for better embedment of research skills into the curriculum (Clarebout et al. 2017). The ACRL Framework can give guidance in establishing a partnership between the library and faculties. As Hosier (2017) discussed in her paper, one major challenge in adopting the ACRL Framework is to translate the threshold concepts into learning outcomes that can be used in day-to-day instructions. Followed by teaching and learning activities, which ensure that students are able to meet these learning outcomes. As discussed by Maybee (2018), students deal with information in each step of the learning activity they follow (C. S. Bruce et al., 2017; Maybee, 2018; Maybee, Doan, et al., 2016). It is therefore critical to make these information processes explicit and guide students through it by providing personalized feedback on their information use. Finally, formative and summative assessments are supportive for educators to evaluate the success of their instructions. If information literacy plays a relevant role in the course design, assessment indicates if the instructions helped students to adopt information literacy skills. Effective assessments address both declarative and procedural knowledge to test students' full understanding of the

information literacy concept (Rosman et al., 2015). In sum, constructively alignment is crucial to provide opportunities for students to practice information literacy throughout the curriculum.

One pitfall is a confusion about the terminology of information literacy, which might hinder better collaboration to integrate information literacy into programme curriculum and course syllabus. While the library provides basic research skills tutorials, they also offer a range of information literacy skills initiatives. However, without a strong connection to the curriculum and subject courses it is conceivable that information literacy skills are not sufficiently developed. This claim is backed up by evidence showing that information literacy skills are often over-identified as library skills and not as competencies associated with academic development and hence not sufficiently addressed within programmes (Saunders, 2012).

As noted above, information literacy education is perceived differently, partly depending on the discipline and context. While faculty staff might assume that information literacy skills are taught by the library, students probably do not perceive the benefit of the acquisition of skills that enable them in finding and evaluating relevant information to their research inquiry. Unsurprisingly, most students overestimate their abilities in information literacy skills, as they come from a younger generation, which is often called 'digital natives'. Saunders (2012) discussed in her paper the different perspectives of teaching staff, librarians and students on information literacy education. She states that one major hurdle for the improvement of information literacy education is the absence of teaching staff in conversations on information literacy education. Apparently, teaching staff have the most direct contact with students as well as the most direct oversight of and responsibility for the curriculum. One important finding of her qualitative study was that teaching staff who were familiar with the concept of information literacy were more likely to integrate it better in their courses or programmes. Hence, it is advised that the library increasingly initiates and continues conversations about information literacy with faculties. Most importantly, the library has a role in bringing ideas and approaches for information literacy to teaching staff. These ideas should take new ways of teaching into account, including blended learning and other e-learning tools. In other words, librarians must be persistent, vocal, and confident in their ability to contribute to faculty learning outcomes (Booke & Wiebe, 2017; Maybee, 2018).

Recommendations

Recommendations for Research at Maastricht University

This review intends to identify recent developments in scholarly research on information literacy skills. Relevant implications for skills-education at the PBL-centred Maastricht University were articulated. Together with the findings of the quick scan of Ferguson (2017), this review provides ample evidence for the importance to conduct more research on the topic of information literacy education at Maastricht University. The call for more research follows the premise that Maastricht University and other institutions should underpin the teaching of information literacy within a theoretical foundation. At Maastricht University, little assessment is apparent to evaluate information literacy skills of students. In addition, the effect of teaching information literacy on students' actual learning and academic success is unexplored. Insights on where students struggle with their information literacy remain scarce. More in-depth research, both quantitative and qualitative, will encourage further evidence-based information literacy education at Maastricht University.

A qualitative research approach could help to gain deeper understanding of how students and staff experience information literacy education at the Maastricht University. Focus groups are a suitable method to investigate information literacy education within universities, as it encourages

social interaction and allows for the efficient collection of rich data with high face validity. Moreover, the interaction that occurs among participants in focus groups often leads to insights that would not occur in individual interviews (Latham & Gross, 2013). Questions could address the perceived benefits in constructively aligning information literacy within the curriculum, both from teaching staff and students. Further research could look into the relation between information and learning. How does the systematic use of information improve self-regulated and deep learning? Does it contribute to the enhancement of the quality of students' academic performance? Which information literacy instructions are effective and which ones diminish students' skills development? In addition, it could be helpful to ask instructors of Maastricht University to critically reflect on their impressions of and expectations for information literacy skills teaching in their courses. Such questions will help to build cases and execute pilots across faculty at Maastricht University.

