FINAL SOCIAL GAME AND IMPLICIT USER INFORMATION TECHNIQUES (ACCOMPANYING DOCUMENT TO THE PROTOYPE)

SmartH2O

Project FP7-ICT-619172

Deliverable D4.4 WP4

Deliverable
Version 1.1 – 30 Sept 2016
Document. ref.:
D44.POLIMI.WP4.V1.13

Programme Name:	ICT
Project Number:	619172
Project Title:	SmartH2O
Partners:	Coordinator: SUPSI Contractors: POLIMI, UoM, SETMOB, EIPCM, TWUL, SES, MOONSUB, UPV, EMIVASA
Document Number:	smarth2o. D4.4.POLIMI.WP4.V1.13
Work-Package:	WP4
Deliverable Type:	Document
Contractual Date of Delivery:	30 September 2016
Actual Date of Delivery:	30 May 2017
Title of Document:	Final social game and implicit user information techniques
Author(s):	Piero Fraternali, Chiara Pasini, Luigi Caldararu, Jasminko Novak, Mark Melenhorst, Isabel Micheel, Luigi Dassenno, Giuseppe Pasceri, Alesandro Facchini, Mattia Brusamento
Approval of this report	
Summary of this report:	This document
History:	see version history table
Keyword List:	social games, gamification, incentive models,
Availability	This report is public

This work is partially funded by the EU under grant ICT-FP7-619172

Disclaimer

This document contains confidential information in the form of the SmartH2O project findings, work and products and its use is strictly regulated by the SmartH2O Consortium Agreement and by Contract no. FP7- ICT-619172.

Neither the SmartH2O Consortium nor any of its officers, employees or agents shall be responsible or liable in negligence or otherwise howsoever in respect of any inaccuracy or omission herein.

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7-ICT-2013-11) under grant agreement n° 619172.

The contents of this document are the sole responsibility of the SmartH2O consortium and can in no way be taken to reflect the views of the European Union.

Document History

Version	Date	Reason	Revised by
0.1	30/06/2016	DDP ready	M. Melenhorst (EIPCM) P. Fraternali (POLIMI) I. Micheel (EIPCM)
0.2	17/08/2016	Added methodology section for user feedback section	M. Melenhorst (EIPCM)
0.3	04/09/2016	Added first log analysis results for Valencia	I. Micheel (EIPCM) M. Melenhorst (EIPCM)
0.4	14/09/2016	Section 2.1 consumer portal and 2.2 mobile version, Drop card game, social game data	I.Micheel (EIPCM), P Fraternali C. Pasini (POLIMI)
0.5	19/09/2016	Added user feedback results Valencia	M. Melenhorst (EIPCM) I. Micheel (EIPCM)
0.6	20/09/2016	Added user feedback results Swiss case study	M. Melenhorst (EIPCM) I. Micheel (EIPCM)
0.7	23/09/2016	Added log analysis results	I. Micheel (EIPCM) M. Melenhorst (EIPCM)
0.8	23/09/2016	Updated social game usage data Updated design and implementation of social games in SmartH2O	S. Dumitru (SETMOB) L. Caldararu (SETMOB)
0.9	25/09/2016	Added introduction and executive summary	P. Fraternali C. Pasini, S Herrera (POLIMI)
0.91	26/09/2016	Resolve final issues, formatting	M. Melenhorst (EIPCM) I. Micheel (EIPCM)
1.1	26/09/2016	Final version	A. Rizzoli (SUPSI)
1.11	23/05/2017	Address reviewer comments	M. Melenhorst (EIPCM)
1.12	24/05/2017	Drop learning curve	C.Pasini (POLIMI)
1.13	30/5/2017	Final quality check	A.Rizzoli (SUPSI)

Table of Contents

Executive Summary

This report is the accompanying document to deliverable *D4.4) Final social game and implicit user information techniques*, which is described as follows in the Description of Work:

> *"The deliverable is the **final prototype** of the game implemented on the selected client platform and modified with respect to the first release on the basis of the use/user feedbacks. It also provides information on the social data analysis: analysis of the data collected through the SmartH2O social game and assessment of the adopted incentive system; it also contains the final implementation of the user experience provided by the social games, as resulting from the feedback collected during usage."*

The actual deliverable consists of a physical item (the Drop! Card Game) and of a set of software modules, which collectively constitute the social games of the SmartH2O approach. The software modules released with this deliverable comprise:

- An industrial-quality version of the Drop! Card game, which has been printed in 2.500 copies by Moonsubmarine and used as a reward in the Swiss and Spanish pilots.
- An improved version of the Drop!TheQuestion mobile Trivia game for Android, which now features more than 470 questions on water, designed based on the early feedback of test users and translated in multiple languages (English, Italian, Spanish, Valencian).

According to the original concept of SmartH2O, i.e., the idea of giving the user a comprehensive, homogeneous, and stimuli-rich water awareness environment, the social games of SmartH2O have been integrated in the broader context of the SmartH2O Platform, so that consumers are offered a variety of ways to learn how to improve water consumption in a playful way. Such integration has requested the extension of existing components and the development of new components for the Smarth2O platform, of which the most relevant ones are:

- The user registration and sign-in process have been extended so that now the user can register either the Consumer Portal or in the Drop!TheQuestion mobile Trivia game and the two identities are reconciled and managed correctly.
- The Gamification Engine, which contains the business rules for computing the users' achievement and assigning rewards, has been duly extended to process also actions that occur in the Drop!TheQuestion mobile game, so that users perceive a continuous experience spanning both the Web portal and the mobile game.
- The Consumer Portal user experience, which has been extended to show also actions performed by the user in the Drop!TheQuestion mobile game and the point achieved in that way.

This deliverable also assesses the adopted incentive model that has been explained in detail in D4.3. After five months of deployment, a questionnaire has been sent out, and user logs have been analysed. Results are promising in that both in perception and in behaviour users confirm the appropriateness of the designed SmartH2O incentive model and its implementation.

The report is structured as follows:

- Section 1 provides a brief introduction on the status of the development and assessment of the SmartH2O social games.
- Section 2 reports the achievements of the social game development task, both in terms of the production and use of the Drop! card game and of its digital extension Drop!TheQuestion, which has been integrated in the Consumer Portal
- Section 3 summarizes the outcome of the analysis of the usage data for Drop!TheQuestion mobile game.
- Section 4 describes the procedure and results of the evaluation of the consumers' feedback to the SmartH2O incentive models

- Section 5 contains the references of the work described in the deliverable.
- Appendices contain collateral information on the software prototype and report
    - Appendix 1 contains the new extended database of Drop!TheQuestion Trivia.
    - Appendix 2 contains the questionnaire used for evaluating the response of the consumers to the SmartH2O incentive model.
    - Appendix 3 contains the messages used to engage the consumers in the evaluation exercise.

1 Introduction

Deliverable D4.4 (the software prototype) and this accompanying document assume knowledge of the main concept of the SmartH2O methodological approach and system architecture, which may be collected from the following previous deliverables:

- D4.1 FIRST SOCIAL GAME AND IMPLICIT USER INFORMATION TECHNIQUES (M9): it contains the original definition and early design of the Drop! card game and of the Drop!TheQuestion mobile game, which digitally extends the card game.
- D4.3 INCENTIVE MODELS AND ALGORITHMS (M24): it overviews behavioural change and gamification theory of SmartH2O and points out how these theoretical notions have informed the game design.
- D6.2 PLATFORM ARCHITECTURE AND DESIGN (M9): it describes the original technical architecture of SmartH2O, introducing the main components and interfaces.
- D6.3 PLATFORM IMPLEMENTATION AND INTEGRATION - INITIAL PROTOTYPE (M12) and D6.4 PLATFORM IMPLEMENTATION AND INTEGRATION - SECOND PROTOTYPE (M24) are prototypes, with an accompanying document that permits the reader to track the technical and functional evolution of the SmartH2O platform.
- D7.2 VALIDATION REPORT is the first report of the Swiss and Spanish case studies validation and describes the deployment of the smart meter monitoring system and social awareness app, and a first evaluation.

Related to the present deliverable is also:

- D7.3 FINAL OVERALL VALIDATION AND IMPACT REPORT (M36), which will put all the pieces together and describe the outcome of the assessment of the effectiveness of the Smarth2O social elements considered as a conjunct over the entire lifespan of the project.

The results documented in this report stem from the process of deploying the social games to the real consumers of two utility companies: SES in Canton Ticino and EMIVASA in Spain. The two case studies have different roles and have been conducted at different times:

- The Swiss Case study has a limited number of potential target users (400), has been assigned the role of early testing the main features of the SmartH2O approach at small scale, and therefore its roll-out comes first in the project timeline.
- The Spanish case study has a potentially larger number of target users (the entire consumer base of EMIVASA amounts to 800.000 users), has the role of testing the scalability of the SmartH2O approach and therefore comes second in the project timeline.

Table 1 recalls the times at which the users in the two case studies have been exposed to the SmartH2O social games.

Table 1. Timeline of deployment of social games to users.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Swiss case study																													
Consumer Portal Basic																													
Consumer Portal Advanced																													
Drop Card Game																													
DropTheQuestion																													
Spanish case study																													
Consumer Portal																													
Drop Card Game																													
DropTheQuestion																													

Notice that the temporal gap between the deployment of the Consumer Portal and the digital extension of the Drop! card game is due to integration overhead required by the much more

complex architecture of the EMIVASA deployment, where the users have a single registration point (the Virtual Office native application of the company) and their identity must be automatically communicated to the SmartH2O applications.

2 Design and implementation of social games in SmartH2O

In SmartH2O the notion of “social game” is implemented in three different instantiations, so to achieve a holistic user experience capable of engaging users into a virtuous cycle of water saving.

- The **Consumer Portal** is where users go to check their actual consumption, set water saving goals, and learn how to improve behaviour. All activities are tracked and submitted to a gamification back-end, called the Gamification Engine, which contains the business rules for transforming the users’ actions into points, badges and rewards. All the tracked activities are turned into a social game, where users compare/compete with one another to attain social and material rewards (see D.4.3 for the motivation theory and the related design of the SmartH2O incentive model).
- The **Drop! card game**, which is a reward granted to the users of the Consumer Portal upon completion of their initial registration and content browsing activities.
- The **Drop!The Question digital mobile game**, which is thematically coordinated with the Drop! card game and allows the players of the card game to change the outcome of a round by using the game digital extension (actually, by responding to quizzes about water and to water-related trivia).

The following subsections describe the new/revised features (deployed at M30) for these three instantiations of the social game concept.

2.1 Consumer Portal

The gamified SmartH2O portal in its current form (Figure 1) has been deployed for 10 months in the Swiss case study and 5 months in the Spanish case study. New gamification features will be released this autumn, which are described in section 2.1.2 and onward. In addition, a mobile version of the portal will be published in conjunction with the new release (Section 2.2).

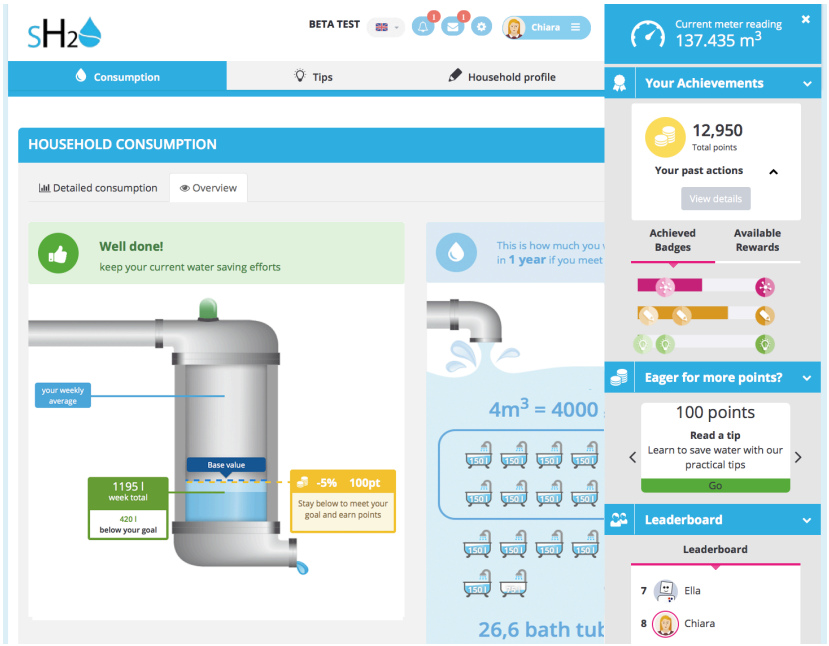


Figure 1. Current version of the SmartH2O portal.

2.1.1 Gamified portal

The current version of the Gamified SmartH2O portal as it is deployed both in the Spanish and the Swiss case study provides the following main features (see also D4.2):

- Detailed consumption visualization (interactive bar chart).
- Overview consumption visualization (pipe metaphor).
- Consumption goals (pre-defined system goals and self-set goals).
- Water consumption alerts, in the overview visualization and sent as notifications.
- Water consumption tips (textual, videos and info graphics).
- Points and badges for actions on the portal, categorized into 4 thematic areas:
    - Water saving.
    - Water saving insights.
    - Profiling.
    - Engagement.
- Overall and weekly leaderboard.
- Rewards page.
- Weekly and overall competitions in Spanish case study.
- Achievements panel with current meter reading, past actions, achieved badges and rewards, suggested actions and leaderboard excerpt.
- Household profile.

In addition, users in the Swiss case study can already connect their SmartH2O portal account to the Drop!TheQuestion mobile game (see Section 2.4).

2.1.2 Social extensions

New social gamification features have been developed and planned, based on the incentive model described in D4.3. Once released, they will enable users to better compare their achievements with other users inside the portal on a neighbourhood map, and to share their actions and achievements outside of the SmartH2O portal via the social networks Facebook and Twitter or via E-Mail, and invite friends and family to join in exchange for points.

As it has been described in D4.3, sharing water saving results via Twitter, Facebook and e-mail contributes to the social norm in the community. More specifically, the achievements communicate both an injunctive social norm message (beliefs about social approval) and a descriptive social message norm (beliefs about prevalence of certain behaviour in the group), which combined is an effective strategy to change behaviour [Schulz et al., 2014].
Second, the social extensions serve the purpose of attracting attention to the portal, by sharing portal invitations and achievements on social networks that are read by the friends of the users. This is expected to increase the number of registered users.

2.1.2.1 Comparing achievements with other SmartH2O users

On the new neighbourhood map, users can compare side-by-side their achievements with households in their neighbourhood. On an opt-in basis, they can share their geo-location with others, and by clicking on any of the shown location markers, they can view a summary of their neighbour's latest achievement next to their own. The feature seeks to provide new social norm-based incentives in addition to the leaderboard, that only compares and ranks users based on points. Sharing achievements changes the beliefs of a group about the prevalence of water saving behaviour (e.g. the descriptive social norm, [Schulz et al., 2014]).

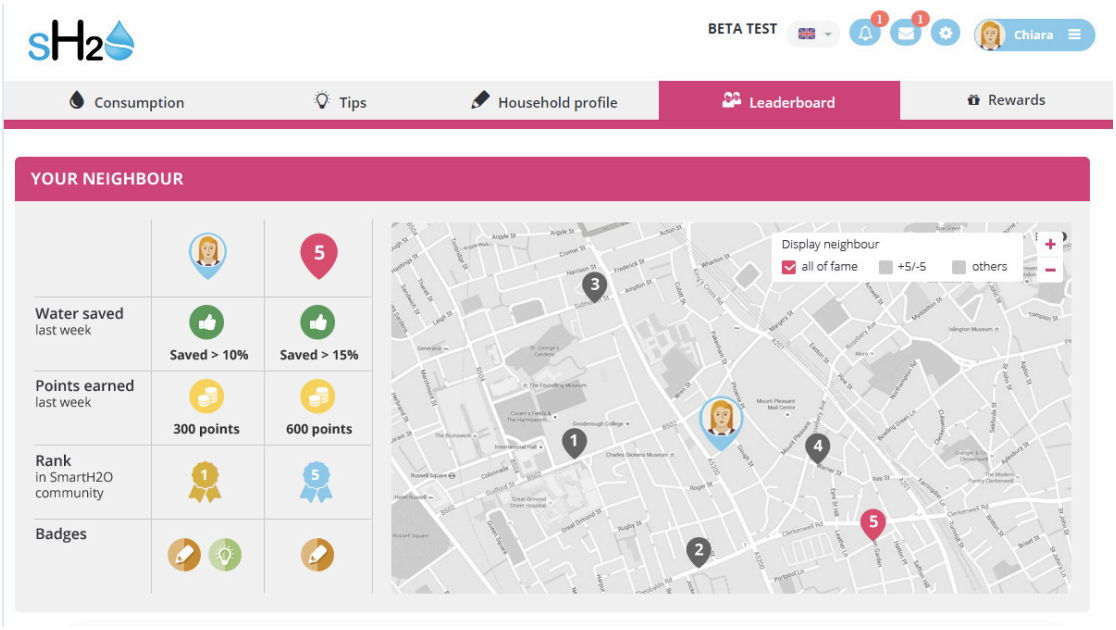


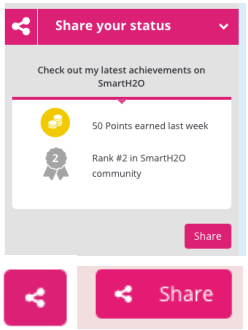
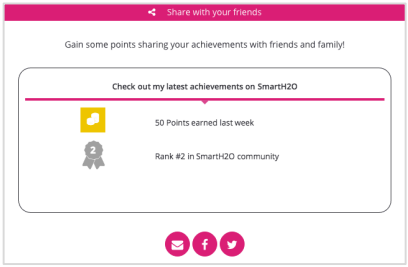
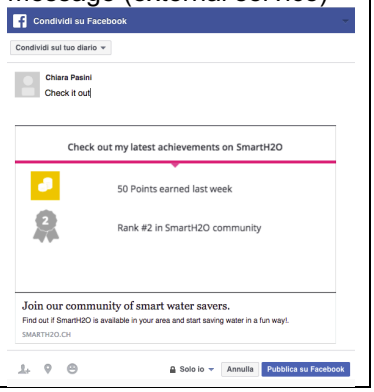
Figure 2. Neighbourhood map for comparison with other SmartH2O users.

2.1.2.2 Sharing achievements and invitations outside of the SmartH2O portal

Thanks to the social extension, users can now share their achievements outside the SmartH2O portal. All achievements can be shared as often as users wish, with the restriction that for each shared action they only earn points once a day per channel. E.g., if a user shared the same water saving tip 3 times via mail and 2 times via Twitter on the same day, they would receive points once for sharing the tip via e-mail and once for sharing via Twitter. The sharing of the weekly achievements status only earns users' points once per week per channel. The following subsections show the different types of actions and achievements that can be shared.

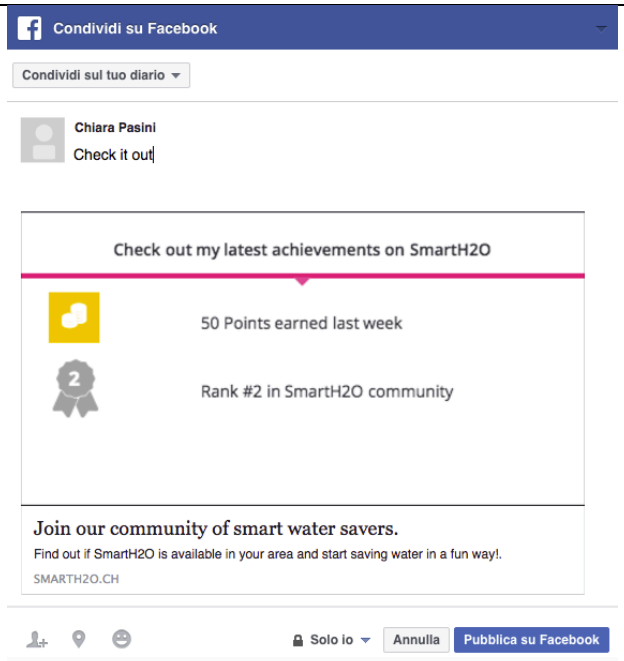
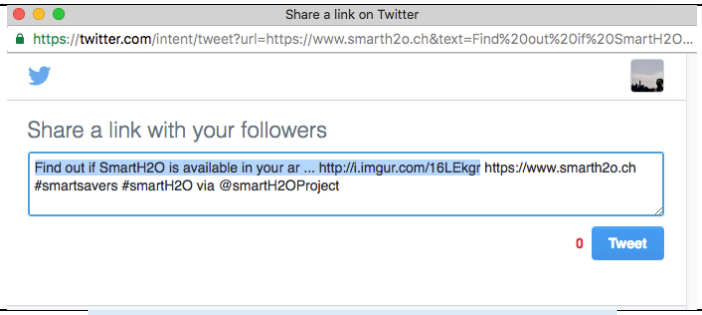
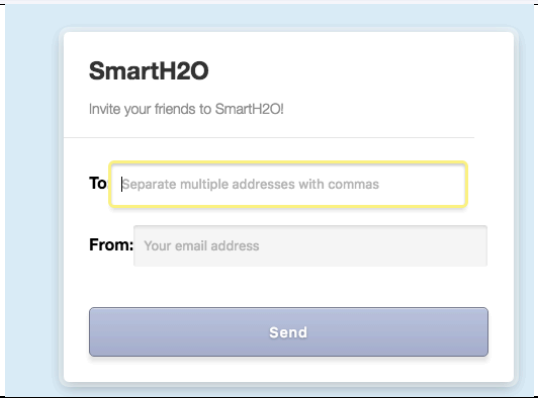
The social sharing options will be available throughout the portal, accessible and recognizable via a standardized sharing button. In a second step, users can select the sharing channel, and thirdly customize the sharing message if they want to after connecting to the respective service.

Table 2. Social sharing in three easy steps.

1. Share button	2. Select channel (pop-up)	3. Connect and customize message (external service)
		

Sharing channels

Users can share their achievements and send invitations via Facebook, Twitter and e-mail:

Sharing via Facebook	
Sharing via Twitter	
Sharing via e-mail	

Sharing your consumption

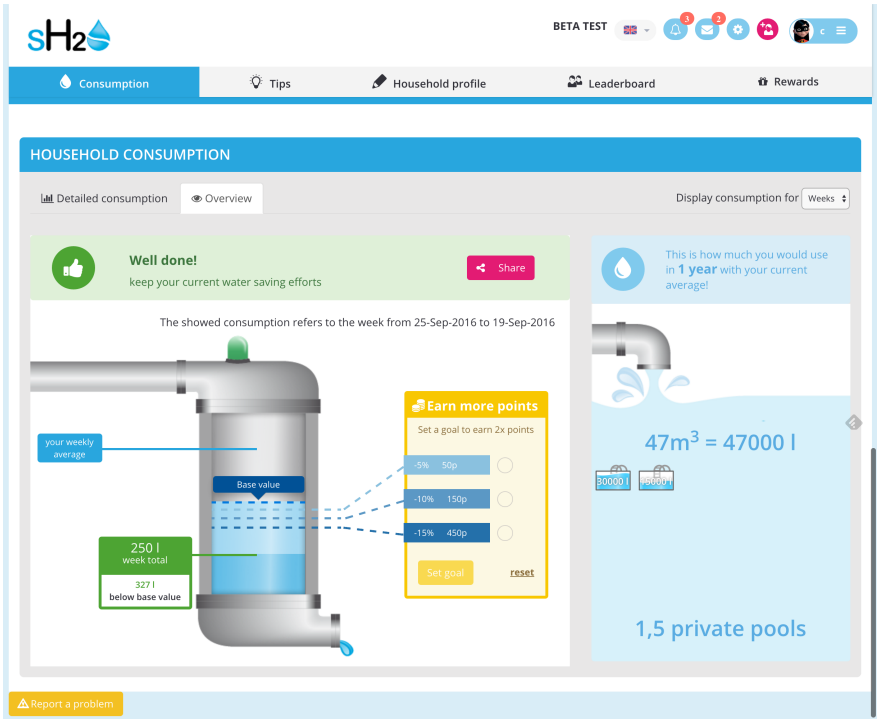
In the consumption overview, users can share their latest consumption achievements consisting of a screenshot of the current pipe visualization and a default sharing message. The default sharing messages is composed of four different elements and differs depending on the achievement:

Table 3. Composition of default "Share consumption"-message.

