SCOREwater

Smart City Observatories implement REsilient Water Management

DELIVERABLE D4.14

DIGITAL TOOLS FOR SCIENCE PARK ACTIVITY PACKAGES

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REVISION HISTORY

Version	Reason for changes	Name	Date
1	Original release to EU	Christa Törn-Lindhe	2022-03-28
2	Addressing the comments of the external reviewer following the review meeting 23 June 2022. The following has been updated: • Page 16. Correction of the numbered list, to start at 1.	Åsa Nilsson	2022-06-30

CONTENT

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ABBREVIATIONS

Abbreviation	Definition
CKAN	Comprehensive Kerbal Archive Network
ICT	Information and Communications Technology
IoT	Internet of Things
SDG	Sustainable Development Goals
SME	Small and Medium-sized Enterprise

PROJECT ABSTRACT

SCOREwater focuses on enhancing the resilience of cities against climate change and urbanization by enabling a water smart society that fulfils SDGs 3, 6, 11, 12 and 13 and secures future ecosystem services. We introduce digital services to improve management of wastewater, stormwater and flooding events. These services are provided by an adaptive digital platform, developed and verified by relevant stakeholders (communities, municipalities, businesses, and civil society) in iterative collaboration with developers, thus tailoring to stakeholders' needs. Existing technical platforms and services (e.g. FIWARE, CKAN) are extended to the water domain by integrating relevant standards, ontologies and vocabularies, and provide an interoperable open-source platform for smart water management. Emerging digital technologies such as IoT, Artificial Intelligence, and Big Data is used to provide accurate real-time predictions and refined information.

We implement three large-scale, cross-cutting innovation demonstrators and enable transfer and upscale by providing harmonized data and services. We initiate a new domain "sewage sociology" mining biomarkers of community-wide lifestyle habits from sewage. We develop new water monitoring techniques and data-adaptive storm water treatment and apply to water resource protection and legal compliance for construction projects. We enhance resilience against flooding by sensing and hydrological modelling coupled to urban water engineering. We will identify best practices for developing and using the digital services, thus addressing water stakeholders beyond the project partners. The project will also develop technologies to increase public engagement in water management.

Moreover, SCOREwater will deliver an innovation ecosystem driven by the financial savings in both maintenance and operation of water systems that are offered using the SCOREwater digital services, providing new business opportunities for water and ICT SMEs.

EXECUTIVE SUMMARY

This deliverable is connected to the work in SCOREwater WP4 *"Large scale demonstrations"*, task 4.3 *"Demonstration: Water-safe infrastructure projects. Gothenburg"*, and specifically subtask 4.3.4. *"Increase public engagement, awareness of the value of water, and innovation creativity from urban water cycle monitoring data."* There is also a strong link to the work performed by Universeum in WP7 *Dissemination and communication*.

The report provides information about Universeum's activities and tools for engaging the public in water and sustainability. They are currently part of Universeum science center exhibition, in order to increase public engagement and awareness of the value of city water.

The activities combine both digital and physical tools in order to reach a broad audience. Activities are launched in the digital portal as well as implemented at the science center. The covid-19 pandemic has unfortunately greatly limited the number of visitors at the Universeum science center.

Water world
The public activity is a digital mission reaching out to families inspiring them to think about their impact on the water cycle and **how citizens affect the city water** – focus on the importance of a sustainable everyday life.

Water purification
The middle age school activity is a **water purification lab** at Universeum in our Chemistry lab. The students do systematic research and gain knowledge about the properties and cycles of water, connect to common chemicals in the home and their impact on the environment.

Visualised water
The high school activity is an activity on site at Universeum's new, public visualisation lab where the students can experiment with data at the stations linked to oceans and water, and collectively discuss a number of issues that highlight water at various levels.

The conclusion from both activities for schools is that

1) the water issue is important to highlight from a sustainability perspective and from several different angles. The most engaging factors are those closest to the target group's own perspective.

