Promoting Digital Data Literacy in Primary Education: First Lessons from the DIRECTORS Project

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***Abstract*—Digital literacy skills are paramount today, especially for young people. The Erasmus+ DIRECTORS (DIgital data-dRiven EduCaTion fOR kidS) project aims to promote data literacy in primary education by introducing new teaching methods and materials designed to support curriculum updates. The project targets pupils aged 8–10 and their teachers, focusing on building foundational digital and data skills through hands-on, interactive learning experiences. In 2024, we conducted three workshops of two sessions each in Marija Corica (Croatia) and Delfgauw (the Netherlands): (1) Data in Our Hands (and Mobile Devices), (2) Spatial Data (and Maps) in Our Hands, and (3) Data Sources. The activities encouraged pupils to explore data concepts interactively, using datasets from their immediate environment and transitioning from conceptualizing data in non-digital forms to applying it in digital contexts. The implementation varied between Croatia and the Netherlands, allowing us to compare outcomes based on cultural and infrastructural differences. This paper presents an overview of the workshop design and content, the evaluation results, and the lessons learned. Key takeaways include the necessity of grounding abstract data concepts in tangible, real-world contexts before introducing digital tools. Finally, we discuss future iterations' directions, including better teachers' involvement and addressing technological limitations like device availability and connectivity.**

Keywords—Digital Data Literacy, Primary Education, Hands-on Activities, Cross-country Comparison, Erasmus+ Project DIRECTORS

I. INTRODUCTION

This paper reports on an empirical study that systematically examines the design, implementation, and evaluation of a teaching and training activity within the DIRECTORS project – an Erasmus+ initiative aimed at promoting digital data literacy in primary education. In today's rapidly evolving digital landscape, developing foundational digital and data skills is essential, particularly for young learners. Data literacy encompasses a wide range of abilities, including "the ability to understand, find, collect, interpret, visualize, and support arguments using quantitative and qualitative data" [1]. Developing these competencies early in a child's education is crucial for providing them with the necessary foundation to understand complex data and make informed decisions in an increasingly data-driven society [2].

Despite the growing interest in data literacy, research indicates that educational programs dedicated to this subject remain underrepresented, especially in the lower grades of primary education [3]. While some countries have started integrating data literacy into their curricula, the lack of systematic approaches and tailored methodologies continues to impede effective implementation [3]. Thus, there is a critical need to investigate and develop effective teaching models for data literacy that are appropriate for the age and cognitive development of young learners [2].

Recognizing this gap, the DIRECTORS project [4] was developed to introduce innovative, hands-on teaching methods that foster digital competence and data literacy among pupils aged 8–10 and their teachers. To achieve these objectives, the project implemented a series of three workshops, each structured into two sessions and targeting different levels of data literacy – basic, moderate, and advanced. These workshops, representing the first cycle of the teaching and training activity within the DIRECTORS project, were conducted in two European contexts – Croatia and the Netherlands – allowing for a cross-country comparison of educational outcomes.

This paper provides a comprehensive overview of the workshop design and content, presents the evaluation results gathered through teacher and pupil surveys, and discusses the lessons learned during this initial cycle. The findings offer critical recommendations for future iterations of the DIRECTORS project (second cycle) and underscore the importance of integrating practical, hands-on data education into primary school curricula to better prepare the next generation for the demands of a digital society.

II. METHODOLOGY, DESIGN, AND IMPLEMENTATION OF THREE-LEVEL DATA LITERACY WORKSHOPS FOR PUPILS IN CROATIA AND THE NETHERLANDS

The workshops were structured into three levels of data literacy – basic, moderate, and advanced data skills – each tailored to children's age and prior knowledge.

- Workshop 1: Data in Our Hands (and Mobile Devices) – Basic Data Skills

- Workshop 2: Geospatial Data (and Maps) in Our Hands – Moderate Data Skills
- Workshop 3: Data Sources – Advanced Data Skills

Each workshop consisted of two sessions, each lasting two 45–60-minute class periods, carefully designed to provide pupils with practical experience through hands-on activities, enabling them to apply learned concepts in real-world contexts and covering the full data cycle – from (1) data collection (by pupils from their real-world environment), (2) data processing (in a "child-readable form"), checking for possible errors, and cleaning if necessary), (3) data analysis (asking questions, extracting insights form data), (4) data visualization (depicting data cleanly, encouraging spatial thinking to (5) critical thinking and drawing conclusions from the data and about the data. In the first session of each workshop, the pupils applied data skills offline, i.e., manually. In the second session, the pupils applied the skills learned in the first session in an online environment, i.e., using technology. The implementation of the workshops was grounded in an interactive and practical learning approach, actively engaging pupils through hands-on activities.

