

Case Studies as a Pedagogical Approach in Responsible Data Literacy: A Conceptual Exploration

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ABSTRACT

Given the increased usage of data-driven systems, being data literate calls for a combined understanding of computational foundations and the critical considerations associated with the contextual implications of deploying such systems. Drawing inspiration from Freirean principles aligned with situational awareness theory, this article highlights how case studies can be developed and used as pedagogical tools for the multidimensional competencies (intertwining critical and computational thinking) needed for the future data worker to responsibly engage with the different facets of data analysis and usage, including data acquisition, data exploration, computational modeling and data storytelling. Essential facets of case studies involving narrative formation, mechanisms for arousing critical thought and student engagement strategies are discussed in conjunction with the combined theoretical frame. The article concludes with considerations to boost educator preparedness and instructional design by envisioning resources and enabling the creation of communities of practice around using case studies in data literacy.

ALISE RESEARCH TAXONOMY TOPICS

Education; Curriculum; Information literacy; Big Data.

AUTHOR KEYWORDS

Data literacy; Critical thinking; Competencies; Case study; Learner engagement.

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Introduction

Given data science's widespread use and application in today's interconnected global economy, core data literacy skills are increasingly essential in varied contextual arenas, including business, policy, healthcare, and education (Kullenberg, 2012; Dichev & Dicheva, 2017; Mennicken & Espeland, 2019). Visions of the future are rife with increased automation, machines working at par with humans, and technology being a key driver and enabler of everyday routines (Batty et al., 2012). In parallel, it is also essential to consider the critical proposition that data-driven automated tools can exacerbate inequities, harm and prejudice if not used and deployed responsibly (Mikalef et al., 2022). In the context of the LIS workforce, having the knowledge and ability to collect, analyze, and communicate inferences from data is crucial (Koltay, 2017). Aligned with the critical viewpoints, it is important to develop curriculum and learning approaches that instill reflective thinking to assess the alignment of computational approaches based on data with societal considerations to inculcate a responsible mindset and vision among future data and knowledge workers (Long & Magerko, 2020). Thus, it is vital to train the future workforce to have the skills and to develop a mindset to operate with all facets of data-driven ecosystems (Demchenko et al., 2023). Toward this aim, this article situates and conceptualizes pedagogical routines that can aid the visions of responsible AI literacy; the goal is to inculcate critical and reflective analysis of the societal implications of data-driven systems.

Akin to the vision of responsible AI literacy, it is essential to prepare learners and future data workers to emerge as multidimensional thinkers who are well-versed in designing analytical pipelines while having the ability to bridge and connect the social and technical domains. Emergent in such discussions is the need to see data literacy as a compound competence, not focused solely on technical skills, application skills and contextual knowledge, but a blend of multiple avenues of thought and practice (Pedersen & Caviglia, 2019). Such a compound and networked skillset calls for the vision of thinking across the full data lifecycle, from the source to the final inferences and narratives drawn from data (Dichev & Dicheva, 2017). However, a vital question that emerges is how such compound competencies can be taught in the classroom so that they promote a holistic thinking vision, enabling learners to visualize the full lifecycle of data-driven products, starting with the technical aspects of the contextual implications and the explicit/implicit connections between the two streams of thinking. Learning approaches are needed to integrate and connect computational and critical thinking pathways in a manner that engages the learner and helps them to grasp the different dimensions of reasoning skills needed cognitively (Pedersen & Caviglia, 2019). The goal of such learning pathways will be to enable learners to understand and address the *how, when and why* using computational skills aligned with contextual stimulus. For example, if tasked with understanding how and why a machine learning algorithm is applied in a specific medical diagnosis setup, learners should not only be able to articulate the computational premise of collecting and analyzing data pertinent to this vision but also develop the intuition to understand the limitations of such approaches, for example, the risks associated and the need for human intervention to check the validity of the results produced by the computational protocol. Hence, the key aim is for learners to connect computational concepts associated with data-driven systems with the nuances of human experience that these systems may fail to recognize.