A systematic and in depth quantitative assessment is needed to measure students' current information literacy skills. While Ferguson (2017) provided an quick overview on Maastricht University students' general level of information literacy, conducting more in depth analyses of how information literacy skills are applied in writing assignments can reveal relevant insights into the challenges students face. This could be done through various assessments ranging from multiple-choice tests which evaluate students' knowledge about certain information literacy concepts (e.g. scholarship as a conversation), to authentic practices where students have to demonstrate their actual skills, e.g. by working on a research task or documenting their search history for a research question. A certain standard, e.g. proficient skills in information literacy could ensure that all students have a fundamental understanding of how to deal with (academic) information.

Furthermore, quantitative research could test the effects of fixed literature lists on students' information literacy abilities. What is the effect of providing no recommended literature with guidance through the search and evaluation phase of information, in comparison to hybrid reference lists or fixed literature lists? Does it enhance their ability to perform independent research? Does it improve their academic performance? What are the effects of guidance from the instructor regarding the use of information on students' ability to answer their learning goals and/or research inquiry?

Choosing the next steps concerning these methodological approaches depends on which aim and vision the library and the Maastricht University pursue with their future research into the topic and how they want to implement the outcomes. For instance, if one wants to focus on a campus wide improvement of information literacy education, various stakeholders (e.g. vice-deans of education, programme coordinators, teaching staff, students, academic librarians) have to be involved. If the aim is to understand how issues such as the literature list affect students abilities to perform independent literature searches, the target group would mainly be students.

Beyond Maastricht University, there seems to be little research and best practices on the implementation of the ACRL Framework into programmes and courses. Until now we know that VU Library started to embed this framework in some curriculum-based information literacy trajectories. Exchanging these practices and further research into the development of learning outcomes, teaching and learning activities, and assessments will help future research in translating the ACRL Framework into practical advice. In addition, the alignment of information literacy education with curriculum frameworks (i.e. constructive alignment) is not well-established in academia. Coherently, scholars urge for a systemic approach in addressing information literacy within curriculum decisions. Therefore, further research could investigate how to integrate information literacy skills into the curriculum.

Practical Recommendations for Maastricht University

The review yields some implications for information literacy education at Maastricht University. First, a clear and campus-wide vision on information literacy education is crucial, because information literacy skills are vital in a 21st-century for the development of critical and self-directed learners. The ACRL Framework provides relevant input to have such a university-wide dialogue. The ACRL Framework comprises six frames related to information literacy concepts, which are adjustable to the PBL system and different needs of programmes and courses at Maastricht University. Considering the difficulties of implementing the ACRL framework, Maastricht University can take advantage out of the ACRL sandbox. The ACRL sandbox offers publicly available materials, shared by other universities, who address the translation of the ACRL Framework into different educational and discipline contexts. Other repositories such as the new curriculum initiative of A New Curriculum for Information Literacy (ANCIL), a blog-based website with a variety of information literacy material, offer further inspirations to (re-)design information literacy education at Maastricht University (accessible here: https://newcurriculum.wordpress.com/).

Second, institutionalizing information literacy education costs effort and time. Building a better partnership between the library, EDLAB and faculties therefore determines the quality of information literacy education at Maastricht University. Information specialists from the library together with educational specialists in blended PBL support can use their rich experience in teaching information literacy to students. Faculty teachers can provide information specialists with their individual needs and requests and share pedagogical acumen. Furthermore, it is vital to connect existing information literacy practices at Maastricht University. For instance, the bachelor's course *Writing Project: The Journal* at University College Maastricht (UCM) integrates information literacy skills into the ILOs, TLAs, and (formative) assessments of the course. In this 4 weeks course of the 6th Period, students operate in a setting of a fictitious academic journal. Each member of a group has to submit a paper to be published in this fictitious journal. Students perform literature searches, join a literature search workshop, have to present their topics to fellow students and give peer feedback to their submitted papers. Students develop information literacy skills through short assignments such as a 250-word paper that reflects the documentation of students' literature search. Students improve systematic searching and learn simultaneously how to define their research question. In this example, the course coordinator and an information specialist co-designed learning outcomes, teaching activities and assessments and therefore ensured that students gain sufficient skills in searching for relevant information. UCM is clearly not the only programme at Maastricht University that integrates information literacy education into their programme. It is highly recommended to identify and to bring best practices together to stimulate exchange and learning from different settings and cases.