Part 1	*[green]* Hooray – I am saving water at home! *[orange]* Oh no – I am using more water at home than I should. *[red]* Oh no – I am wasting way too much water at home.
Part 2	*[all]* I have spent X l of water today/this week/this month.
Part 3	*[If green & goal set]* I can still meet my daily/weekly/monthly water saving goal of X % compared to last year's consumption! *[If green & no goal set]* I can still save X % of water today/this week/this month compared to last year's consumption. *[if orange / red]* That means I am wasting X % of water today/this week/this month compared to last year's consumption.
Part 4	*[all]* Do you know how much water you are spending at home every day? Find out on the SmartH2O portal.

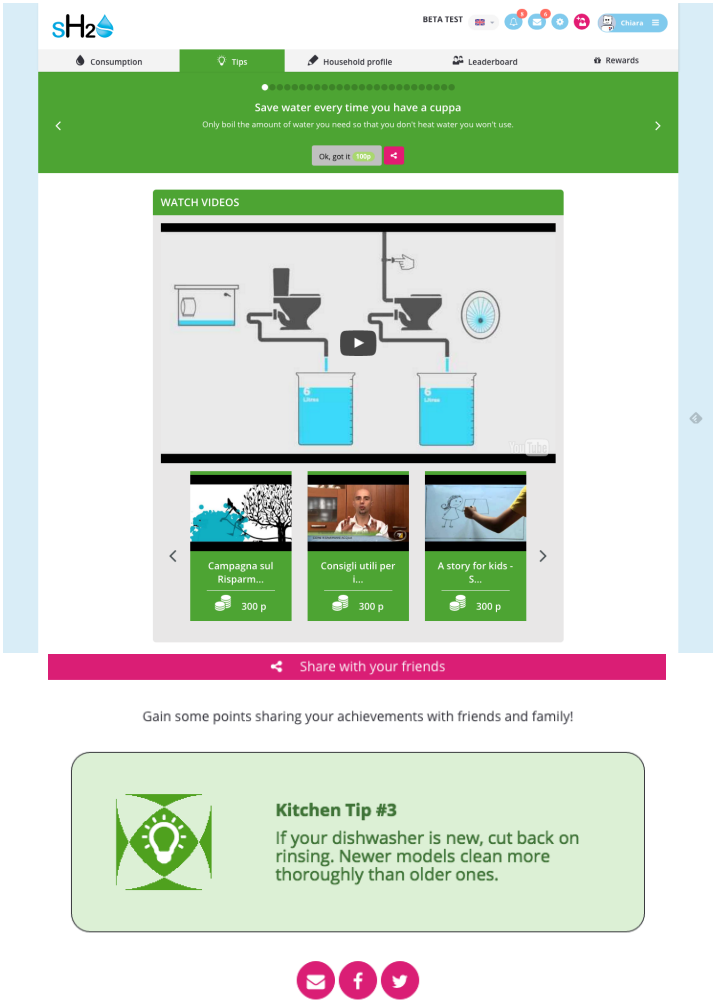
In the scenario below (green, no goal set), the default message would be:

"Hooray – I am saving water at home! I have spent 250l of water this week. I can still save 15% of water this week compared to last year's consumption. Do you know how much water you are spending at home every day? Find out on the SmartH2O portal."



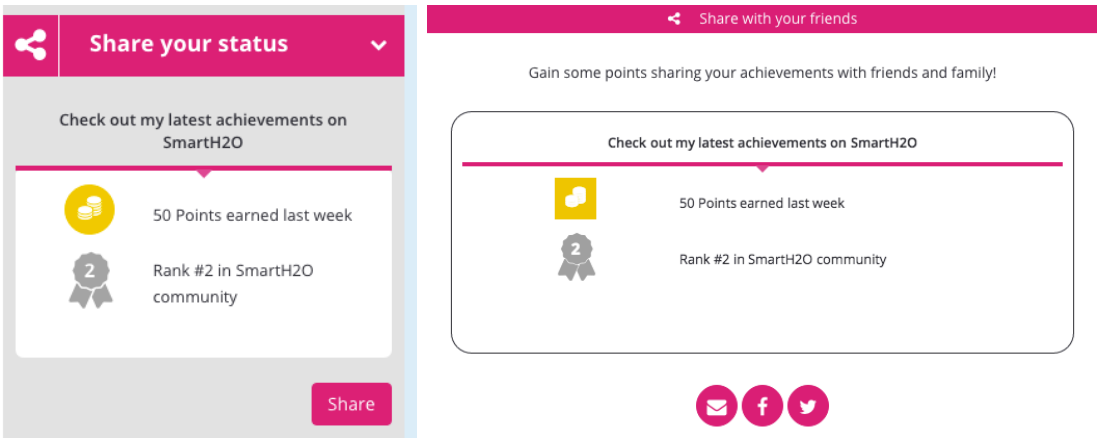
Sharing a water saving tip

On the tips page, users can share textual water saving tips.



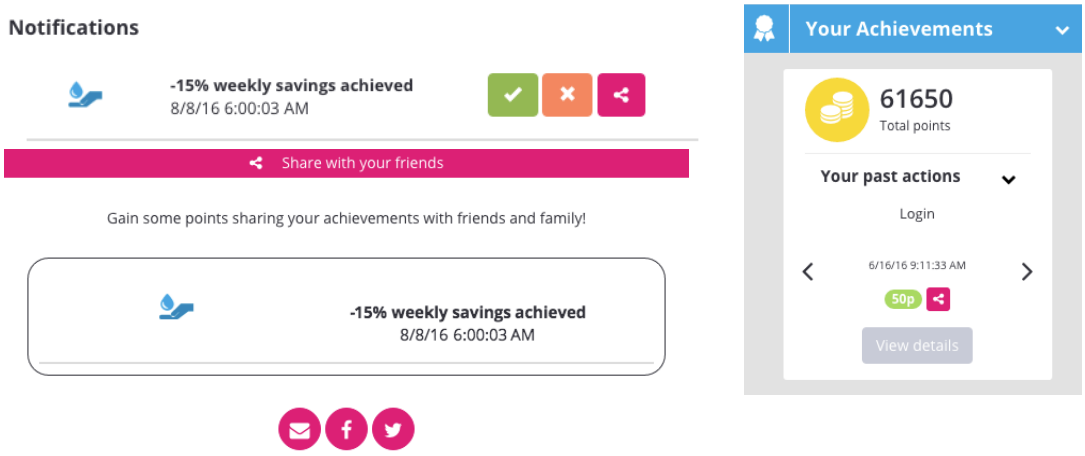
Sharing your weekly status (summary of achievements)

Each week, SmartH2O generates a summary of achievements for each user, including points earned, water saving achievements, community rank, earned badges and claimed rewards.



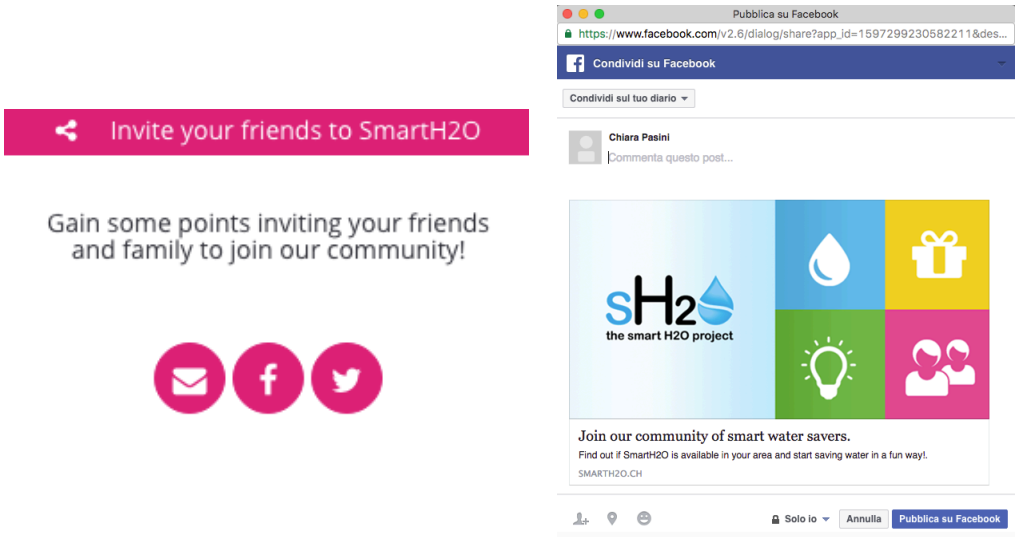
Sharing single achievements and actions

Users can also share achievements out of notifications they receive and past actions that are listed in the achievements panel.



Inviting friends and family

Even without sharing achievements, users can reach out to their social networks by inviting them to join the portal and its community of water savers. When achievements are shared, they also include a link back to the portal and a motivational statement to invite friends and family to join.

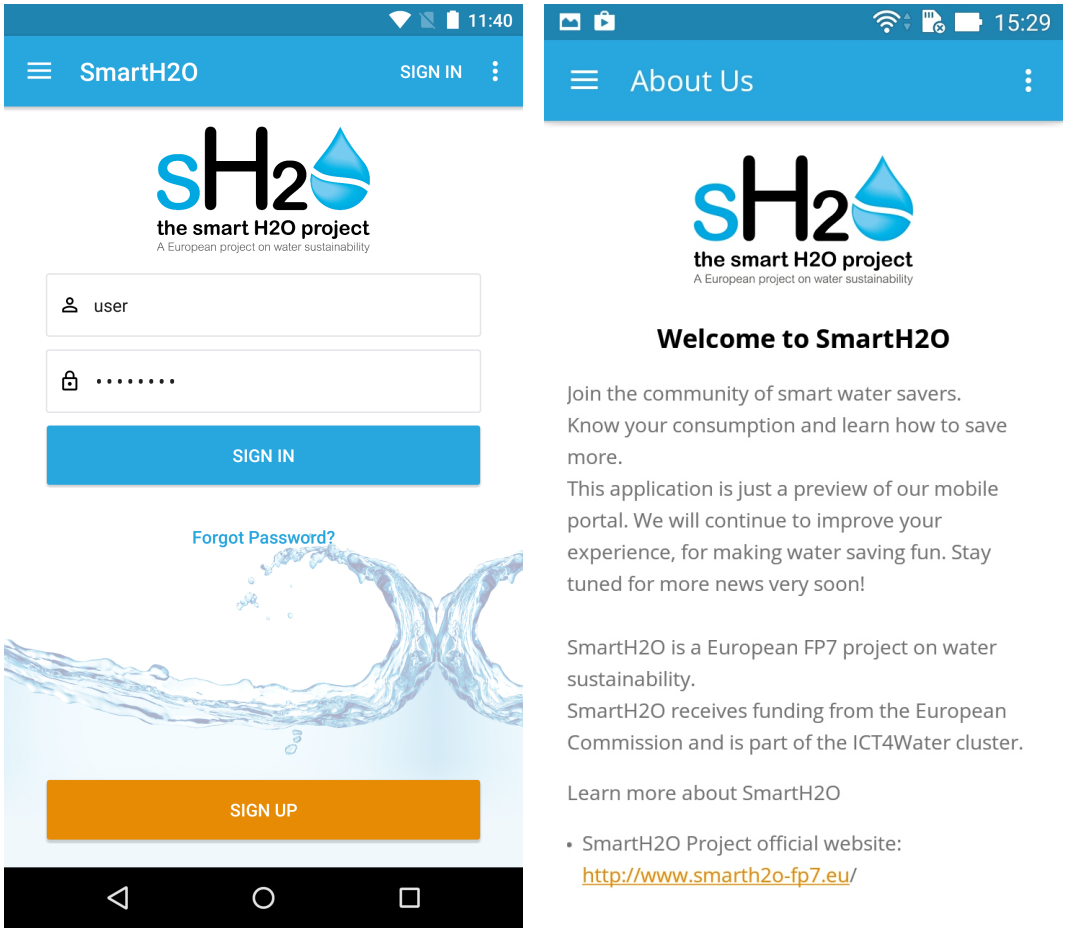


2.2 Mobile version of the consumer portal

In addition to the web version, a mobile version of the Gamified SmartH2O portal has been conceptualized and implemented. It will be an added bonus for users, providing them easy on-the-go access to their water consumption even when they are not at home or in front of a computer. The app allows users also to get alerted about high consumption and receive notifications anywhere and everywhere.

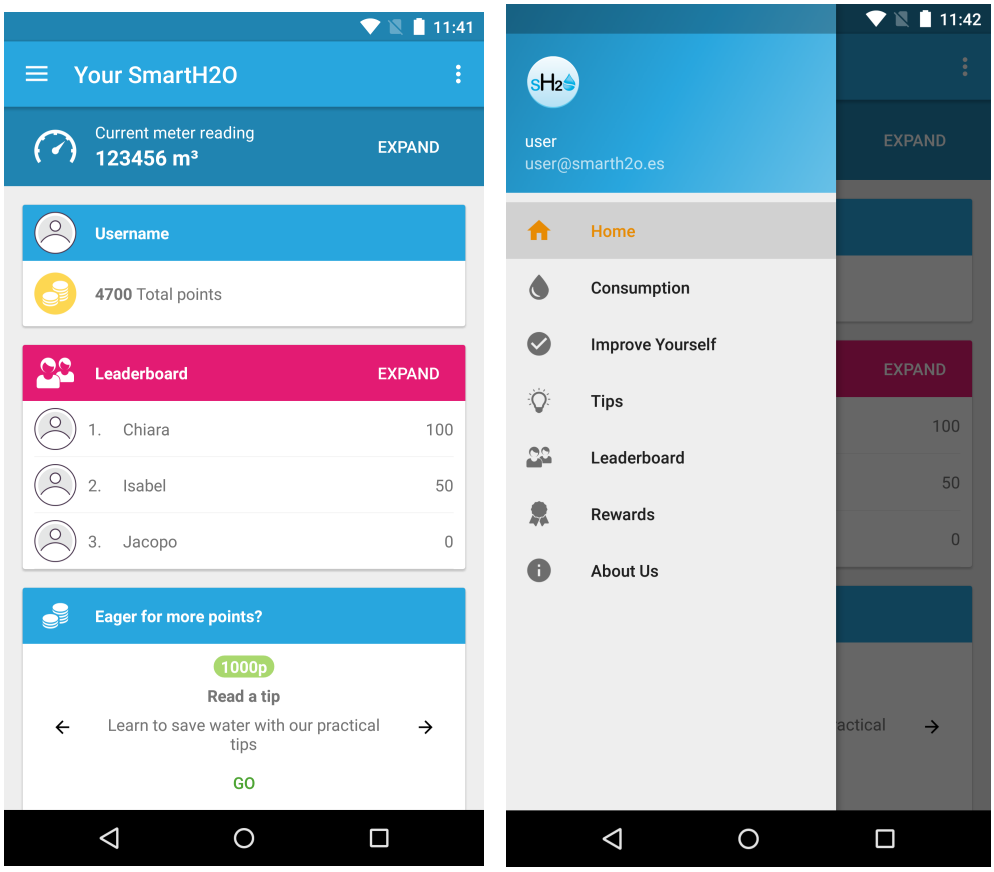
The SmartH2O mobile app will be available free of charge for Android mobile devices on Google Play. It will be advertised in a separate email campaign targeted at existing users, and used as an asset to market the main portal.

Public screen



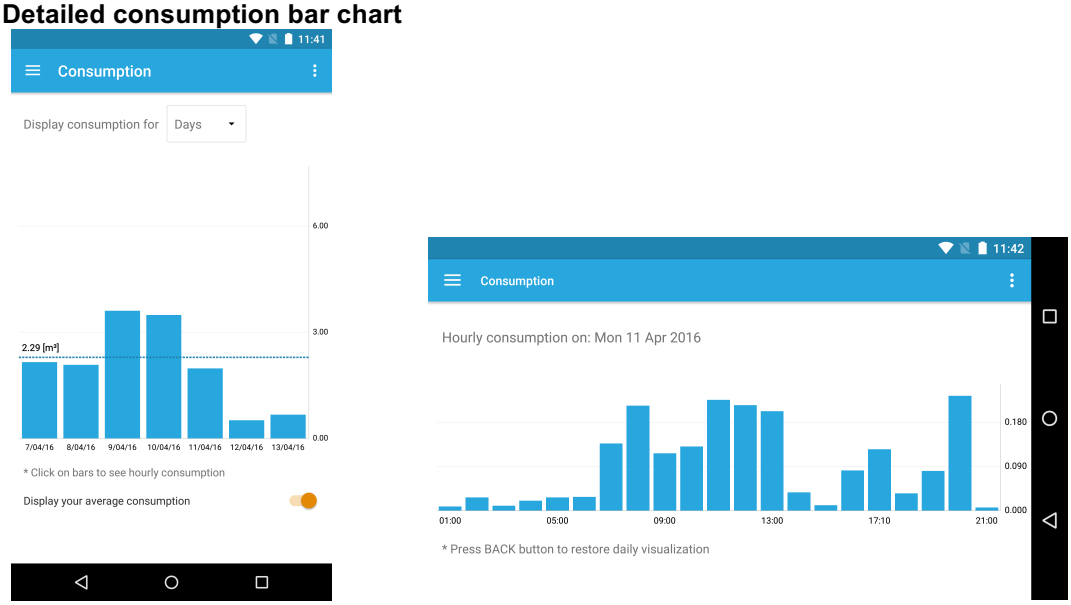
The public screen of the mobile app provides a login mask (left) and basic info about the project (right) which also links to the official project website. To sign-up, users are redirected to the web portal. After signing up on the web portal, all users receive an email that points them to the mobile app, providing them with temporary mobile credentials, and, in case they haven't yet downloaded the app, it also provides a download link to Google Play.

Home screen and navigation



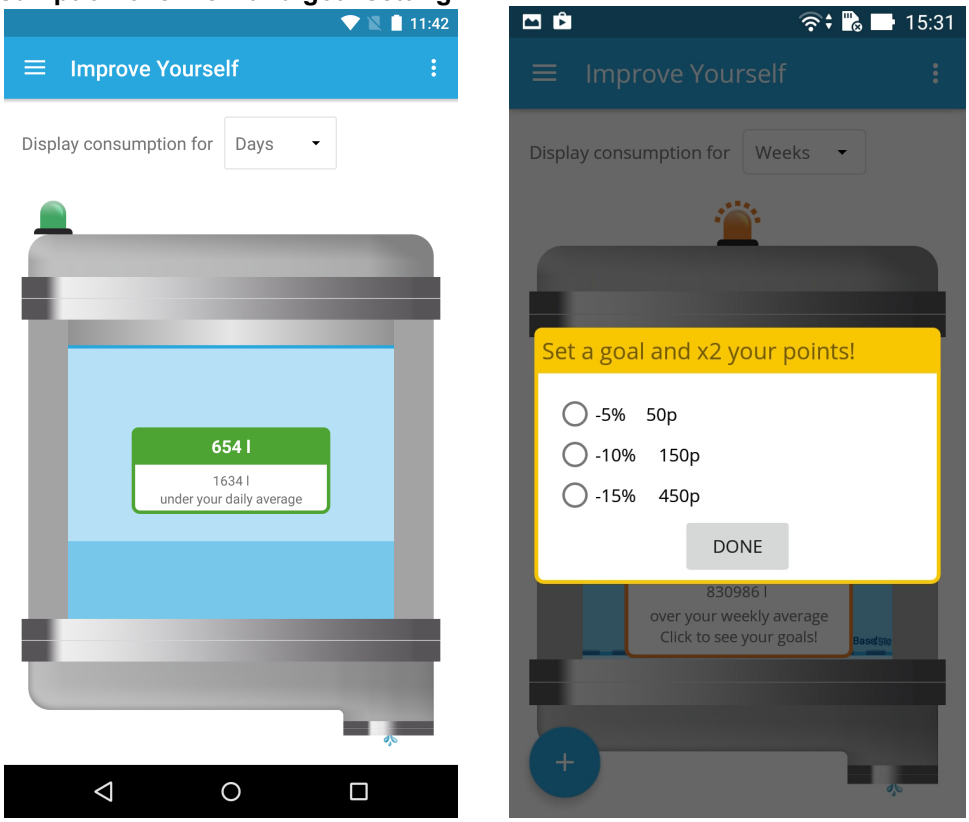
On their home screen (left), users immediately see their current meter reading, and their gamification profile: the number of points they have earned, their rank on the leaderboard, and actionable suggestions what else they can do on the portal to earn points.
The in-app navigation menu (right) is accessible following the Android design pattern widely familiar to Android users. There, users can navigate to the main app elements: their consumption, the overview visualization with the goal setting mechanisms (“improve yourself”), water consumption tips, the leaderboard and the rewards page.

