Evaluating the Development Experience in Open Science Tools: A Case Study of the dataWASHES API

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Abstract. *Open science has gained prominence in Software Engineering research, yet Developer Experience (DX) in open science tools remains an underexplored topic. Recognizing this relevance, this study investigates developers' perceptions of DX when using dataWASHES, an open source API that facilitates access to WASHES proceedings data. A qualitative study was conducted with 13 participants performing scenario-based tasks using the API, followed by a questionnaire inspired by the SPACE framework. Results indicate a positive DX, with 84.6% of participants rating their experience at the highest level. While satisfaction and efficiency were strengths, minor usability issues suggest areas for improvement. Analyzing DX in tools like dataWASHES advances our understanding of the relationship between open science tools and DX, providing important lessons towards the engineering of open science solutions.*

1. Introduction

Open science has emerged as a relevant movement in the production and dissemination of scientific knowledge, promoting practices that prioritize transparency, accessibility, and collaboration [Peršić and Straza 2023]. One of the pillars enabling these practices is open infrastructure, which provides the technological foundation to make data, tools, and research outputs accessible and reusable [Sellanga 2023]. In the context of Software Engineering, initiatives that adopt open infrastructure have gained prominence, as they facilitate resource sharing, enhance the reproducibility of studies, and encourage new investigations. By embodying the values of open science, these initiatives create the conditions for scientific advancement and diffusion.

A recent example of an initiative that leverages open science principles and open infrastructure is dataWASHES[1], an Application Programming Interface (API) developed

[1]https://gesid.github.io/datawashes

to support access to publication data from the Workshop on Social, Human, and Economic Aspects of Software (WASHES) [Araújo et al. 2024]. The API aims to serve the academic community by facilitating systematic data consumption, improving efficiency in tasks such as secondary studies, literature reviews, and research trend analyses.

However, despite advancements in open infrastructure solutions, Developer Experience (DX) remains an underexplored topic in this context. In summary, DX refers to the factors that shape developers' interactions with tools, platforms, and development processes, such as documentation clarity and task efficiency [Fagerholm and Münch 2012]. Studies have shown that a positive DX can directly impact productivity, satisfaction, and work quality [Mikkonen 2016, Razzaq et al. 2024]. As clarified by Nylund (2020), although developers create software, they are also users of the tools that support their work.

The dataWASHES API presents a valuable opportunity to investigate how DX manifests in the usage of open science initiatives. From an academic standpoint, analyzing DX in tools like dataWASHES contributes to advancing our understanding of the relationship between open infrastructure and Software Engineering, enriching a still-developing research field. From a practical perspective, this research has the potential to inform recommendations for providing insights for developing other tools aligned with open science principles. Thus, the central research problem addressed in this study is the need to evaluate DX in the context of open infrastructure, using dataWASHES as a case study. This investigation is especially important as open science tools grow in relevance. Hence, understanding DX in this context ensures these tools are both functional and user-friendly in line with the broader principles of collaboration.

Given the motivation outlined above, this study aims to understand developers' perceptions of DX when using the dataWASHES API. To achieve this goal, we formulated the following research question: *What are developers' perceptions of the developer experience with the dataWASHES API?* To answer this research question, we conducted a study involving 13 participants who performed scenario-based tasks using the API. The data collection protocol included an analysis of the API documentation, task execution with think-aloud reflections, followed by the completion of a semi-structured questionnaire inspired by the SPACE framework proposed by Forsgren et al. (2021), which evaluates key dimensions for DX. Quantitative analysis was performed using descriptive statistics, while qualitative data were analyzed through open coding.

Academically, this study offers preliminary findings into DX in the context of open science tools, a notably underexplored research area. In particular, it illustrates how the SPACE framework can be applied to investigate DX in tools designed to support open science practices. From a practical perspective, the results offer reflections that contributes to the improvement of the dataWASHES API and, potentially, inspire enhancements in similar tools within comparable academic and research environments.

This paper is structured as follows: Section 2 discusses the theoretical background and related work. Section 3 details the methodological approach, including the evaluation protocol, participant selection, and tools used. Section 4 presents the study results. Section 5 provides a discussion of the findings in light of existing literature. Finally, Section 6 offers concluding remarks.