The third recommendation is to gradually reformulate the provision of fixed reading lists throughout the curriculum and to provide systematic support for students in their information use. While first year bachelor students might need full support in searching for relevant literature, at a later stage of their bachelor programmes students should be able to independently search for sources relevant to their research inquiry. In addition, the search for sources can be guided by prompting questions and reflection tasks on the usage of information. The tutor has a key role to act as a facilitator and continually challenge students in the way they search, process and use information. Tutors might need training in teaching information literacy. This could be done through train the trainer sessions taught by information specialists of the university library. Another possibility is to integrate basic information literacy training into the University Teaching Qualification (BKO), a programme that supports teaching staff to develop relevant competences for teaching, and/or the

upcoming Continuous Professional Development (CPD), a senior programme for teacher professionalization.

Fourth, it is advised to constructively align information literacy education within and alongside the faculty curriculum. This means either developing information literacy instructions that are linked to course assignments and learning goals, or by directly embedding skills within the programme curriculum or course syllabus. Following the recommendation of this review would imply the redesign of measurable ILOs based on the threshold concepts of the ACRL Framework. The process of redefining information literacy learning outcomes would greatly benefit from an inclusive approach. Instructional designer, faculty staff, information specialists and curriculum experts could collaborate to design effective information literacy education. This would entail teaching activities, which address the question of what kinds of information students need to use in order to meet a learning objective. Blended and technology-supported methods in combination with traditional teaching can help to diversify information literacy instructions and therefore reach every type of learner. To ensure high quality information literacy education it is not enough to set ILOs. It is advisable to measure and refine those ILOS over time. As part of a subject course, assessment can help to redefine information literacy learning outcomes and tasks within the course. Assessments could be addressed in various forms, such as multiple choice or authentic evaluations, depending on the interest of the evaluation.

Lastly, academic librarians continue to take a responsibility in identifying core ideas within their own knowledge domain that can extend learning for students, in creating a new cohesive curriculum for information literacy, and in collaborating more extensively with EDLAB and faculties. Academic librarians can take several steps to further advance their understanding and skills set to benefit information literacy education. First, academic librarians could familiarize themselves with the ACRL Framework. Second, they are advised to form a task force to translate the new directions from the ACRL Framework into their own pedagogical work. At Maastricht University, this implies both a well-defined understanding of PBL, and the acquisition of the skills needed to apply pedagogical concepts (e.g. threshold concept) and models (e.g. constructive alignment model) to their work. In order to become more fluent in the language of instructional designers and teaching staff, academic librarians at Maastricht University can take further lessons in the field of learning and teaching within and outside the university. Gaining a deeper understanding of the ACRL framework will most likely improve the cooperation between faculties and library. A partnership between faculties and library will be from utmost importance when co-developing learning outcomes, teaching activities and assessments continuing to enhance information literacy education at Maastricht University.

Limitations

This literature review revealed also some limitations. The review considered mostly literature from academic librarian journals and only a few sources within the educational science domain. Therefore, the paper takes rather an information lens than a pedagogical and didactical view. However, recent academic librarianship shifted towards an educational perspective, in which information literacy skills are situated in the learning process of students. In addition, the main view of this review focused on the ACRL Framework. There are other conceptual information literacy frameworks, which could be adopted at Maastricht University. For example, the revised Seven Pillars of Information Skills model, which considers information literacy as an umbrella term for various literacies (e.g. data literacy, media literacies, digital literacy). Yet, the core of most renewed frameworks is essentially similar. In addition, due to the scarce research at Maastricht University, the conclusion and recommendations of this literature review have to be considered with caution. As already, proposed, future research will

bring new insights in the applicability of the ACRL Framework at Maastricht University. Another limitation is the fact that most literature reviewed originate from the United States, United Kingdom, Australia, and East-Asian countries. In addition, the ACRL Framework was developed by academic libraries from the United States. Research on information literacy remains scarce in the Netherlands. However, this is can be also seen as an avenue for Maastricht University to become a frontrunner among Dutch Universities, in researching and establishing information literacy within the curriculum.