2) tools that they do not have access to in the classroom are important and appealing to use, e.g. actual data visualisations of the latest research, along with a proper chemistry lab with new purification methods and innovations.

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1. BACKGROUND

1.1. PROJECT MANDATE

The SCOREwater project aims to investigate how sensors and digital tools can be used to improve knowledge and contingency planning for handling a variety of changes. Technology developers are working closely with users on technical development and testing in order to develop tools that are of real benefit to municipalities, companies, citizens, civil society and other users. The aim of the project is to develop digital services, games and a variety of experiences that cities can use to increase awareness of and engagement with water-related issues.

Universeum's role is to assist with tools for transformative learning for citizens and engagement on the part of local residents. Universeum has developed three activities for local residents within the framework of the project.

The hereby described activities developed at Universeum are based on results from case study Göteborg which has been incorporated into a broader context of water in the city. Relative to the original plan, the deliverable has been modified to reflect the reality of the progress of data collection and experience build-up. To put the monitoring and pollution control of the West-Link construction and the water body recipient at direct display and connecting the physical and digital world has been done by the means of all three activities: Waterworld for the public and the Water purification lab and Water visualization for schools. Citizens were invited to take part in these activities, digitally via Digitala Universeum and interactively at the Universeum science center.

In several ways these activities go beyond the frame of the original plan for the deliverable D4.14 in order to compensate for the fact that real time monitoring of Mölndalsån could not be included due to the delay in processing the data and uploading it on the SCOREwater platform. While that activity is about to be completed at the time of submitting this deliverable, it was too late to include interaction with the platform data in the development of Universeum activities. Citizens can explore water purification technology by hands-on physical demonstration of purification technology used in SCOREwater and in the case study Göteborg. The importance of data from sensors and synthesis of the knowledge about the water in the city, now and in the future, is done in the activity Water visualisation through which the citizens have the opportunity to interact with real data. This activity makes use of several data sources from within and outside SCOREwater which deviates from the original plan to only use data from Kvillebäcken and Mölndalsån but was necessary due to the lack of data available at the time of D4.14 development. However, the creating of the interactive learning from data analysis, application and visualization of data has not been made difficult or less ambitious because of that.

1.2. UNIVERSEUM'S METHODS AND APPROACH

All content at Universeum, from learning environments to programs, is developed with Agenda 2030 as a starting point and based on Universeum's educational platform. We are creating a variety of experiences to aid people in understanding the world around them and connections between different scientific phenomena. Universeum presents knowledge about nature, technology, the environment and humans in ways that differ from the formal education system. Visitors encounter lifelong learning via interdisciplinary programs and in the form of a STEM initiative (Science technology engineering mathematics), involving technology such as sensors, AI and visualisation technology.

1.3. TESTS AND FEEDBACK

All activities are followed up in accordance with our plan for evaluation and validation. With regard to the SCOREwater project, the activities have been tested with two main target groups (the public and schools) and the impacts are measured in terms of both quantitative and quality aspects. For the quantitative aspect, we have looked at statistics, for example the number of users and the reach. For quality, we have followed up through verbal discussions with users to gain in-depth answers as to whether the activities resulted in increased knowledge and greater engagement with water-related issues.

1.4. UNIVERSEUM'S EDUCATIONAL PLATFORM

Universeum's activities and programs are based on Universeum's educational platform. Ultimately our educational approach is about being an arena that delivers science-based opportunities for children and adults to boost their creativity and capacity for innovation, develop skills and activate their critical thinking. Our visitors should feel that together with us they can transform the world around them and their living conditions – that they are gaining knowledge and resources to enrich their lives and to take action to achieve a sustainable world.

Our approach is founded on research and the educational platform showcases our process for learning and knowledge development. This is the starting point for new and further development of all our content, from learning environments to programs and individual activities, regardless of target group.

