

Integrating Data Literacy into Information Literacy Programmes: Any Difference?

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ABSTRACT: *There is an urgent need to address data literacy in undergraduate library instruction. In Africa and especially in Nigeria, the need for a data information literacy program (DIL) to prepare students to engage in an electronic research environment is also articulated by scholars in recent literature. However, the question as to whether data literacy should replace information literacy has not been properly articulated in recent times in Africa even though it is acknowledged that the resultant effect of this data literacy is expected to precipitate the advent of the data revolution and the rise of digital technologies which are needed in today's information age. The question of the degree of the nature of the integration of data literacy into information literacy programs and how it could be taught synergistically and push data literacy strategically for the fourth industrial revolution is a major fulcrum of this study. This paper, therefore, involves a theoretical and systematic literature engagement with a focus on integrating data literacy into information literacy programs in academic libraries and in undergraduate library instruction and curriculum.*

KEYWORDS: data literacy, information literacy, fourth industrial revolution, library instruction, academic library

INTRODUCTION

Data is not a new concept, but, only recently has it been discussed outside of the Information Technology field because its role and significance are ever-increasing in every area ranging from governance of education by the virtue of digitalization. Data enables individuals and organizations to make more informed choices and is vital to the success of organizations around the world. The fact that data offer limitless opportunities to improve society, empower individuals and benefit many businesses according to Davies, Walker, Rubinstein & Perini (2019) is indubitable. The significance of data is being widely recognised such that various studies (Herzog, 2015; Harari, 2016b; Glass, 2018; Fernandez-Lasquetty, 2020; Guler, 2022) have considered data as the new oil of the 21st century. Data, like technology, is a way to know how actions are conducted, how things happen, or how change happens. However, data itself does not decide the direction of the change, but it requires an individual to be data literate in

order to actively decide which way such changes should be happening. This idea is referred to as data literacy, which empowers individuals with the competence to use data.

An apparent disclosure that emerged from the COVID-19 pandemic is an increased awareness of data and data literacy. Data literacy has become the new reality and the universal language of the 4th Industrial revolution that we all live in today. The Fourth Industrial Revolution is fast-paced and dynamic. The effect impact of the Fourth Industrial Revolution on education is extensive – both in terms of what universities can or should contribute to advancement and how programs and learning must change. According to Butler-Adam (2018), to succeed as a member of society, and as an employee, in the era of the Fourth Industrial Revolution, numeracy, literacy and an understanding of how the world operates are all essential.

Butler-Adam (2018) while emphasising the importance of data literacy for students in basic and applied sciences, humanities and social sciences stated that the implication has further requirements which entail that people must have the skills required to implement, manage and work with the new technology, and with one another. In addition, the World Economic Forum cited a daunting estimate while highlighting how quickly the current technical workforce needs to adapt to changing technologies that, roughly half of the area of subject knowledge a student learns in the first year of a four-year technical education will be obsolete by the time she graduates. As a result, flexibility to changing technologies is one of the most sought-after characteristics of an employee in today's technical workforce, according to *Forbes*. They emphasized that, with the unpredictability of technology, companies need to pivot quickly or perish, and so top talent needs to remain sharp and teachable. This implies that, in this era of transformation there is a requirement for libraries to shift away from teaching just information literacy and to ensure that regardless of undergraduates' course of study; they are prepared to be able to engage in an electronic research environment.

Data literacy does not just connote how to find and read charts; it is considered a crucial skill for 21st century citizens and it is a requirement for making data-based decisions. Data literacy empowers students to access, assess, manipulate, summarize and use data. This implies that providing graduates with a foundational knowledge of data literacy allows for those students entering the 21st-century workforce to apply diverse skills to a variety of situations. However, data literacy education in Nigeria is currently incoherent in the public, private and academic sectors, and data literacy training has not been systematically addressed in most institutions. This study aims to contribute to the advancement of data literacy in libraries by exploring a theoretical and systematic literature engagement with a focus on integrating data literacy into information literacy programs in academic libraries and in undergraduate library instruction and curriculum.

Concept of literacy, information literacy and data literacy

UNESCO (2022), defined literacy as the “ability to identify, understand, interpret, create, communicate and compute using printed and written materials associated with varying contexts. This is similar to the assertion of the American Library Association (ALA) that,

information literacy is a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information.

