

Towards categorizing ethical questions in data literacy Results of a focus groups study at the NFDI4Ing conference 2022

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Abstract. Data Literacy is crucial for a sustainable engineering education. In aiming to find solutions to solve future challenges, mechanical engineering has started to integrate data literacy into the higher education curriculum. However, in current frameworks ethics are seen as a side topic or are equated to data privacy issues. Since literacy aims to empower people to make informed decisions based on their or other data, the development of critical reflection and discussion on ethics is central for data literacy. Those frameworks who do address ethics often remain general in their examples. In our contribution, we aim to add ethical questions that data scientist face in their work with data. Therefore, we will first summarize current existing data literacy frameworks and their ethics concept. Then, through a focus group study among data literacy experts' we collect ethical and categorized questions. The study was conducted with 15 experts at the NFDI4Ing Conference 2022. This approach expands examples in ethics for data literacy beyond data privacy towards applied, current and pressing ethical questions.

1 Introduction

2 Describing a 'set of abilities around the use of data as part of everyday thinking and reasoning for
3 solving real-world problems' [1], data literacy is key for an increasingly digital and data driven
4 society [2]. Along with the ability to solve real-world problems with the use of data, the critical
5 reflection with data is becoming increasingly important [3]. Moreover, there are many risks of
6 incorrect assumptions based on data that might lead to incorrect knowledge and decisions. This
7 then might further fuels biases in societies. There is a responsibility for those communicating
8 through data to inadvertently reduce biases [1].

9 Ethics is a moral philosophy that aims to systematize, defend, and recommend concepts of right
10 and wrong behavior and action [4] [5]. This often results in extensive discussions of complex,
11 interdisciplinary and ambiguous questions – especially in an increasing dynamic and complex
12 global society. To become agent in their decision making, ethical guidelines based on democratic
13 values had been introduced in different literacies such as media literacy [6] and AI literacy [7].
14 As the relevance of data increased along with the difficulty for human beings to comprehend the
15 influence on our knowledge and decision-making, ethics need to be further considered in the

16 data literacy frameworks.

17 Ethical considerations should not be understood as a side subject to be taught with many others,
18 Ethical questions in data literacy are a core element and basis for all subsequent decision making.
19 Especially competencies that consider critical thinking and enabling agency are barely mentioned
20 in current data literacy frameworks. As the relevance of data increased along with the difficulty
21 for human beings to comprehend and process, the influence to our knowledge culture should be
22 further considered in the frameworks.

23 While there are already concepts on teaching ethics in data literacy [8]. However, when training
24 ethics in data literacy those examples are less from actual daily work but from social media
25 interaction [9]. To prepare future workforce for ethical decision making through data, the
26 examples given should be realistic and actual examples that professionals working with data
27 experience.

28 Indeed, many literacy discussions consider ethical discussions as important for supporting
29 empowered citizens [10] [6] [9]. Still, when applying ethics in the curricular topics of data
30 literacy, they are often pushed to the side in favor of more applicable topics such as data
31 visualisation, data analytic or data tasting. The objective of this contribution is to invite data
32 scientist and mechanical engineers to reflect on ethical question in their work with data and
33 collect those questions into actual ethical question that arise in daily business. The research
34 question is therefore:

- 35 • What ethical questions are present with data experts and should therefore be addressed
36 and considered as examples, when applying data literacy frameworks?

37 The first part of this contribution will highlight ethics concepts in existing data literacy frame-
38 works. The following part will introduce a focus group study as a explorative method to collect
39 ethical issues in the interaction with data. The focus group study took place among data literacy
40 experts at the NFDI4Ing conference in November 2022. The different ethical questions are
41 summarized to identify key ethical categories that should to be included in ethics discussions
42 on data literacy. Finally, the conclusion will open further potential research questions in data
43 literacy and give examples for addressing ethical questions in daily practice with data.