Conclusion

In the digital age, one of the challenge of students is to understand the contours and dynamics of the information environment and often feel overwhelmed by a vast amount and abundance of information and data. The immense load of information, in various forms, asks students to acquire a broad set of skills to steer their way through this "information jungle". HEIs are urged to put emphasis on the development of 21st century skills that enable students to access, process and assess information (van Laar et al., 2017). Most scholarly papers reviewed, provided ample-evidence that single library workshops, detached to the curriculum's content, structure and sequence are not sufficient to stimulate students in developing information literacy skills. To increase students' readiness and capability to use (scholarly) information, it is important to provide opportunities for the development of information literacy skills in the context of a discipline (Wiebe, 2016). At Maastricht University, there is a need to have an institution-wide perspective on information literacy education and adapt it to discipline context. A constructive dialogue between faculty, EDLAB and the library can further ensure high-quality information literacy education. It is advised to integrate information literacy skills into specific learning outcomes, teaching activities and assessments that address information literacy both on programme and course level. It is crucial to start with the premise that information is part of a complex learning process leading to critical and deep understanding, which contributes to the development of reflective and self-directed students at Maastricht University. A real partnership between faculties, EDLAB and the library could result in a university-wide information literacy education, which prepares students for a rapidly changing information landscape.

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Appendix

Appendix 1

General search Terms (all fields) and Thesauri: "Higher education", "Problem Based Learning", "problem solving", "Information skills", "information literacy", "information seeking" , "information retrieving", "information processing", "digital literacy", "digital skills", "Information and Communication Technology (ICT)", "21st century skills", "informed learning", "information overload", "information anxiety", "constructive alignment", "curriculum-embedded skills training", "backward design", "embedded librarianship", "library instruction", "self-regulated learning", "self-directed learning", "self-control", "learning outcome", "learning problems", "learning strategies", "assessment", "evaluation", "test", "rubrics"

As the main target of this review was evidence-based literature, we included mainly peer-reviewed items from book chapters and academic journals and excluded popular magazines, newspapers and other informal sources. In addition, scientific and internal reports were selected for this review. Most studies included in this review were published in information literacy and librarianship journals. However, some of the other scholars included in this review were published in educational science journals, such as *Computer & Education or Learning and Instruction*. The majority of depicted articles were published from 2008. We selected a few papers and reports that were published before 2008 and provided relevant evidence in answering the research question.

Search Build:

1. "Higher Education" AND "Information Literacy" AND "Problem Based Learning"
2. ("information skill*" OR "information literacy" OR "digital skills" OR "digital literacy" OR "21st century skills" or "Information and Communication Technology (ICT")) AND ("problem based learning" OR "PBL")
3. ("information skill*" OR "information literacy" OR "information retrieval" OR "information processing" OR "digital literacy") AND ("problem based learning" OR "PBL")
4. ("self-directed learning" OR "self-regulated learning" OR "self-efficacy" OR "self-control") AND ("problem based learning" OR "PBL")
5. ("self-directed learning" OR "self-regulated learning" OR "self-efficacy" OR "self-control") AND ("information skill*" OR "information literacy" OR "information retrieval" OR "information processing" OR "digital literacy")
6. ("embedded librarianship" OR "constructive alignment" OR "curriculum-embedded skills training" OR "backward design") AND ("information skills" OR "information literacy" OR "information retrieval" OR "information processing" OR "digital literacy")
7. ("learning outcome*" OR "learning problem*" OR "learning strateg*" OR "learning objective*") AND ("information skill*" OR "information literacy" OR "information retrieval" OR "information processing" OR "digital literacy")
8. ("information skill*" OR "information literacy" OR "information retrieval" OR "information processing" OR "digital literacy") AND ("assessment" OR "evaluation" OR "test" OR "rubric")