Our mission at Universeum is to help make children and adults aware of their habitual lines of thought. This means that those of us interacting with visitors must be conscious of both our own and their prejudices and perspectives of the world and encourage wide-ranging discussion on areas of knowledge and a critical approach.

2. ACTIVITIES

2.1. PROGRAM FOR THE GENERAL PUBLIC: WATER WORLD (LINK)

Water world – to increase the public's engagement with and basic knowledge of the city's water resources by means of digital tools.

Water world is a digital program released on 21 June 2021 and available to everyone via Universeum's digital platform. The overall aim is to encourage our visitors to be more mindful in their use of water as per SCOREwater's overall purpose. Three intermediate goals have been formulated, based on discussion with the City of Gothenburg (and its departments dealing with water and the environment) regarding the challenges faced by the city in its aim to be a sustainable water city. These intermediate goals are intended to contribute in the long term to understanding of:

1) our collective water consumption and how it can be reduced
2) the fact that we can contribute to improved water quality and how
3) complex urban and natural cycles

2.1.1. TARGET GROUP AND USER STORY

Universeum employs User stories in digital product development, as per the principle: As a <consumer> I want to be able to <function> so that I can <why>.

Universeum's educational platform is a good method for achieving the above intermediate goals, i.e. collective learning through interactive experiences. Since the product is being developed during the ongoing pandemic, digital experiences are the most effective way to bring about collective learning. A digital product could also increase the product's reach (i.e. reach more people than just visitors to Universeum).

The city's water is most affected by its residents and their homes, so the choice of target group is simple: families with children aged 7-10. Children with insights often have a positive influence on their parents, and at the same time parents want their children's digital activity to be useful. The digital experience will take place in the home environment and can last as long as families need and want.

The following User story was used in developing Water world:

As a family we want to have fun together while gaining insights and knowledge about water.

2.1.2. CONTENT AND STRUCTURE OF WATER WORLD

Start quiz

In order to gain access to the digital Water world visitors have to complete a quiz of six questions to move forward. The quiz is relatively simple and gives us an idea of visitors' basic knowledge about water. The user is given three answer options and once the question has been answered an immediate response is given: a green box for a correct answer or red for incorrect – together with a fact box providing additional information relating to the question.
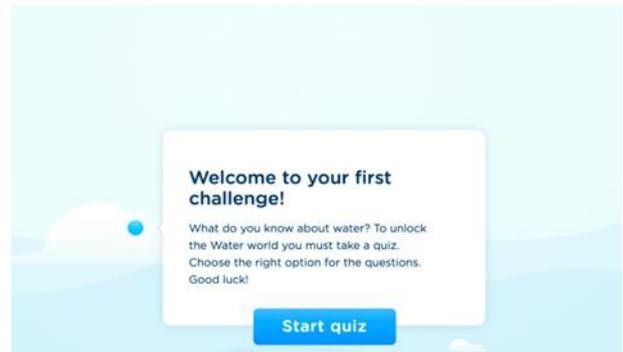
Even if incorrect answers are given for the quiz, Water world still opens up, since the quiz is a way for Universeum to gauge players' basic knowledge at the start of the activity. There is also an end quiz for the same purpose (see below).

Water world

When a player enters Water world they are presented with an overview in the form of a house surrounded by a community. The image contains a number of large blue dots and seven water drops in the top right corner.

When the player clicks on the blue dots in the house, this opens up the various Water world missions. Once a mission is completed, a drop of water is added to their collection (top right corner of the image). In the image below one of the blue dots is ticked and a drop of water has been collected – this provides visual confirmation that one (1) mission, the start quiz, has been completed.