Detailed consumption bar chart



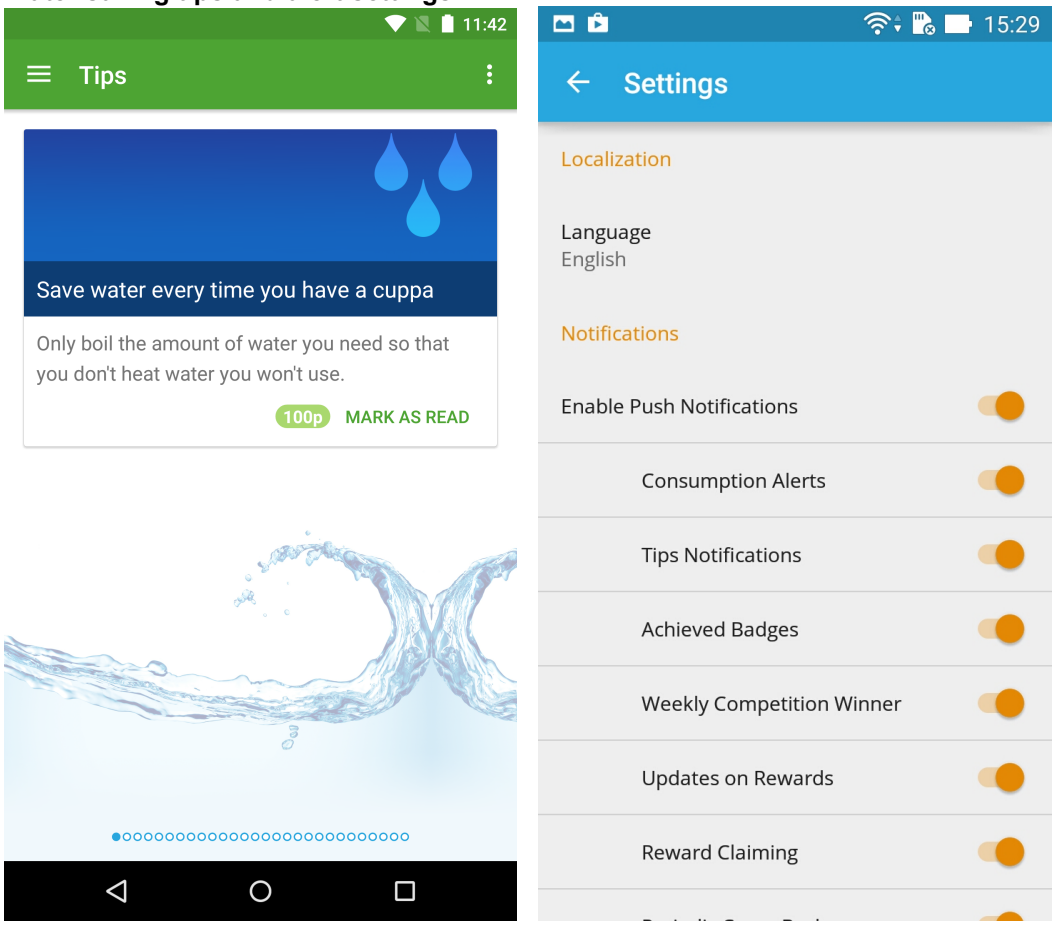
Users can view, explore and filter the bar chart of their consumption (left). They can also display their average consumption. Flipping the screen will trigger the daily consumption view (right).

Consumption overview and goal setting



The pipe-visualization was adapted to the mobile screen and is presented as the main way to keep track of and improve one's water consumption (left). This is emphasized by adding it to the app as an extra menu item named "Improve yourself". Users can set their goal to receive more points in exchange for their water saving efforts (right).

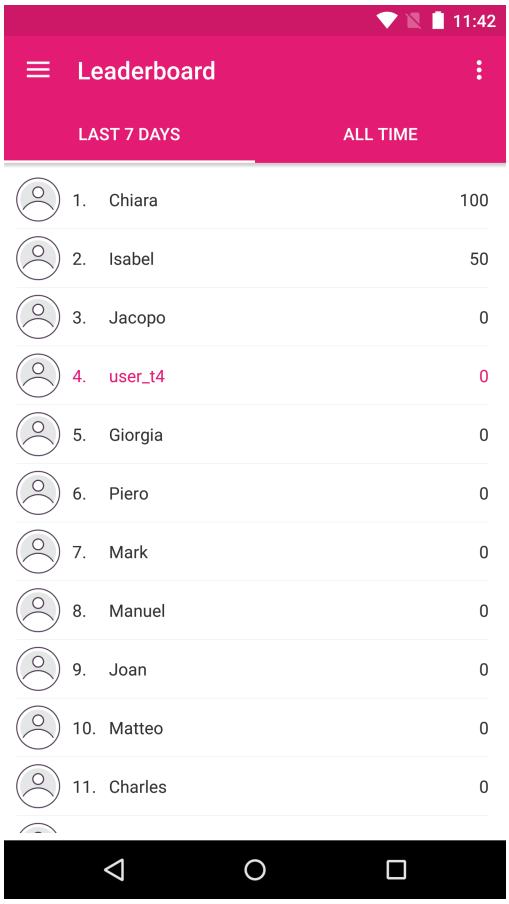
Water saving tips and alert settings

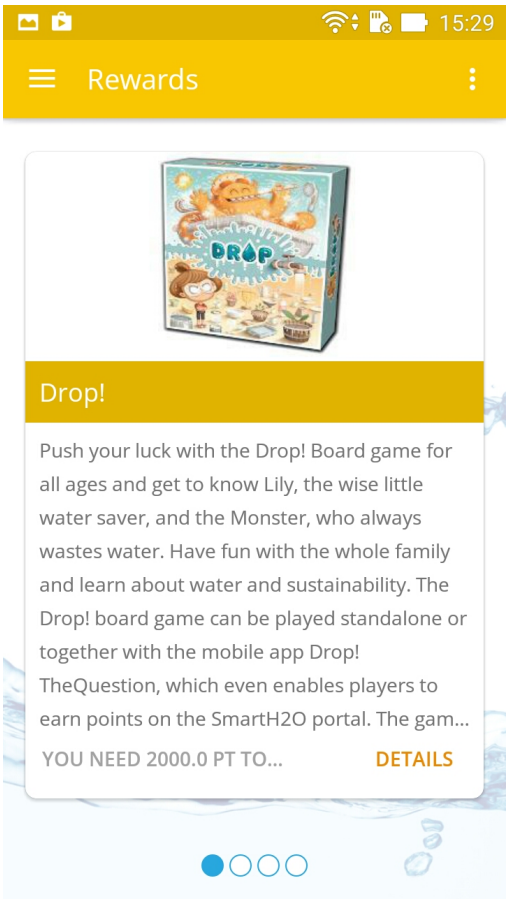


Tips are presented in a separate page that can be navigated by a simple swipe left / right (left). Like in the web app, users can mark tips as “read” and receive points in exchange for each read tip.

In the settings of the app (right), users can turn and off notifications e.g. for consumption alerts, or to receive tips and news updates on SmartH2O achievements on a regular basis.

Gamification elements: Leaderboard and rewards overview





The leaderboard page can be navigated by a tap on the respective leaderboard type: Last 7 days or All time and the he user's own position is highlighted (left).
Rewards can be viewed and selected in a slider on a separate page (right), using a swipe left / right gesture to view different rewards and tap on details to find out more about each reward.

2.3 Drop! Card Game

Deliverable D4.1 FIRST SOCIAL GAME AND IMPLICIT USER INFORMATION TECHNIQUES described the design of a game concept (called Drop!) to be used alongside the SmartH2O platform to improve water awareness in users.
In this report we document the production and distribution status of the card game.
The Card game has been produced in 2500 copies.
Each copy of the card game is wrapped in a box, shown in Figure 3, containing:

- 40 numbered positive (Lily) cards.
- 10 Negative (Monster) cards.
- 50 points markers.
- 1 game instruction sheet (the English version is shown in Figure 4, other languages include: Italian, German, Spanish, and Valencian).

Figure 3. final version of the Drop! card game.

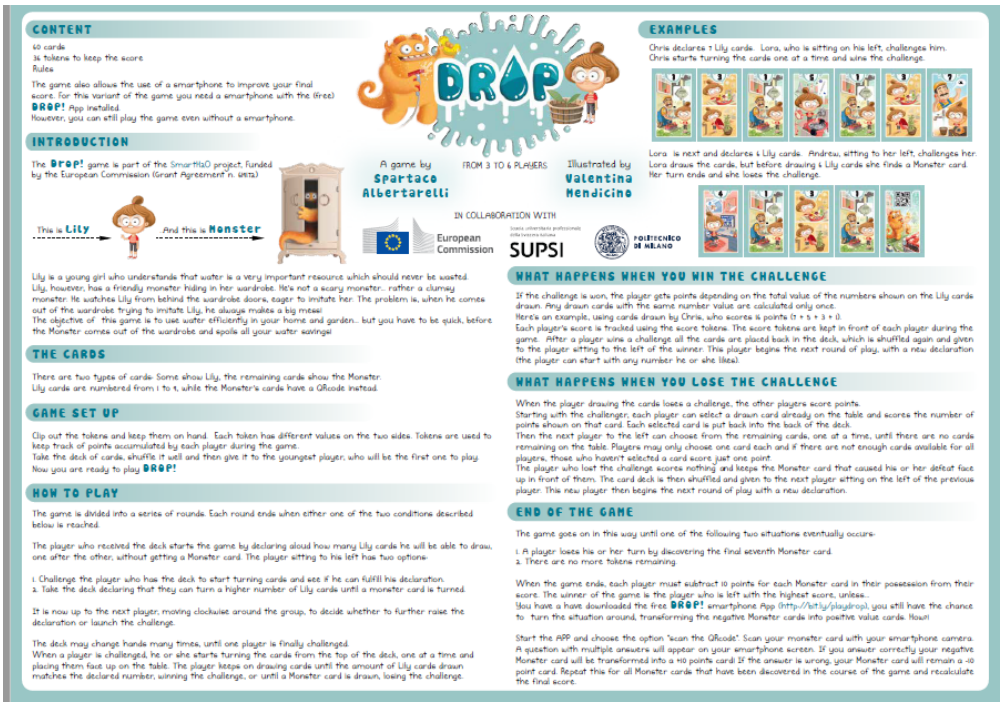


Figure 4. The Drop Instruction sheet (English version).

The produced copies of the Drop! game have been used in the two pilots and in testing activities as follows:

- 500 copies have been delivered to SES and used for rewards and promotional activities in the Tegna pilot.
- 1500 copies have been delivered to EMIVASA and used for rewards and promotional activities in the Valencia pilot
- The remaining copies have been retained for testing and dissemination purposes, including use with pilot schools, and distribution during promotional events such as the SmartH2O Summer School, the European Water Utility Week, and the “G come Giochiamo” game Fair.

2.4 Drop!TheQuestion Digital Game

The implementation of the Drop!TheQuestion digital extension of the Drop! card game has been finalized with the integration into the SES and Aguas de Valencia pilots. This has required the development of the following additional functions

- **Question editor**: a Web application for the utility content manager, who can edit the questions of the Drop! TheQuestion Digital Game and set their properties (answers, correct answer, language, difficulty level, etc). Figure 5 shows the home page of the interface of the Question Editor and Figure 6 shows the question editing page of the Question Editor.

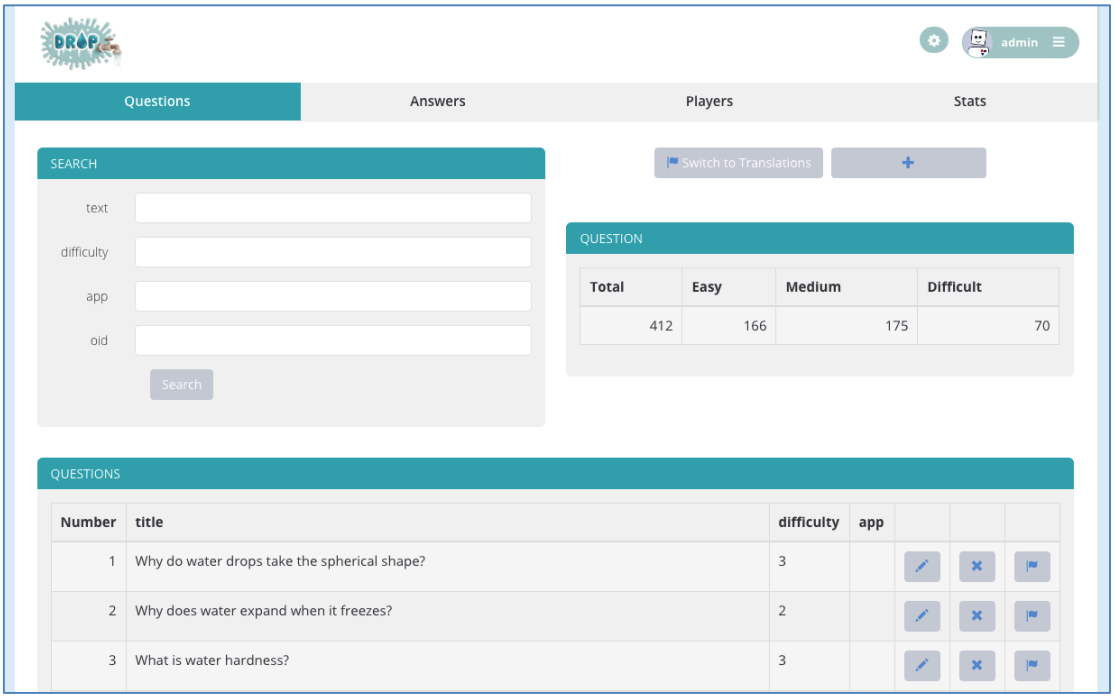


Figure 5. Home page of the interface of the Question Editor.

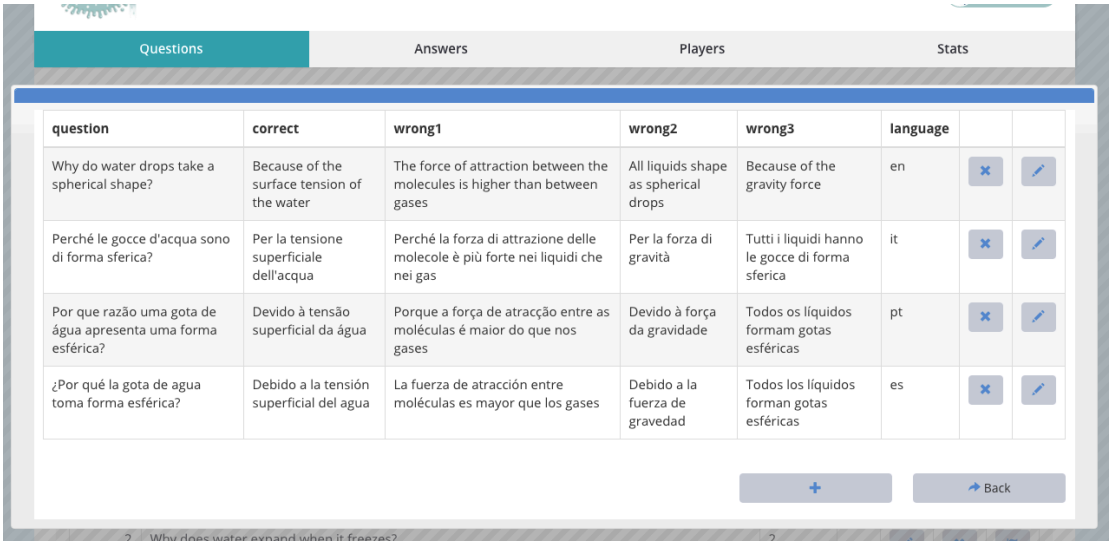


Figure 6. Question editing page.

- **Crowdsourcing translation application**: a Web application for voluntary crowdsourcing (i.e., sending as a task to an open group of contributors) the translation of questions from a source to a target language. The Drop!TheQuestion Digital Game will help scale the Drop!TheQuestion Digital Game to thousands of questions and tens of languages, where the top users of the Drop!TheQuestion game could be engaged as contributors in the translation of the game questions into their own language. Figure 7 shows a page of the interface of the Crowdsourcing translation application.

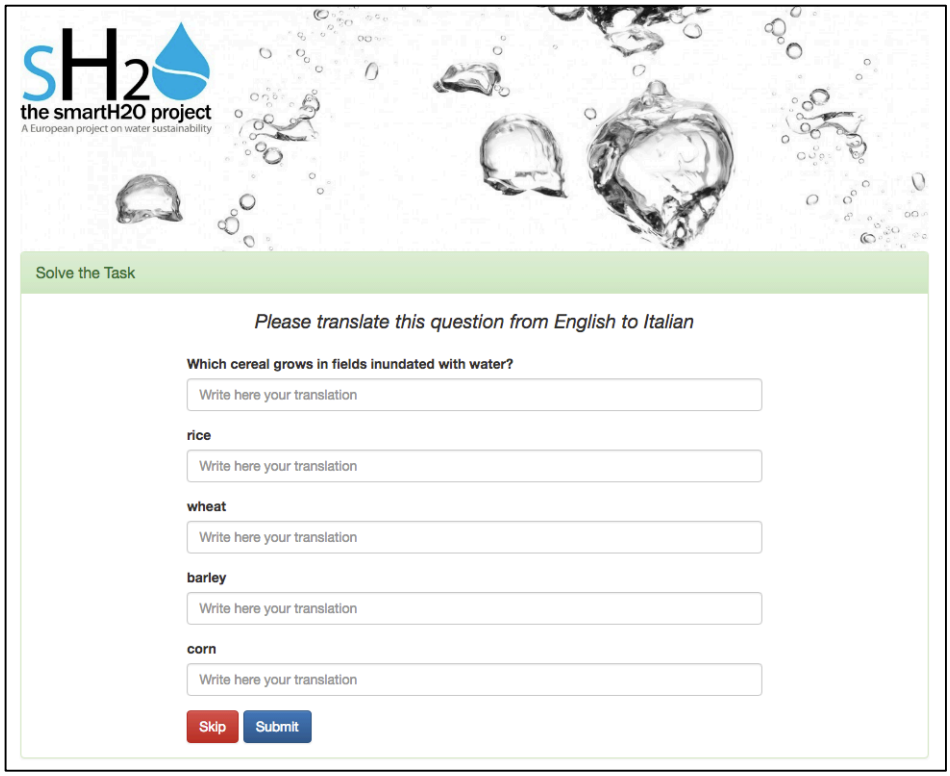


Figure 7. Page of the interface of the Crowdsourcing translation application.

- **Email sign-up and sign-in**: the Drop!TheQuestion Digital Game has been extended with a procedure for the sign-up and sign-in of the user. This functionality is required to enable the integration of the game with the smartH2O platform and enable the association of points to the successful answer to a Drop!TheQuestion question. As a unique user identifier the email address is used, which is one of the attributes that the user provides in the SmartH2O Consumer Portal. Figure 8 shows the interface of the new sign-up procedure for Drop!TheQuestion digital game.

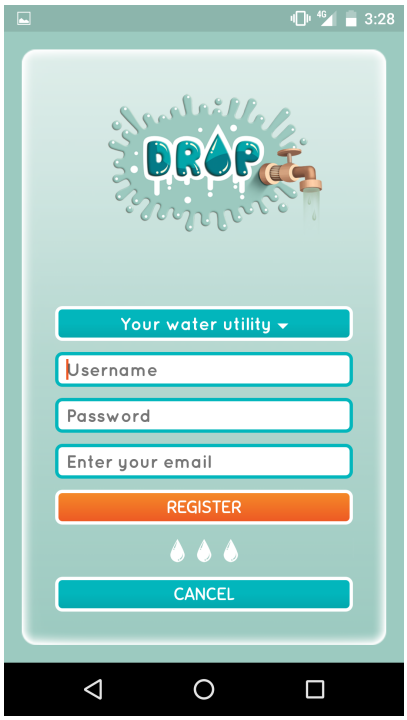


Figure 8. Interface of the new sign-up procedure for Drop!TheQuestion.

- **Identity reconciliation**: a user who registered in the mobile digital game Drop!TheQuestion may later decide to join the community of his utility company. In this case the identity of the player user must be communicated and expanded into an identity for the Consumer Portal user. This functionality has been added to the SmartH2O platform. Figure 9 shows the landing page of the procedure for extending the identity of a mobile player to the Consumer Portal

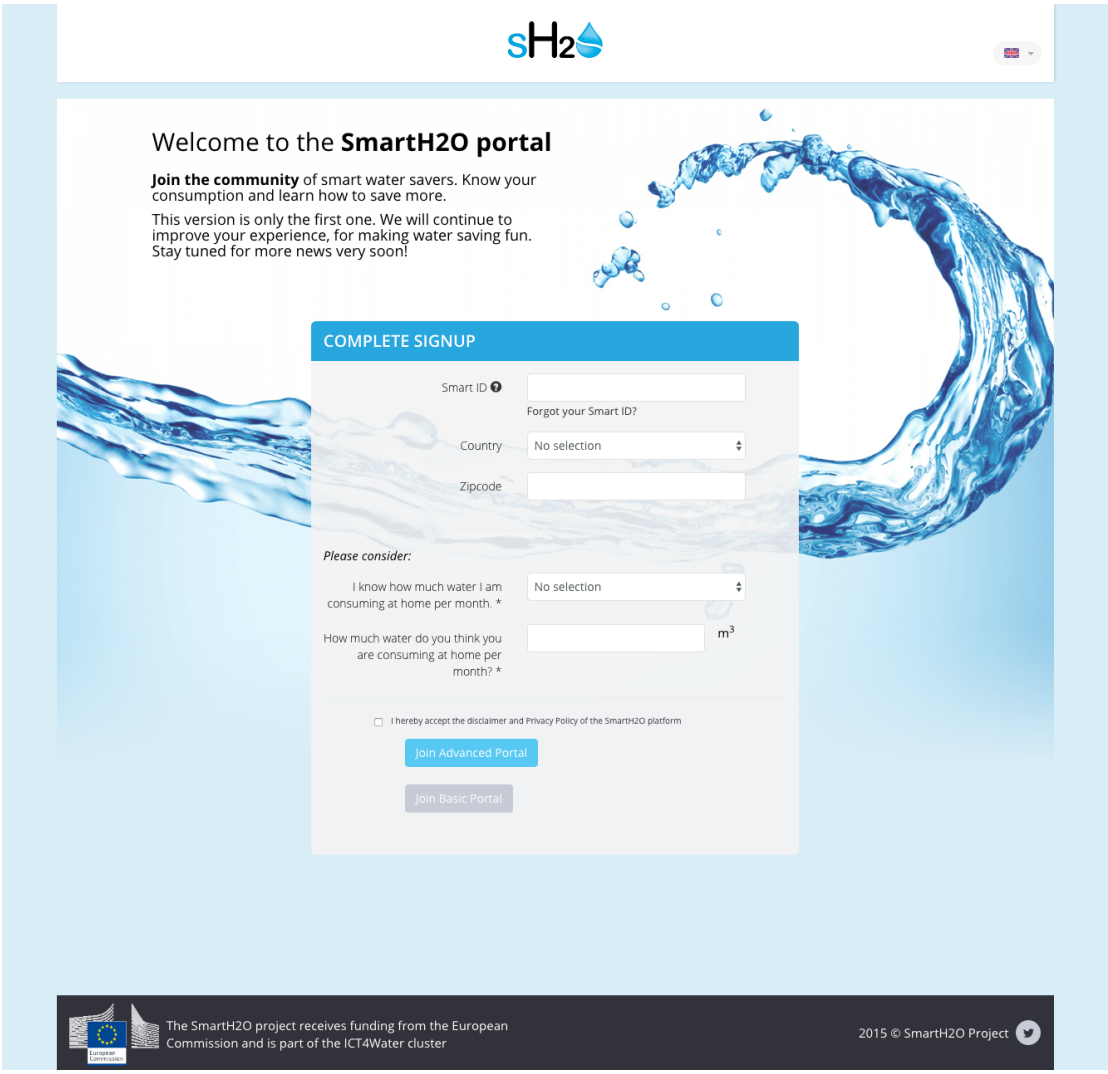


Figure 9. Landing page of the procedure for extending the identity of a mobile player to the Consumer Portal.

- **Game Usage Monitoring Tool**: a web dedicated application has been developed for the utility company operator, to enable the monitoring of the users' performance in the Drop!TheQuestion mobile game. Such application allows the operator to monitor the engagement of the game and the difficulty of each question, which may suggest improvements in the classification of questions.

3 Social game usage data

3.1 Drop! The questions users

The deployment of the Drop!TheQuestion follows the same logic as for the platform, in which first the platform was deployed in a small scale setting, to allow for not only technical testing, but also for optimization of the game content. The next step - scheduled for this fall – is then then large-scale deployment in EMIVASA.

