

Engagement in Open Data Workshops

The dark side of remote settings

Alessia Antelmi^[0000–0002–6366–0546]

Università di Torino, Torino, Italy
alessia.antelmi@unito.it

Abstract. The increasing availability of Open Data gives birth to a fertile field for interested stakeholders to create value out of them; however, limited technical expertise and poor awareness are crucial barriers to their exploitation. Because of these reasons, there is an urge for learners to acquire data and information literacy competencies, which are essential for 21st-century skills, and become familiar with available Open Data sources and their potential uses. To promote the dialogue around activities to boost recognition of Open Data and improve users' skills to work with them, we proposed a series of workshops to introduce Italian high school learners to searching for, authoring, and building effective communication based on Open Data. This article describes an ongoing activity and details its organization, reports preliminary results on learners' engagement, and discusses both challenges of the remote setting as well as promising learning outcomes.

Cite as: Antelmi, A. (2023). Engagement in Open Data Workshops. In: Kubincová, Z., Caruso, F., Kim, Te., Ivanova, M., Lancia, L., Pellegrino, M.A. (eds) Methodologies and Intelligent Systems for Technology Enhanced Learning, Workshops - 13th International Conference. MIS4TEL 2023. Lecture Notes in Networks and Systems, vol 769. Springer, Cham. https://doi.org/10.1007/978-3-031-42134-1_33

Keywords: Open Data · Data literacy · Workshops · K-12 learners

1 Introduction

Open Data (OD) are data that can be freely used, shared, and built on by anyone, anywhere, for any purpose - subject only to the requirement to attribute and share-alike [21]. The use of OD has the capacity to enhance transparency in government, promote citizen collaboration and engagement, and stimulate innovation [15]. Despite their importance, limited technical skills [30] and poor awareness hinder OD exploitation [19]; hence, training citizens becomes crucial to let them author and exploit OD effectively. In the current academic landscape, there is limited research on strategies to train users [13] as well as on understanding the underlying reasons why end-users are scarcely involved [30, 31]. Further, a few isolated efforts exist to verify which skills and tasks are required to deal with data [18, 32]. In addition, citizens usually play the role of OD

users without having the possibility to author data of interest and experience the challenges of the OD publication process [23].

To increase awareness of OD, improve users' skills to author and work with OD, and let K-12 learners develop data and information literacy, we propose a series of workshops introducing Italian high school learners to searching for, authoring, and building effective communication based on OD. The activities offered in the workshops were designed to be delivered in both in-person and remote settings, given that the involved school explicitly asked for remote and online lessons. This constraint imposed more challenges on the overall delivery process since the online environment required re-thinking collaborative interactions among peers, adjusting the activity protocol, and guaranteeing the presence and detailed guidance of experienced instructors to support novice learners also at a distance [16]. Moreover, engaging learners is potentially more challenging when activities are held at a distance [27]. This article describes an ongoing activity and details its protocol, reports preliminary quantitative results on learners' engagement, and discusses both challenges of the remote setting as well as some promising learning outcomes. In particular, an initial analysis of learners' engagement highlighted two major points. On one side, students were especially interested in taking part in anonymous questionnaires with respect to other tasks requiring more direct interaction. On the other side, it emphasized a generally low student engagement, probably due to remote setting-related issues.

The rest of the article is structured as follows. Section 2 reports related work; Section 3 overviews the protocol followed in the remote setting; Section 4 describes and discusses quantitative and qualitative observations collected during the workshops concerning participants' engagement; and Section 5 concludes with final remarks and suggestions for future OD workshops.

2 Related work

Over the past few years, an increasing number of researchers and educators have recognized the potentiality of using OD as an educational resource [24], especially for environmental education and data visualization. For instance, the INSPIRE4Youth project [8] aimed at encouraging higher grades of elementary schools, high schools, and universities to reuse Linked Open Data (LOD) and environmental data for educational and gaming purposes. Along the same lines, the GI-Learner project [22] targeted secondary schools with the goal of exploiting OD on the cloud to inform about protected areas in Spain. Similarly, the interactive art exhibition Erica the Rhino [3] aimed to raise awareness of rhino conservation by implicitly allowing children to consume and publish LOD through interacting with Erica. Kurada et al. [17], Windhager et al. [34], and De Donato et al. [11] focused on the second direction by discussing the role played by data visualization in letting learners make sense of complex data.