44 **2 The role of ethics in data literacy frameworks**

45 Contrary to its importance in decision making, ethics remain a minor course within data literacy.
46 They rarely play the central role that is required. Most of the current frameworks that do consider
47 data ethics as important then lack concrete applicable topics in their curricula. They rarely
48 are concrete and give hints to educators on how exactly they can apply ethics in data literacy
49 programs.

50 For example, Heidrich et al. introduce ethics as a side competency in their framework [11].
51 In the study from Wolff et al., they identify through card sorting that professionals see ethical
52 competence as highly relevant within data literacy, but do not give further examples on what
53 asked professionals understand by this [1]. Card sorting is a user research technique used to help
54 evaluate the information by having participants organize topics into categories that make sense
55 to them. In Grillenberges and Romeikes approach to create a data literacy Competency Model
56 based of Risdale et al., they introduce their competencies along the data management cycle and

57 divide them into process and content-oriented competencies [12]. They introduce a layer called
58 ethics, but do not connect it visibly with the introduced competencies or exemplify it. Schüller
59 et al. introduce a comprehensive data literacy framework considering both comprehensive and
60 selective competencies along a data value chain [10]. In their model ethics is pushed to the side
61 of the framework and is seen as a separate ethics literacy.

62 A general guideline with data processing can be understood in the FAIR principles that ...
63 (Source). The FAIR principles are findability, accessibility, interoperability, and reusability
64 (FAIR) [13]. **They were introduced by and function as However**

65 Closest to concrete examples in ethics is the research team around Giese. They introduce ethics
66 as part of the transparency and awareness pillar [9]. This pillar is one of three other pillars and
67 additionally includes a law and technical component. The ethical pillar in the concept of Giese
68 et al. was introduced through real-world examples and thinking and pairing exercises [9].

69 In their example, they introduce a case from twitter, which indicates the importance of (social)
70 media understanding, when it comes to ethics in data literacy. The example of Giese's application
71 of ethics reveals that ethics within data literacy is often connected to other literacy types. This
72 might be the reason why Schüller et al. frameworks introduce ethics as an additional literacy in
73 their concept.

74 Ethical considerations in data literacy should be seen as a core element for all subsequent decision
75 making. They should not merely be applied at some point in the process, but always remain in the
76 core of a data literacy concept. Regardless of the data processing step aside from the *how* there
77 should always also be the question of the *why*. As ethical questions require the consideration of
78 a wide range of stakeholders and other fields, therefore ethical questions are usually overlapping
79 with other literacy concepts.

80 **3 Method focus group study**

81 To answer the research question concerning the content of the ethic topics, a focus group study
82 with data literacy experts and professionals was conducted. Focus group studies are a qualitative
83 discourse method in which a group is stimulated to discuss a specific topic [14]. While the
84 researchers provide a specific focus, such as ethics in data processing, the data is collected
85 through the observation of a groups response through this topics. According to Kitzinger, this
86 method is used to generate and explore questions among a group and encourage the development
87 of their own analysis of common experiences [15]. While this method might not give a deep
88 insight into individual perspectives and experiences [14], it is well suited to identify norms and
89 values based on a common experience within a group [15].

90 Therefore, this method has been selected to gain a further understanding of ethical issues among
91 a group of data experts (see figure 1). Due to being a complex topic, ethical problems are a
92 helpful to identify shared experiences in the decision making process of data. Through the
93 discussion in groups, the individuals might find solutions or at least see that there are patterns to
94 their experienced dilemma. This is helpful for developing a collection of applied ethic topics
95 that go beyond the usual questions of data privacy.