Koltay (2015) averred that the initial concept of data literacy grew from information literacy based on students' need to better utilize data in research projects. Data literacy is a broad concept and there are diverging definitions of data literacy prior to 2013 with all having slightly different meaning and sources of data literacy. Vanhoof, Verhaeghe, Verhaeghe, Valcke, and Van Petegem (2011) assumed data literacy was “the strategies, skills and knowledge needed to define information needs, and to locate, evaluate, synthesize, organize, present and/or communicate information as needed”. Though this definition covers relevant data-based skills but lacks any mention of action based on the data. Van Audenhove, Van den Broeck, & Mariën, (2020). Mandinach and Gummer, (2013, p. 30) opined that, data literacy is “composed of a specific skill set and knowledge base that enables educators to transform data into information and ultimately into actionable knowledge”.

Bhargava, Deahl, Letouzé, Noona, Sangokoya, & Shoup (2015) define data literacy as “the desire and ability to constructively engage in society through and about data”. While, this is a very high-level definition, it has the merit of pointing at two basic components of data literacy: using data and understanding data. This is in line with many definitions and competence models on media literacy (Van Audenhove, Vanwynsberghe, & Mariën, 2018). Ridsdale, Rothwell, Smit, Hossam, Bliemel, Irvine and Wuetherick (2015) define data literacy as the ability to collect, manage, evaluate and apply data in critical ways. The underlying assumption of many of these works is that fostering competences for using data will automatically and inevitably lead to understanding data.

Ronak Pansara (2021), explains challenges in implementing & consolidating master data management systems are examined. These challenges encompass model agility, data governance, data standards, and data integration. Model agility is crucial for accommodating changes in the master data model, while data governance ensures data integrity and reliability. Establishing consistent data standards across departments can be complex due to varying requirements. Effective data integration is vital to prevent errors and data loss during data transfer. Pansara's review underscores the complexity of implementing master data management systems due to these challenges.

For example, Mandinach and Gummer (2013) define data literacy as “knowing how to identify, collect, organize, analyze, summarize and prioritize data... how to develop hypotheses, identify problems, interpret the data, and determine, plan, implement, and monitor courses of action” (p. 30). Similarly, Athanases, Bennett, and Wahleithner (2013) define data literacy as the “capacity to conduct focused and purposeful collection and analysis of student work, reflections, and process data, in order to promote reflection on student learning and to guide and inform new understandings of practice” (p. 9). Many of the data literacy definitions pertaining to educators focus on the knowledge and skills needed by teachers rather than administrators. Mandinach, and Gummer (2013), however, state that administrative data literacy requires similar skills as teacher data literacy; but also includes planning for data use, establishing a vision for data use, and aligning learning goals with available data. These skills

are distinct from teacher data literacy in that they require integrating “educational leadership and management skills” (p. 32).

The definitions of data literacy presented above are quite expansive, encompassing not only skills for collecting and analyzing data commonly associated with assessment literacy, but also knowledge and skills necessary to know what data to collect and how to effectively proceed from data analysis to application.

The world has evolved to become data-driven and the concept of and need for data literacy is expressed (Hochschulforum Digitalisierung, 2018). Thus, information literacy empowers citizens to develop informed views that will enable them engage fully with the society. For this reason, data literacy is considered one of the most relevant and “essential survival skills for the 21st century” (Chinien & Boutin, 2011, p. 8). It entails competencies that strengthen individuals’ aptitude to process complex cognitive problems, including the ability to analyze, create abstractions, and propose effective solutions to said problems (Chinien & Boutin, 2011; Cowan, Alencar, & McGarry, 2014). Thus, data literacy basically will allow undergraduates to fully engage and tackle the new challenges, threats, and opportunities that will face them in the years to come.

From that perspective, information literacy and data literacy form part of a continuum. Hence, data literacy can be defined, as the component of information literacy that enables individuals to access, interpret, critically assess, manage, handle and ethically use data appropriately.