2. Background

Open science is transforming the way knowledge is created and shared [Peršić and Straza 2023]. At its core, this movement focuses on making research more open, transparent, and accessible to everyone [Persic et al. 2021]. This shift has been widely embraced by the Software Engineering community, as it fosters collaboration, enables the replication of studies, and facilitates the sharing of data, tools, and findings across the global research community [Mendez et al. 2020, Fernández et al. 2019]. As we previously introduced, a fundamental enabler of this movement is open infrastructure, which encompasses the technology that underpins these processes [UNESCO 2021]. With open infrastructure, data and research tools are accessible and designed for reuse. In other words, open infrastructure enables researchers to share resources, ensure reproducibility, and collaborate more efficiently [Kags 2023]. A practical example of this perspective is the dataWASHES, which provides an API to promote programmatic access to data from the WASHES proceedings [Araújo et al. 2024]. Such tools illustrates how open infrastructure can streamline research workflows and improve access to scientific knowledge. However, the effectiveness of these tools depends not only on their technical capabilities but also on the Developer Experience (DX) they offer.

While DX has been widely studied in traditional software development, its role in open science tools remains largely unexplored [Razzaq et al. 2024]. Originally derived from User Experience (UX), DX shifts the focus to developers as the primary users of software development tools [Nylund 2020]. Although developers create software, they are also users of the tools that support their work. As defined by Fagerholm and Münch (2012), DX encompasses how developers perceive, interact with, and find value in their tools and workflows. Therefore, a well-crafted DX promotes productivity, engagement, and efficiency, while a poor DX can lead to frustration, inefficiency, and even burnout [Greiler et al. 2022, Hicks 2024]. In fact, research consistently shows that well-designed, intuitive tools positively impact both developer productivity and the quality of their output [Mikkonen 2016, Forsgren et al. 2024].

More recently, Forsgren *et al.* (2021) introduced the SPACE framework, a comprehensive model that breaks DX down into key dimensions: satisfaction and well-being, performance, activity, communication and collaboration, and efficiency and flow. Consequently, by recognizing and measuring productivity through multiple lenses, teams and organizations can gain an better understanding of work dynamics and make more informed decisions [Forsgren et al. 2021]. Sikand *et al.* (2024), for example, approached the SPACE to assess GenAI-assisted development, identifying gaps in collaboration metrics and biases in productivity assessments. In turn, Ziegler *et al.* (2024) employed SPACE to measure GitHub Copilot's impact, linking tool usage with perceived productivity. In addition, Guenes *et al.* (2024) explored the Impostor Phenomenon in software engineers, revealing its negative effect across all SPACE dimensions.

The studies mentioned above highlight the effectiveness of the SPACE framework in addressing real-world DX challenges. However, research on DX in open science tools is still limited. This study aims to fill that gap by examining DX within an open science tool called dataWASHES. By analyzing developer interactions with its API, we seek to uncover insights into the tool's effectiveness, identify potential shortcomings, and improve its design and usability.

3. Methodological Procedures

This exploratory case study was conducted following the guidelines for case studies outlined by Runeson and Höst (2009), which highlight key elements such as the research phases: study design, preparation for data collection, data collection, data analysis, and reporting. These phases are described in Section 3.1, while Section 3.2 clarifies the context of the case study and the characterization of the participants.

3.1. Research Stages

First, the **study design** involved defining the research objective, which is to understand participants' perceptions of DX when using the dataWASHES API. The research question formulated was: "*What are developers' perceptions of the developer experience with the dataWASHES API?* ". The dataWASHES was selected as a case study because it aligns with open science principles and offers a realistic example for evaluating API exploration.

In the **data collection preparation** phase, a data collection protocol was developed, including the definition of participant profiles and the procedures to be followed. Participants were selected through convenience sampling, totaling 13 participants from a pool of 17 invitations sent via email or WhatsApp. Each invitation included the study objective, a form containing the Term of Free and Informed Consent, characterization questions such as demographic data and level of knowledge about APIs, and a field for indicating the preferred day and time for the study. Two inclusion criteria were established: having basic knowledge of how APIs work and having passed a course on Programming Fundamentals (or equivalent). Based on the participants' preferences, evaluation sessions were scheduled individually.