96 The focus group study was conducted at the NFDI4Ing conference in October 2022 to a group of
97 15 participants with various background in mechanical engineering, information science and
98 software engineering. After defining ethics and their relation to data literacy, the starburst method

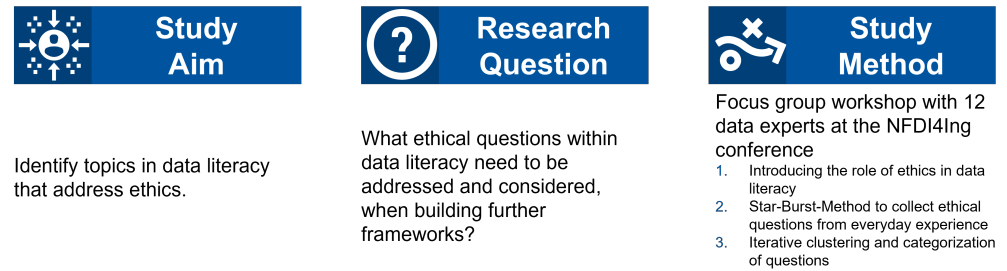


Figure 1: Overview on focus group study design

99 was introduced to collect ethical questions from the experts in smaller rotating groups.
 100 The star bursting method is a method in design thinking to collect questions in order to understand
 101 a problem from different perspectives [16]. In this method a star with six spikes represents six
 102 question words (how, who, why, what, when and where). The task for the participants is to
 103 reflect and fill the question words with ethical questions they have faced in their professional
 104 work with data.
 105 The group was divided into two groups and asked to collect and discuss ethical question based
 106 on the six question words. The idea behind the ethical questions was not focused on finding
 107 solutions at this point, as it is the nature of such questions to not be easily answerable from the
 108 point of one domain. Rather, this collection was useful in understanding the spectrum of ethical
 109 questions and the contexts that need to be considered when working with data. These questions
 110 were subsequently anonymized and categorized and are presented in the following part.
 111 The categorization of the questions was conducted with an iterative open coding method following
 112 the grounded theory method. The grounded theory is a research method and approach towards data
 113 for generating theories of medium range [17]. While the application of grounded theory would
 114 have exceeded the analysis of the focus groups study, the iterative proceeding of summarizing,
 115 coding and categorizing to identify a core image was implemented [17].

116 3.1 Results of the focus group study - categorizing data ethics

117 Through this study around 20 ethical questions in data focused research were collected among the
 118 experts. While the explicit answering of these questions was not the aim of the study, the different
 119 considerations help to gain an understanding of ethical aspects that need to be considered when
 120 addressing ethical questions in data literacy.
 121 The ethical questions were summarized in the following six categories (See figure 2): the appli-
 122 cation of the FAIR Principles (4), Stakeholders (4), Role of Authorities (3), Data Representation
 123 (3), ethical problems and Examples (3), and a category consisting of questions that did not fit the
 124 other categories (2).
 125 The clustering of the categories in human oriented and process oriented describes whether the
 126 questions address data interaction processes or reflect context in which data is processes. Process
 127 oriented are ethical question that address the interactions with data along a data management
 128 process of gathering, analyzing, visualization and documentation. Human centered questions are
 129 addressing different stakeholders interacting with or through the results and decision-making
 130 through data.
 131 The FAIR principles are findability, accessibility, interoperability, and reusability (FAIR) [13].