Theoretical Underpinnings

Data literacy has been mainly teacher focused and Mandinach *et al.* have become foundational literature on the topic of data literacy in education, as is demonstrated from the high number of citations they receive in the other data literacy articles. Gummer and Mandinach (2015) put forth a framework for data literacy for teachers that includes “three important domains: disciplinary content knowledge and practices, pedagogical content knowledge and practices, and data use for teaching knowledge and skills... [and] includes the components of the inquiry process” (p. 14). Lastly, Athanases, Bennett, and Wahleithner (2013) propose a framework of systematicity in teacher inquiry that informs data literacy. The model includes five levels. From the bottom up, these are a data collection event, analysis, information for use in teaching, synthesis and lastly, teacher knowledge, which “can develop from reflecting on rounds of collection and analysis” (p. 11). The authors state that data literacy for teaching is made up of these framework elements: data collection events, analysis, and using the information for teaching.

According to Hogenboom, Holler Phillips, & Hensley (2011; Hunt, 2004; Koltay, 2014), data literacy shares the same theoretical grounding as information and statistical literacies. Data literacy is related to several other types of literacy—information literacy, media literacy, quantitative literacy (or numeracy), and computational thinking—that have been widely discussed and researched. In order to better define data literacy’s theoretical approach and what it aims to accomplish, we can situate it among these other literacies and the disciplines from

which they are derived. Data literacy is at the intersection of information and media literacy, which represent two theoretical approaches to the notion of literacy (Koltay, 2014). Information literacy is a pre-Internet era concept that originated in Library and Information Sciences and aimed to prepare individuals to be productive citizens in an “information age.” Information literacy tends to put an emphasis on locating and determining the credibility of information; the concept of information literacy has been extended to apply to navigating information online. A digitally literate individual, then, would be someone who can search for sources, compare them, and assess their credibility.

Pushing Data Literacy for the fourth industrial revolution

The fourth industrial revolution which is referred to as Industry 4.0 is distinguished from the third revolution by velocity, breadth, depth and systems impact. This revolution is a fundamental shift in the way technology, communications, data, and analytics impact almost all aspects of society and the economy: businesses, governments and people. The fourth industrial revolution is rapidly transforming workplaces into workspaces. Unlike the previous industrial revolutions which used water and steam power to drive industry, the fourth industrial revolution signifies the impact on industry of ubiquitous computing, sensor technology and high-speed communications. It involves not only the exponential growth in computing power per unit cost but also the ability to gather large amounts of data. That needs to be processed in ways that can have both technically or economically impact on businesses.

Capone (2019) remarked that, never have we had access to the second-by-second creation of so much information. And just like smartphones accelerated expectations of access and convenience, the same is taking place in business. The scalability of the internet of things (IoT), AI in the data center, and software-embedded machine learning is creating large shifts in business data expectations and demands. Kumar (2020) also affirmed that, while data is becoming more influential than ever, the big problem is that most of us are not good at understanding and making sense of the data. This is where the workforce needs to enhance and improve their data literacy.

Previous studies have shown the need for data literacy to be pushed strategically for the fourth industrial revolution. Banister (2019) stated that, in the fourth revolution, data is the new language. Those individuals, who can understand, analyze and drive insights from data will be better positioned to succeed in (and outside) of the workplace. Capone (2019) noted there is a real need for data literacy both in the workforce and as a catalyst for business transformation and success. However, both individuals and companies that will succeed moving forward are ones with robust and evolving data skills. Kumar (2020) also remarked that, in order to survive the fourth industrial revolution, it is essential to understand the nature of the literate practice of modern work. Today’s workplaces must deliberate literacy texts and practices that reinforce the skills, knowledge and attributes required to empower the workforce that drives businesses in the modern data revolution.

With respect to capacity building, Crofts (2018) posited that, we are at a tipping point - we have come to a point in time where organisations, governments, educators and community

leaders must start to work together and pool resources if we are to truly understand and respond to this global imperative. We must become a data literate population if we are to participate and thrive in the new economy. Jewell (2020) opined that, data literacy should be therefore be treated as a crucial skill for pretty much everyone. That does not mean everyone needs to become a qualified data scientist, But for companies to successfully implement digital transformation initiatives, they must first focus on building a culture of data literacy within their company. Only by empowering data workers at all levels of the company, regardless of technical acumen, to become more data literate as well as improve their analytic knowledge will companies succeed.

Jewell (2020) averred that, the potential of industry 4.0 is huge – but revolutions do not take place in a vacuum. The key component to success-data literacy - comes from within, and companies will only realise that full potential if they foster data driven cultures fuelled by collaboration and diversity, presenting an opportunity for everyone to accelerate their careers by embracing analytic roles. Hence the need for data literacy which is the key to the fourth industrial revolution becomes inevitable.