Missions

In Water world you then click through to the various missions via the dot symbols in the house. The dots are located in places linked to the specific mission and information to be learned.
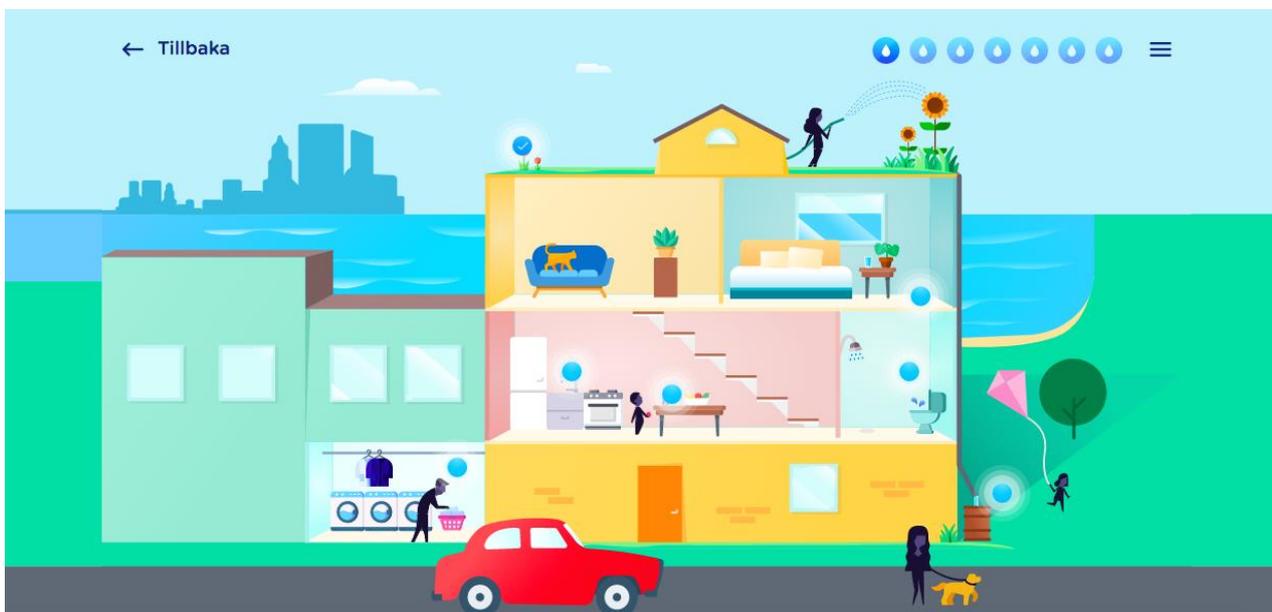
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The different missions contribute in a variety of ways to the overall intermediate goals (see 2.1).

Clean water is a mission where the player can use five different substances and tools to purify differing types of dirty water.


In *The toilet game* the player must ensure that the right types of waste go in the right container: should it be flushed down the toilet or go in the trash can?

Pipes! (from source to treatment plant) is a classic game where the player must turn the pipes so water can flow between the different points on its way to our taps.
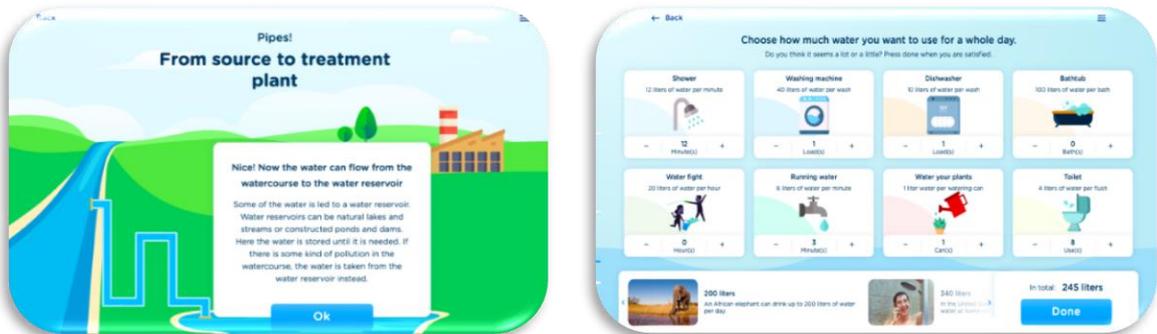
The invisible water and *How much water?* are two missions that allow players to discover how much water we use in our everyday activities and our food consumption.