Appendix 2a
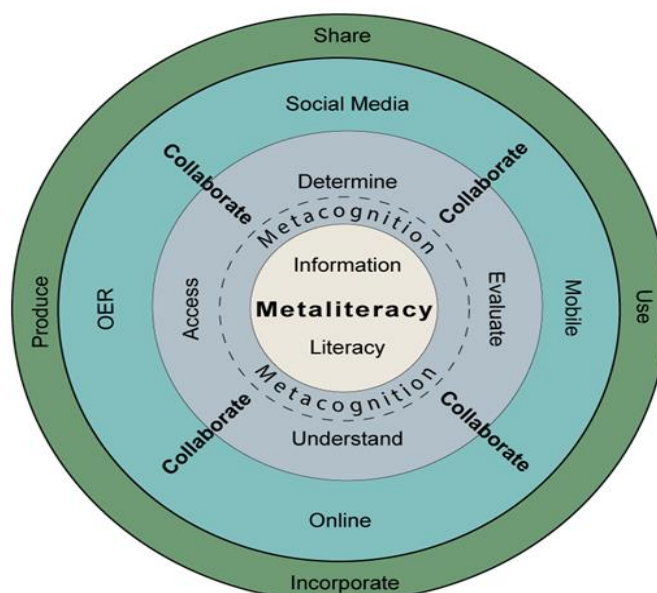
Mackey, T. & Jacobson, T. (n.d). Metaliteracy. Retrieved from

Appendix 2b
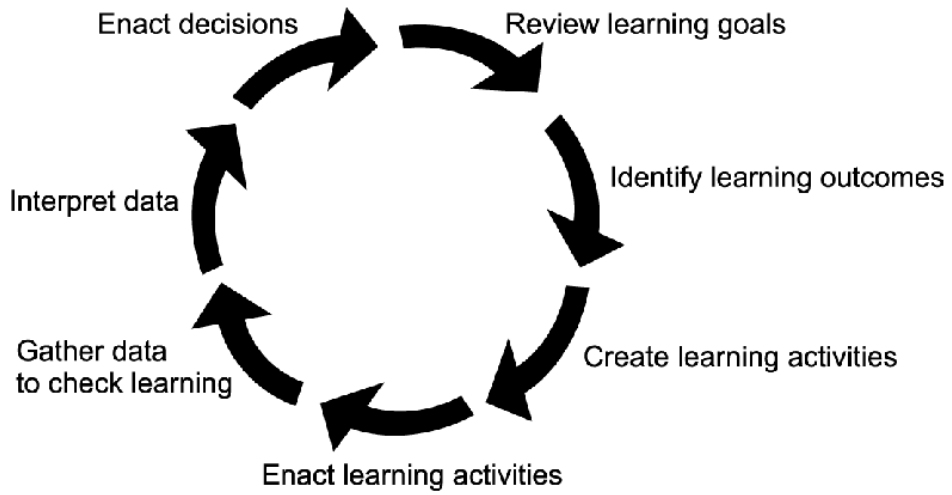
Oakleaf (2009). The information literacy instruction assessment cycle.

Appendix 2c

	Capstone 4	Milestones 3	Milestones 2	Benchmark 1
Determine the Extent of Information Needed	Effectively defines the scope of the research question or thesis. Effectively determines key concepts. Types of information (sources) selected directly relate to concepts or answer research question.	Defines the scope of the research question or thesis completely. Can determine key concepts. Types of information (sources) selected relate to concepts or answer research question.	Defines the scope of the research question or thesis incompletely (parts are missing, remains too broad or too narrow, etc.). Can determine key concepts. Types of information (sources) selected partially relate to concepts or answer research question.	Has difficulty defining the scope of the research question or thesis. Has difficulty determining key concepts. Types of information (sources) selected do not relate to concepts or answer research question.
Access the Needed Information	Accesses information using effective, well-designed search strategies and most appropriate information sources.	Accesses information using variety of search strategies and some relevant information sources. Demonstrates ability to refine search.	Accesses information using simple search strategies, retrieves information from limited and similar sources.	Accesses information randomly, retrieves information that lacks relevance and quality.
Evaluate Information and its Sources Critically*	Chooses a variety of information sources appropriate to the scope and discipline of the research question. Selects sources after considering the importance (to the researched topic) of the multiple criteria used (such as relevance to the research question, currency, authority, audience, and bias or point of view).	Chooses a variety of information sources appropriate to the scope and discipline of the research question. Selects sources using multiple criteria (such as relevance to the research question, currency, and authority).	Chooses a variety of information sources. Selects sources using basic criteria (such as relevance to the research question and currency).	Chooses a few information sources. Selects sources using limited criteria (such as relevance to the research question).
Use Information Effectively to Accomplish a Specific Purpose	Communicates, organizes and synthesizes information from sources to fully achieve a specific purpose, with clarity and depth	Communicates, organizes and synthesizes information from sources. Intended purpose is achieved.	Communicates and organizes information from sources. The information is not yet synthesized, so the intended purpose is not fully achieved.	Communicates information from sources. The information is fragmented and/or used inappropriately (misquoted, taken out of context, or incorrectly paraphrased, etc.), so the intended purpose is not achieved.
Access and Use Information Ethically and Legally	Students use correctly all of the following information use strategies (use of citations and references; choice of paraphrasing, summary, or quoting; using information in ways that are true to original context; distinguishing between common knowledge and ideas requiring attribution) and demonstrate a full understanding of the ethical and legal restrictions on the use of published, confidential, and/or proprietary information.	Students use correctly three of the following information use strategies (use of citations and references; choice of paraphrasing, summary, or quoting; using information in ways that are true to original context; distinguishing between common knowledge and ideas requiring attribution) and demonstrates a full understanding of the ethical and legal restrictions on the use of published, confidential, and/or proprietary information.	Students use correctly two of the following information use strategies (use of citations and references; choice of paraphrasing, summary, or quoting; using information in ways that are true to original context; distinguishing between common knowledge and ideas requiring attribution) and demonstrates a full understanding of the ethical and legal restrictions on the use of published, confidential, and/or proprietary information.	Students use correctly one of the following information use strategies (use of citations and references; choice of paraphrasing, summary, or quoting; using information in ways that are true to original context; distinguishing between common knowledge and ideas requiring attribution) and demonstrates a full understanding of the ethical and legal restrictions on the use of published, confidential, and/or proprietary information.