Interventions specifically designed to directly improve users' skills and knowledge related to OD are rare in the literature, and they mainly focus on OD exploitation [13]. Chen et al. [9], Dickinson et al. [12], and Vargianniti et al. [33]

gamified the learning of OD-related principles by proposing OD game-based workshops to engage learners. On the contrary, Wolff et al. [35] and Saddiqa et al. [29] let learners directly exploit OD to improve their awareness of the quality of the local environment and smart city development. Similarly, Saddiqa et al. [28] and Antelmi et al. [2] allowed learners to directly utilize OD, focusing on the importance and challenges of mastering OD visualizations. A survey and comparison of interventions to increase awareness of OD, enhance users' skills, and engage them in the use of OD can be found in Gasco et al. [13] and Pellegrino et al. [23].

Generally, OD-based workshops are organized in physical meetings, with rare examples of online activities mainly due to COVID-19. Vargianniti et al. [33] and Antelmi et al. [2] described two examples of remote workshops due to the global pandemic. In particular, Vargianniti et al. [33] proposed Geopoly, a physical and digital game similar to Monopoly that exploits OD to teach geography. This activity successfully kept learners engaged and motivated, which was especially difficult given that schools were closed and strict measures were enforced during the experiment. Antelmi et al. [2] focused on OD visualization, mixing theory classes and hands-on sessions. Despite promising learning and engagement outcomes, moderators observed participants' reluctance to switch on cameras and technological immaturity that hindered activities in remote settings.

In this paper, we describe a series of workshops about OD exploitation and authoring (in the same vein as the activities proposed by HETOR [1]) held in a remote setting according to the school requirements. In particular, this initiative inherited from the HETOR project a series of best practices about employing collaborative and experiential sessions to facilitate a collective exploration of OD-related subjects. At the same time, the workshops also aimed to enhance attendees' engagement by incorporating elements of anonymity into some activities. Drawing from a previous experience [2], the moderators were aware of students' hesitancy to switch on their cameras or microphones during virtual sessions. For this reason, they introduced an anonymous quiz as an interactive exercise to foster a sense of psychological safety and encourage students to participate without fear of judgment.

3 Open Data workshops

This section first delineates the research questions underlying our article, then discusses the protocol of the delivered activities, describes the details about the audience and the workshop setting, and finally delineates the data-gathering process to collect learners' engagement.

Research Questions. The research questions (RQs) we focused on in this article relate to understanding the engagement of OD authoring and exploitation workshops in a remote setting when it is not strictly required. Specifically, we are interested in quantitatively characterizing learners' engagement by exploring the following RQs:

- *RQ₁*: Which activity does engage attendees the most?
- *RQ₂*: Does the freedom perceived in a remote setting affect learners' engagement?

Protocol. Each activity cycle is formed by three workshops spanning three non-consecutive days and covering both authoring and exploitation tasks. Each workshop is two-hour long and includes an introductory phase and a hands-on session. Specifically, the moderators explain concepts, encourage participants to reply to questions and quick oral exercises, and clarify doubts in the introductory phase. During the hands-on session, participants work on the assigned task alone or in small groups of up to three members, assisted by the moderator when needed. The proposed protocol is based on the previous experience of the workshop moderators described in Antelmi et al. [2], where each workshop comprises theoretical and practical phases. On top of this organization, the protocol described in this article introduces themes such as data storytelling, whose engagement capabilities have been proven on several occasions [13, 23]. Details on the learning content of each workshop ($W_{\#}$ with $\#$ progressive number) follow.