The workshops were conducted in Croatia and the Netherlands in the last quarter of 2024. In Croatia, during four visits to Ante Kovačić Elementary School in Marija Gorica, six workshops were conducted – two workshops for each grade (second, third, and fourth). A total of 53 pupils participated in the workshops, of which 15 were second graders, 18 were third graders, and 20 were fourth graders. In the Netherlands, the six workshops were conducted for ten-year-olds in two parallel groups (7A and 7B) at De Triangel Primary School in Delfgauw. Group 7A participated in Workshop 1 – Basic Data Skills and Workshop 3 – Advanced Data Skills, while Group 7B participated in Workshop 2 – Moderate Data Skills. A total of 44 pupils participated, although not all pupils were able to attend all sessions.

A. Workshop 1: Data in Our Hands (and Mobile Devices)

The aim of Workshop 1 was for the pupils to learn about the concept of data by using data already being collected by their mobile phones or tablets: the data related to their mobile phone or tablet usage. This theme was chosen as the data is widely available, easy to collect, and diverse with several variables (time spent on the device and each app, screen on time, etc.). Our learning objectives were that pupils could recognize and identify different types of data in the real world, could classify, categorize and group the data, analyze the similarities and the differences in data, and answer investigative questions with real-life data.

Session 1: Mobile device usage data. In the first session, the pupils created data cards with the estimates of their mobile phone usage data. We used four categories of data: favorite game, video channel, social media app and general usage (other than these three categories). For each category, the pupils wrote down their favorite application, how many minutes they estimated that they used this application per day, and how often they would pick up their phone to use this application. They then used their data cards to find classmates with similar data. We allocated each corner of the classroom to one favorite game. In each corner, the pupils compared their usage data with their classmates and discussed the similarities and differences. Per corner, the pupils tabulated their usage data and added the total estimated usage times and the number of times they picked up their phones to play their favorite game. In the meantime, one of the instructors visualized the names of their favorite games as a word cloud in two versions: one as raw data with all spelling errors and use of capital or small letters and one as a data-cleansed version. The two versions of the word clouds were shown to the pupils as input for an open discussion of the differences between the raw and the cleansed data and why data quality (such as spelling uniformly) is important. As homework for the next session, the pupils were asked to record their actual mobile phone usage data.

Session 2: Collecting and analyzing mobile device usage data. In the second session, the pupils compared their mobile phone usage data using their mobile phones with their estimates of the first session. The session started with discussing the types of data collected by mobile phones. The pupils then retrieved their mobile phone usage data from their mobile phones or their homework sheets and entered their usage data in an online spreadsheet. The pupils also entered their demographic data in the spreadsheet, such as gender and number of siblings. Some pupils used their mobile phones to upload the data; other pupils used laptops provided by the school. The uploaded data were shown to the pupils as a table and as graphs. The pupils compared their actual usage data with their estimates of their data cards. They discussed and analyzed why there were so many variations. Not only were the variations in actual usage data and their estimates discussed, but we also discussed the differences in usage data between genders and by the size of their household. We also introduced the pupils to the concept of anonymizing data and whether it was possible to (re)identify individual pupils based on demographic data in combination with their favorite applications.

Approaches and Methods in Workshop 1 Implementation. The implementation of Workshop 1 was grounded in an interactive and practical learning approach, actively engaging pupils through hands-on activities. a combination of individual activities or in pairs and groups. By seeking classmates with similar interests and discussing these, new insights were formed. By using real-life data from their mobile phones, the concept of data became tangible. Showing a visualization of the number of game downloads over the last decade and how the popularity of games changed over time was an eye-opener and created a lot of discussions. By visualizing the pupils' usage data in various ways – as a table, word clouds, bar graphs, and pie charts – the pupils were able to understand and critically consider abstract concepts such as data quality and data privacy.

Figure 1. A collage showing pupils engaged in hands-on activities during the DIRECTORS project workshops. The images capture pupils collaborating on tasks spanning the entire data lifecycle, illustrating the approach used to develop digital data literacy in primary education.