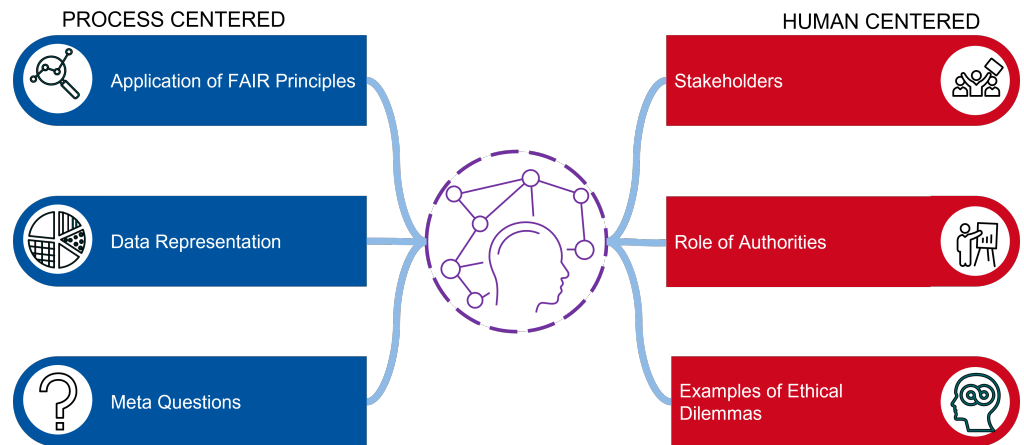


Figure 2: Overview on categorized results of focus groups study

132 An example question based on these principles was *'When should data transparency be given*
 133 *and when is it too much?'*. As transparency is an underlying theme and the central aim of the
 134 FAIR principles, this question addresses an important decision that people working with data are
 135 considered daily.

136 The Stakeholder category reflects different groups that are affected by data-based applications.
 137 The question pair reflecting this is *'Who might struggle with such ethical standards?'* and *'Who*
 138 *would mainly benefit from such ethical standards?'*. This category has an overlap with both the
 139 role of authorities and data representation categories.

140 The role of authorities has evolved around the power that states and companies hold. An example
 141 question here was, *'Where can I turn to with an ethical problem in data?'* in combination with
 142 *'Who could have the responsibility for deploying ethical standards in different application areas*
 143 *(e.g. research, practice)?'*. This is more of a meta-category describing the organization of ethics
 144 rather than their application, which is reflected more in the Stakeholder category. It might be a
 145 subcategory of the Stakeholder category but is presented here as a separate category due to the
 146 amount of questions that arise in the discussion.

147 Data Representation overlaps with Stakeholders and includes questions like *'What can we do*
 148 *against misinterpretation of data?'* and *'How can we show that data representation reflects the*
 149 *truth?'*. This category is strongly connected to practical guidelines in design and visualization.
 150 As the visualization of data is closely connected to visual and media literacy, those ideas might
 151 be found in overlapping areas of the other literacies.

152 The ethical problems and Examples category collected questions from concrete, applied exam-
 153 ples in daily life. An example question for the category is *'How can we detect bias in data?'*.
 154 The further collection of examples would be helpful for a concrete design of an educational
 155 curriculum, as this category tends to become more specific than the others. There were further
 156 ethical questions that were sorted into the remaining collected category, such as *'When should*
 157 *data literacy and ethical maturity be taught?'*, which is more oriented towards education, and
 158 *'How could Ethics impede data content generation?'* as further practical ethics questions. As
 159 this is a first attempt to address the variety of ethical questions in data management, further focus
 160 studies might develop further categories based on those questions.

161 Finally, in a reflection and feedback round of the study, the exchange gave new insights for
162 the group as well as for the data. The biggest downside addressed by the group was that this
163 exchange was too short and could have been extended further. Still, the collected categories
164 extend current ethics in data literacy with a collection of topics that professionals recently face.
165 For the design of educational frameworks this suggests that ethics in data literacy is both human
166 centered and process oriented. Ethics is present through the full data management cycle. Along
167 with the known FAIR Principles the perspective of different stakeholders and identification of
168 authorities in ethical problems are relevant to teach about data ethics. Also the question about
169 the limitations of representing and suggesting truths in your own data set are suitable reflecting
170 questions. Further applications of those results need to be tested further.

171 **4 Conclusion and outlook**

172 This paper aims to broaden the understanding of data literacy by including discussions and
173 critiques from media literacy into the development of a data literacy framework. This approach,
174 with a literature review on how ethics is applied in combination with a focus group study among
175 data literacy experts, can be seen as a first step towards developing ethical foundations in literacy
176 frameworks that go beyond data privacy discussions.