- *W₁: OD portals and OD quality.* W_1 describes key concepts of OD, such as the need for a license, why creating OD, the actors involved in the creation and exploitation process in several application domains, and the problem of OD quality. It further introduces regional and national OD repositories, particularly focusing on the portal of the Campania region¹. In the hands-on session, scholars are expected to answer questions anonymously about the topics discussed using the Mentimeter web application².
- *W₂: Exploiting OD.* W_2 introduces how it is possible to exploit OD to create information and then knowledge by visualizing data and creating data stories via Google Sheets. In the hands-on phase, scholars are invited to co-create and discuss charts based on a portion of the 2017 World Happiness Report Data³. The expected outcome of this workshop is the creation of a meaningful chart complemented with a relevant title and brief description.
- *W₃: Authoring OD.* W_3 focuses on letting participants create OD collaboratively via Google Sheets based on three different topics related to cultural heritage, sports, and society proposed by the moderator. During the hands-on session, participants are organized into small groups of up to three members. Each group has to choose a topic and look for publicly available data related to it to populate a newly co-created dataset. The outcome of this workshop is the authored (portion of a) dataset stored as a data table.

Workshop Setting and Attendees. The workshops described in this article were organized by BIMED⁴, an Italian educational and cultural association,

¹ <https://dati.regione.campania.it/opendata>

² <https://www.mentimeter.com/>

³ <https://data.world/laurel/world-happiness-report-data>

⁴ <https://www.bimed.net>

upon request by an Italian high school based in Salerno. The school curated the learners’ recruitment process (from 16 to 19 years old), the overall activity duration, and the delivery setting (i.e., remote after-school activities via the Webex meeting tool). BIMED arranged the recruitment process of two moderators from the University of Salerno, which already had experience in other initiatives concerning OD exploitation [2]. The moderators proposed the lessons’ topics and structure, considering that the main objective of the activity was to let attendees familiarize themselves with concepts related to data literacy (e.g., data manipulation and chart creation) and tools used to exploit data (e.g., Excel and Google Sheets). A single moderator led each workshop. Meetings started in January 2023 and terminated in April of the same year for a total of three groups attending all three workshops. The number of attendees varied across learners’ groups, workshops, and activities, ranging from a few students (even 0) to a maximum of 15. Further details will be discussed in Section 4 to highlight the gap between the number of attendees and active participants as a measure of engagement.

Data gathering. For each event, the moderators collected observations concerning students’ engagement during and immediately after each workshop, tracking data in diaries. In this work, we report a quantitative analysis of the *(i)* number of attendees and the *(ii)* number of students answering the oral questions, *(iii)* joining the online and anonymous questionnaires, and *(iv)* (actively) participating in the hands-on sessions as a proxy for quantifying learners’ engagement. Specifically, moderators collected the number of attendees directly from the Webex application, reporting the maximum number of students connected to the online meeting, while they kept track of any oral or written (via the Webex chat) interventions through notes to report the number of spontaneous/stimulated comments and questions. The participation data related to the anonymous questionnaire and the hands-on activity was gathered after each workshop. In particular, the Mentimeter application keeps track of the number of users connected and submitted answers for each question. For the hands-on session, moderators collected the number of outputs the students shared, where each output represents the contribution made by a group of at least two participants.

It is worth clarifying that engagement is an ambiguous term, and it broadly relates to motivated participation and not just participation numbers. However, this work focused on identifying any discrepancy between the number of workshop attendees (intended as the number of learners connected to the online lesson) and the number of active participants (intended as learners who actively contributed to the workshops’ activities). Based on this consideration, future work will focus on characterizing engagement based on more advanced tools, such as post-workshop questionnaires [14] and the BROMP protocol [20].

4 Results and Discussion

In this section, we critically review workshops’ attendance and outputs. Table 1 reports the learners’ age range and participation details for each group. Specifi-

Table 1. Workshops’ details in numbers. The symbol - means not available.

Group	Age	Wrk	# attendees	Avg # of parts. (min, max) - questionnaire	# groups - hands-on session	# shared outputs	Prof.
I	18-19	W ₁	4	2 (1, 3)	-	-	
		W ₂	12	9 (8, 10)	2	1	
		W ₃	7	-	2	1	
II	14-15	W ₁	15	6 (1, 12)	-	-	
		W ₂	12	2 (1, 3)	1	1	✓
		W ₃	0	-	-	-	✓
III	14-16	W ₁	13	3 (1, 5)	-	-	✓
		W ₂	8	4 (3, 5)	3	3	✓
		W ₃	12	-	2	2	✓

cally, for each workshop, we list the maximum number of attendees⁵, the average number of participants to the anonymous questionnaires, the number of groups formed during the hands-on session, the number of shared outputs, and whether a professor was actively involved during the workshop. The numbers reported are an estimation of the real number of attendees and activity participants since students often said using a single device for more than two people.