The **evidence collection** was conducted online and individually, structured around a hypothetical scenario of a literature review on software quality, focusing on the WASHES proceedings. In this context, participants used the dataWASHES API to complete three specific tasks involving the exploration of the API's main routes and supporting the review process. For example, the first task required participants to use the `/editions` route to retrieve data on the 2022 and 2023 editions of WASHES. However, before performing the tasks, participants reviewed the API documentation using the *Think-Aloud* method, which allowed them to verbally express their impressions of the clarity and organization of the presented information. This preliminary step aimed to capture initial difficulties and perceptions regarding the accessibility of the documentation.

After gaining an initial understanding of the documentation, participants completed the three proposed tasks, answering six structured questions at the end of each task, inspired by the SPACE framework [Forsgren et al. 2021], using a Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). The *satisfaction and well-being* component aimed to understand whether participants were satisfied (Q1) and whether they felt good and happy (Q2) after completing the tasks with the API. *Performance* was assessed based on the perceived simplicity (Q3) in executing the proposed tasks. The *adequacy of the documentation* (Q4) to support task completion was evaluated in terms of communication and collaboration. Finally, *efficiency and flow* were examined based on the perception of efficiency (Q5) and the ability to maintain a proper workflow (Q6) while using the API. At the end of the three tasks, participants evaluated the overall experience of using the API, indicating on a scale from 1 ("strongly disagree") to 5 ("strongly

agree") whether they considered the experience positive. There was also an open-ended question to collect additional feedback (positive points, suggestions, etc.). The collected data, as well as session recordings, were previously authorized by the participants. All instruments and primary data used in this research are available in the supporting repository for this paper [Souza et al. 2024].

The **data analysis** was conducted using a mixed-methods approach, combining quantitative and qualitative methods. Quantitative data, derived from the questionnaire responses, were analyzed using descriptive statistics such as means, standard deviations, and response distributions. Qualitative data, collected from the think-aloud reflections and open-ended questions, were analyzed using open coding. This process involved a detailed and iterative reading of the data to identify emerging categories, organize the reports into recurring themes, and establish connections between the reported perceptions. In this process, the initial coding was conducted by one author, and another co-author reviewed and refined the codes iteratively, resolving discrepancies through discussion. Given that the responses to the open-ended question were straightforward, no significant challenges were encountered during the qualitative analysis.

Finally, the **reporting** takes the form of the present paper, aiming to present the study's findings and conclusions. The goal is to provide a clear view of the obtained results, articulating the conclusions to highlight their implications. We analyzed the results for each task separately, followed by the overall experience.

3.2. Case Study Context and Participant Characterization

The study was conducted using dataWASHES[2], a public, open source, and academic API developed to facilitate programmatic access to data from the WASHES proceedings. The motivation for developing dataWASHES stems from the growing relevance of WASHES and, consequently, the need for more efficient access to event data. While the WASHES proceedings are accessible via the SBC OpenLib (SOL)[3], the manual data retrieval process limits the efficiency of secondary studies and comprehensive analyses that demand efficient data handling. From a technical perspective, the API defines three primary resources corresponding to distinct domain entities: `papers`, which includes endpoints for retrieving and managing information related to papers; `authors`, which provides endpoints to access details about authors and their associated papers; and `editions`, which offers endpoints to retrieve details about each edition and lists of published papers.

Regarding participant characterization, the sample consisted of 13 individuals aged between 20 and 38 years, with an average age of 28. All participants confirmed meeting the two eligibility prerequisite. In terms of education, eight participants were enrolled in undergraduate programs, one in Computer Science, six in Systems Analysis and Development, and one in Information Technology. Nine participants had completed a previous degree, with three in Computer Science and the others in diverse fields such as Law, Business Administration, Information Technology, Materials Engineering, and Logistics. Regarding professional experience, nine participants were employed in the software industry, holding roles such as software developer (7), quality analyst (1), and product owner (1). The remaining four participants were not currently employed. As for

[2]https://gesid.github.io/datawashes

[3]https://sol.sbc.org.br

self-assessed knowledge of APIs on a scale from 1 to 5, three participants (23.1%) rated themselves at level 3, seven participants (53.8%) at level 4, and three participants (23.1%) at level 5, indicating a generally solid understanding of APIs among the participants.