Towards this aim, in this article, we discuss how *case studies* can be used as a learning method to connect and situate multidimensional, cross-disciplinary intuition and reasoning skills. Drawing on situational awareness theory, this article will discuss how case studies can be conceptualized and used in data literacy and align pedagogical visions in the LIS curriculum towards the goal of augmenting critical thinking pathways with computational thinking. Situational awareness has three main tenets: (1) Understanding dimensions of environmental variables, (2) Understanding the implications of the variables identified in the situation or context of the application, and (3) Future projection to understand the long-term impact of the incident. The goal of drawing on situational awareness theory stems from prior research highlighting how the three wheels of situational awareness theory can help articulate safety consciousness, which can be crucial in high-risk situations such as healthcare and clinical practice (Walshe et al., 2019). Further, using case studies following a theoretically guided framework rooted in situational awareness theory can be helpful in developing innovative pathways to infuse experiential learning pathways into the data literacy vision. Complementing the situational awareness perspective in articulating case studies as learning devices, Freirean philosophical visions of critical pedagogy can also help to provide avenues to infuse reflexive thinking through the case study-based paradigms beyond the standardized norms of scientific tradition and training (Santos, 2009). Since case studies are malleable in their contextual standpoints and narratives, sociopolitical considerations and implications associated with critical and responsible usage of data-driven products can be infused into data literacy pathways, offering novel, humanistic, interdisciplinary visions to interweave with scientific methods and practices (Tygel & Kirsch, 2016). Motivated by these synergistic viewpoints and approaches, this article explores the implications of employing case studies as a learning approach in data literacy. Particularly, the key questions explored are:

- 1) Using situational awareness theory and Freirean philosophy, how can case studies be used as a pedagogical tool in data literacy?
- 2) How can computational thinking and critical thinking pathways be aligned in case studies toward developing compound competency in data literacy?
- 3) What associated scaffolds and support mechanisms might facilitate using case studies as part of the pedagogical apparatus for data literacy?

Theoretical framing of case study as a pedagogical method: Combining Freirean philosophy with situational awareness

This section positions how we can frame case studies from a combined understanding of Freirean philosophy and situational awareness theory to highlight how these two strands of thinking align and enrich the application of case studies as literacy devices for responsible AI education. First, we will briefly overview these two frames and then articulate their combined application to framing case studies from a pedagogical standpoint. Freirean philosophy provides a pedagogical ‘wrapper’ to situational awareness theory, highlighting how experiences and

contextual implications can be situated and aligned with learning visions and outcomes. Freirean philosophy champions the cause for human experience and signifies its importance within literacy frameworks and approaches to addressing disparities in society, calling for heightened awareness and consciousness through pedagogical approaches (Glass, 2001). Thus, it questions the status quo and the objectivity of the different frames of reference we use for drawing on experience and communicating experience, allowing flexibility and agency associated with empowering the learner to immerse in creative, critical and reflexive ideation (Saleh, 2023). Thus, drawing on Freirean philosophy provides a basis for establishing case studies as literacy mechanisms to elicit deliberative and innovative critical thinking akin to the vision of responsible AI literacy.

An important facet of Freirean pedagogy is its positioning of learners in the social fabric of the classroom, more from the standpoint of active, thinking entities engaged in dialogic, problem-posing interaction rather than passive consumers of a set standardized practice and regime (Shor, 2002). This ideas of ‘problematizing’ and ‘dialogue construction’ are the key viewpoints that drive how case studies can be positioned and developed to connect computational and critical thinking. It allows for opening the space of provocative thought and expression, allowing students to question norms implicitly and explicitly embedded in data-driven systems. Such viewpoints can be essential for the narrative framing of case studies and the critical dimensions of thinking they aim to instill among learners. For example, suppose a case study is formulated around the use of algorithmic routines for recommending digital content. The case study method can be used to understand the technical infrastructure, critique its limitations, and analyze solutions to mitigate the drawbacks of such systems. Further, motivated by Freirean philosophy, additional deliberative content can seek to explore the power structures embedded in these systems. Such reflexive practice can be crucial to disrupting existing ideologies, potentially driven by socio-political agendas that drive a specific economic outcome, thus, in a way, liberating learners to gain a holistic and empowered understanding of data-driven systems, their implications and the necessary mechanisms to develop collective vigilance of the use of such systems (Tygel & Kirsch, 2016). Such ideologies can be vital to set the stage for critical action as a pedagogical approach. Particularly, they can help to ‘systematize’ critical thinking skills within data literacy. Learners can strengthen their voice and critical vision through repeated practice and engagement in such problem-posing, dialogue-driven techniques (Beckett, 2013).