Integrating Data Literacy in Libraries' Undergraduate Instruction and Curriculum

Data literacy instruction is still emerging in academic libraries. However, a few prominent initiatives have emerged in recent years documenting their data literacy programs and results. Prado and Marzal (2013) asserted that, while training to master some of the basic data literacy competencies has formed or is gradually becoming part of the curriculum in all levels of schooling, training delivered in libraries or with their support has focused primarily on higher education. Researchers affirmed that the major challenge to data literacy courses includes a full curriculum and have recommended integrating it into complementary subjects. Shorish (2015) recommends a generally useful class such as research methods, allowing for a fluid environment to apply skills. Several other authors recommend integrating data literacy into other literacy education, because of the overlap in competencies. The most popular match is data information literacy (Carlson, Fosmire, Miller, & Sapp Nelson, 2011; MacMillan, 2010; Bresnahan & Johnson, 2014; Schneider, 2013).

Carlson and Johnston (2015) posited that ‘developing an effective and successful curriculum starts with learning the needs of your constituencies to determine which learning goals and outcomes will most resonate with, and benefit, your students. He emphasised that, whether using a structured interview tool, such as the Data Information Literacy Interview Tool), or a tool developed in house, such as a quick survey sent to students to identify pain points and areas of interest, this feedback will help guide curriculum development.

The model by Prado and Marzal (2013) has been adopted in this study as a theoretical foundation. However, it is not the only approach to characterize data literacy or its competencies. The model adopted describes central aspects and areas of this field and gives insight into the competencies that shape data literacy. There are many different views and competencies currently being associated with data literacy. The question, then, is: when designing standard data literacy instruction, what competencies should be covered? Prado and

Marzal (2013) averred that, a common reference framework might be useful in order to promote library adoption on wide basis. Such a framework may be built on the commonalities found among the competencies so far presented as well as including any others that might be considered appropriate. The following framework is inspired by the general structure of information literacy standards and includes most of the aforementioned common competencies. Additionally, the framework translates competencies into instructional topics or units to facilitate interpretation and direct implementation.

The framework includes five modules: (1) Understanding data, (2) Finding and/or obtaining data, (3) Reading, interpreting and evaluating data, (4) Managing data, and (5) Using data. Below is a list of competencies and skills for each module.

1. Understanding data.

1.1. What is data?

Competency: learners need to know what is meant by data and be aware of the various possible types of data.

Contents: Data definition; Types of data (depending on origin, format, usage license and so on).

1.2. Data in society: a tool for knowledge and innovation.

Competency: learners need to be aware of the role of data in society, how they are generated and by whom, and their possible applications, as well as the implications of their use.

Contents: Data producers and consumers; Data lifecycle; Data applications: their impact on science and society; Copyright and licenses influencing data reuse.

2. Finding and/or obtaining data.

2.1. Data sources.

Competency: learners need to be aware of the possible data sources, be able to evaluate them and select the ones most relevant to an informational need or a given problem. *Contents:* Data sources; Criteria for assessing data sources.

2.2. Obtaining data.

Competency: learners need to be able to detect when a given problem or need cannot be (totally or partially) solved with the existing data and, as appropriate, undertake research to obtain new data.

Contents: Main research methods for obtaining original data.

3. Reading, interpreting and evaluating data.

3.1. Reading and interpreting data.

Competency: learners need to be aware of the various forms in which data can be presented (written, numerical or graphic), and their respective conventions, and be able to interpret them.

Contents: Ways to present and represent data.

3.2. Evaluating data.

Competency: learners need to be able to evaluate data critically

Content: Data evaluation criteria (including authorship, method of obtaining and analyzing data, comparability, inference and data summaries).

4. Managing data.

4.1. Data and metadata collection and management.

Competency: learners need to be aware of the need to save the data selected or generated and of descriptive or other data associated therewith, for due identification, management and subsequent reuse.

Content: Metadata; Reference management tools; Databases; Data management repositories: policies and practices.

5. Using data.

5.1. Data handling.

Competency: learners need to be able to prepare data for analysis, analyze them in keeping with the results sought and know how to use the necessary tools. *Contents:* Data conversion; Handling data analysis tools, both locally (Excel, R, SPSS, Stata or similar) and on-line.