B. Workshop 2: Geospatial Data (and Maps) in Our Hands – Moderate Data Skills

Session 1: Smart Maps in action: trace, overlay and discover! The objectives of the second Workshop included the development of fundamental geospatial data literacy skills, such as understanding geospatial data and cartographic concepts, spatial data collection, georeferencing, vectorization, use of GIS tools, and spatial data analysis and visualization. Additionally, the session aimed to foster analytical and collaborative thinking by encouraging pupils to apply these concepts in real-world contexts.

During this session, the pupils participated in a hands-on activity, creating map layers in groups using transparent sheets. Each layer represented specific elements of the school environment, including buildings, roads, shops, churches, and playgrounds. By layering these sheets, the pupils demonstrated how GIS organizes spatial data into distinct layers for effective analysis and visualization.

This session was structured into several phases to ensure comprehensive learning. It began with an interactive map presentation to engage the pupils and introduce the topic of maps. This was followed by connecting theoretical concepts to the pupils' real-life experiences through identifying elements within the school environment on the map. Subsequently, pupils learned to georeference raster maps (aerial images) and to position data accurately within geographic space. The process of vectorizing objects such as buildings, streets, trees, and water bodies was then undertaken, allowing the pupils to acquire practical skills in creating cartographic layers. In the final phase, the pupils enhanced their maps by adding scale, orientation, symbolization, and legends. The lesson concluded with the presentation of their created maps, a discussion of the results, and reflections on the importance of data precision and organization. By introducing the pupils to digital maps, they deepened their understanding of the significance of maps in contemporary contexts.

Session 2: Escape (Class)Room – The Mystery of the Missing Principal or Teacher. The objectives of the second session encompassed the application of GIS concepts in a digital environment, the development of problem-solving skills through geo-information, and the promotion of teamwork and collaboration among pupils. In this session, pupils engaged in a detective game, "The Mystery of the Missing Principal / Teacher," where they applied their GIS knowledge in a digital setting. In Croatia, the pupils had to find the missing School Principal; in the Netherlands, the pupils had to find a missing teacher. Utilizing GIS layers and digital data, the pupils solved a series of puzzles that provided geographic coordinates leading them to the location of the missing principal/teacher near the school. The activity concluded successfully with the discovery of a hidden box of candies, reinforcing their engagement and practical application of GIS tools.

This lesson was structured into distinct phases to facilitate structured learning. After a brief review of the material covered in the first session, the pupils began by solving puzzles to uncover digits needed to crack the initial code. This was followed by various GIS operations, including data filtering, buffer zone creation, spatial data analysis, key point identification, navigation to coordinates, and result visualization. Finally, pupils employed GIS tools to navigate and locate the target within the game. The session concluded with an analysis of the effectiveness of their strategies and a discussion of the learned concepts, further deepening their knowledge through conversations about the real-world applications of GIS.

Approaches and Methods in Workshop 2 Implementation. Our approach centered around teamwork and collaboration, with pupils divided into groups to collaboratively create maps and solve puzzles, thereby enhancing their communication and cooperative decision-making skills. Utilizing local data from the immediate school environment increased the relevance and engagement of the activities, allowing pupils to connect theoretical concepts with their real-life experiences and surroundings. Practical tasks, such as constructing map layers with transparent sheets and participating in detective games, facilitated the application of theoretical knowledge, fostering critical thinking and creativity. Furthermore, the integration of digital tools, including a web mapping app, enabled the pupils to apply their learned concepts in a digital context, transitioning from paper-based maps to digital platforms. This reinforced their understanding of geospatial concepts but also equipped them with essential digital skills crucial for modern education.

C. Workshop 3: Data sources – Advanced Data Skills

This workshop aimed to introduce the pupils to more advanced data skills, relating real-world data sources, evaluating data quality, manipulating data, critically evaluating data sources, and acquiring the same data using various data sources and methods. The learning objectives aimed for the pupils to use different types of sensors to obtain data, from using their bodies to using technology, and to explain the differences in measurements when obtaining data for the same purpose but using different methods and issues related to data quality. They should also be able to relate data variables and choose the most appropriate method to obtain data depending on the needed purpose.