While Freirean philosophy can be an important envelope for situating case studies as pedagogical tools, particularly to facilitate the mindset and dynamic within the educational context, situational awareness provides a theoretical foundation for *how* case studies should problematize existing knowledge associated with the technical foundations of data-driven systems. The three tenets of situational awareness theory can be critical for identifying the technical foundations of a data-driven system, recognizing the strengths and limitations of such tools and gaining a deeper understanding of the implications of such tools based on the projection of these technical foundations in a larger timeframe (Parush et al., 2011). In many ways, situational awareness can be seen as the outcome of drawing on Freirean principles to outline how case studies are developed and harnessed within learning contexts to stimulate critical and deliberate discussion. For example, situational awareness has been shown to be vital

to aid training initiatives aimed at heightening recognition of errors and the implications of errors in clinical settings (for example, surgical procedures) (Graafland et al., 2015). Similarly, drawing on situational awareness can provide a framework for the questions that case studies allude to for arousing critical consciousness among learners. For example, drawing the example of algorithmic content recommendation engines used in digital forums, situational awareness theory can inform questions about the type of data used to create these systems (akin to the 1st tenet of situational awareness), the algorithmic constructs (type of model used to combine and process the data) (aligned with the 2nd tenet of situational awareness theory) and the interactive and user-facing elements (such as visualizations) of how the insights from the data-driven systems are communicated to understand implications (aligned with the 3rd facet of situational awareness). Thus, situational awareness theory can help augment implementational viewpoints aligned with the philosophical ‘envelope’ of Freirean principles, which can be helpful in articulating how case studies are formulated and the learning outcomes they serve.

Aligned with the goal of the Freirean philosophy to empower agentic participation and engagement, case studies can also capture ‘solutions’ or how users can be given greater agency and control of user participation. This can also align with situational awareness theory's 2nd and 3rd tenets to inform future goals of how data-driven systems will be conceptualized, developed and deployed. For example, in the case of recommendation systems used in digital contexts, this blended theoretical perspective can help to raise awareness of issues such as user agency and privacy, allowing learners to understand the importance of the human experience associated with these data-powered systems. Further, case studies can also draw on synergistic approaches to cultivate creative ideation among learners to innovate on how users can participate in such systems and how they should be informed about the system particulars to understand their situatedness within data-driven interventions better (Cheney-Lippold, 2017). For example, in the case of recommendation systems, learners can ideate on presentation and interaction design elements that can empower all users by infusing design thinking and solution-based action, complementing Freirean principles (Noel, 2022). Again, such frames and visions for using theoretically grounded case study-based approaches as pedagogical tools can help to create pathways to nurturing compound competencies among learners and boost awareness of multiple implications associated with data-driven thinking and practice.

Conclusion: Practical considerations for scaffolding case studies as a pedagogical mechanism and future work

Case studies are creative and constructive and, in many ways, propel creative thinking and critical action among learners and educators alike. To boost case study usage in pedagogical visions, it is important to understand the need for teacher training, signaling a paradigmatic shift from traditional technical education to innovative interdisciplinary visions to help teachers develop novel and creative pathways to engage and design case studies that blend computational skills and critical foresight. Associated with that, conversational mechanisms that enable the development of communities of practice (such as online forums) can also be powerful avenues for collective perspectives on how educators can use and implement case studies for varied

learning outcomes and how this impacts the structure and operations of the learning ecosystem in alignment with the needs of the future workforce. Repositories or resources can be pivotal for the ideation and use of case studies, digital archives, and other mechanisms to store and aid in constructing case study narratives and practices that can augment teacher training visions, learning goals and strategies. Finally, learner perspectives and engagement to make the use and incorporation of case studies as pedagogical mechanisms for blending computational and critical thinking. Future work can further expand on the conceptual dimensions discussed in this article, and empirical investigations can add nuance to the practical considerations and implications discussed in this section.

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