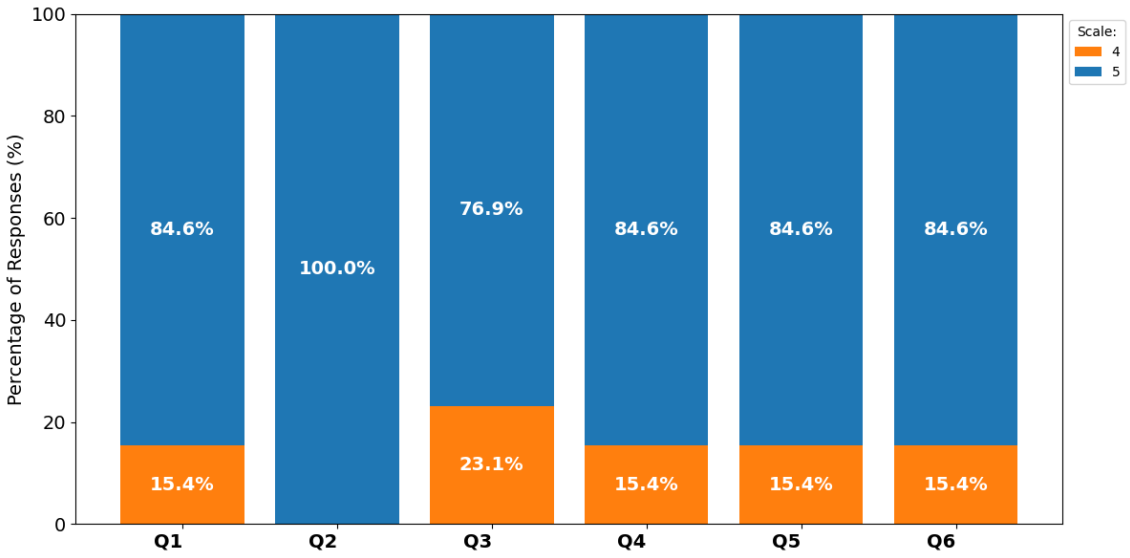
4. Results and Analysis

This section presents the results obtained in this study, encompassing the analysis of each of the three tasks explored in the investigated scenario and, finally, an overall assessment of the experience as a whole from the participants' perspective.

4.1. Task #1 Analysis (focusing on the /editions route)

Task #1 aimed to retrieve data on the 2022 and 2023 editions of WASHES using the `/editions` route. Participants were instructed to identify the edition IDs and then make requests to retrieve the papers from each edition. Figure 1 presents an overview of the results for Task #1.

Figure 1. Task #1 - Results.



At first glance, it is clear that no responses were recorded on scales 1, 2, or 3 for any of the questions. Specifically, regarding satisfaction (Q1), 84.6% of participants strongly agreed, while 15.4% partially agreed. For the sense of well-being and happiness (Q2), 100% of participants agreed with the statement, which represents a highly positive outcome. Concerning the perception that the task was simple to perform (Q3), 76.9% of participants strongly agreed, and 23.1% partially agreed. Regarding the adequacy of the documentation in supporting task execution (Q4), 84.6% strongly agreed, and 15.4% partially agreed. Similarly, for the feeling of efficiency while performing the task (Q5), the same percentages were observed: 84.6% strong agreement and 15.4% partial agreement. Finally, for the perception of maintaining a proper workflow while using the tool (Q6), the same distribution was recorded.