RQ₁: Which activity does engage attendees the most? The three workshops were designed to let learners engage with OD-related topics through different activities. Specifically, W₁ only challenges students with anonymous questionnaires, W₂ adds exploitation tasks, while W₃ entirely focuses on authoring assignments. From the values listed in Table 1, the activity that registered the higher number of involved learners was answering questionnaires. Generally, the peak of participation was reached at the beginning of each new questionnaire session, whereas a drop in the participants’ number was observed throughout the activity. Overall, the groups formed by the students were quite heterogeneous in size (from a single student to 5 members), and only one person per group used to interact with the moderator to ask for clarification or present their work in both exploitation and exploitation authoring activities.

Possible explanations for this outcome could lay their foundations in two main reasons. First, regardless of their age, students often reported (to either their professor or the moderator) several technical problems, ranging from accessing Webex, turning on their microphone, or working on Google Sheets (e.g., importing, selecting, and visualizing data). Further, learners were required to simultaneously deal with different software applications, such as WebEx, Mentimeter, and Google Sheets. The second cause could be sought in the inherent nature of the activities proposed. In particular, the anonymity characteristic of the questionnaires allowed students to either not feel exposed or pressured to answer accurately. This feature probably led to a higher number of actively engaged learners. In contrast, exploitation and authoring activities required students to present their work (at least to the moderator), and this process could act as an

⁵ This number was highly variable during the two-hour lesson.

inhibitor to their participation. In addition, the perceived easiness in authoring activities or perceived difficulty in exploitation activities could also have impacted the participation. In general, all workshops registered at least one/two participants who were highly engaged during the whole lesson, thus, suggesting that proactive learners tend to contribute to all phases of the activities. These dynamics will be the focus of future work.

RQ₂: Does the freedom perceived in a remote setting affect learners' engagement? Research on engagement and learning in remote settings proliferated during the COVID-19 pandemic [26]. However, in the current post-pandemic landscape, it is essential to understand whether delivering remote activities can be as beneficial as the standard in presence activities.

Experienced challenges. In the following, we comment on the experienced challenges which may have hindered learners' attendance and active participation.

- Organizational challenges. The first non-negligible factor influencing the workshops' attendance was the existence of other concurrent school or extra activities which students had to attend. The need to choose one activity over another inevitably led to a lower audience. Further, we cannot assume that learners could access a no-distraction zone in their homes and attend lessons in a quiet environment [5]. As a result, the level of engagement in online learning is generally lower, and children with weaker self-discipline may find it harder to replicate the same attention they have in the classroom at home [1].
- Technical challenges. Another crucial issue relates to the equipment each student can access since distance learning effectiveness crucially depends on learners' possibility to attend virtual courses [6]. As noted at the beginning of this section, workshop attendees often reported using a single device for more than two students to join the online class. Unfortunately, we could not assess the actual attendance rate due to students' reluctance to switch on their cameras and the lack of communication. In addition, learners may need more proper technical support at home since families might be unprepared for distance learning and homeschooling [10].
- Technological challenges. An additional concern arises regarding the learners' insufficient technological proficiency to engage in the proposed activities effectively. Given the post-pandemic era, it is reasonable to assume that students are already familiar with online teaching tools. Moreover, considering the age of the participants and the user-friendly nature of the tools employed (e.g., Google Sheets), favorable conditions were expected to facilitate collaboration among attendees. Nevertheless, past experiences from a previous edition of the Open Data workshop [2] have demonstrated that students may still need help to adequately utilize the selected applications. Therefore, it is crucial for moderators to thoroughly assess and evaluate the attendees' expertise in IT skills and remote collaboration tools to appropriately tailor and customize the design of the workshop's protocol and recommended tools to ensure the effective delivery of the activities.