Thus, at the time of this report, the use of Drop!TheQuestion is still confined to the users of the SES case study and to beta testers (e. g, school kids and teachers). The deployment of integrated version of Drop!TheQuestion in the Valencia pilot – scheduled for September 2016 (M30) - will contribute more usage data (just as the Valencia deployment of the SmartH2O consumer portal already did), which will be reported in D7.3.

3.1.1 Players

So far, there have been 54 players of Drop!TheQuestion in the Swiss case study, comprised of the following types the users with respect to different versions of the game (standalone vs. connected to the SmartH2O portal) and the SmartH2O portal (basic vs. gamified):

Table 4. Portal usages by Drop! players.

Number of SES portal users	50
Basic version	*24*
Advanced gamified version	*26*
Number of Drop! The question players	54
No. of portal users playing the Drop! Game	8 (16%)
Of which basic portal users	-
Of which advanced portal users	8

While the absolute number of players is not high, it has to be reminded that this concerns only the Tegna case study that was used as a small-scale test preceding the Valencia deployment. The data also shows that only users who opted for the gamified (aka Advanced) version of the portal try the associated Drop!TheQuestion game, which confirms the design decision of splitting the consumer portal into basic (non-gamified) and advanced (gamified) to account for different types of SmartH2O users.

3.2 Characteristics of play sessions

The first usage data on Drop!TheQuestion indicates that the game seems to be attractive users (see Table 4, Figure 10), as they return to the game multiple times, even if the database of the questions was still of a limited size (around 100 questions for the SES trial). The game has been played in 658 play sessions (85 in card scan mode, 573 in single player mode) with a number of returning users.

Table 5. Returning users to Drop!TheQuestion.

	...more than 1 time	*...more than 3 times*	*...more than 6 times*	*...more than 12 times*
% of users playing Drop!	62%	40%	26%	15%

Figure 10 charts the number of session played by Drop!TheQuestion users.

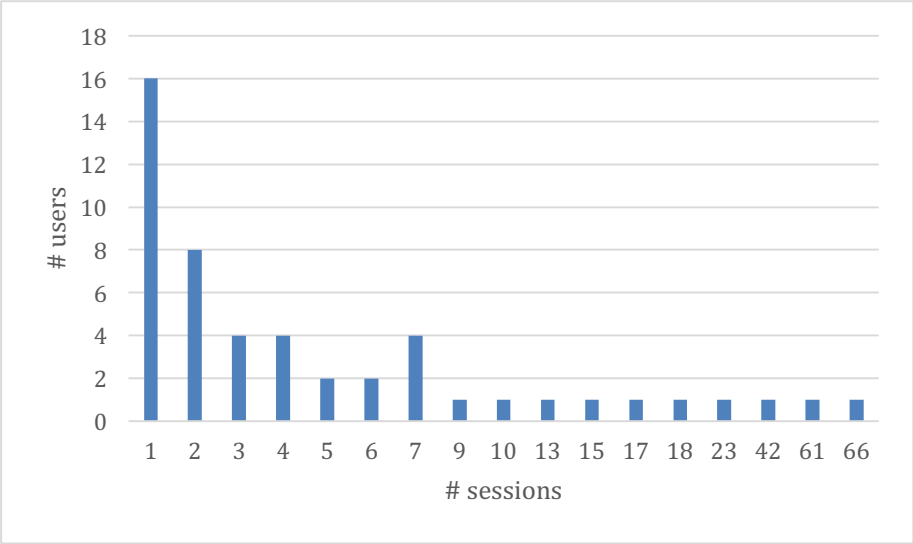


Figure 10. Number of session played by Drop!TheQuestion users.

The scan mode is used in conjunction with the Drop! card game. Most users like to use the game in a standalone manner, also disconnected with the usage of the card game. Though the average play duration per session with more than one question is only 3 minutes (with a span of ca. 1-9min), the associated average number of answers per session (13.6) suggests high engagement of players. The conjunction of these two parameters suggests that the game has been designed well, as it allows engaged usage in a short time slot – a typical usage pattern for mobile devices that are commonly used in frequent but short spans of attention.

- Average session per user: 658/54=12.18.
- Average number of answers per session: 8948/658=13.60.
- Average duration per session with more than one question (573): 3 minutes.

Figure 11 charts the duration of play sessions in Drop!TheQuestion.

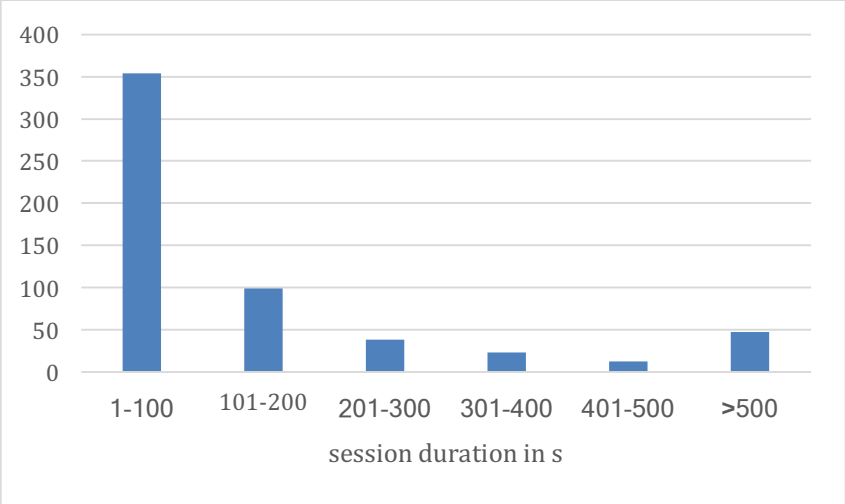


Figure 11. Play session duration in Drop!TheQuestion.

3.3 Characteristics of the answers

Players of the Drop!theQuestion game may reiterate through the questions, until they provide a correct answer, choosing one of the 4 options provided.
The statistics about answers are as follows:

- Number of answers: 8948.
- Number of answers in single player mode: 8670/8948=96.8%.
- Number of answers in scan mode: 278/8948=3.2%.
- Average number of answers per user: 8948/54= 165.7 questions per user.
- Number of times users answer to the same question: average 2.8, variance 3.7.
- Correct answer per user: average 51%, variance 0.24.

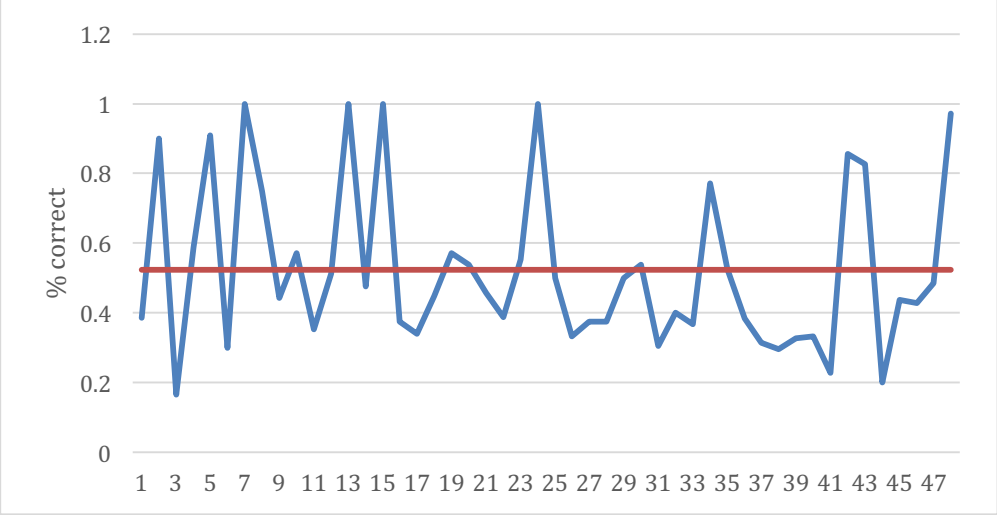


Figure 12. distribution of percentage of correct answers among players (47/54 responded at least to one question correctly).

The rate of 51% of correct answers on average is too low and signals that the questions provided were too difficult for the players. Accordingly, the questions of the game have been redesigned with respect to different levels of difficulty and a more refined mechanism of selecting the appropriate level of question difficulty based current user performance has been implemented. In addition, answer explanations have been added to further improve player learning and performance (see Section 3.4 for both aspects).

While DropTheQuestion always proposes different questions and different difficulty level, the learning curve (Figure 13) of correct answers for SES users registered to the portal shows a general improvement. Figure 13 shows the average percentage of correct answers progress over the number of answered questions.

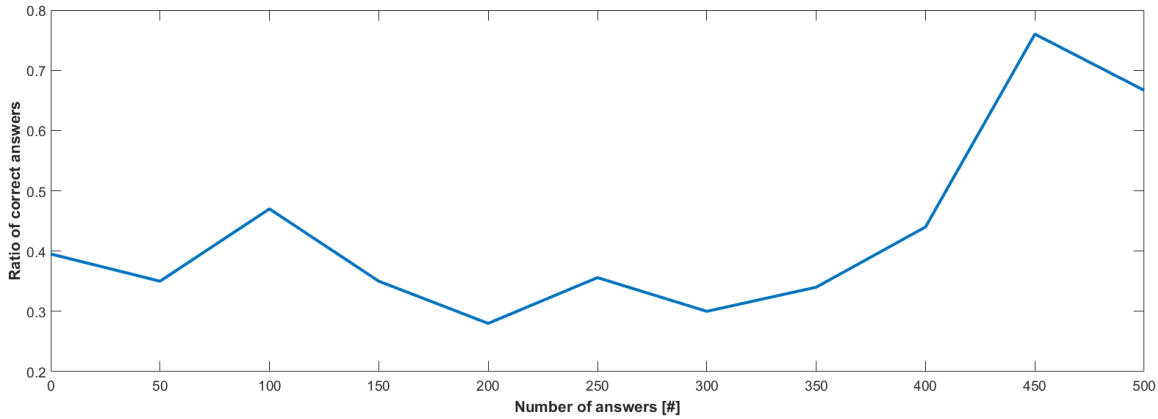


Figure 13: learning curve of DropTheQuestion answers for SES users.

3.4 Comments and actions

Although confined to the small scale pilot users in the Swiss case study, the usage data of the social game Drop!TheQuestion collected up to M30 of the project have permitted the identification of problems and the elicitation of new requirements, some of which have already been (and others will be) incorporated in the next releases of the game. As it turns out, this process with small scale testing and analysis has been crucial in getting the design right in an iterative process, while minimising risk of user deterrence (that would have likely happened had we released an early version already in the large scale case study). Instead, we now have an optimized version of the game that has been tested and improved with respect to user acceptance and can be more safely deployed in the large-scale study. The following observations summarize the lessons learned from the first usage experience, as deduced from interviews with SES users and external beta testers and fro the analysis of usage data:

- **Question difficulty**: 51% of correct response overall is a too low rate. The provided questions are perceived as too difficult by players. More simple questions must be added to the database. This has already been done in the second release of the game (part of the software prototype of this deliverable) that is about to be released in the large scale Spanish case study.
- **Play mode**: usage data show that the Drop!TheQuestion mobile game has a value per se, also independently of the Drop! card game. However, this requires addressing a more generalist audience, which in turn requires a better engagement mechanism and an improved approach to questions and answers. Responses to these requirements are detailed next.
- **Engagement**: decreasing question difficulty for increasing success rates may demotivate users and diminish their return rate. The second version of the game, and thus the Question Editor Web application, now incorporate a progressive mechanism whereby questions are associated to a difficulty level and served to the player in progressive value of difficulty, in accordance to the motivation theories illustrated in D4.3 INCENTIVE MODELS AND ALGORITHMS. This is the version that is about to be released in the Spanish case study.
- **Question database**: the average number of answers per user (m=165,0; median=37; s.d.=352.4) shows that users may quickly consume all the questions in the database. Two outliers have answered as much as 1331 and 1883 questions, which is partly responsible for the high standard deviations – without the outliers, s.d.=189.3). These figures prompt for a much larger database to accommodate both average behaviour

and behaviour of highly engaged users. In the second version of the game we have quadruplicated the number of questions (now they are 474). However, this is a problem that should be tackled by a commercial implementation of the game. As a response to this requirement, the Crowdsourcing translation application could be extended to let a crowd of community members or senior game players collectively participate to the construction of a large database of interesting questions.

- **Answer Explanation**: interviews with users highlighted that several questions have a short answer, which does not satisfy enough the curiosity of the player. In an ideal situation, the right question could be enriched with some explanatory text that points the player to "further readings" useful to deepen her knowledge of the subject. As a response to this requirement, the Crowdsourcing translation application could be extended to let a crowd of community members or senior game players edit the explanations of the correct answer.

3.5 User feedback on the Drop! Game

In addition to behavioural metrics reported in the previous section, the questionnaire that was distributed among all SmartH2O users in Tegna (see section 4) included a number of question related to the Drop! Game. The following topics were addressed to cover the following user-based performance indicators, introduced in D2.2.

- Effort expectancy and ease of use.
- Attitude towards the technology.
- Perceived social influences.
- Perceived joy of use.
- Perceived challenge level of playing the game.

In line with the objectives of the Tegna pilot, this evaluation sought to collect preliminary data on the Drop! Game in anticipation of the large-scale release of the game in the Valencia area. Given common low response rates in online questionnaires, the questionnaire that was distributed among Tegna users has yielded a high response rate of 43%. From these 4 have played the Drop! Game. Even though the response rate was high (ca. 10%), in absolute terms this gives a small number of 4 responses. This is obviously not sufficient for generalized analysis; rather, it corresponds to the very purpose of the Tegna case being a small test setting preceding deployment in the large Spanish case study.

Accordingly, the responses reported are considered as a preliminary user acceptance test, to identify possible problems before a large rollout. As shown by the results given below, the responses are uniform even within the small sample and suggest positive user attitude towards the design of the Drop! application. In connection with the previously presented log analysis of user activity (for a significantly larger number of users), this suggests a positive up-take of the Drop! game test in the small scale Tegna setting.

Below we summarize the results we have found from each of these users.

First, we analysed the technology acceptance indicators that were measured using the UTAUT framework [Venkatesh et al., 2003]. From this framework, effort expectancy (e.g. ease of use), attitude towards technology, and social influences were measured with respect to the Drop! mobile game. UTAUT measures these constructs using five-point Likert scale items ranging from strongly disagree (1) to strongly agree (5).

All users provided high ratings for effort expectancy, with three users scoring 5, and one user scoring 1 on the items learnability, the clarity and understandability of the interaction with the game, and the ease of use. The item on the ease with which one can become skilful at playing the Drop! Game received 2x a 5 score, once a 4, and once a 2, pointing to the potential difficulty of the questions. Next, we inspected the attitude towards technology results. Three users scored a five on all items, one user scored a 4 on all three items. This pattern was found for the user's liking of the game, whether they found playing the game a good idea, and their opinion on the Drop! Game with respect to the game making saving water more interesting.

Even though the results should be taken with care, the pattern across indicators has proven to be consistently positive for the four users that have filled out the technology acceptance items on Drop!. Results suggest that the Drop! game is easy to use, and that it makes saving water more interesting. In connection with the previously presented log analysis of user activity (for a significantly larger number of users), this suggests a positive up-take of the Drop! game test in the small scale Tegna setting.

Subsequently, we addressed the more specific user-based performance indicators for all instances of the game. Fun of use was rated positively for the board game (1 undecided; 1 agree, 3 strongly agree) and for the mobile game (1 undecided; 2 strongly agree; 1 did not play). Earning points for the portal was also considered rather fun to use, with half of the users being very outspoken (2 undecided; 2 strongly agree).

Users were overall positive about the ease of use of the Drop! Mobile game. Three users found scanning the QR-codes in the graphs easy to use, with one user being undecided, and one user who has not played the mobile version. Earning points on the SmartH2O portal was very easy for three users. Two users were undecided.

Users were ambivalent with respect to the difficulty of the questions. Two users were undecided, one user found the question rather easy, and two users found them rather difficult.

The results display a similar pattern with users positively responding to the fun of use questions, as well as on the question on ease of use. In connection with the previously presented log analysis of user activity (for a significantly larger number of users), this suggests a positive up-take of the Drop! game test in the small scale Tegna setting.

The item on comprehension demonstrates that users have mixed opinions with respect to the difficulty of the questions. This result, combined with the relatively low percentage of questions correctly answered (51%), suggest that the content of the questions needs to be improved in order to better fit the audience's knowledge levels.

3.6 Conclusion

This section has demonstrated the potential of the Drop! social game to stimulate users to engage with saving water. Usage data and user responses were presented from the small-scale Tegna pilot show promising results in terms of e.g. duration of the play, of returning users, and perceived joy of use. This leads to the conclusion that there has been a successful uptake of the Drop! Game in the small-scale Tegna pilot. Adopting lessons learnt from this first pilot on e.g. question difficulty, the large-scale rollout of the Drop! Game in Valencia will yield more data on the effectiveness of the Drop! Game to engage users.

4 User feedback to the SmartH2O gamified incentive model

As anticipated in Chapter 2, in SmartH2O the notion of "social game" is implemented in three different instantiations, so to achieve a holistic user experience capable of engaging users into a virtuous cycle of water saving, with a major element being the gamified Consumer Portal. The implementation of the SmartH2O incentive model in this portal transforms user activities into a social game by turning them into points, badges and rewards that allow users to compare/compete with one another to attain social and material rewards (see D.4.3 for the detailed description of the SmartH2O incentive model).

In this chapter we present the results of the assessment of the implemented gamified incentive system, by presenting user feedback results.

4.1 Methodology

4.1.1 Questionnaire construction

Questionnaires were used to elicit the users' opinions about the SmartH2O portal in general and the employed incentive model in particular. Questionnaires were distributed to users in both the Spanish and the Swiss case study. To enable repeated measures analyses, the same measurements were used as reported in D7.2, supplemented with the specific user-based performance indicators that were introduced in D2.2.

Technology acceptance was measured on the level of the application as a whole and on the level of individual use cases.

- *Awareness with respect to water consumption*
  In D4.3, the psychological factors affecting water consumption – called determinants – were discussed in detail. This led to the operationalization of the social awareness construct into measurable determinants of water consumption. This questionnaire addresses the same psychological determinants as reported in the first validation results (D7.2):
  - Attitudes towards water conservation (bipolar scales; e.g. good-bad) .
  - Beliefs with respect to water conservation (four-point Likert scale; e.g. "Drinkable water is an unlimited resource.") .
  - Water conservation intention (two[1] (Spain) or three (Switzerland) five-point Likert scale; e.g. "I expect I will engage in everyday actions to save water in the next six months.").
  - Subjective norm (three five-point Likert scale; e.g. "It is expected of me that I save water.).
  - Perceived behavioural control (one five-point Likert scale; "I am confident that I could save water.").

- *Technology acceptance indicators on application level*
  Technology acceptance was measured based on the UTAUT model [Venkatesh et al. 2012]. The following constructs were measured:
  - Performance expectancy (2 five-point Likert scale items).
  - Effort expectancy (4 five-point Likert scale items).
  - Attitude towards technology (4 five-point Likert scale items).

  Additionally, hedonic (HQ) and pragmatic quality (PQ) were measured to assess the hedonic and utilitarian value users derive from using the SmartH2O platform. The

[1] Difference is due to language specificities. In Spanish, intention items with 'I want' and 'I intend' cannot be distinguished.

AttrakDiff2 questionnaire [Hassenzahl, 2004] was used for this purpose.

- *Technology acceptance on use case level*
  For each of the portal's features, questions were asked to assess the user-based performance indicators that were outlined in D2.2. Five-point Likert items were used. In summary, the following topics were addressed:
  - Perceived usefulness.
  - Ease of use.
  - Joy of use.
  - Comprehension.
  - Effect of the gamification elements on the motivation to save water and to use the SmartH2O portal.

  All user-based performance indicators on use case level were addressed with five-point Likert scale items.

  In addition to questions on the SmartH2O portal, Tegna users were asked a set of questions with respect to the Drop! Game. Questions and results are reported in Section 3.5.

The complete set of questionnaire items can be found in Appendix A.2.

4.1.2 Participant recruitment

In both case studies, participants are recruited via e-mail. Users who have a SmartH2O account for at least four weeks have received an invitation to fill out the questionnaire. To motivate users to fill out the questionnaire, the recruitment message highlighted the possibility to receive points on the portal, as well as the contribution to the development of the portal and the research in SmartH2O. The recruitment messages can be found in Appendix A.3.

4.2 Results from the Spanish case study

The Spanish case study targets a significantly larger potential population in the Valencia metropolitan area. At the time of writing 368 have registered for the portal. A similar questionnaire-based approach was followed as in the Swiss case study. From the SmartH2O user base in Valencia, 32 participants have filled out the questionnaire, which means a 9% response rate. This 9% response rate should be considered high, since other similar online surveys can yield rates as low as 1% to 3%.

4.2.1 Technology acceptance on application level

Technology acceptance on application level was measured using the established UTAUT framework [Venkatesh et al., 2003] and by means of the AttrakDiff2 questionnaire for hedonic and pragmatic quality [Hassenzahl, 2004].

UTAUT results

From the UTAUT framework, effort expectancy, performance expectancy, and attitude towards technology were measured. In Figure 14 'effort expectancy' results are displayed, as a measure of the perceived ease of use.

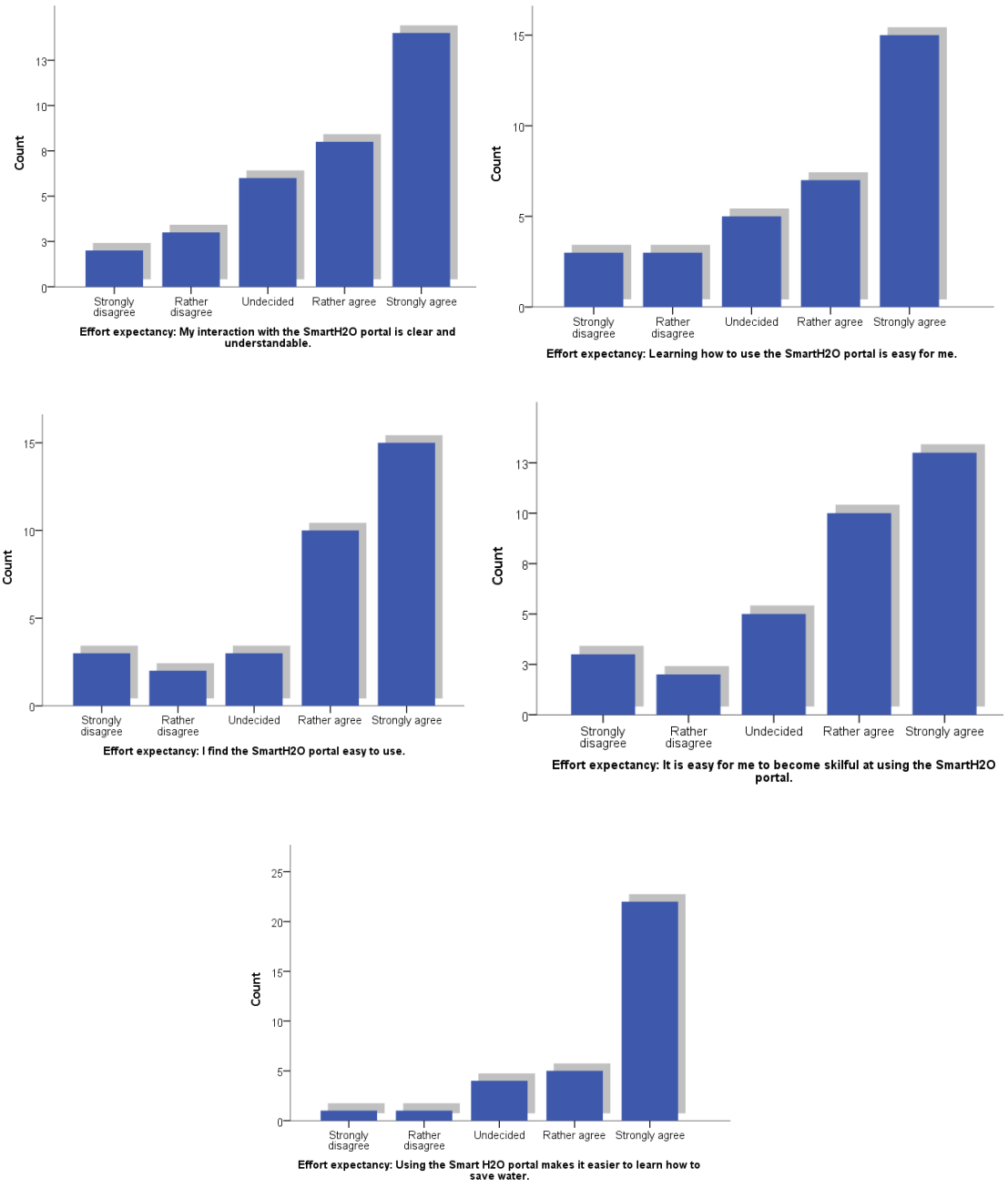


Figure 14. UTAUT: Effort expectancy item results.