Finally, in *Outside*, Water world visitors can obtain specific tips on ways to contribute to a sustainable cycle in their own local environment.
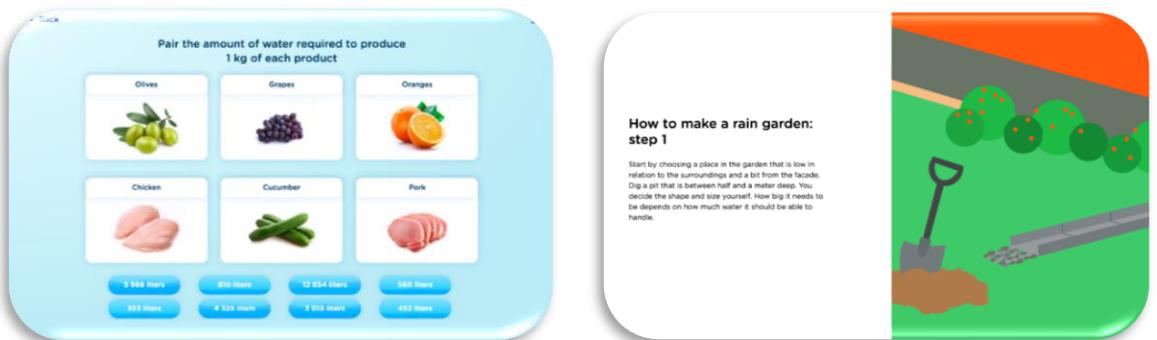
End quiz

Once players have completed all the missions, they can try the Water world end quiz. This summarises the lessons learned from the various Water world missions in the form of six questions. Once you have taken the end quiz, you will be awarded a diploma to show that you are now a water expert. You can also enter your e-mail address to take part in the draw to win an annual pass to Universeum.

The end quiz enables Universeum to gauge players' knowledge development – how much they now know about water in relation to when they started.
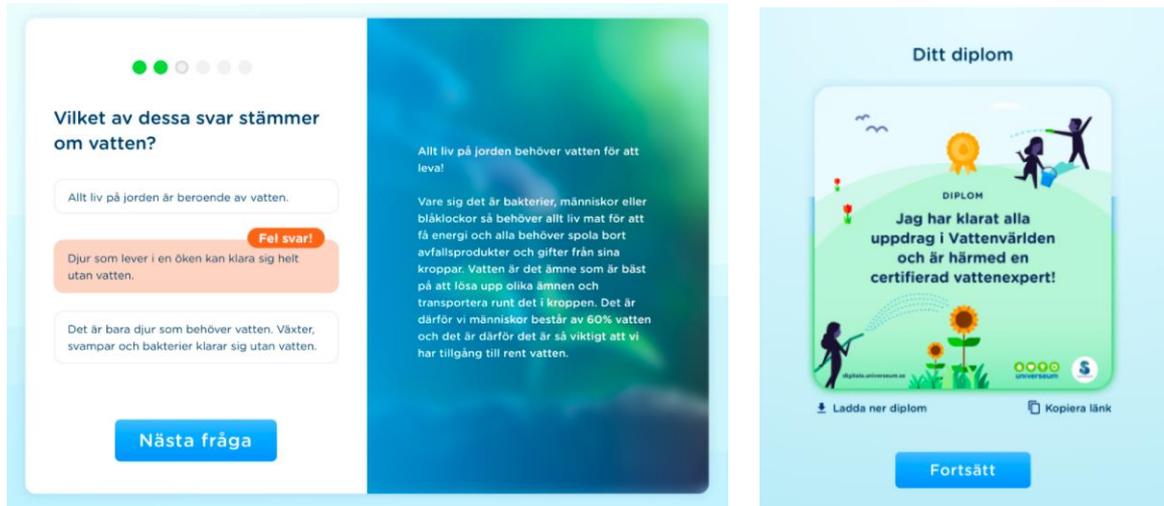
2.1.3. STATISTICS AND USER ANALYSIS

The game is simple to understand and the knowledge content is easy to absorb on a general level.