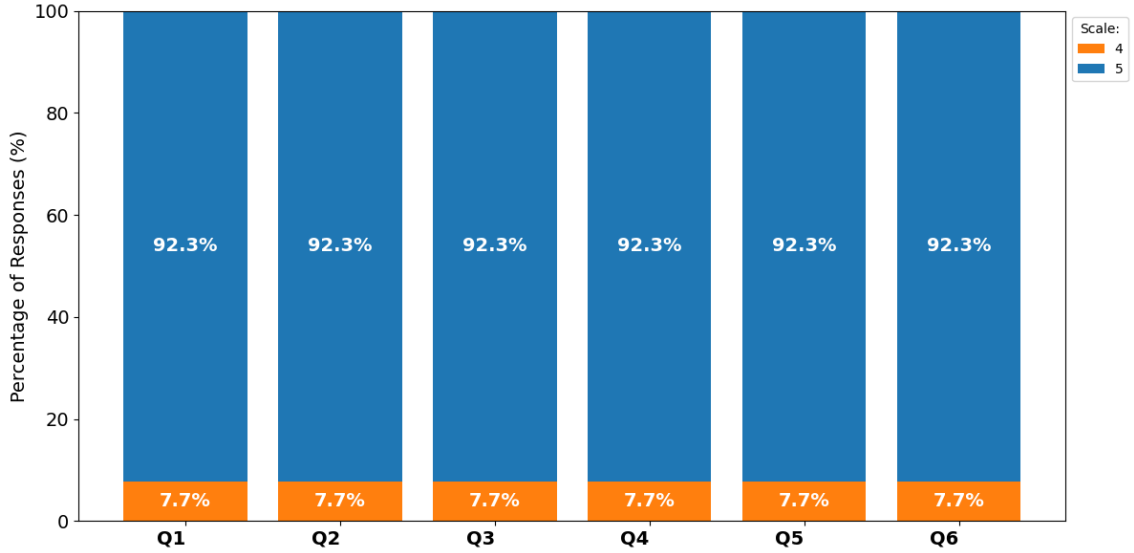
Questions Q1, Q4, Q5, and Q6 reported an average score of 4.85, while Q2 achieved the maximum average score of 5.0. Q3, on the other hand, had a slightly lower average of 4.77, indicating that although participants predominantly felt satisfied and

happy when using dataWASHES, the simplicity of task execution was perceived slightly less unanimously, though still rated very positively.

4.2. Task #2 Analysis (focusing on the /papers route)

In Task #2, participants were instructed to search for papers related to "qualidade" using the `/papers/by-title/search` route and to explore details about a specific paper using other routes. The results for Task #2 are summarized in Figure 3.

Figure 2. Task #2 - Results.



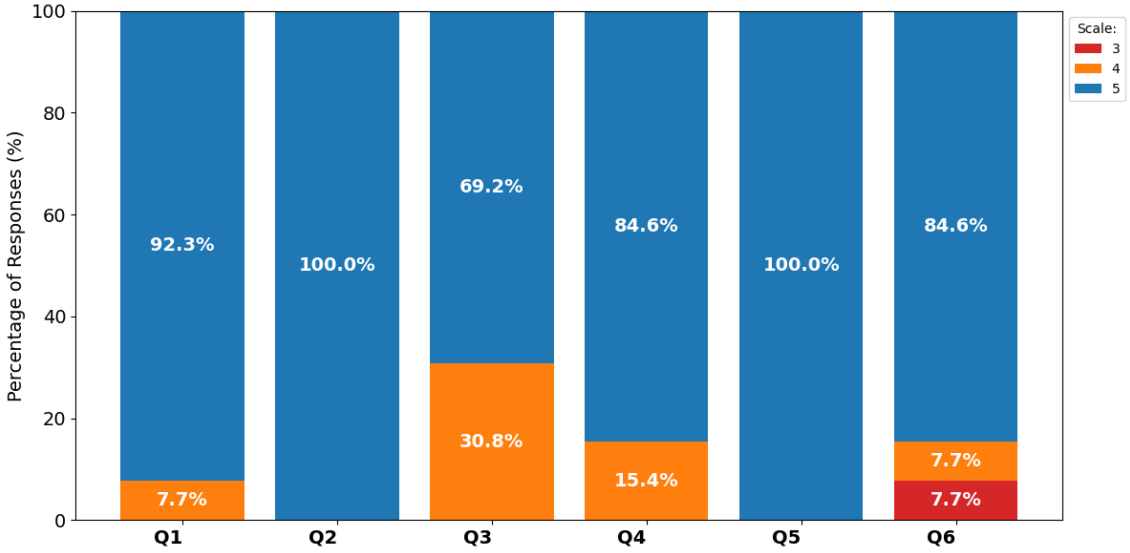
Similar to Task #1, no responses were recorded on scales 1, 2, or 3 for Task #2. However, quite notably, the results were consistent across all questionnaire items for Task #2. This finding indicates a high level of agreement among participants, as 92.3% rated the maximum score (5), indicating strong agreement, while 7.7% gave a score of 4. The average score was 4.92 across all responses, reinforcing a strong positive perception of the task performed.