177 In order to address the research questions:

- 178 • What ethical questions are present with data experts and should therefore be addressed
179 and considered as examples, when applying data literacy frameworks?

180 First a literature study compared how different data literacy concepts applied ethics in their
181 frameworks. As a result, it became clear that ethics is often seen as important but is rarely
182 prominently applied. Additionally, it was concluded that applied reflection of ethical questions
183 needs to include multiple perspectives. Still, the shift of ethics into the center is required, as
184 ethical considerations are not limited to one scientific field.

185 To fill ethics in data literacy, a focus group study was conducted among data literacy experts
186 at the NFDI4Ing conference in October 2022. Through an online workshop around 20 ethical
187 questions were collected, categorized, and introduced (see figure 1). The main categories are the
188 Application of FAIR Principles, Stakeholders, Role of Authorities, Data Representation, ethical
189 problems and Examples (see figure 2). These questions give further insights into themes that
190 ethical programs in Data literacy apply and which are worth further examination.

191 As a next step, the scientific exchange between different literacy framework is highly recom-
192 mended. Some of the collected ethical questions overlap other scientific fields such as media or
193 sustainability literacy. Through further interdisciplinary exchange, data literacy will empower
194 professionals, students and educators to make informed data-based decisions. First steps in
195 this direction have already been achieved in February 2024 by an Ethics Working Group of the
196 ELSA-section in the NFDI [18]. They had been established to ensure that ethical considerations
197 are integrated into every aspect of research data practices and aim at addressing the complex
198 ethical issues associated with research data management.

199 5 Annex - Table

Category	Definition	Questions
Application of FAIR Principles	Questions that are related to the FAIR Principles in either pointing towards an answer or giving guidelines for those questions. The FAIR Principles are findability, accessibility, interoperability, and reusability (FAIR).	<ul style="list-style-type: none"> - How can I discern how long my research data must remain in the area of confidentiality until we have safeguarded the internal scientific process of gaining knowledge? - Where should data be stored? Is only EU really applicable? - When should data transparency be given and when is it too much? - Who would have the responsibility for the implementation of FAIR principles?
Data Representation	Data Representation describe questions that evolve around rules for visualizing and representing data without misleading implications.	<ul style="list-style-type: none"> - Why should ethical aspects influence data visibility? - What can we do against misinterpretation of data? - How can we visualize the truth (data visualization)?
Meta Questions	This category collects questions that are discussing the (teaching) methods behind ethics in data literacy.	<ul style="list-style-type: none"> - How could ethics impede data content generation? - How can we distinguish between ethical methods and ethical data content? - When should data literacy and ethical maturity be taught? - is this a topic that needs to be started in primary school and WHEN should the levels be deepened?

Examples of ethical problems	The ethical problems and Examples category collected questions from concrete, applied examples in daily life.	<ul style="list-style-type: none"> - How can we detect bias in data? - How have ethical considerations evolved over time and how do we address research subjects that are no longer up to date from an ethical point of view? - What are good examples for ethical questions in data literacy? - Where can I turn to with an ethical problem?
Stakeholders	The Stakeholder category reflects different groups that are affected by data-based applications.	<ul style="list-style-type: none"> Who would be mainly affected by such ethical standards? - Who might struggle with such ethical standards? - Who would mainly benefit from such ethical standards? - Who are the stakeholders and what requirements do they have?
Role of Authorities	The role of authorities evolves reflections on entities that give authority in ethical questions.	<ul style="list-style-type: none"> Who is the authority for ethical standards? - Where can I turn to with an ethical problem? - Who could have the responsibility for deploying ethical standards in different application areas (e.g. research, practice)?

Table 1: Table showing how questions are defined and categorized

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 204 professional life and the open exchange on eye-level.

205 7 Roles and contributions

206 **Samira Khodaei:** Conceptualization, Execution, Writing, Original Draft

207 **Anas Abdelrazeq:** Review & Editing

208 **Ingrid Isenhardt:** Review & Editing

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