However, it's surprising that many users don't complete the game from start to end quiz. There doesn't seem to be any system to doing all the missions in order from start to finish. The game can be completed in any order, which affects this result.

In the image showing the overview of the house it may be possible to add further educational information/content to give the user more context.

This program can be replicated, as we can use the same basis/principles for games within other areas of knowledge.

By 21 December, 6 months after it was released, 247 guests had visited Water world. Of these, 52 people had completed the challenge and obtained their diploma, i.e. 20% of visitors. The average result for the start quiz is 4.8 out of 6, and for the end quiz 6.6 out of 10.

2.1.4. MARKETING EFFORTS

Water world is available on Universeum's digital portal, but outside the paywall. This means that anyone, in Sweden or internationally, can experience this digital world. For the same reason, it is available in both Swedish and English.

In order to generate traffic to the site, a number of marketing initiatives have been implemented, on Facebook, LinkedIn and in newsletters:

LinkedIn	Facebook	Newsletter
Reach: 1,054 Likes: 32 Link click: 19 Shares: 6	Reach: 2,827 Likes: 19 Shares: 5	Number of recipients: 13,700 Number of opened newsletters: 6,540 Number of clicks: 31

2.1.5. THE FUTURE

By the turn of the year (2021/22) Water world had been up and running for six months and Universeum plans to keep it open for another year. After that it will probably be moved behind the paywall together with Digital Universeum's other digital worlds and experiences, designed for subscribers and annual pass holders.

2.2. PROGRAM FOR SCHOOLS: WATER PURIFICATION & VISIBLE WATER

2.2.1. WATER PURIFICATION

The Water purification student program forms part of one of Universeum's development programs for schools: Global goals/Sustainable oceans. Sustainable oceans is a combination program offered to intermediate-level teachers with a focus on strengthening their work methods and approach relating to the global goals in schools. Teachers are provided with skills development relating to the global goals, while students benefit from two student programs and an ambassador day, where teacher and students evaluate the programs. Teacher and students undertake the program both at Universeum and in the classroom and complete assignments linked to problems associated with sustainable oceans.

The student program takes place in Universeum's Chemistry Lab and has been developed for students in years 4, 5 or 6. The purpose of the lab is to create understanding of different ways to help animals, humans and plants stay healthy and ensure that we have sustainable oceans by both purifying water in a variety of ways and also minimising emissions. It also aims to increase knowledge about the fact that many different purification methods are required to deal with water from differing processes.

Students get to investigate three different types of contaminated water. They get to work with muddy clay water from a building site, acidified water from an abandoned mine and water contaminated with oil. The students will get to carry out tests on all three water samples if they have time. They can try to purify the clay water using fibre husk and chitosan. In the beaker of acidified water they measure the pH value and then try to neutralise it. In the final beaker they try to remove the oil from the water using 'recycled fibre' and 'hydrophobic cellulose' (i.e. kitchen roll and GreenAll).

The students follow written instructions and then answer questions linked to each experiment. The answers are logged digitally so that everyone can view the results even if they didn't manage to do all the stages. With this in mind, the groups do the experiments in a different order, so that collectively they have covered all three.

2.2.2. VISUALISED WATER

The program has been developed for students in year 7, 8 and 9. On site at Universeum's public visualisation lab the students can experiment with data at the stations linked to oceans and water, and collectively discuss a number of issues that highlight water at various levels. The aim is to link together technology and issues relating to water.