4.3. Task #3 Analysis (focusing on the /authors route)

Task #3 involved searching for information about the author "Davi Viana" and retrieving related papers. The task focused on the `/authors` route, allowing participants to explore the academic output of the specified author. Figure 2 summarizes the results obtained for Task #3. As with the previous tasks, most responses for Task #3 were concentrated at the higher end of the scale. However, unlike the other tasks, one response rated a 3 on Q6, which pertains to the workflow.

Regarding satisfaction (Q1), 92.3% of participants strongly agreed, while 7.7% partially agreed. For the sense of well-being (Q2), 100% of participants strongly agreed, reflecting an overwhelmingly positive experience. In terms of task performance (Q3), 69.2% strongly agreed and 30.8% partially agreed. Regarding the documentation (Q4), 84.6% strongly agreed and 15.4% partially agreed. For task efficiency (Q5), all participants (100%) strongly agreed. Finally, for workflow (Q6), 84.6% strongly agreed, 7.7% partially agreed, and 7.7% were neutral.

Figure 3. Task #3 - Results.



Overall, the results once again reflect a highly positive evaluation across the assessed questions. Q1 and Q4 recorded an average score of 4.85, while Q2 and Q5 achieved the highest possible average of 5. Q3 had a slightly lower average of 4.69 compared to the others, indicating that while performance was positively rated, there is room for improvement. Similarly, Q6 had an average score of 4.77, which is close to the others.

4.4. Analysis of the experience as a whole

In the final section of the questionnaire, participants were invited to provide an overall evaluation of their experience as developers using dataWASHES on a scale from 1 to 5. The general perception of participants about their experience as developers using dataWASHES was overwhelmingly positive, with an average score of 4.77. Most participants (84.6%) gave the highest rating, while one person (7.7%) selected level 4, and another (7.7%) chose level 3.

An open-ended question gave participants the opportunity to provide further qualitative feedback. Participants highlighted positive aspects, including ease of use, the quality of the documentation, the tool's intuitiveness, and the availability of the documentation in English. According to P1, "*The API is well implemented and easy to use*". P3 appreciated, "*I really liked that the documentation was in English, each route was well documented with its purpose and specification*". P12 shared, "*I really liked the tool, I found it very useful in the context of its use in research by the academic community*".

On the other hand, some suggestions for improvement were made, including expanding the routes by default, removing ambiguous filters, offering documentation in Portuguese, providing an explanatory PDF, and clarifying the need to rerun the tool to update the file type. P2 noted, "*The only criticism is that you have to run it again to download the file in another format*". P5 suggested, "*Routes could be expanded by default to make route searching easier*". P6 added, "*It would be great to have a PDF containing more detailed descriptions of the endpoints and their parameters*".

5. Discussion

The obtained results reinforce that the dataWASHES API consistently provides a positive Developer Experience (DX), especially regarding satisfaction, well-being, and efficiency during task execution. These findings align with the literature on DX, which emphasizes that well-documented, intuitive, and efficient tools have a direct impact on developers' productivity [Mikkonen 2016, Razzaq et al. 2024]. However, as noted by Greiller *et al*. (2022), DX is influenced by many factors and moderated by contextual characteristics. This issue suggests that even developers within the same team can have different experiences, depending on individual roles, work environments, and task-specific demands.

Our study showed an unanimous evaluation regarding well-being and the high scores assigned to satisfaction, efficiency, and documentation indicate that dataWASHES meets user expectations. This perception is important in the context of open science initiatives, as it reinforces that the availability of accessible data and tools can be enhanced when the DX is considered. By providing a smooth workflow and an intuitive interface, the API aims to facilitate access to WASHES proceedings data and encourage the replication of studies and the development of new investigations, aligning with the principles of open science and open infrastructure [Mendez et al. 2020, Sellanga 2023].