High internal consistency among the four effort expectancy items (Cronbach's α=0.96) allows for averaging the items, constituting the effort expectancy scale. Figure 15 displays the histogram for this scale.

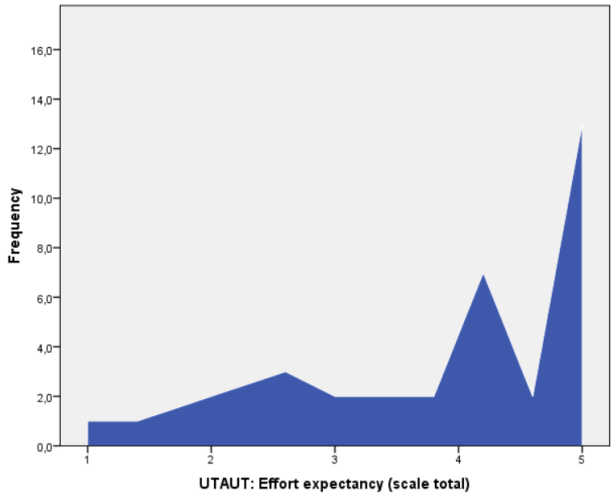


Figure 15. Distribution of effort expectancy scale.

The results demonstrate that users found the SmartH2O portal easy to use, with the large majority of the users (71%) answering the questions with either agree (4) or strongly agree (5). The scale average was 4.0 (s.d.=1.1). These results suggest that the portal has been capable of combining gamified incentives with water-related information in an easily understandable way. In the next subsection we will inspect the perceived ease of use of the individual features in more detail.

Performance expectancy was measured with two items, displayed in below. Results are shown in Figure 16.

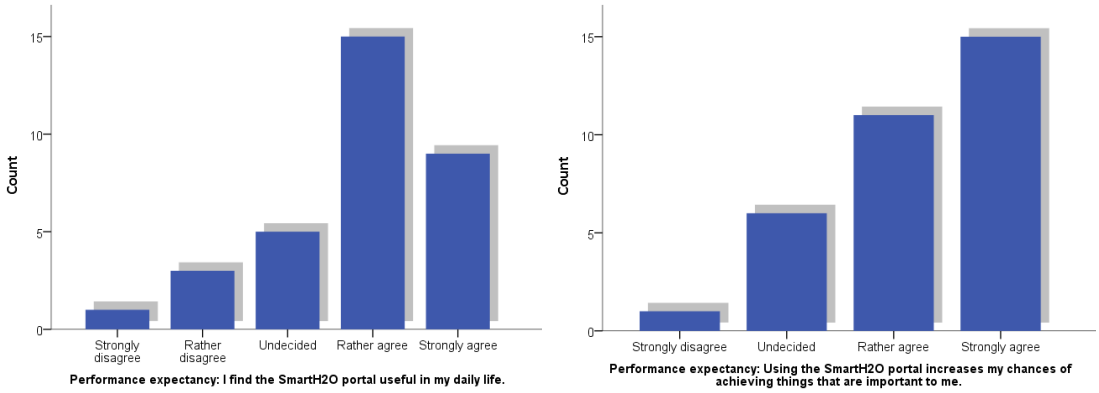


Figure 16. Performance expectancy item results.

Intercorrelation between the two items was r(32)=.72. Given this high correlation, a performance expectancy scale could be created by averaging the two items. In Figure 17 the distribution of the scale total is displayed.

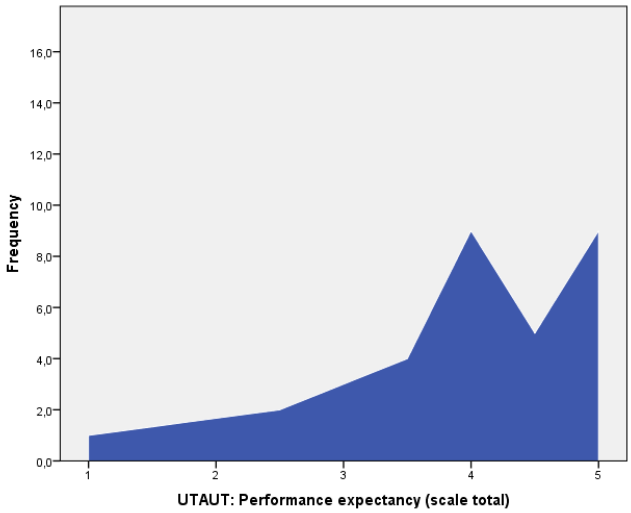


Figure 17. Distribution of performance expectancy scale.

On average, users assessed performance expectancy with a score of 4.0 (s.d.=.9). Scale total results and the results of the individual items both suggest that users were positive about the portal's usefulness for things that are important to them, which in technology acceptance frameworks is a predictor for usage of the technology (e.g. [Venkatesh et al., 2003]).

Finally, attitude towards technology was measured with four items. Results are displayed in Figure 18.

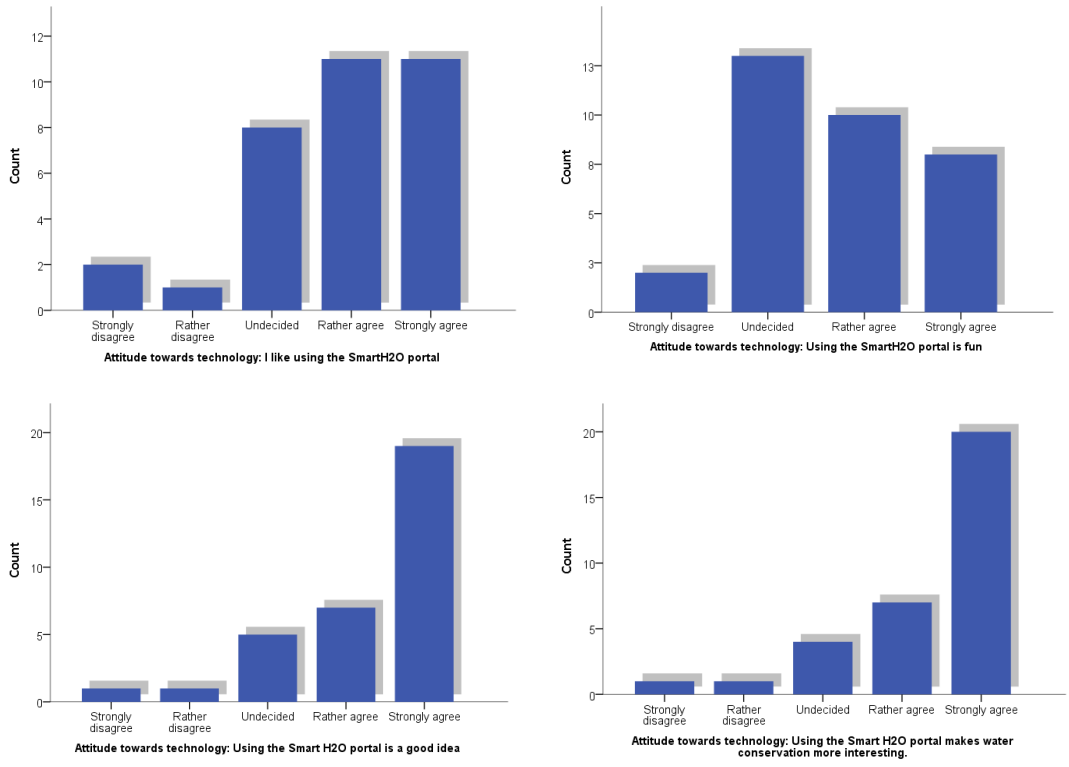


Figure 18. UTAUT: Attitude towards technology item results.

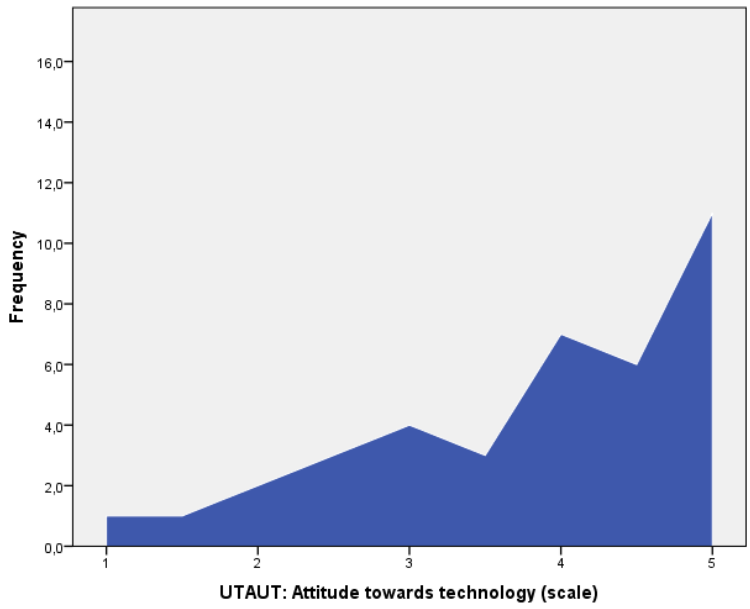


Figure 19. UTAUT: attitude towards technology (scale total).

Similar to the performance expectancy and effort expectancy results, users had a positive attitude towards the SmartH2O portal (scale m=4.0; s.d.=1.0). Particularly important is that they considered the portal to make saving water more interesting (m=4.3; s.d.=1.0). This result suggest that the motivational affordances included in the portal have been effective to raise interest in water conservation, the extent that this can be judged from self-reported measures. User behaviour results will be able to support – or refute – this preliminary conclusion.

The UTAUT results on effort expectancy, performance expectancy, and attitude towards technology suggest that the SmartH2O portal is deemed ease to use, and useful, with users liking the usage of the portal.

Hedonic and pragmatic quality

Hedonic and pragmatic quality was measured using the AttrakDiff2 questionnaire [Hassenzahl, 2004, 2008], of which hedonic quality (stimulation) and pragmatic quality were measured. The results are displayed below in Figure 20.

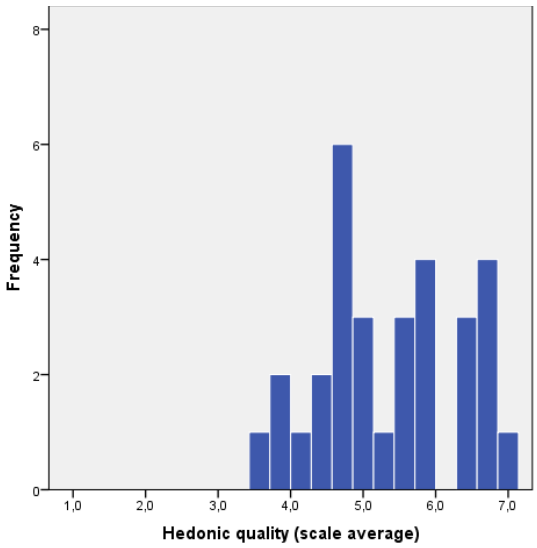


Figure 20. Hedonic quality (stimulation) results (Valencia).

Hedonic quality (stimulation) received on average a score of 5.4 (s.d.=0.9) on a scale 1-7, which is considered as stimulating. This result suggests that the innovativeness an originality of the SmartH2O portal were highly rated, and the users found the portal stimulating to use. This is a positive result, as this was the primary purpose behind the incentive model: to make saving water and engaging with water consumption information not only useful, but also stimulating and fun to do.

The pragmatic quality results are displayed in Figure 21.

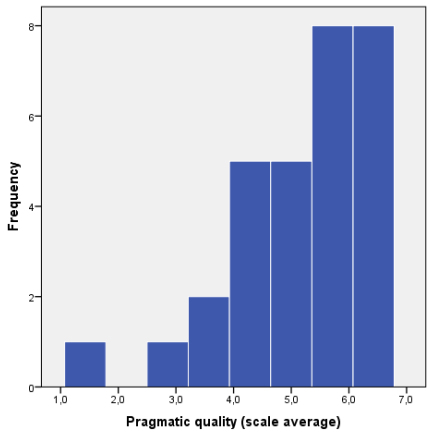


Figure 21. Pragmatic quality results (Valencia).

Pragmatic quality scores were on average slightly lower than hedonic quality – stimulation at m=5.2 (s.d.=1.2), but still rather positive. The balance between pragmatic quality and hedonic quality suggests that users are both stimulated by the innovative nature of the portal, and able to derive utilitarian value from it.

These results are encouraging since they depict attitudes of regular customers of Aguas de Valencia to which the gamified SmartH2O platform has been proposed as a replacement for the common water consumption statistics in their existing Virtual Office. These first results suggest that the gamified SmartH2O portal can both well stimulate users at the hedonic level

(important to motivate acceptance and continuous usage) and support the pragmatic purpose for which they use the water consumption data and saving tips. In fact, these results are both in line with the very positive user acceptance feedback described in the previous section and with the assessment of the individual functionalities of the gamified SmartH2O portal, discussed in the next section.

4.2.2 User-reported effectiveness of the incentive model

Whereas in the previous deliverable D4.3 only preliminary results with respect to the evaluation of the incentive model from the small Tegna case study could be presented, in this deliverable we can present user feedback on the incentive model from the users in the large-scale pilot in Valencia.

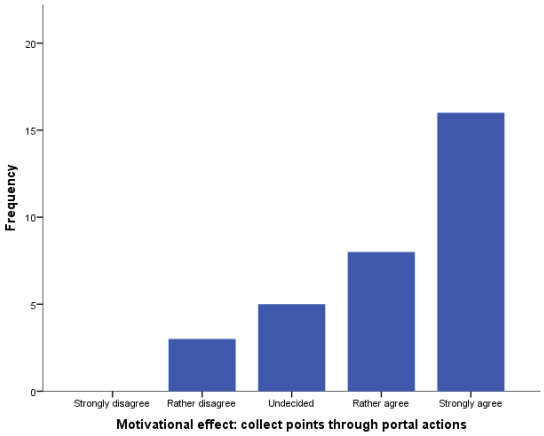
Gamification elements as incentives

For this purpose, questions were introduced to cover the key performance indicators reported in D2.2, which primarily focus on the motivational affordances of the portal's gamified features. Users were asked "I feel motivated to use the portal, because I can…", which was followed by the a number of incentive model elements. Users were asked to respond on a five-point scale from strongly disagree (1) to strongly agree (5). In Figure 22 the results are displayed.
The results suggest that all indicated incentive model elements offer a strong motivational affordance to the users, with average values around or above 4. The small standard deviations imply that little disagreement was found between the users, suggesting that the incentive model elements work for *all* users in this target group.

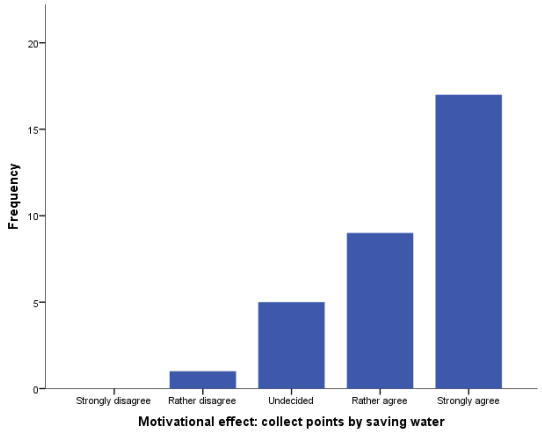
Users feel particularly motivated to use the portal, as a result of being able to collect points (m=4.2, s.d.=1.1), by receiving points for saving water (m=4.3, s.d.=.9), and by receiving rewards for their points (m=4.3, s.d.=.8). In that sense, the strongest perceived motivational effects reflect the pillars of the incentive model: points per se as virtual rewards, the connection between points and the ultimate goal of saving water, and the relationship between points and physical rewards.

Motivational effect of gamification elements

Collect points through portal actions



Collect points by saving water



Receiving badges by collecting points

Receiving suggestions for portal actions

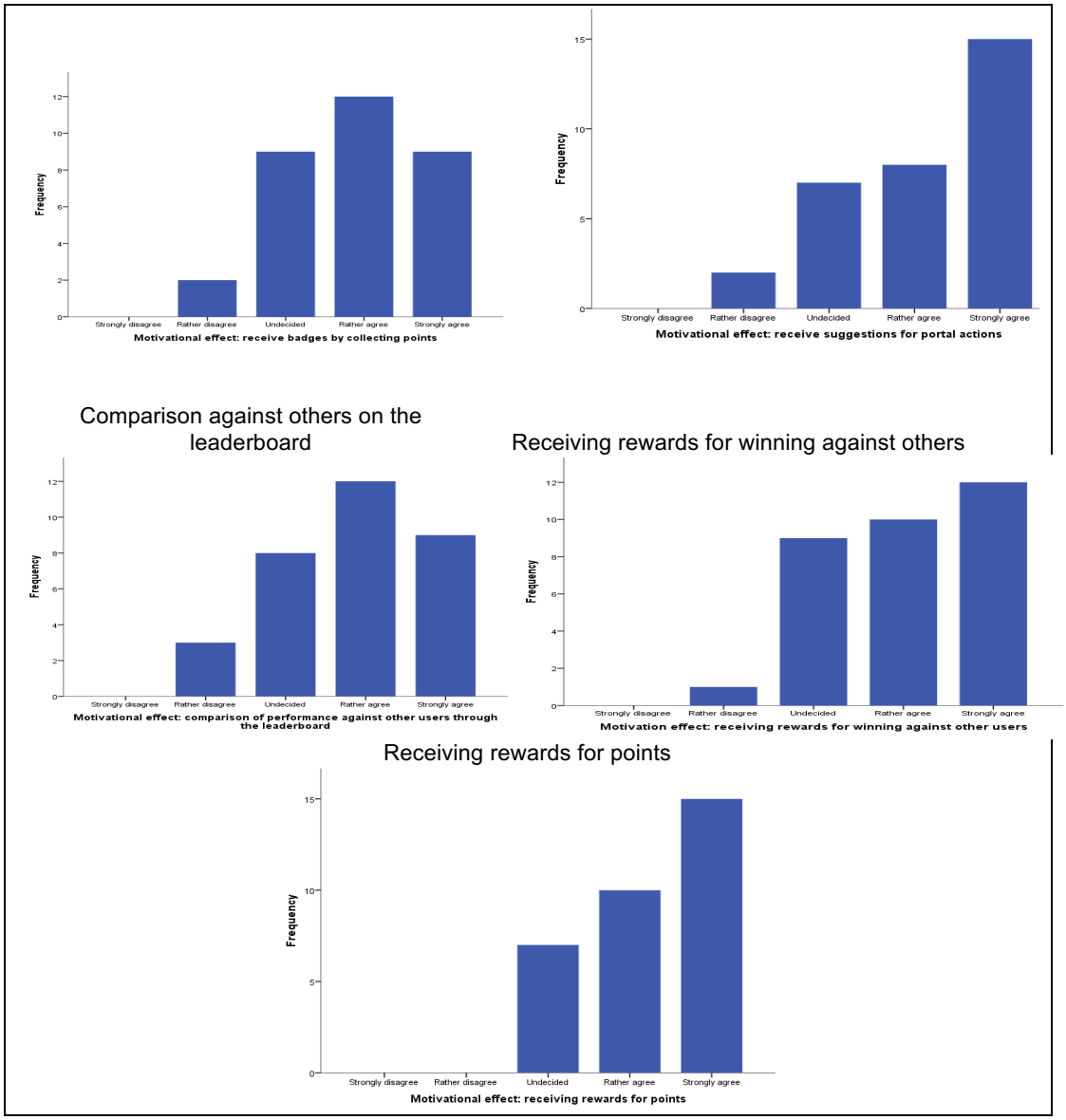


Figure 22. Motivational effect of gamification elements.

Subsequently, we assessed the user's motivation to engage in competition with other SmartH2O users through the leaderboard. This was assessed with two Likert scale items whose results are depicted in Figure 23.

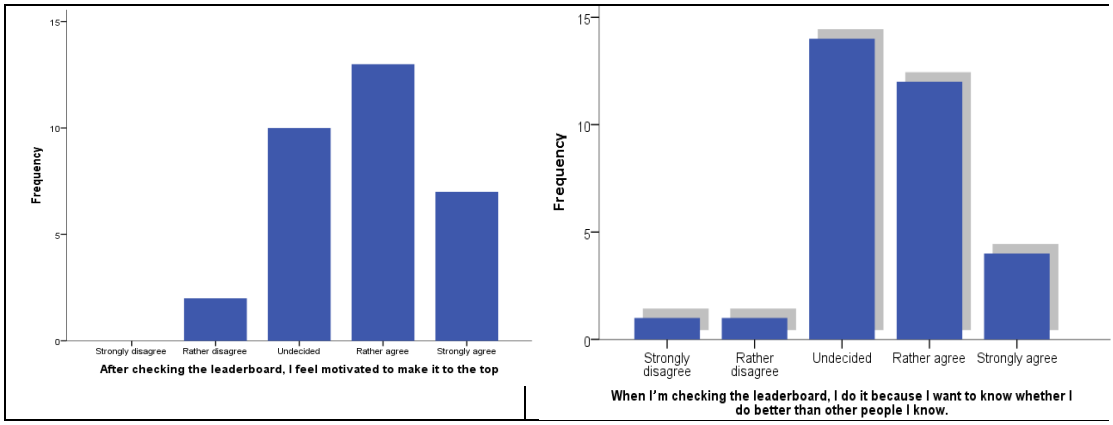


Figure 23. Motivational effect of competition through the leaderboard (Valencia).