- **Communication challenges.** Arguably, the most critical obstacle inhibiting students' active participation was their hesitance in switching on their cameras and engaging in the lesson by commenting and answering questions, even when encouraged by the moderator or their professor. Still, the active presence of one or more professors helped to recreate a more familiar learning environment by mimicking students' lessons at school. Such a dynamic alleviated some problems mentioned above, probably because learners were not intimidated by sharing problems with a known figure and were more encouraged to complete their assignments.

Teaching OD by remote: a retrospective analysis. As discussed in Section 3 (cf. §Protocol), the workshop protocol described in this article is based on the workshop moderators' previous experience, held remotely in collaboration with the same school in 2022 [2]. Specifically, each workshop offered the same approach to the lesson by including (in this case, alternating) theoretical and hands-on sessions, while the topics discussed aimed to deepen the concepts introduced in the previous workshop series. As an enhancement to the previous protocol, the moderators introduced activities like data storytelling and interactive questionnaire, which were included in several successful initiatives [13, 23].

Although many aspects of the workshops remained unchanged from the previous cycle (i.e., mentors, schools, topics, approach, remote setting), the moderators registered an overall lower learners' engagement, visible in the number of attendees, formed groups and their size, and submitted outputs (see Table 1 and cf. Antelmi et al. [2]). This outcome raises a critical concern about whether delivering remote activities can be as beneficial as the standard in presence activities. Further, it stressed the accent around the more general discourse of how to engage the audience, especially students, in a remote environment. From the experience described in this article, it seems that the remote setting, when not really required due to external factors, may represent an obstacle to the engagement process rather than facilitating it. Since before the COVID-19 pandemic, several studies analyzed the effects of school closures on scholars' engagement and found a significant loss in acquiring basic skills, particularly for the most disadvantaged children [25, 7]; the pandemic only worsened such educational inequalities [4]. These considerations should drive the design of remote activities, which should be based on the tasks learners find more engaging and less inhibiting while considering and trying to alleviate all well-known issues of remote settings.

5 Conclusions

OD have the potential to enhance transparency in government, promote citizen collaboration and engagement, and stimulate innovation [15]. However, the exploitation of OD is hindered by limited technical skills and poor awareness among citizens [30, 19]. To increase awareness of OD, improve users' skills to author and work with OD, and let K-12 learners develop data and information literacy, this

article proposed a series of workshops introducing Italian high school learners to searching for, authoring, and building effective communication based on OD.

Preliminary quantitative findings on learners' engagement revealed several noteworthy implications. First, all workshops registered at least one/two participants who were highly engaged during the whole lesson, thus, suggesting that proactive learners tend to contribute to all phases of the activities. Second, learners were primarily engaged in anonymous questionnaires rather than other tasks requiring more direct interaction, probably due to the inherent nature of the activities proposed. Third, the lower student engagement compared with a similar workshop cycle held in 2022 in a comparable setting suggests that remote activities may prevent rather than facilitate students' engagement process when not necessarily required from external events (e.g., the COVID-19 pandemic).

In a nutshell, this article presents a partial failure in teaching OD exploitation, which is likely attributed to the remote learning environment. One initial observation is that employing ICT tools may not be optimal for participants lacking experience. However, considering the increasing demand for digital skills, prioritizing the ICT component over the remote setting becomes necessary. Recently, a growing body of literature has emphasized that remote learning fails to replicate the same level of engagement as in-person activities. One valuable lesson from this experience is the importance of promoting remote learning only when absolutely necessary and instead favoring in-person or hybrid activities to ensure greater user participation. These insights will inform future initiatives that we intend to propose.

Future work will focus on deepening the analyses of learners' engagement by considering the delivery quality experienced as well as the learned content by looking at the output produced by the students.

Acknowledgement

I would like to express my appreciation to BIMED, represented by its president Andrea Iovino, for allowing me to conduct the research upon which this article is based. Further, I sincerely thank Maria Angela Pellegrino, who participated in the activity discussed in this paper and contributed valuable insights and feedback.