Rhodes, T. (2009). *Assessing outcomes and improving achievement: Tips and tools for using the rubrics.* Washington, DC: Association of American Colleges and Universities.

Appendix 2d

Student Learning Outcomes	Level 1	Level 2	Level 3	Level 4	Level 5
RESEARCH AS INQUIRY - DETERMINES THE NATURE AND EXTENT OF THE INFORMATION NEEDED					
Identifies and develops a research topic into a manageable focus	Student fails to develop a research question or topic. Does not seek assistance from librarian/professor to refine topic.	Student selects a topic that is too broad or narrow. Defines the scope of the research question or hypothesis too broadly or narrowly.	Student develops a research question that is somewhat focused and appropriate for the assignment.	Student develops a research question that is generally focused and relevant.	Student develops and clearly articulates a quality research question/hypothesis that is appropriately focused and relevant to the assignment.
SEARCHING AS STRATEGIC EXPLORATION - ACCESSES NEEDED INFORMATION EFFICIENTLY AND EFFECTIVELY					
Constructs and implements effectively designed search strategies using appropriate methods or information retrieval systems **Continued on next page...**	Student accesses information randomly, retrieves information that lacks relevance and quality.	Student identified only a few, broad key terms and uses minimal or same-type search sources and may not go beyond web searching.	Students demonstrates understanding of basic search concepts through development of simple search strategy and a list of useful keywords/search terms. Student lacks sophistication in selecting discipline-specific search engines.	Student demonstrates use of basic search concepts through development of simple search strategy and a list of useful keywords/subject search terms. Student selects appropriate indexes/search engines and articulates the way that Library databases work (e.g. fields, records, indexing).	Student demonstrates the ability to use appropriate indexes/search engines by using a mix of basic and advanced searching techniques, including discipline-specific subject headings, to access library collections and other relevant resources.