After a short review the students can independently explore the technology based on prepared questions. They can immerse themselves in different aspects of water. The main installations used are Virtual Gothenburg, Climate and Our world. Virtual Gothenburg is a 3D-printed model of Gothenburg with projected data provided courtesy of the City of Gothenburg and its work to develop a digital representation of the city. The program allows students to explore what happens in the event of cloudbursts and flooding, and subsequently tie this to surface water and various challenges presented by this scenario. They can reflect on how a city is affected and how urban planning can be implemented. A film about cloudbursts is also used to further highlight the consequences from water flooding our streets.

Another data set that is used is Climate food. Here the students can consider how our consumption and our eating habits affect global water usage. By both looking at the food consumption of various families and creating their own meals they can reflect on water usage around the world.

The Our world installation, i.e. the large globe projection at the center of the exhibition, is used to give the water issues a more global perspective. What are the implications of rises in sea level, for example, around the world? What happens if the world's reserves of fresh water begin to melt away as the glaciers melt?

The program is then tied together by educators at Universeum linking the issues about water together and discussing them with the group of students as a whole.

2.2.3. TARGET GROUP

Primary and secondary school students need to contribute to a sustainable society in the short and long term and have an understanding of the global goals and how they are interconnected.

Their teachers should aim to improve understanding of complex problems and solutions, which in turn leads to increased knowledge and capacity to act among students. The target group needs to understand methods for systematic study in the fields of natural science, technology and sustainable development.

2.2.4. ASSESSMENT & CONCLUSION

The pilot tests of the two school programs involved 20 classes, 21 teachers and around 490 students.

Water purification

The school activity focusing on water purification was greatly appreciated by the students and teachers. The evaluation shows that it helped to connect water purification to reality in a way that the teachers could not have delivered back in the classroom. They also feel that they have gained increased knowledge of water purification. The students feel that they have been made aware that you need to consider what you flush down the toilet and that they have gained increased understanding of what, and how much, must be purified. They have been made more aware that our watercourses are important and must be protected in a variety of ways. It is clear to see that they link it to their everyday life and that they then focus a lot on not dropping litter because it ends up in our watercourses. This is where they can most easily have an influence at their age.

The water purification lab session was adjusted regularly during the period by clarifying certain instructions and questions that the students did not understand. We also needed to be clearer with regard to the quantities of material they should use in each test. However, it was very positive that they could work at their own pace to a great extent during the lab sessions. In addition to learning about water purification, they are also learning to experiment and use equipment in a way that is not very common at this age, since schools often lack lab rooms.

Visualised water

Visualised water was run during a period when it was difficult for classes to undertake activities away from their school due to the pandemic, which unfortunately meant that far fewer classes could try out this activity.

During the pilot project, the students were observed at work and this was followed by discussions with the teachers about their thoughts on the activity. The students themselves said it opened their eyes to how many processes require water, both our consumption and everything else we do. They also reflected on how cloudbursts affect our cities and how large quantities of water can affect our planet.

When we observed the students at work, we noted that they were very interested in the things that were closely linked to themselves, their lives and everyday activities. The pilot classes came from Gothenburg, and as a result the 'Virtual Gothenburg' installation in the visualisation lab generated particular enthusiasm. When they located their school and other familiar places, they became more interested in the water-related issues.

The 'Our world' installation highlighting the global challenges got a more mixed response. Some students took a very focused approach and discussed consequences and challenges, while others approached the global data in a more general manner.

The teachers thought that it was very good that the students themselves got to experiment with the research data at each installation and that the activity included questions that generated discussion. However, they wanted the focus to be on solutions rather than problems and challenges. The questions have therefore been adjusted accordingly.

Conclusion

The conclusion from both activities for schools is that

1) the water issue is important to highlight from a sustainability perspective and from several different angles. The most engaging factors are those closest to the target group's own perspective.