5.2. Producing elements for data synthesis.

Competency: learners need to be able to synthesize and represent the results of data analysis in ways suited to the nature of the data, their purpose and the audience targeted in the inquiry.

Contents: Choosing suitable data representation methods (tables, graphs or similar); Handling tools (built into analytical tools or stand-alone applications such as Gap minder, Visually or IBM's Many Eyes).

5.3. Ethical use of data.

Competency: learners need to make ethical use of data, acknowledging the source when obtained or formulated by others, and making sure that used methods are deployed and results interpreted transparently and honestly.

Contents: What is the ethical use of data; How to cite data sources.

Prado and Marzal (2013) noted that, although the scheme aspires to be universal, covering the core of what would be potentially applicable to school, public or academic libraries, the key to its success will lie in the depth to or specificity with which it is developed, after adaptation to each library's particular needs. While in public and school libraries teaching will target the statistics appearing in the media, in universities the primary target will be the data from official sources or original research. Public and school library instruction on data management, for instance, may need to cover no more than basic spreadsheet and database use, while in universities training may include such complex topics as the formulation of data management plans for research projects.

How can data literacy and information literacy be taught synergistically?

Data literacy is a competency that is as essential as information literacy. Prado and Marzal (2013) affirmed that, the two are complementary and clearly form part of libraries' educational role in the furtherance of the significant use of information resources to generate knowledge and innovate. Its inclusion in libraries' instructional programs is therefore wholly justified.

Based on experience on teaching information literacy (Bättig, 2005) maintained that, the courses should be integrated in study programs where possible, the courses developed in collaboration with other universities, the teachers will be trained in teaching data literacy and the courses will be developed methodically and pedagogically thought out with the help of teacher educators.

Data literacy continues to be a growth opportunity for librarian engagement and influence on teaching and learning in higher education (Burrell, 2020). Previous studies (Carlson, Fosmire, & Nelson, 2011; Hogenboom, Phillips, & Henseley, 2011) have shown that librarians are increasingly involved with a wide range of data related initiatives, including campus-wide assessments to determine needs for data-related instruction. According to Maybee & Zilinski, (2015) and Prado & Marzal (2013), new frameworks have built on established information literacy frameworks to develop and teach data-related competencies, some of which are meant primarily for graduate education (Carlson & Johnston, 2015; Prado & Marzal, 2013), while others are beginning to focus on undergraduate students (Shorish, 2015).

While it is clear that librarians have potential skills and abilities to teach information literacy, there are a number of challenges. Although many research intensive universities have added functional librarian positions that require specialized expertise in data-related services (e.g., Librarian Lisa Zilinski at Carnegie Mellon University, co-author of Maybee & Zilinski, 2015), 4-year and Master's level regional college and university libraries often do not have functional specialist librarian positions and instead rely on a strong team of liaison librarians to contribute in these areas (Mcburney & Kubas, 2019). At the ACRL 2019 conference, Dr. Sheila Corral led a roundtable discussion on "Repositioning Data Literacy as a Mission-Critical Competence," using Bhargava et al.'s visualization of data literacy as an interdisciplinary multi-literacy construct to argue that librarians should be engaging in this conversation (Corral, 2019).

Librarians have a roadmap for information literacy education in universities. By focusing on data literacy, it makes sense to expand the teaching of information literacy to include data literacy. Therefore, a core curriculum for the promotion of data literacy should be developed, implemented, and evaluated with a focus on knowledge about basic data skills, the application of data literacy, the responsible handling of data and data management as well as ethical aspects and critical thinking regarding the use and interpretation of data. Educational concepts may vary according to the students' prior knowledge and the educational needs of the university concerned. Carlson (2015) affirmed that digital information literacy (DIL) is a logical outgrowth of information literacy and therefore expanding the scope of information literacy to include data management and curation is a logical extension of information literacy concepts.

CONCLUSION AND RECOMMENDATION

Data literacy is as essential as information literacy and the two are complementary in the furtherance of the significant use of information resources to generate knowledge and innovate. The resultant effect is expected to reinforce the skills, knowledge, and attributes

required to empower the workforce that drives businesses in the modern data revolution. Therefore, the integration of data information literacy in undergraduate library instruction and curriculum is entirely appropriate.

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