Funding

This work has been partially supported by the spoke "FutureHPC & BigData" of the ICSC – Centro Nazionale di Ricerca in High-Performance Computing, Big Data and Quantum Computing funded by European Union – NextGenerationEU.

References

1. Ambrosino, M.A., Annunziata, V., Gonnella, G., Pellegrino, M.A.: The impact of covid-19 on authoring open data workshop settings in high school. In: Proceedings of the 15th International Conference on Computer Supported Education, CSEDU (2023)
2. Antelmi, A., Pellegrino, M.A.: Open data literacy by remote: Hiccups and lessons (2022)
3. Basford, P., Bragg, G., Hare, J., Jewell, M., Martinez, K., Newman, D., Pau, R., Smith, A., Ward, T.: Erica the rhino: A case study in using raspberry pi single board computers for interactive art. *Electronics* **5**, 35 (2016). <https://doi.org/10.3390/electronics5030035>
4. Blaskó, Z., Costa, P.d., Schnepf, S.V.: Learning losses and educational inequalities in europe: Mapping the potential consequences of the covid-19 crisis. *Journal of European Social Policy* **32**(4), 361–375 (2022)
5. Bol, T.: Inequality in homeschooling during the corona crisis in the netherlands. first results from the liss panel. (2020)
6. Bonacini, L., Murat, M.: Coronavirus pandemic, remote learning and education inequalities. Tech. rep., GLO Discussion Paper (2021)
7. Cattaneo, M.A., Oggenfuss, C., Wolter, S.C.: The more, the better? the impact of instructional time on student performance. *Education economics* **25**(5), 433–445 (2017)
8. Charvat, K., Cerba, O., Kozuch, D., Splichal, M.: Geospatial data based environment in inspire4youth. *Procedia Computer Science* **104**, 183–189 (2017). <https://doi.org/https://doi.org/10.1016/j.procs.2017.01.101>
9. Chen, C.P., Shih, J.L., Ma, Y.C.: Using instructional pervasive game for school children’s cultural learning. *Journal of Educational Technology & Society* **17**(2), 169–182 (2014)
10. Cordini, M., De Angelis, G.: Families between care, education and work: The effects of the pandemic on educational inequalities in italy and milan. *European Journal of Education* **56**(4), 578–594 (2021)
11. De Donato, R., Garofalo, M., Malandrino, D., Pellegrino, M.A., Petta, A.: Education meets knowledge graphs for the knowledge management. In: Methodologies and Intelligent Systems for Technology Enhanced Learning, 10th International Conference. Workshops. pp. 272–280. Springer International Publishing, Cham (2021)
12. Dickinson, A., Lochrie, M., Egglestone, P.: Datapet: Designing a participatory sensing data game for children. In: Proceedings of the British Human-Computer Interaction Conference. p. 263–264 (2015)
13. Gascó-Hernández, M., Martin, E.G., Reggi, L., Pyo, S., Luna-Reyes, L.F.: Promoting the use of open government data: Cases of training and engagement. *Government Information Quarterly* **35**(2), 233–242 (2018)
14. Gennari, R., Matera, M., Melonio, A., Rizvi, M., Roumelioti, E.: Engaging pre-teens in ideating and programming smart objects through play. In: Methodologies and Intelligent Systems for Technology Enhanced Learning, 10th International Conference. pp. 31–40. Springer International Publishing, Cham (2020). https://doi.org/10.1007/978-3-030-52538-5_4
15. Harrison, T.M., Pardo, T.A., Cook, M.: Creating open government ecosystems: A research and development agenda. *Future Internet* **4**(4), 900–928 (2012)