Student Learning Outcomes	Level 1	Level 2	Level 3	Level 4	Level 5
INFORMATION CREATION AS A PROCESS – DESCRIBE AND SELECT APPROPRIATE INFORMATION FORMATS					
Identifies and describes potential formats/creation processes that would be appropriate to their research topic, recognizing the difference between formal publication and information exchange.	Student fails to identify sources that are appropriate for the assignment. The research need is not met by the types of sources used.	Student identifies information sources that minimally meet the assignment requirements or reflect little relevance. Student is unable to distinguish between scholarly & non-scholarly sources	Student identifies information sources that are somewhat relevant or partially meet the research need. Student minimally articulates difference between scholarly & non-scholarly sources.	Student identifies a variety of scholarly & non-scholarly information sources that are generally appropriate and relevant for the assignment or research need. Student articulates the value of information each format would bring to their research.	Student identifies and selects a variety of scholarly & non-scholarly information sources that best answer the research need. Student clearly articulates the value of information each format would bring to their research.
AUTHORITY IS CONSTRUCTED & CONTEXTUAL - EVALUATE INFORMATION AND ITS SOURCES CRITICALLY					
Evaluates information and its sources critically for its value, relevance and accuracy.	Uses sources that may be dated or irrelevant, lacking authority or biased. Sources do not support the research need or thesis.	Uses sources that may be questionable as to credibility and reliability. Sources often do not show relevance or support to the research need or thesis. Has trouble recognizing authority in various media types	Uses sources that are generally credible, reliable, and lacking bias. Some sources may be of questionable significance to the research need or thesis. Shows awareness of how to identify authoritative content.	Applies evaluation criteria when selecting sources, and usually recognizes bias. Sources usually are relevant and significant to support the research need.	Applies evaluation criteria (timeliness, authority, relevance, accuracy, purpose) when selecting sources. Recognizes context and bias when present. Recognizes that authoritative content may be packaged formally or informally. Articulates distinctions when appropriate.
SCHOLARSHIP AS CONVERSATION					
Students will be able to (**Continued on next page...**)	Student is unable to articulate that there is a	Student acknowledges that there are different points of view on a topic but does not articulate that	Student articulates the need to incorporate different points of view	Student incorporates different points of	Student demonstrates the value of incorporating different

Student Learning Outcomes	Level 1	Level 2	Level 3	Level 4	Level 5
describe the scholarly communication process, including scholarly articles and monographs, as parts of an ongoing scholarly conversation in which a variety of perspectives may be represented and meaning must be negotiated.	sustained discourse within a community of scholars. Unable to articulate how new insights and discoveries occur over time as a result of this discourse.	there is a sustained discourse within a community of scholars. Has difficulty explaining how new insights and discoveries occur over time as a result of this discourse.	but marginally articulates that a given scholarly work may not represent the only - or even the majority - perspective on the issue	view and articulates that there is a sustained discourse within a community of scholars. Recognizes that a given scholarly work may not represent the only - or even the majority - perspective on the issue	points of view and articulates that there is a sustained discourse within a community of scholars. Clearly articulates that a given scholarly - or even the majority - perspective on the issue work may not represent the only perspective.
INFORMATION HAS VALUE – DEMONSTRATES KNOWLEDGE OF ECONOMIC, LEGAL, AND SOCIAL ISSUES SURROUNDING THE USE OF INFORMATION					
Acknowledges sources and use information following the conventions of a particular discipline **Continued on next page...**	May exhibit plagiarism. Does not cite sources, or lists sources in bibliography that are not used in paper.	May fail to attribute ideas and words to others. May show improper use of sources or lack or quotation marks.	Generally uses discipline appropriate citation style, but with errors. Some ambiguity in attribution about original thought.	Uses discipline appropriate citation style with minor errors in citation of sources. Usually shows proper attribution of ideas.	Student uses discipline appropriate citation style with no errors; Demonstrates consistent and appropriate use of paraphrasing and quotation of sources. Shows no ambiguity about original thought and the ideas of others.

Student Learning Outcomes	Level 1	Level 2	Level 3	Level 4	Level 5
Demonstrates an awareness of university policies regarding plagiarism, academic integrity and use of campus networks and information resources	Shows little or no awareness of plagiarism and university policies about use of networks and information.	May show an awareness of some aspects of plagiarism and usage policies of networks and information.	Demonstrates an awareness of plagiarism and university policies about networks and information.	Usually demonstrates an awareness of plagiarism and university networks and information. Demonstrates some of the disciplinary conventions regarding ethical use of information.	Consistently demonstrates awareness of the restrictions on the legal and ethical use of information and information resources. Applies ethical use of information to conventions of discipline.
DIGITAL LITERACY					
Effectively demonstrate the ability to use relevant technologies to manage and communicate information.	Student shows minimal skill and/or interest in using current technologies in the preparation of an information product.	Has difficulty attempting to use digital tools to organize information, construct new knowledge, create media expressions, and communicate with others.	Generally able to use digital tools to organize information, construct new knowledge, create media expressions, and communicate with others. .	Effective use of digital tools to organize information, construct new knowledge, create media expressions, and communicate with others..	Highly accomplished in the use of digital tools to organize information, construct new knowledge, create media expressions, and communicate with others.

Wilmington University Undergraduate Information Literacy Rubric 2017. Retrieved from: https://researchguides.ben.edu/c.php?g=494715&p=3385272