2) tools that they do not have access to in the classroom are important and appealing to use, e.g. actual data visualisations of the latest research, along with a proper chemistry lab with new purification methods and innovations.

ANNEX 1 – STOCKTAKING

A final Annex of stocktaking was included in all Deliverables of SCOREwater produced after the first half-year of the project. It provides an easy follow-up of how the work leading up to the Deliverable has addressed and contributed to four important project aspects:

1. Strategic Objectives

2. Project KPI

3. Ethical aspects

4. Risk management

STRATEGIC OBJECTIVES

Table 1 lists those strategic objectives of SCOREwater that are relevant for this Deliverable and gives a brief explanation on the specific contribution of this Deliverable.

Table 1. Stocktaking on Deliverable's contribution to reaching the SCOREwater strategic objectives.

Strategic objective	Contribution by this Deliverable
SO6 Increase citizen involvement and engagement in the transition to a water-smart, resilient society by increasing the public perception of the value of water and public engagement and commitment.	This deliverable is about drawing the attention of children and their families to how we affect the quality of water and how much water we actually consume. Through program activities for both visitors to the science center, targeted programs for teachers and students, and digital programs for families to experience from home this deliverable also helps to draw the attention of a broad target group to how we can contribute to change and more sustainable water use.

PROJECT KPI

Table 2 lists the project KPI that are relevant for this Deliverable and gives a brief explanation on the specific contribution of this Deliverable.

Table 2. Stocktaking on Deliverable's contribution to SCOREwater project KPI's.

Project KPI	Contribution by this deliverable
KPI 17. Number of visitors in science center installations, school programs and serious game on sustainable water use.	Visitors to Universeum during 2021: **225 000** (closed during most of the year due to the pandemic) Unique users of Waterworld, the digital program, during the first 6 months: **300** Teachers and students that helped us assess the school activities (launched in March 2022): **500**

ETHICAL ASPECTS

Table 3 lists the project's Ethical aspects and gives a brief explanation on the specific treatment in the work leading up to this Deliverable. Ethical aspects are not relevant for all Deliverables. Table 3 indicates "N/A" for aspects that are irrelevant for this Deliverable.

Table 3. Stocktaking on Deliverable's treatment of Ethical aspects.

Ethical aspect	Treatment in the work on this Deliverable
Justification of ethics data used in project	N/A
Procedures and criteria for identifying research participants	N/A
Informed consent procedures	N/A
Informed consent procedure in case of legal guardians	N/A
Filing of ethics committee's opinions/approval	N/A
Technical and organizational measures taken to safeguard data subjects' rights and freedoms	N/A
Implemented security measures to prevent unauthorized access to ethics data	N/A
Describe anonymization techniques	N/A
Interaction with the SCOREwater Ethics Advisor	The work plan for this deliverable was shared with our ethics advisor. No objections to the plans. Only a request to clarify that: All the procedures mentioned for this deliverable follows the REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation). For further information on the use of personal information you may contact Universeum AB Organization number: 556548-7427 VAT number: SE556548742701 Telephone (exchange): 031–335 64 00 E-mail address: info@universeum.se Postal address: Universeum AB

Box 14365 400 20 Gothenburg Visiting address: Södra vägen 50 412 54 Gothenburg or visit: https://www.universeum.se/dataskyddspolicy/

RISK MANAGEMENT

Table 4 lists the risks, from the project's risk log, that have been identified as relevant for the work on this Deliverable and gives a brief explanation on the specific treatment in the work leading up to this Deliverable.

Table 4. Stocktaking on Deliverable's treatment of Risks.

Associated risk	Treatment in the work on this Deliverable
Risks of delay in implementation of activities due to covid-19 (Universeum not open, schools restricted from visiting…)	In order to have pilot classes test and evaluate the activities, we had to postpone the delivery for three months. That way the schools were able to visit our closed Universeum (due to the pandemic) in safe ways even though a bit more time consuming.