16. Kinnula, M., Sánchez Milara, I., Norouzi, B., Sharma, S., Iivari, N.: The show must go on! strategies for making and makerspaces during pandemic. *International Journal of Child-Computer Interaction* **29**, 100303 (2021). <https://doi.org/https://doi.org/10.1016/j.ijcci.2021.100303>
17. Kurada, R.R., Ramu, Y., Patten, S.: Lessoning geospatial visualizations on real-time data. In: 2021 IEEE International Conference on Computation System and Information Technology for Sustainable Solutions (CSITSS). pp. 1–6 (2021). <https://doi.org/10.1109/CSITSS54238.2021.9683776>
18. Martin, E.G., Begany, G.M.: Opening government health data to the public: benefits, challenges, and lessons learned from early innovators. *Journal of the American Medical Informatics Association* **24**(2), 345–351 (2017)
19. Martin, E.G., Helbig, N., Birkhead, G.S.: Opening health data: what do researchers want? early experiences with new york’s open health data platform. *Journal of Public Health Management and Practice* **21**(5), E1–E7 (2015)
20. Ocumpaugh, J.: Baker rodrigo ocumpaugh monitoring protocol (bromp) 2.0 technical and training manual. New York, NY and Manila, Philippines: Teachers College, Columbia University and Ateneo Laboratory for the Learning Sciences **60** (2015)
21. Open Knowledge Foundation: Defining open data. <https://blog.okfn.org/2013/10/03/defining-open-data> (2013), [Online at , Last access November 2022]
22. Álvarez Otero, J., Lázaro, M., JesusG, M.: A cloud-based giscience learning approach to spanish national parks. *European Journal of Geography* **9**, 6–20 (2018)
23. Pellegrino, M.A., Antelmi, A.: *At School of Open Data*: a literature review. In: Proceedings of the 15th International Conference on Computer Supported Education, CSEDU (2023)
24. Piedra, N., Chicaiza, J., López, J., Caro, E.T.: A rating system that open-data repositories must satisfy to be considered oer: Reusing open data resources in teaching. In: Global Engineering Education Conference. pp. 1768–1777 (2017)
25. Quinn, D.M., Cooc, N., McIntyre, J., Gomez, C.J.: Seasonal dynamics of academic achievement inequality by socioeconomic status and race/ethnicity: Updating and extending past research with new national data. *Educational Researcher* **45**(8), 443–453 (2016)
26. Reimers, F.e.a.: Primary and Secondary Education During Covid-19: Disruptions to Educational Opportunity During a Pandemic. Springer Cham, Berlin/Heidelberg, Germany (2022). <https://doi.org/10.1007/978-3-030-81500-4>
27. Roumelioti, E., Pellegrino, M.A., Rizvi, M., D’Angelo, M., Gennari, R.: Smart-thing design by children at a distance: How to engage them and make them learn. *International Journal of Child-Computer Interaction* **33**, 100482 (2022)
28. Saddiqa, M., Larsen, B., Magnussen, R., Rasmussen, L.L., Pedersen, J.M.: Open data visualization in danish schools: A case study. In: Proc. of Intern. Conf. in Central Europe on Computer Graphics, Visualization and Computer Vision (2019)
29. Saddiqa, M., Rasmussen, L., Magnussen, R., Larsen, B., Pedersen, J.M.: Bringing open data into danish schools and its potential impact on school pupils. In: Proc. of the 15th International Symposium on Open Collaboration (2019)
30. Safarov, I., Meijer, A., Grimmelikhuijsen, S.: Utilization of open government data: A systematic literature review of types, conditions, effects and users. *Information Polity* **22**(1), 1–24 (2017)
31. Styrin, E., Luna-Reyes, L.F., Harrison, T.M.: Open data ecosystems: an international comparison. *Transforming Government: People, Process and Policy* (2017)

32. Susha, I., Grönlund, Å., Janssen, M.: Driving factors of service innovation using open government data: An exploratory study of entrepreneurs in two countries. *Information polity* **20**(1), 19–34 (2015)
33. Vargianniti, I., Karpouzis, K.: Using big and open data to generate content for an educational game to increase student performance and interest. *Big Data and Cognitive Computing* **4**(4) (2020)
34. Windhager, F., Mayr, E., Schreder, G., Smuc, M.: Linked information visualization for linked open government data. a visual synthetics approach to governmental data and knowledge collections. *JeDEM-eJournal of eDemocracy and Open Government* **8**(2), 87–116 (2016)
35. Wolff, A., Wermelinger, M., Petre, M.: Exploring design principles for data literacy activities to support children’s inquiries from complex data. *International Journal of Human-Computer Studies* **129**, 41–54 (2019)