Session 1: From our bodies to sensor technologies. The concept of data sensors was explained: what are sensors, what can they measure, how accurate are they, etc.? As an exercise, the pupils recorded the number of steps needed to cross the classroom in several ways, with or without technology. First, they manually counted their steps. Then, they used mobile phone pedometers and step counter apps in a smartwatch. They were also introduced to calculating the distances from the number of steps. We showed them the relation between their body length and stride length. By estimating their stride length, they calculated the length of the classroom. The children compared their results to the results of their classmates. They also compared their calculated distance with the distances provided by the apps of mobile phones and smartwatches. In the Netherlands, the pupils also used a toilet roll to calculate the length of the classroom by measuring one sheet and multiplying it by the total number of sheets needed to cover the length. The session concluded with a critical assessment of the results of the methods. As homework, the pupils were asked to record the number of steps between home and school or another longer distance, e.g., the circumference of a local park.

Session 2: Technology to the rescue! Or not? In the second session, the pupils were introduced to different methods for measuring distances using online tools. They compared the methods of measuring distances by placing points in Google Maps with automated route planners. The pupils worked in pairs using their phones or the school's laptops. We then introduced the concept of GPS and GPX tracker devices. In a short video clip, the pupils were shown how satellites can be used to measure distances. Some of the shortcomings of these measurements were shown; for instance, GPS cannot be used indoors. The pupils went outside to measure the circumference of their schoolyard. The pupils were divided into groups, whereby one group counted steps manually, one group used a GPX tracker app on their mobile phones, and one group used a smartwatch to record their track. The pupils using their phones were asked to keep their phones in different positions during the track recording, for instance, in their hand, in their pocket, or their bag. The pupils using a smartwatch also had to store their device in different locations, such as on their wrist, holding it in their hand as still as possible, or in their pocket. Back in the classroom, the pupils calculated the distances by multiplying the step count by their average stride length. The groups that had used devices made a note of the measured distances. Meanwhile, they uploaded their recorded tracks to the email address or WhatsApp of the DIRECTORS instructor, who then visualized these tracks simultaneously in Google Maps. The session concluded with a discussion of the differences between the recorded tracks depending on their locations during the track recording and the differences between the number of manually counted steps and those recorded by devices.

Approaches and Methods in Workshop 3 Implementation. The implementation of Workshop 3 was grounded in an interactive and practical learning approach, actively engaging pupils through hands-on activities. We used a combination of individual and group activities. By using and comparing the different methods for calculating distances, the pupils related different variables in one context. By using manual step-counting and technological devices, the pupils could experiment by changing one variable to see what the effect would be on the outcomes. Using the toilet paper roll was a way for the groups to agree on a strategy beforehand as the classroom was full, and simply rolling out was not possible. Seeing the different strategies employed by the different groups was an eye-opener for their teacher, who had expected chaos and instead saw examples of self-organization. The pupils also learned that although devices are nice to use, they also have their limitations in terms of accuracy and dependency on access to 4G networks. By visualizing the different recorded tracks on one map, the pupils were able to understand and critically consider abstract concepts such as data quality, accuracy, and the limitations of smart devices, especially when these devices have settings related to adults (affecting stride length). In the Netherlands, there were technical problems with transferring the recorded tracks to the instructor. A proxy was used to demonstrate differences in tracks depending on the position of the mobile phone. This worked well enough for the general discussion but not for the actual track comparisons.

III. Results

The results of the workshops were, in general, positive. The pupils enjoyed the active learning activities, finding out things, and the room for open discussions. There were some minor differences between the outcomes in Croatia and the Netherlands.

A. Evaluation of the workshops in general by the teachers

The evaluation of the workshops was conducted through teacher surveys completed after each session, utilizing colored smileys to reflect a rating scale from 1 (lowest satisfaction) to 5 (highest satisfaction). The form included boxes for recommendations for the second cycle. In general, the teachers enjoyed the sessions and provided some useful suggestions.

B. Evaluation of the workshops in general by the pupils

The evaluation of the workshops was conducted using pupil surveys completed after each session, with colored smileys representing a rating scale from 1 (lowest satisfaction) to 5 (highest satisfaction). Overall, the results indicate a high level of pupil satisfaction and engagement,

with Croatian pupils generally providing slightly higher average ratings compared to their Dutch counterparts. It is important to note, however, that these quantitative ratings offer only a preliminary indication of the pupils' overall appreciation, and observations suggest that such measures may not fully capture the nuances of young learners' experiences compared to in-class oral, qualitative feedback. Thus, while these scores provide a useful snapshot, they should not be overinterpreted; for a comprehensive understanding of the workshops' impact, alternative evaluation methods should be considered in future cycles.