With average scores of 3.8 (s.d.=.9) and 3.5 (s.d.=.9) respectively, users appear to feel motivated by their leaderboard position. However, in comparison to the other incentive model elements, the motivational effect of collecting points and rewards seems to have a stronger influence on their motivation than the leaderboard position, suggesting for this user base the need to collect is a stronger incentive than the need to compete (basic desires theory; e.g. [Reiss, 2002]; see also D4.3). Nevertheless, the weekly competition results and the variety of users who actively seek to win this competition suggests that there is a part of the user population that can be engaged through weekly competitions and/or associated physical rewards (see Section 4.4.2).

Consumption visualization and saving tips as incentives

In addition to the gamification features that make up the core of the incentive model, the visualization of water consumption and provision of practical water saving tips also aim to serve as incentives to use the portal and raise awareness on water consumption. To assess their effectiveness, users were asked if they thought about water consumption more often than before, felt more motivated to save water and to use the portal due to the specific element. The overall perceived usefulness per portal element was also assessed, as well as the effect of a specific element on users' understanding of their own water consumption.
Nearly all users found the water consumption chart (m=4.7; s.d=.7) and overview (m=4.6; s.d.=.6) useful, the majority of which even strongly agreed to the statement that the two elements were useful to them (Figure 24). The responses also suggest that both elements are equally appreciated (paired samples t-test: t(30)=.81; n.s.).

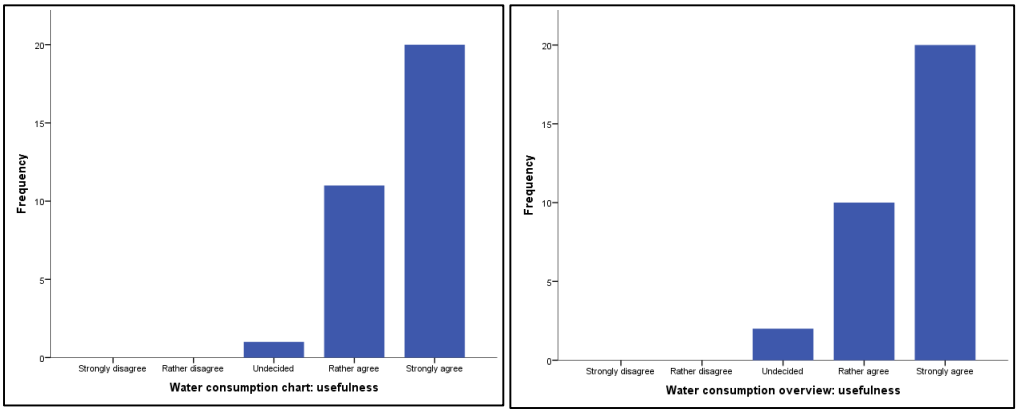


Figure 24. Perceived usefulness of water consumption chart (left) and overview (right).

Nearly all respondents stated that the water consumption chart and the water consumption overview made them think about water consumption more often and most of them even agreed strongly with this (Figure 25-1). Similarly, but with few more indecisive respondents, most also agreed that the chart (m=4.4; s.d.=.7) and overview (m=4.5; s.d.=.6) motivate them to save water (Figure 25-2). Differences between the chart and the overview were non-significant (t(30)=1.17; n.s.)

While the majority also found that the chart (m=4.3; s.d.=.8) and overview (m=4.3; s.d.=.7) motivated portal usage, a minority was undecided or, in the case of the consumption chart, disagreed (Figure 25-3). Overall, this is a very positive assessment that supports the rationale behind the approach of using the different ways of visualizing consumption as a means to motivate water saving.

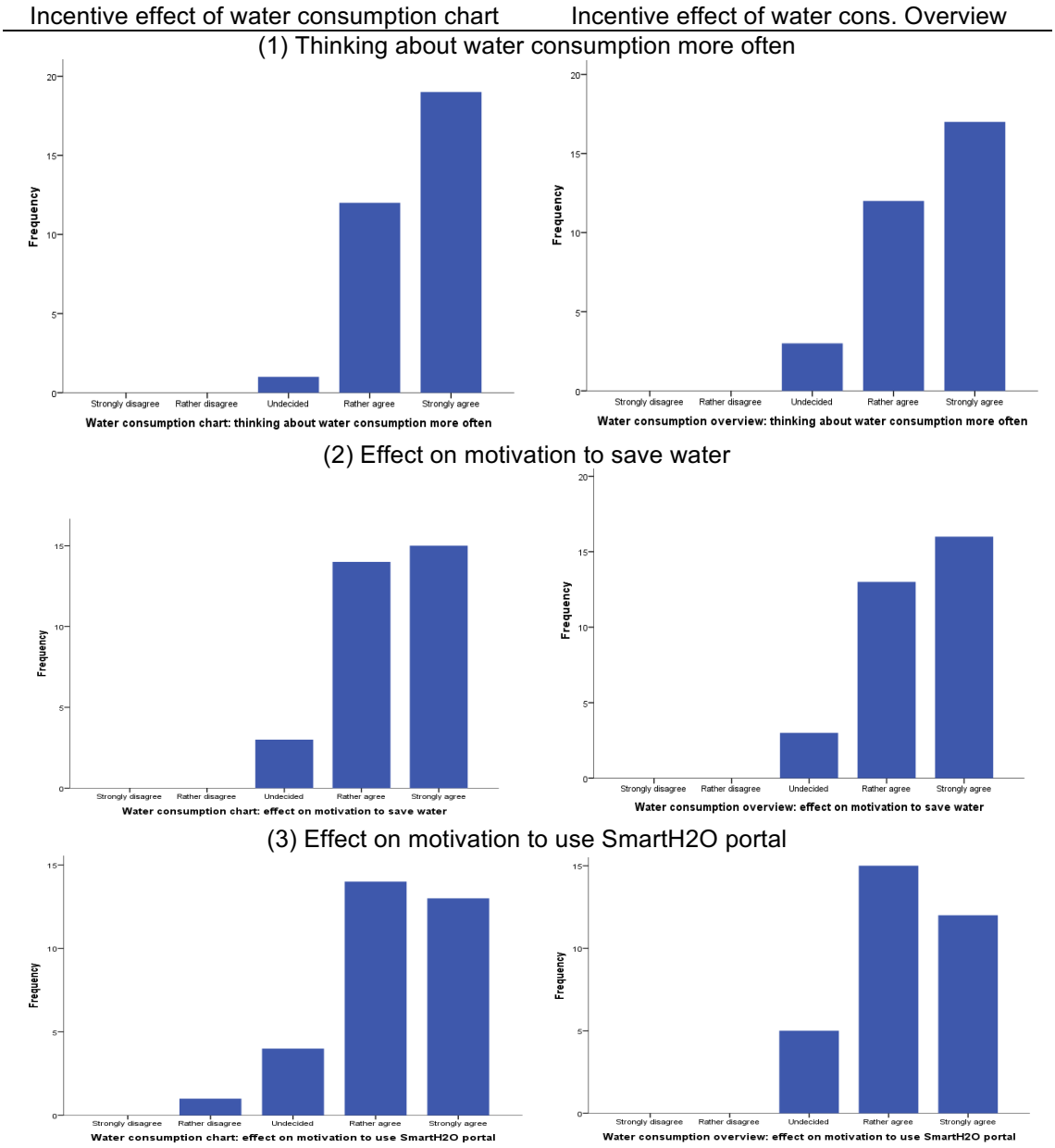


Figure 25. Incentive effect of water consumption chart.

The vast majority found the water consumption chart very effective towards understanding their own consumption (Figure 26-1). Responses towards individual features varied a bit more, but nevertheless paint an overall very positive picture, with average values ranging from 3.6 to 4.1.

While displaying one's own average was found very effective by nearly all users (m=4.1; s.d.=1.2), and was also known to nearly all (Figure 26-2), roughly a third of the users were more indecisive towards the effectiveness of displaying the neighbourhood average (Figure 26-3; m=3.6; s.d.=1.4) or viewing hourly consumption (Figure 26-4; m=3.6; s.d.=1.6), and a (still relatively small) group stated they hadn't used these two options at all.

The relatively high averages suggest that the addition of interactivity that allows for comparison with averages can support the user's understanding of their water consumption, which is expected to contribute to the user's awareness.

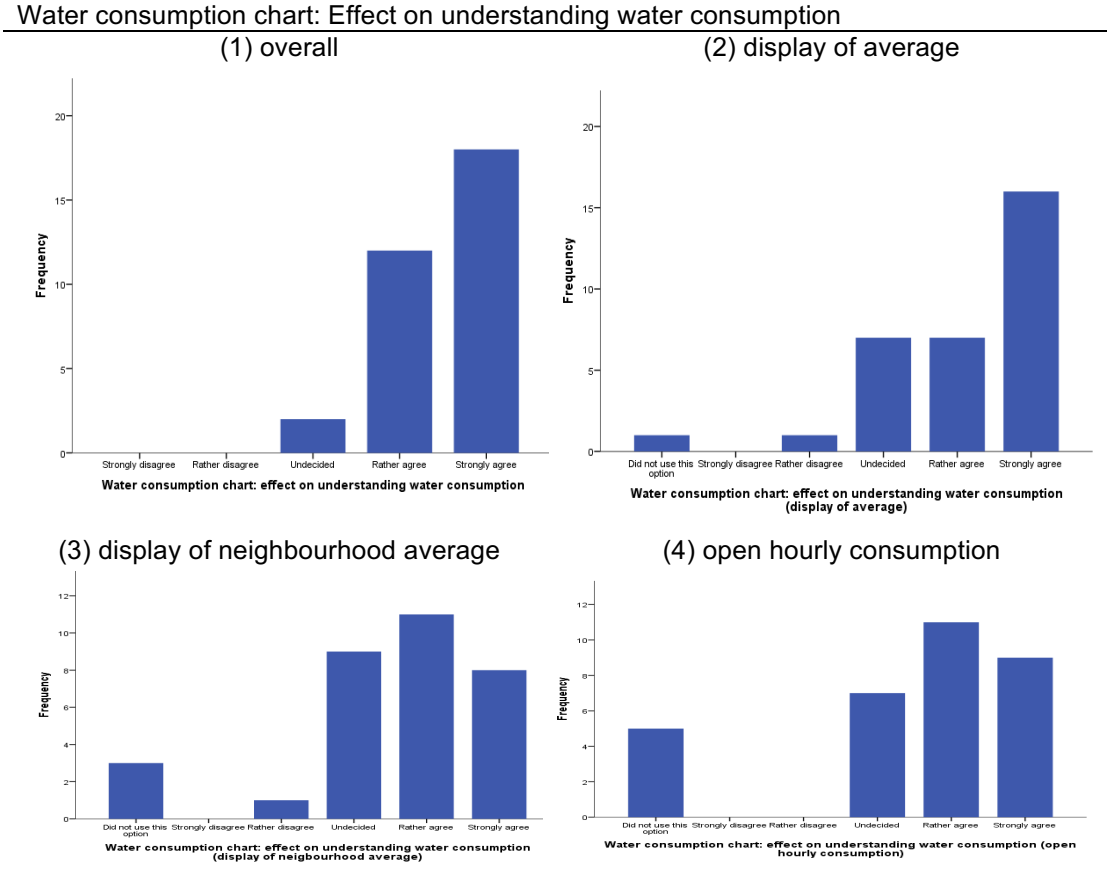


Figure 26. Water consumption chart: Effect on understanding water consumption.

The water consumption overview was also assessed very positively regarding its effect on facilitating the understanding of water consumption (Figure 27-1). Its individual aspects were assessed equally positively with mean values around 4 and standard deviations ~.8 (Figure 27-2,3,4). Out of the three aspects, display of the expected yearly consumption was assessed the most effective (m=4.1; s.d.=.7; see Figure 27-4).

The interaction that was offered to users and the comparisons they can do, appear to stimulate engagement with water consumption, which was an underlying assumption of the SmartH2O incentive model.

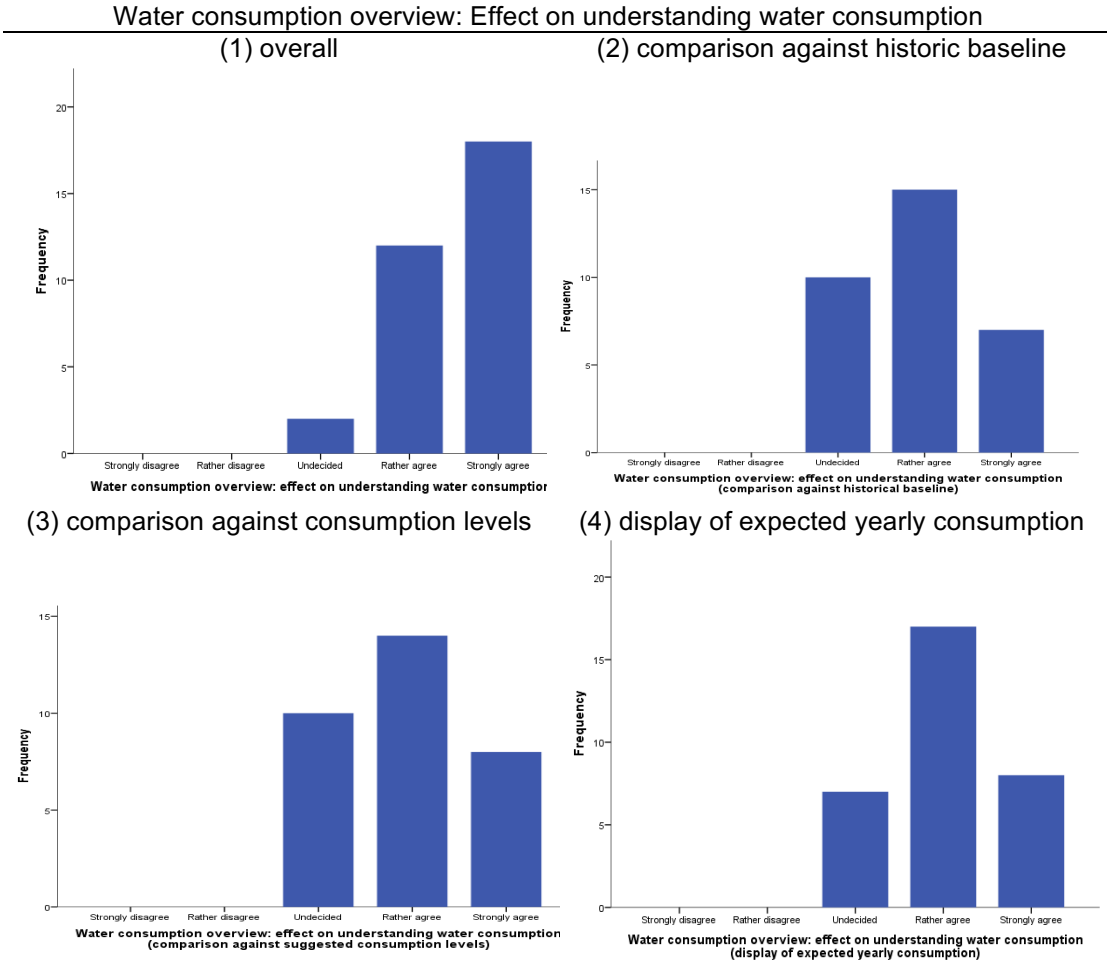


Figure 27.Water consumption overview: effect on understanding water consumption.

Water consumption alerts were found useful by a vast majority of respondents (m=4.4; s.d.=.9; see Figure 28-r). They could prove to be a strong incentive for people to use smart metering technology and accompanying visualizations and services. Consumption goals were also assessed as very useful by nearly all users (m=4.4; s.d.=.7; see Figure 28-l).

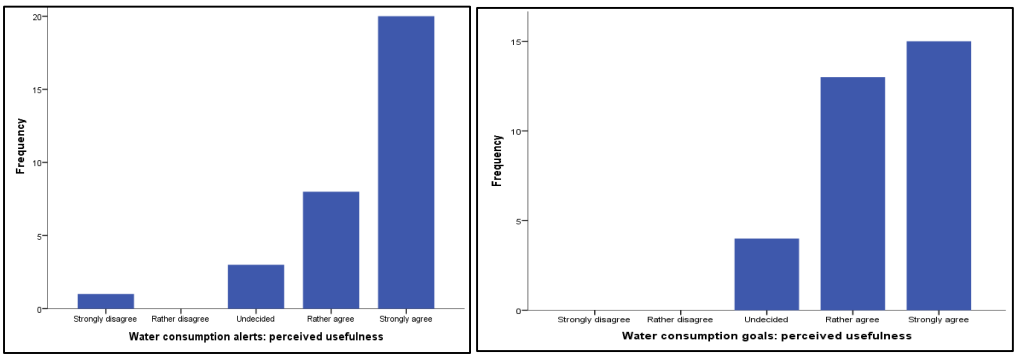
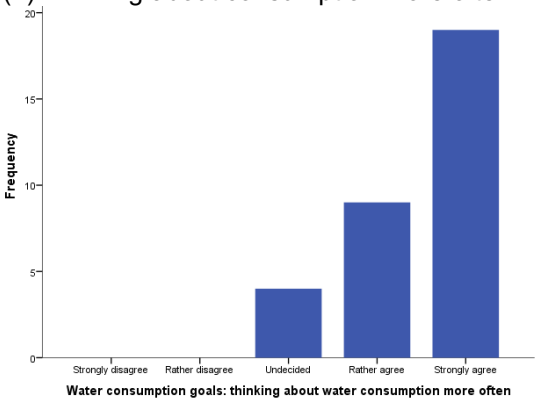


Figure 28. Perceived usefulness of consumption alerts (l) and goals (r).

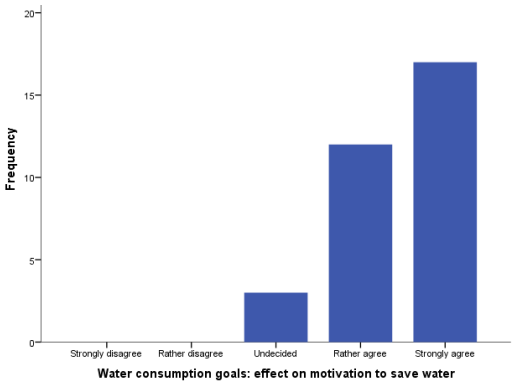
This is emphasized by the positive responses towards the incentive effect of the consumption goals. Overall, a vast majority strongly agreed that the consumption goals made them think more about water conservation than before (m=4.5; s.d.=.7; see Figure 29-1) and, to a similar extent, motivated them to save water (m=4.5; s.d.=.7;see Figure 29-2). They also stated goals motivated them to use the SmartH2O portal (m=4.3; s.d.=.7; see Figure 29-3), with a few indecisive responses. The individual elements were also assessed positively, and very similarly in terms of the level of agreement, although being able to compare consumption to goals (Figure 29-4) yielded the most positive responses in comparison (m=4.3; s.d.=.7) to the other two aspects of earning points for meeting consumption goals (m~4.2; see Figure 29-5) and being able to view expected savings when meeting a certain goal (Figure 29-6). The results reassure the importance of goal setting mechanisms in the context of systems aiming at changes in awareness and behaviour, by appealing to the user's sense of achievement.

Incentive effect of water consumption goals

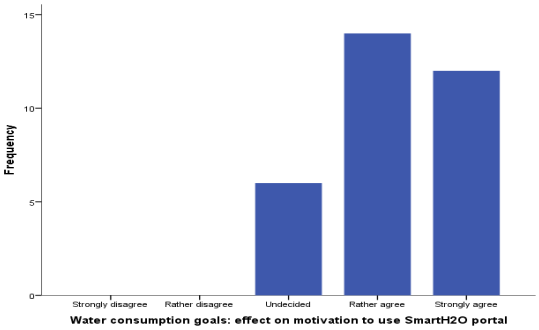
(1) Thinking about consumption more often



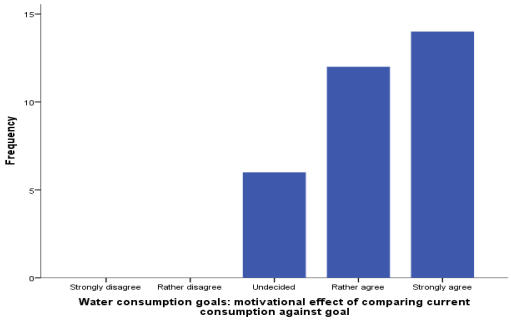
(2) Effect on motivation to save water



(3) motivation to use the SmartH2O portal



(4) comparing current cons. against goal



(5) points for meeting goals

(6) expected yearly water savings

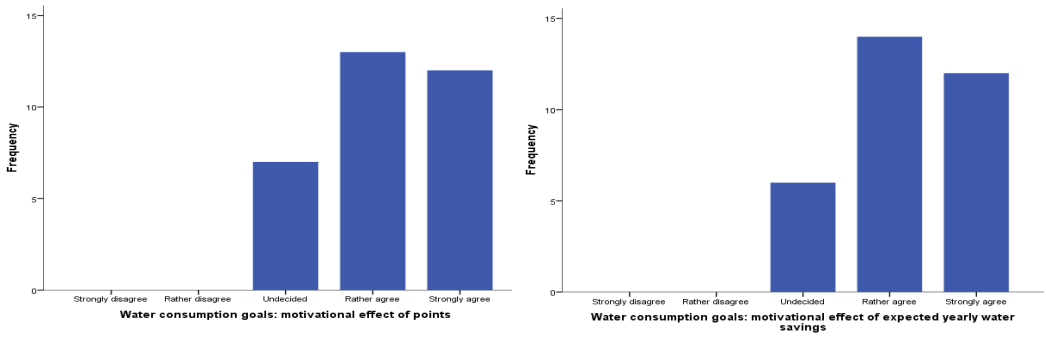


Figure 29. Incentive effect of water consumption goals.

Finally, water consumption tips were assessed in terms of their incentivating effect. Respondents found them very useful (m=4.6; s.d.=.6; see Figure 30-1), and also stated they made them think about water consumption more often, with only very few who were indicisive or disagreed (m=4.2; s.d.=.8; see Figure 30-2). Respodents also strongly agreed that the tips motivate them to save water (m=4.4; s.d.=.8; see Figure 30-3), and to fairly large extent motivate them also to use the portal (m=4.1; s.d.=.9 see Figure 30-4). The stated motivation to put tips into practice (m=4.3; s.d.=.7; see Figure 30-5) is slightly higher than the stated ability to follow through (m=4.1; s.d.=1.0; see Figure 30-6). This can be the result of the users balancing three different goals in environmental behaviour: hedonic goals, normative goals, and gain goals, with each of these goals gaining the upper hand in different situations ([Lindenberg & Steg, 2007]; see D4.3).

The rather positive results on the water consumption overview options that allow for comparioson against one's own historic or predicted consumption levels, as well as the well-received water consumption goals and alerts provide initial support for the hypothesis in the incentive model that these features appeal to the user's need for achievement [Atkinson, 1960] and stimulate the user's feeling of autonomy [Deci and Ryan, 1985].

Correlational analyses have been performed to relate the perceptions of the users on the two different visualizations to each other. Correlations were computed for the impact on the frequency with which users think about water consumption, the motivation to save water, perceived usefulness of the visualisations, and the motivation to use the portal more often. Results reveal strong correlations between the user's perceptions of the different visualisations, with intercorrelations ranging from r(29)=.57 (p=.001) to r(29)=.72 (p=.000). Thus, the water consumption chart and the water consumption overview are evaluated by the users in similar terms, with respect to the impact on their awareness and motivation to get engaged with water consumption. As the overview pipe visualization is novel and unknown to the user and it requires an additional click to access it, it is a good result to see that it yields similar perceptions from users.