Although most indicators were positively evaluated, some nuances also deserve proper attention. For example, in Task #1 and Task #3, the perception of simplicity and workflow had slightly lower averages compared to other dimensions. These results suggest that, despite the overall positive experience, small adjustments (such as improving clarity in task execution and removing ambiguous filters) could potentially enhance the quality of DX. Such improvements are particularly relevant considering the participants' qualitative feedback, which highlighted the need to expand default routes and provide additional documentation, including in Portuguese and PDF format.

In terms of academic contribution, this study explores the application of the SPACE framework [Forsgren et al. 2021] in an innovative context: open science tools. By focusing on DX in a tool designed for scientific data dissemination, the study contributes to an initial understanding of how open science can be evaluated from a developer-centered perspective. Thus, the findings presented here highlight the importance of good DX and also offer a reproducible methodological approach for evaluating DX of similar tools. From a practical standpoint, while the results are not generalizable, they offer early evidence that applying DX principles can enhance the usability and adoption of open infrastructure tools. Recommendations such as improving documentation clarity (including multilingual support), reducing workflow friction, and providing structured reference materials emerged directly from user feedback. Moreover, the mixed-method evaluation (combining scenario-based tasks, think-aloud protocols, and a SPACE-informed questionnaire) can serve as a practical model for assessing DX in similar contexts. Therefore, the findings of this study answer the research question: *What are developers' perceptions of the developer experience with the dataWASHES API?*

Answer to RQ: *The participants had an overwhelmingly positive experience with the dataWASHES API, with 84.6% rating it at the highest level. They highlighted the value of clear documentation and an intuitive workflow. However, minor improvements (such as removing ambiguous filters and expanding default routes) could further enhance DX.*

6. Final Remarks

Open science has emerged as a movement focused on enhancing transparency, accessibility, and knowledge sharing in academia. The effectiveness of open science tools depends on more than just their technical capabilities, it is also shaped by the Developer Experience (DX) they provide. Despite progress in open infrastructure solutions, DX remains an underexplored aspect in this domain.

In this regard, the dataWASHES API emerges as an example of an open science tool created by the community for the community. The goal of the API is to serve the community by facilitating the systematic consumption of data, enabling greater efficiency in tasks such as secondary studies, literature reviews, and research trend analyses. This study aimed to assess the DX when using this API, investigating the developers' perception of the experience. The research was conducted with 13 participants who completed practical tasks based on real-world literature review scenarios, allowing for the collection of dimensions covered by the SPACE framework.

The results indicated a broad positive reception, with high levels of agreement regarding satisfaction, well-being, and efficiency in task execution. The documentation was well-rated, although some participants suggested specific improvements to make it even more accessible and detailed. Additionally, opportunities were identified for refining the simplicity of task execution and workflow navigation. Overall, the study emphasizes the importance of considering DX in the development of tools for open science, highlighting aspects that can be optimized to enhance usability and adoption.

The validity of the study was rigorously addressed throughout all stages of the research process. Regarding internal validity, we acknowledge the potential for response and interpretation bias, as the data were based on the participants' perceptions. To mitigate this threat, we employed a triangulation of data collection methods (combining the Think-Aloud method, task execution, and semi-structured questionnaires), which allowed the integration of both quantitative and qualitative data. External validity is limited by the use of a non-probabilistic and relatively small sample (13 participants); however, this number is considered adequate in usability studies or with homogeneous groups, where classical studies suggest that 5-12 participants [Bevan et al. 2003, Guest et al. 2006]. Furthermore, the diversity of academic and professional profiles, along with well-defined eligibility criteria, contributes to the representativeness of the investigated context. Participants also demonstrated adequate API knowledge. Regarding construct validity, we adopted a structured protocol based on the widely used SPACE framework in DX studies to ensure the coherence of the instruments. Finally, validity of conclusions was reinforced by the convergence of quantitative and qualitative findings. All employed instruments and raw data are available in our supporting repository [Souza et al. 2024].

For future work, DX analysis could be expanded through studies with more diverse participants and additional data collection methods. Another direction involves testing suggested improvements (such as refining documentation and interface adjustments) to enhance usability and efficiency. Finally, integrating dataWASHES with other open science platforms and extending the API to new research communities could broaden its impact, requiring updates to the database and route configurations.

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