Highlights of Workshop 1. The pupils specifically enjoyed discussing the data with examples of popular games, which is a topic that motivated the pupils to talk freely. Filling in the data cards provided a quick way to find classmates with similar interests. Comparing their usage data with their classmates rated well, with an average of 4.2 in Croatia and a 3.9 in the Netherlands. They also enjoyed seeing in the word clouds the different variations in spelling the names of games, again with a rating of 4.2 in Croatia and 3.9 in the Netherlands. The visualization of the popularity of games over time was very popular. The pupils enjoyed entering their usage data in the online form and then seeing the different visualizations. They also enjoyed finding out how to retrieve data from their mobile phones.

Highlights of Workshop 2. The pupils expressed significant satisfaction with activities such as smart map creation and detective puzzle solving, achieving average ratings of 4.1 and 4.9 in Croatia versus 3.3 and 3.7 in the Netherlands. Many in both countries were particularly enthusiastic about the concept of "smart maps," which allowed them to visualize how layers of information combine to form a detailed representation of their environment. Dividing the pupils into teams added an element of fun and collaboration; for example, by matching candy labels to find their partners and assigned areas, they enjoyed creating maps together. A notable highlight was the creation of a large mosaic map assembled from individual map pieces on the classroom floor, demonstrating how each contribution helps form a comprehensive overall picture.

Furthermore, evaluations indicated that pupils successfully comprehended fundamental GIS and cartography concepts and were able to apply them in practical tasks, with average understanding scores of 4.6 in Croatia and 3.6 in the Netherlands. The accompanying web application offered an engaging, escape room-like experience, guiding the pupils step-by-step through tasks such as data filtering and buffer creation. Additionally, the pupils particularly enjoyed the outdoor search for the final clue and the subsequent reward of treats from the missing teacher.

Highlights of Workshop 3. The pupils enjoyed experimenting with the different methods for counting steps and using technology to calculate distances, although the ratings in Croatia were higher than in the Netherlands. In Croatia, the pupils especially liked using the technology – mobile phones and smart watches – to experiment with counting the steps in the classroom. They liked seeing that the results provided by the devices were not fully correct and that they differed. The pupils also reported that they found it interesting to learn that technology can be manipulated to cheat, and therefore, results should not be blindly trusted. In the Netherlands, the pupils found the manual ways of counting steps to be more reliable than using the technology. The pupils especially enjoyed using a toilet roll as it triggered their imagination on how to devise a strategy and implement this as a group. This was also the activity whereby the pupils with learning problems fully engaged for the first time, and one even took the lead. For the second session, the pupils enjoyed going outdoors to test and experiment with all the methods. They were surprised by the differences in the results obtained using different methods. They were also triggered by the differences in the recorded tracks using different technologies and different locations of the device (in the hand, in the pocket or backpack, etc.).

IV. Analysis and Recommendations

A. Lessons learned in general

Based on the implementation of the first cycle of workshops, several key lessons were learned. Firstly, it is crucial to connect abstract concepts with concrete contexts; introducing theoretical ideas within tangible, real-world settings before integrating digital tools facilitated a better understanding and application of the learned concepts among pupils. Secondly, it is essential to provide clear and consistent instructions, along with thorough preparation of materials, to prevent confusion and to ensure smooth execution of activities. This approach reduces uncertainty and enhances the overall effectiveness of the workshops. Active teacher involvement was also found to be vital, as it will enable the teachers to effectively support pupils and integrate the acquired knowledge into their daily teaching practices, thereby increasing the relevance and continuity of the learning process. Additionally, ensuring technological readiness by providing the necessary devices and maintaining stable internet connectivity is important to use digital devices effectively during the workshops. This preparation minimizes disruptions and allows for the seamless utilization of digital resources. Furthermore, adapting activities to accommodate varying levels of knowledge and providing options for pupils with different abilities and interests ensure that all participants can engage and learn effectively at their own pace.