It can be concluded from the evaluation of the water consumption chart and overview that they are able to encourage more reflection on water consumption and are capable of increasing the user's motivation to save water, confirming the designed SmartH2O incentive model and its implementation.

Whereas the water consumption chart and overview have been intended to stimulate thinking about one's water consumption levels, water consumption tips are offered to provide practical support with saving water. The impact of the water saving tips, as assessed by the users is displayed in Figure 30.

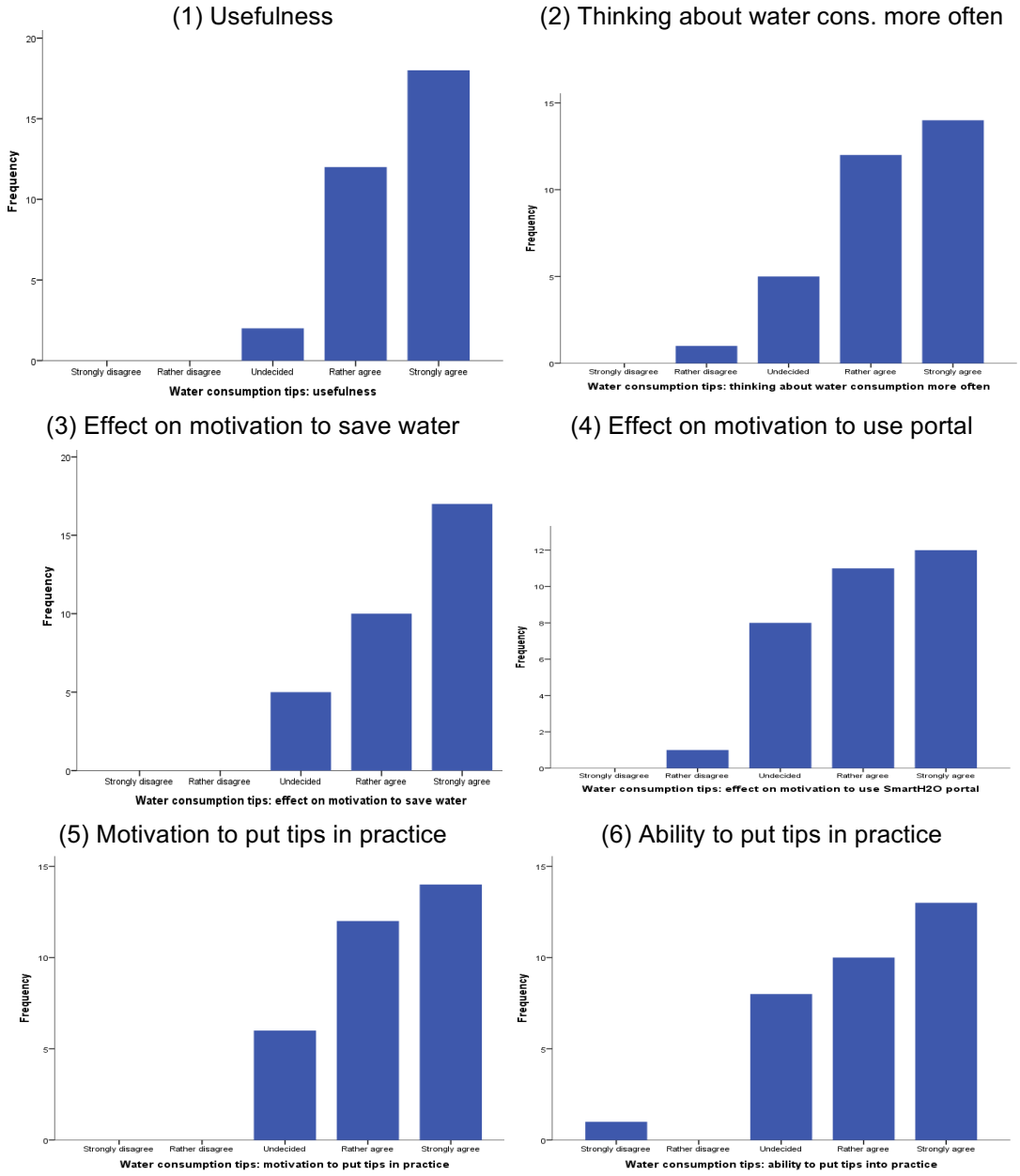


Figure 30. Water consumption tips as incentives.

Results demonstrate that the water consumption tips are deemed very useful (m=4.5; s.d.=.6). The questionnaire results also indicate that the tips are capable of making people think about water saving more often (m=4.2; s.d.=.8).

In contrast to the earlier Tegna evaluations (see D7.2), users have become more positive about their ability to put the tips into practice (m=4.1; s.d.=1.0), suggesting that the editorial improvements that have been made on the tips, have been successful. Users also appear to be very motivated to put the tips into practice (m=4.3; s.d.=.8).

The water saving tips are an important part of the SmartH2O incentive model that has proven to be effective, in terms of providing users with actionable tips, but also to raise awareness on water consumption.

4.2.3 Conclusions

This section addressed the perceptions of the users with respective to technology acceptance and the effectiveness of the incentive model. The perception of the users are consistently positive, in terms of perceived ease of use, the innovative nature of the application, and its ability to motivate people to think about and engage with saving water. The results provide empirical support for the theoretical assumptions behind the incentive model and the design choices that were accordingly made.

In section 4.4 we shift our attention to the actual behaviour of the users on the portal by analysing the user logs. This provides us with behaviour-based indications of the incentive model's effectiveness, as an addition to the perception-based evidence that was reported in this section.

4.3 Results from the Swiss case study

This section reports on the questionnaire results, in terms of technology acceptance and the effectiveness of the incentive model, as perceived by the users in the Swiss case study. In sum, out of the 23 users of the gamified portal, 10 participants filled out the questionnaire. This 43% response rate is very high when compared against response rates common for evaluations of online applications.

Since the Swiss pilot is considered to be a small-scale pilot set up for testing of the incentive model, due to the low absolute numbers in the user base and thus also in the sample size, results must be considered with certain caution.

4.3.1 Technology acceptance on application level

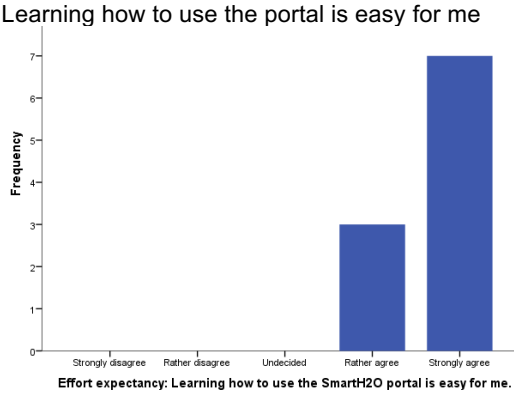
Technology acceptance on application level was measured using the established UTAUT framework [Venkatesh et al., 2003] and by means of the AttrakDiff2 questionnaire for hedonic and pragmatic quality [Hassenzahl, 2004].

UTAUT results

From the UTAUT framework, effort expectancy, performance expectancy, and attitude towards technology were measured. In Figure 31 'effort expectancy' results are displayed.

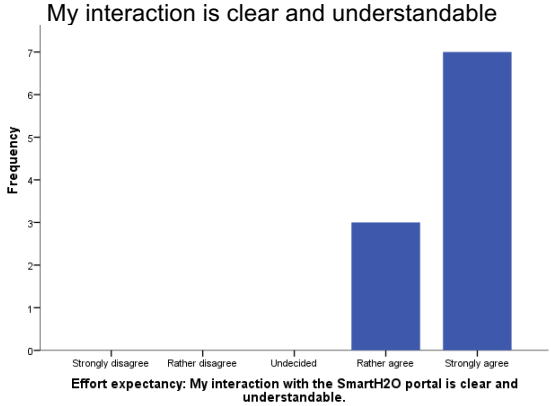
UTAUT (Effort expectancy)

Learning how to use the portal is easy for me



I find the portal easy to use

My interaction is clear and understandable



It is easy for me to become skilfull at using the portal

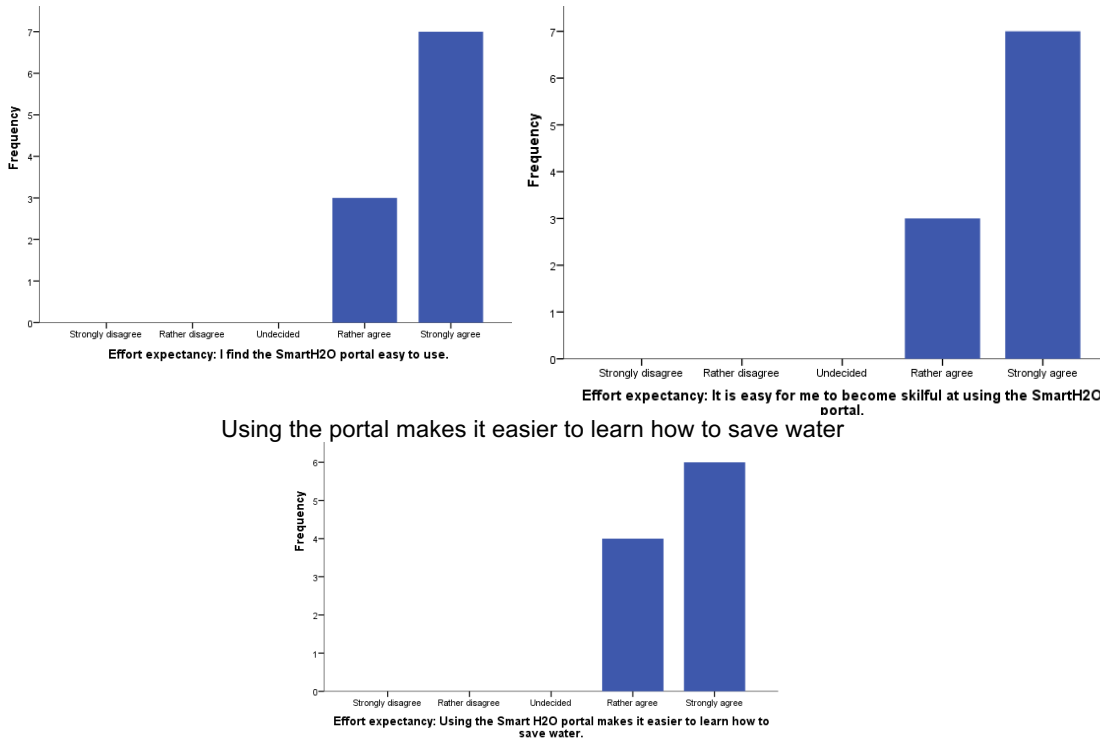


Figure 31. Effort expectancy item results.

The very positive results on the ease of use of the portal indicate that the portal has been capable of combining gamified incentives with water-related information in an easily understandable way. While the results are consistent with earlier preliminary findings, results from the Spanish case study will be able to confirm this notion drawing on data from a larger sample.

Performance expectancy was measured with two items, displayed in Figure 32, indicating that the portal has the potential to influence peoples daily lives and things that are important to them in a positive manner.

Performance expectancy

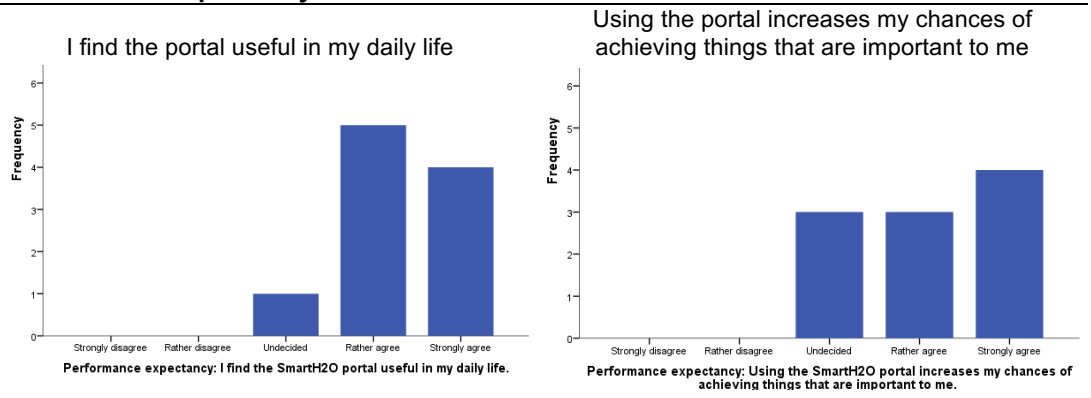


Figure 32. Performance expectancy item results.

Finally, attitude towards technology was measured with four items. Results are displayed in Figure 33.

Attitude towards technology

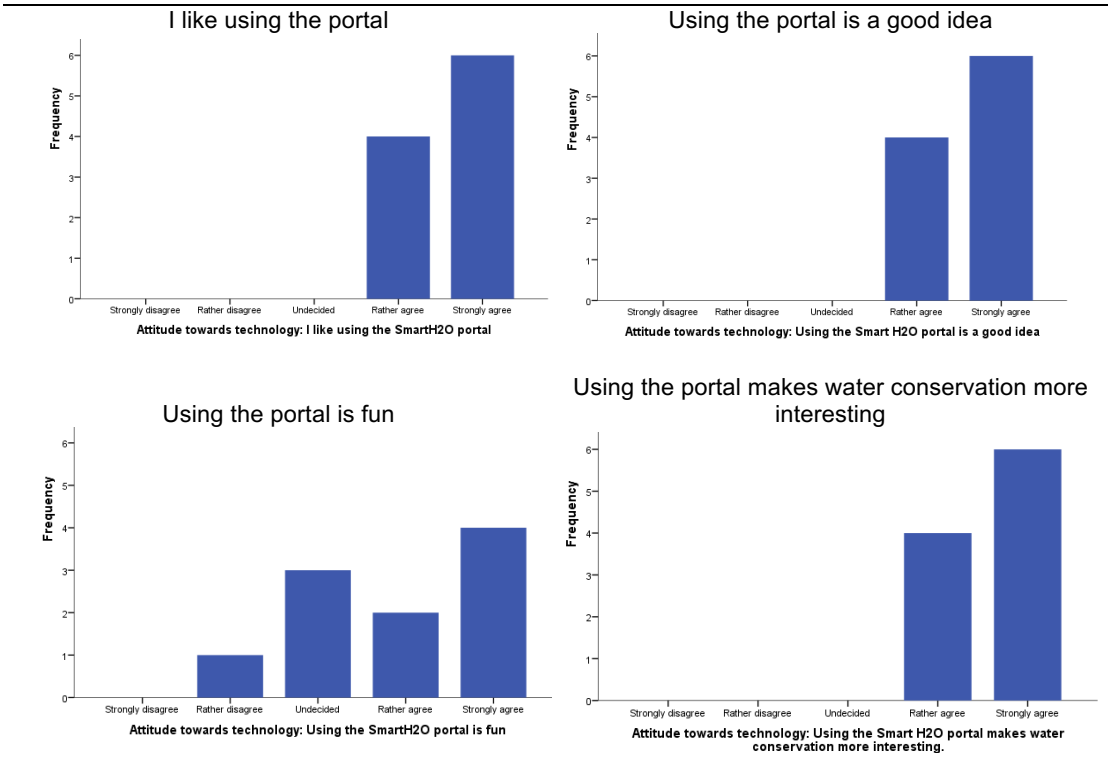


Figure 33. Attitude towards technology item results.

Similar to the performance expectancy and effort expectancy results, users had a positive attitude towards the SmartH2O portal. Users were a bit more indecisive towards finding the portal fun to use. All users agreed they liked using it, that using it was a good idea and that it made water conservation more interesting. A majority even indicated that they strongly agreed to said statements.

It can be concluded from the UTAUT results, that the users in the Swiss pilot considered the portal easy to use, useful, and that they also liked to use the portal. These results are prerequisites for the effectiveness of the SmartH2O incentive model, which based on the ddata can be considered to be fulfilled.

Hedonic and pragmatic quality

Hedonic and pragmatic quality were measured using the AttrakDiff2 questionnaire [Hassenzahl, 2004, 2008], of which hedonic quality (stimulation) and pragmatic quality were measured. The scores of the seven individual items were averaged, yielding an average pragmatic quality score of 6.0 (s.d.=.7) and a hedonic quality (stimulation) average of 5.9 (s.d.=1.0). The distributions of the scale averages are displayed in Figure 34.

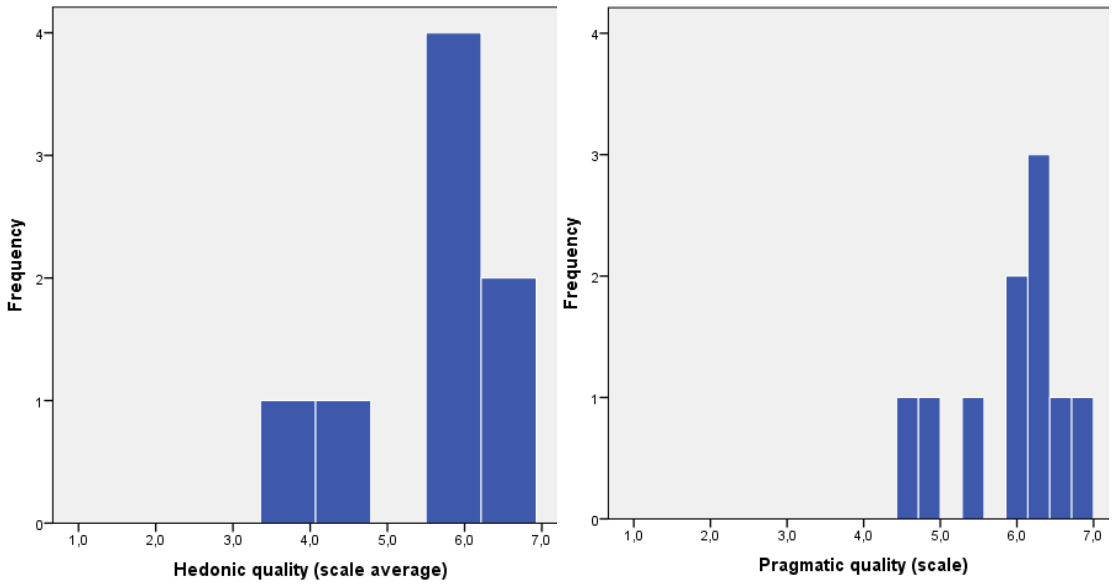


Figure 34. Average hedonic quality (left) and pragmatic quality (right) scores.

The closely matched and high average scores indicate that the SmartH2O portal is capable of providing users with a stimulating user experience that is well-balanced against the pragmatic goals of the users (e.g. learning about their water consumption). Whereas the portal seeks to convey the meaning of the water consumption data to the users as incentive to start saving water, users deem this information useful (see next sub section), contributing to the pragmatic quality they derive from the portal. On the other hand, the portal stimulates users through gamification and encourages users to think about water consumption. This is reflected in the hedonic quality scores, and confirmed by more detailed evaluation data on the portal's features (see next sub section). In sum, the hedonic and pragmatic quality of the portal are well-balanced.

4.3.2 User-reported effectiveness of the incentive model

In the previous deliverable D4.3, only preliminary user feedback from the Swiss case study was reported, i.e. on the effectiveness of incentive model elements that also applied in the basic portal. In this round of feedback collection in the Swiss case study, only advanced portal users were targeted, and questions on feature level were based on the key performance indicators reported in D2.2. The primary target of the evaluation was to assess the incentive model outlined in D4.3 – and more specifically the gamification elements, while simultaneously assessing ease of use and comprehension as critical success factors for the incentive model. The Drop! Game has also been evaluated with users. Results were reported in Section 3.5.

Gamification elements as incentives

The primary goal of this round of feedback was to evaluate user-based performance indicators that focus on the motivational affordances of the portal's gamified features. Users were asked "I feel motivated to use the portal, because I can…", which was followed by the a number of incentive model elements. Users were asked to respond on a five-point scale from strongly disagree (1) to strongly agree (5). Figure 35 displays the results.

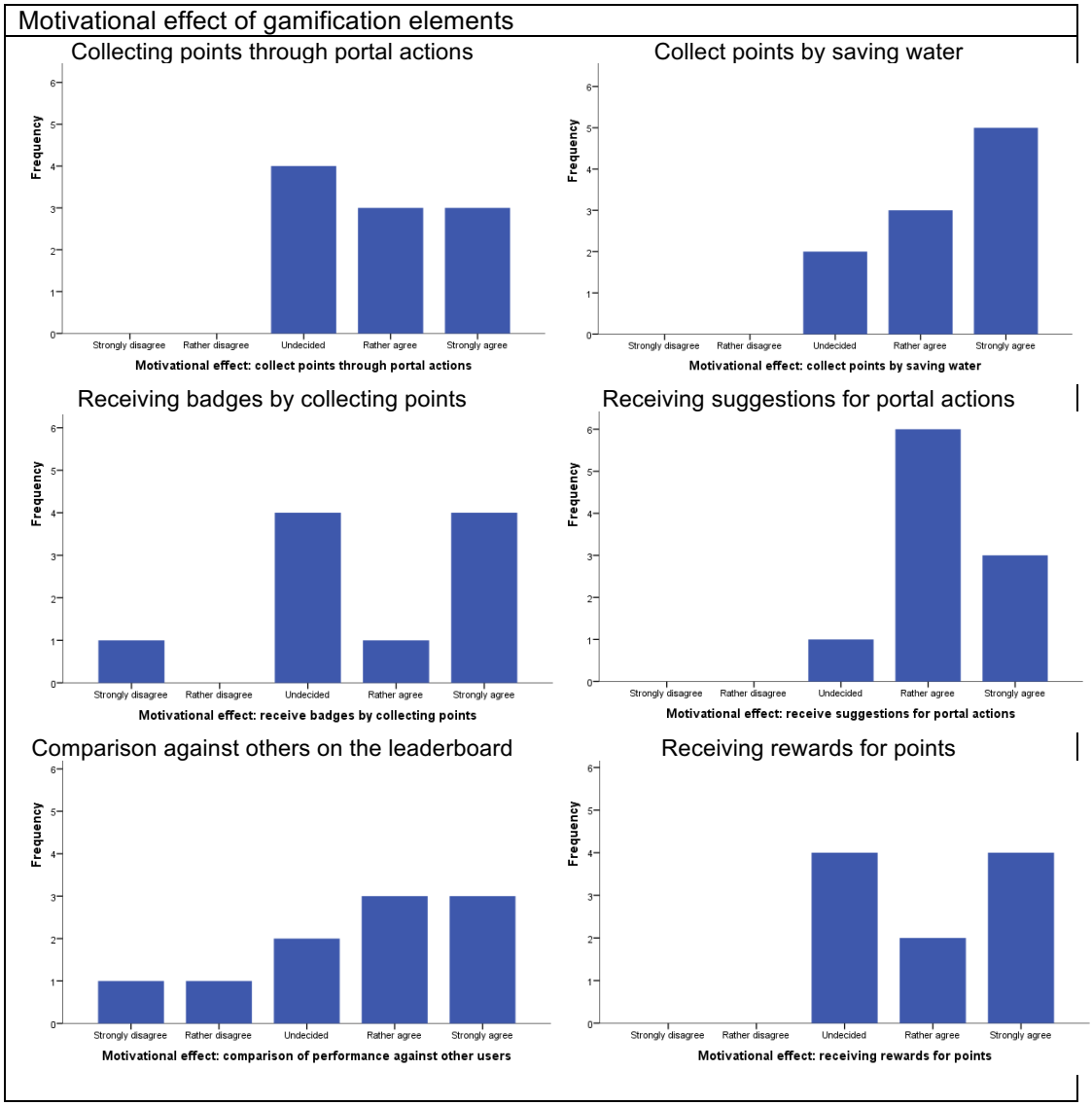


Figure 35. Motivational effect of gamification elements.