From a practical point of view, we need to (re)design the activities in the second session of the workshops so that the pupils do not need to bring a mobile phone. Firstly, not all pupils have a mobile phone and feel somewhat left out. Secondly, the pupils were distracted by their phones.

Finally, we need to review the pupil's evaluation. Many of the pupils rated the workshops either very well or very badly. Doing an in-class oral evaluation in the future might provide us with more qualitative information.

B. Recommendations for the second cycle

Although the first cycle of workshops was very successful in both countries and the main structure will be maintained, some minor adaptations are needed. We found that we need to develop two options for the workshops to

suit the specific age group – a basic version for 8-year-olds and an advanced version for 10-year-olds.

Workshop 1. We need to simplify the data cards with fewer categories and clarify in advance that no mobile phones are to be used during the sessions. Furthermore, we must instill that the homework must be filled in before the next session so that the pupils do not need to bring their mobile phones to class. Reminders to do so must be sent to the teachers in advance. Finally, we need to ensure that there are sufficient laptops or tablets available in the classroom for the pupils.

Workshop 2. The first cycle of workshop 2 was very successful in both case studies. Therefore, the structure will be maintained. In Croatia, the workshop requires no adaptations. In the Netherlands, for session 1, the vectorization' step will be shortened, and more time will be dedicated to discussing the results. From a practical point, we will allow pupils to glue the symbols on the map instead of using the self-adhesive symbol stickers as the pupils had difficulties in removing the backing paper. In session 2, the results of the pupil work will be discussed in the plenary instead of in small groups. This goes for the GIS quiz as well as the GIS operations to find the missing teacher. This should ensure that all pupils obtain the same knowledge of the GIS concepts.

Workshop 3. We recommend that the pupils do not bring their own mobile phones. If pupils are to use their mobile phones, we need to provide clearer instructions for the parents on how their children can use the step-counting apps. By only using the instructors' phones, these issues can be overcome. We need to allow more time for the devices to sync as, especially in the Netherlands, mobile phones took longer than the instructed 10 seconds to sync. We need to provide clearer instructions for the pupils to carry out the activities. Furthermore, we need to provide more tools, e.g., a whiteboard, for the pupils to do the subtractions needed to calculate the number of steps per activity. We also need to prepare templates in advance.

Unlike in Croatia, in the Netherlands, only a few children have a smartwatch or pedometer. Therefore, it is suggested that pupils be provided with cheap pedometers. It is essential that there is good access to the internet for the activities and that there are sufficient laptops available in class. We need to find suitable videos, preferably European, for the pupils to explain how satellites and GPS work. The videos must be short and available in their native language. Finally, the distance for the outdoor activity must be carefully selected: at least 200m and in a quiet location, as the schoolyard used in the Netherlands was too crowded with other groups of pupils.

V. Conclusion

This paper presents an empirical investigation into a teaching and training activity conducted as part of the DIRECTORS project—an Erasmus+ initiative aimed at promoting digital data literacy in primary education. Our study examined the design, implementation, and evaluation of a series of hands-on workshops that introduced young learners to the complete data cycle, from collection and processing to analysis, visualization, and interpretation.

The evaluation of the workshops, based on teacher and pupil surveys as well as observational assessments, suggests that the interactive, hands-on approach adopted in the workshops generally fostered engagement and helped develop foundational digital and data skills. Overall, the initial results indicate that our approach is successful. While some differences emerged between the implementations in Croatia and the Netherlands, reflecting variations in technological infrastructure, the age groups involved, and the instructional approaches used, these findings provide valuable insights for further refinement.

The lessons learned from this first cycle underscore the importance of grounding abstract data concepts in concrete, real-world contexts, starting with analogue/materialized data (e.g., a paper map) before delving into the digital, clear plenary instructions of the core concepts, and active teacher involvement. Although our findings offer a useful starting point and provide valuable insights, we recognize that further refinement is necessary to address challenges such as technological limitations and varying levels of pupil engagement.

In our methodology, only one additional cycle – representing the second cycle of workshops implementation – will be conducted to build on the lessons learned from this initial phase. These forthcoming workshops aim to further refine our approach, incorporating the recommendations identified in our study. Overall, while our study provides modest evidence that hands-on, interactive data literacy workshops can be effectively integrated into primary school curricula, continued iterative improvements will be essential to fully realize the potential of these educational interventions in preparing young learners for a data-driven future.

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