While collecting points through portal actions was perceived as a motivator by most users but also yielded indecisive responses, collecting points by saving water was strongly confirmed to be a motivator for portal usage. This indicates that the approach the SmartH2O portal is taking by rewarding significantly more points to water saving could indeed be going into the right direction towards facilitating usage and raising awareness.

Opinions about badges are a bit more divided among respondents, yielding either strong agreement about their motivational affordance or indecisiveness. Actionable suggestions on what users can do on the portal were also found motivating aspects towards portal usage. 6 out of 10 users found the comparison against others on a leaderboard motivating.

Receiving rewards in exchange for points was assessed to be more motivating (6 out of 10 users), which could possibly indicate that the market place approach has been an appropriate choice for this particular case study. Overall, responses are rather positive towards the applied gamification elements, assuring the approach we've taken but also calling for more investigation towards more indecisive users.

Responses to two additional questions about the leaderboard (see Figure 36) indicate that the leaderboard may foster competitiveness among users, or that users that are using the portal are by selection more competitive.

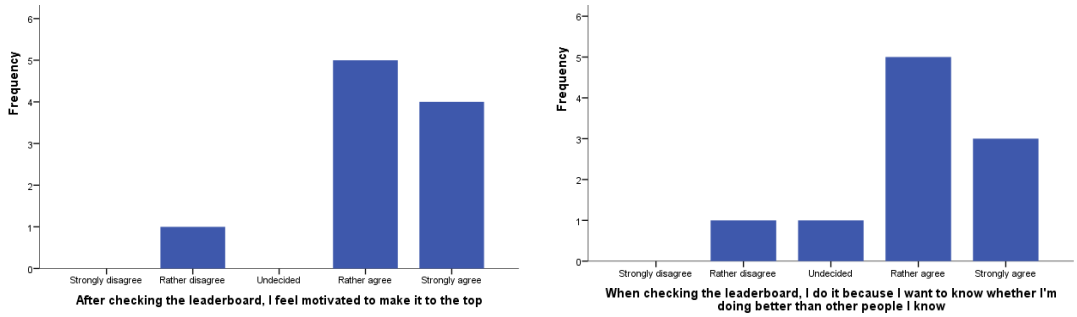


Figure 36. Motivational effect of competition through the leaderboard.

Consumption visualization as an incentive

Since in the Swiss case study, feedback on the water consumption chart and saving tips had already been collected (see D4.3 and D7.2), the focus of this evaluation has been the new water consumption overview in addition to the gamification incentives. Users in the Swiss case study strongly agreed that the water consumption overview visualization was useful (Figure 37-1), and also agreed that it made them think about water conservation more often than before (Figure 37-2). The level of agreement towards the latter was higher than responses to the same question about the chart and first overview version in the first evaluation round (see D4.3), indicating tentatively that the visualization using the pipe metaphor could be even more effective to convey meaning and purpose of water saving.
Users also stated that the visualization motivates them to save water (Figure 37-3), and to an even slightly larger extent agreeing that it motivates portal usage (Figure 37-4), showing that a more playful visualization does also have the potential to greatly influence both portal usage but also users' drive to save water.

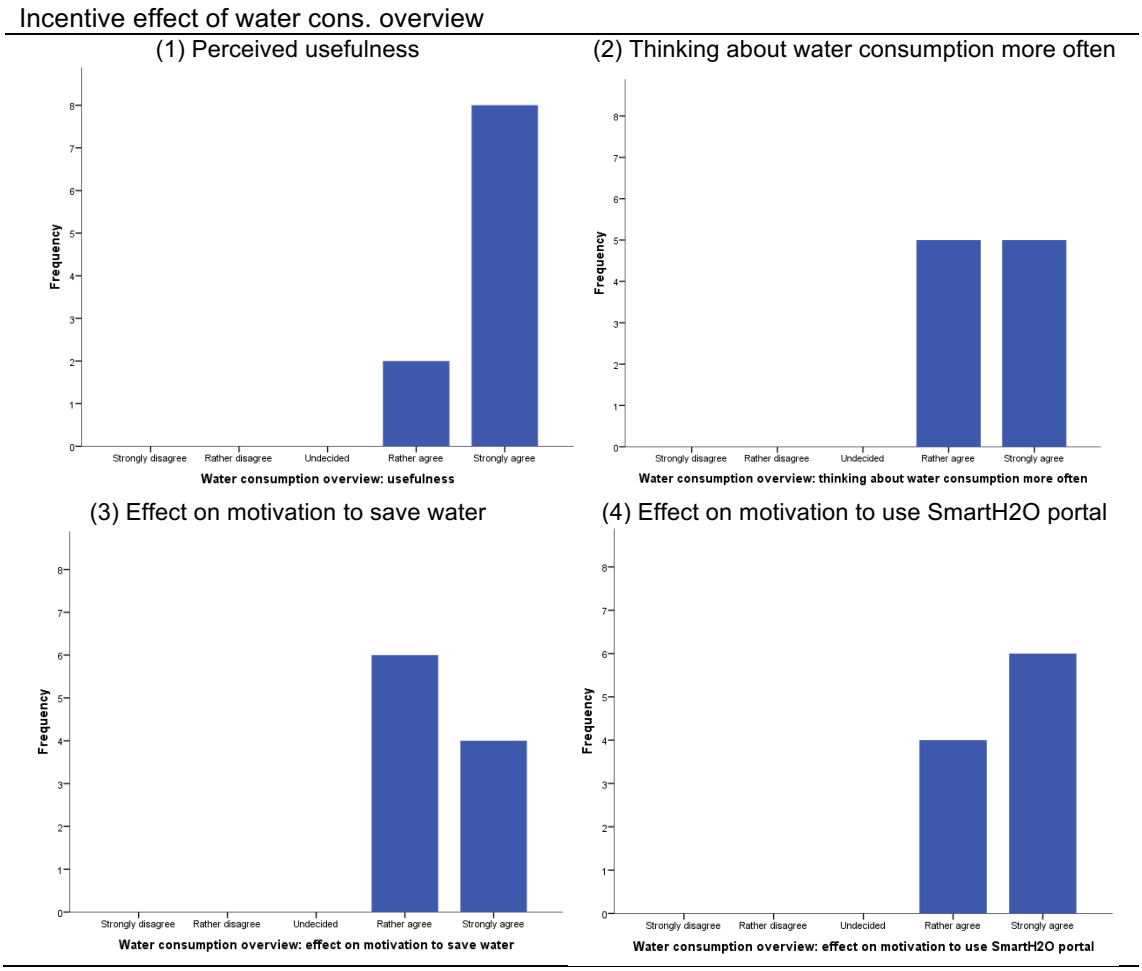


Figure 37. Incentive effect of water consumption overview.

Users strongly agreed that the overview visualization helped them in understanding their water consumption, with 8 out of 10 even agreeing strongly (Figure 38-1). All three main elements of the consumption overview seem to attribute to that almost equally (Figure 38-2,3,4).

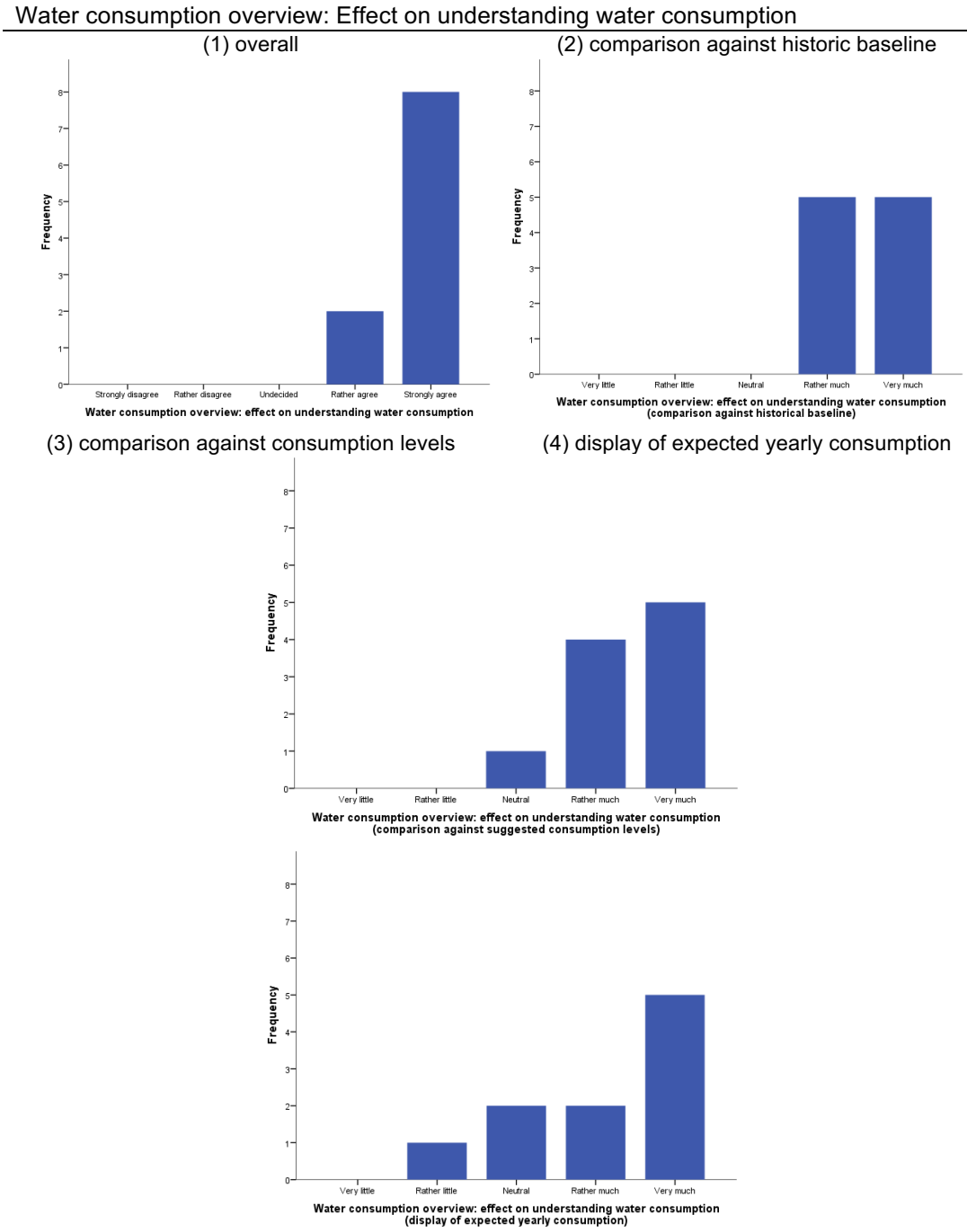


Figure 38. Water consumption overview: effect on understanding water consumption.

This result is very positive for the SmartH2O project, in that the incentive model strongly assumes that understanding of one's water consumption precedes favorable attitudes and ultimately behaviour. These results demonstrate that the water consumption overview is capable of contributing to the user's beliefs about one's own water consumption.

Alerts were found useful by 7 of 9 users, whereas the other 2 disagreed (Figure 39-left). Water consumption goals were found useful by all respondents (Figure 39-right), which was also confirmed in the positive responses to the follow-up questions.

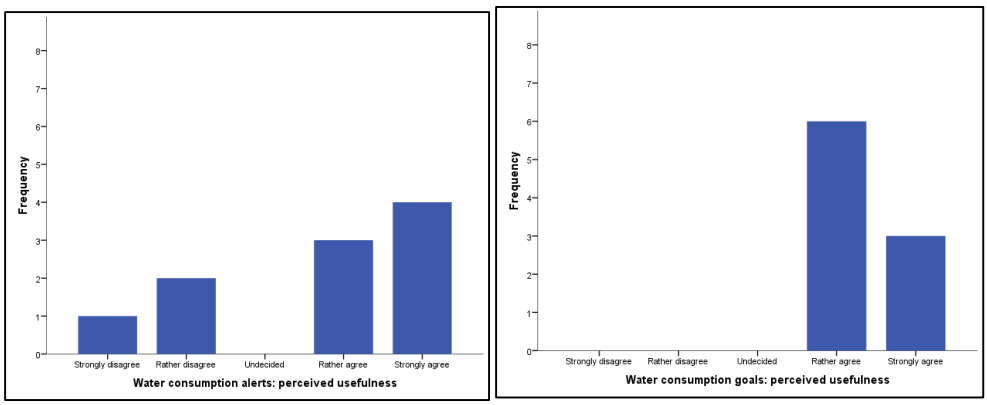
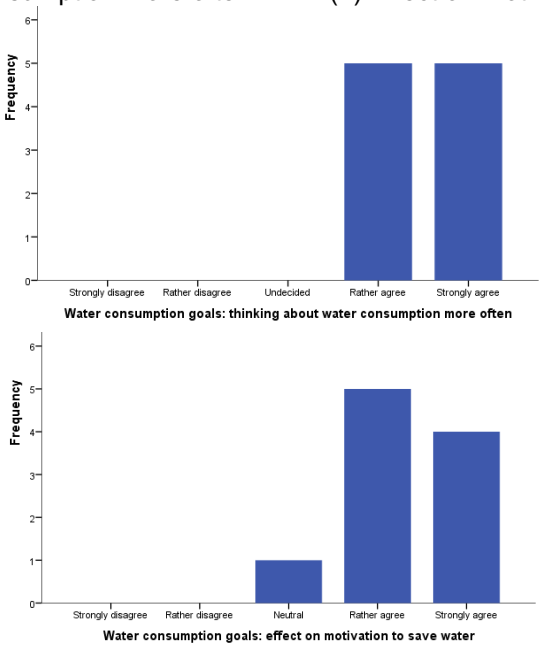


Figure 39. Perceived usefulness of water consumption alerts (l) and goals (r).

Users agreed that the water consumption goals made them think about water consumption more often (Figure 40-1), and that they motivated them to save water (Figure 40-2). To the same extent, they also claimed it motivated them to use the portal (Figure 40-3). They also found it motivating to be able to compare their consumption against goals (Figure 40-4), and 6 out of 9 users agreed that receiving points for meeting goals was motivating (Figure 40-5). The aspect of seeing yearly water savings in relation to goals was also found motivating (Figure 40-6). In summary, these are great tentative results for users' attitude towards goals, indicating the possible importance of goals as part of incentive models.

Incentive effect of water consumption goals

(1) Thinking about consumption more often (2) Effect on motivation to save water



(3) motivation to use the SmartH2O portal (4) comparing current cons. against goal

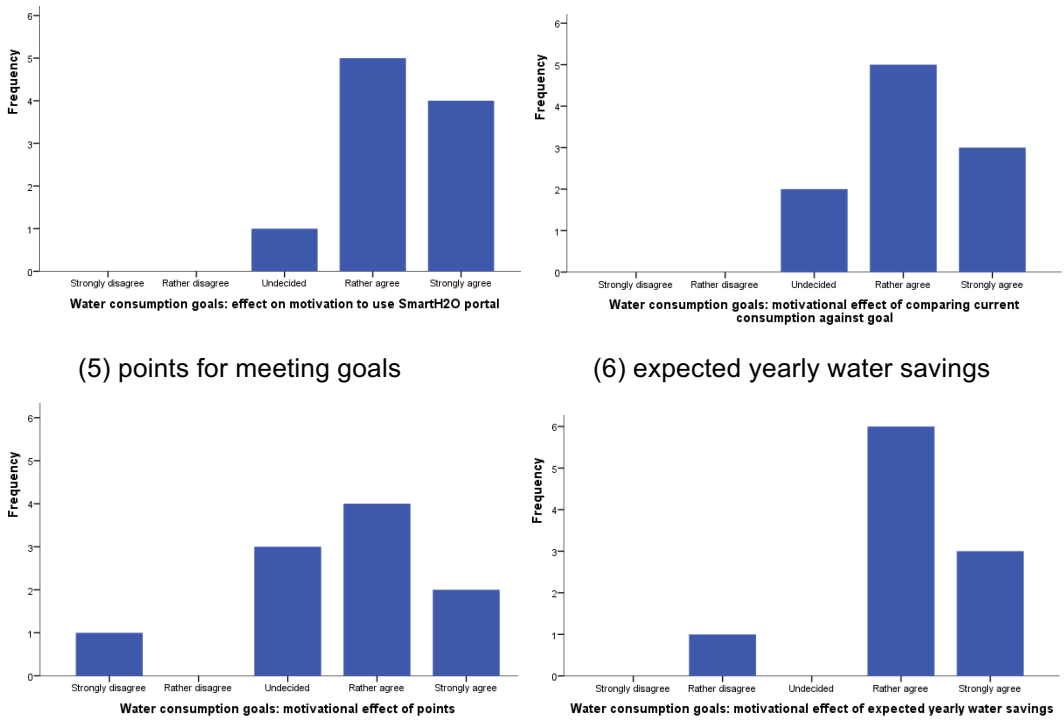


Figure 40. Incentive effect of water consumption goals.

4.3.3 Conclusions

The questionnaire-based assessment of the small-scale Swiss pilot has yielded – in line with the preliminary results reported in D4.3 – promising feedback on the effectiveness of the incentive model. Results suggest that water consumption feedback and the gamification elements increase their engagement with water conservation and support their understanding of their own water consumption. Additionally, technology acceptance and user experience evaluations have demonstrated that users found the portal stimulating (e.g. the hedonic quality results) and easy to use. These results are consistent with the findings from the more large-scale pilot that were discussed in the previous section.

4.4 User behaviour results from Spanish case study

The first promotion campaign for the Spanish case study took place late May. Since then a first use base has been established whose activity on the portal gives the first indications of the effectiveness of the incentive model. The incentive model described in D4.3 assumes that interaction with gamified elements yields a motivation for portal usage that will subsequently motivate users to interact with water-related information (e.g. tips, water consumption visualisations). Below portal actions of the users are reviewed from this perspective.

4.4.1 Summary of user activity

As a first step in the log analysis, we inspected the onboarding of users by analysing the time of registration. Results are depicted in Figure 41.

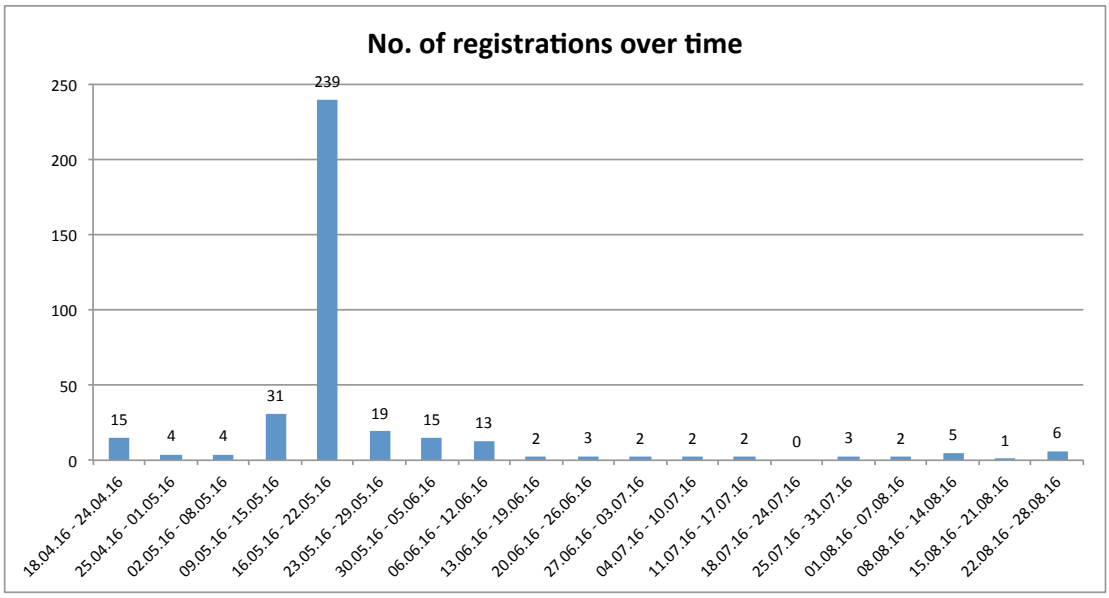


Figure 41. No. of user registrations over time (Spanish case study).

As can be seen from the 239 of the 368 users (65%) have registered in the week between 16th and 22nd of May, which was the time of the promotion campaign (see D4.3 for a description). The results also suggest that encouraging new users to register is highly dependent on such promotion campaigns. While a new promotion campaign is scheduled shortly after the release of this deliverable to attract attention to the new portal release, the social sharing features in the new portal also support attracting new users to the portal.

Subsequently, we investigate the activity of the users after registration. In Figure 42 the no. of times active users have logged in. Active users are defined as those users who have logged in more than once.

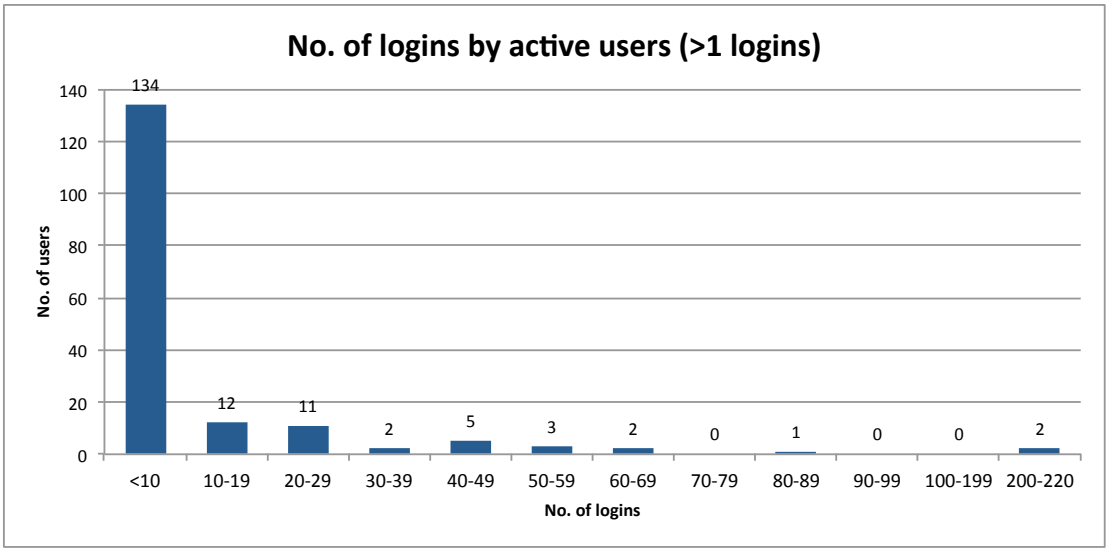


Figure 42. Number of logins by active users (Spanish case study).

The results demonstrate that the majority of the active users (134; 36% of all users) log in between 2 and 9 times over the total duration of their membership until the first of September 2016. The average across all users was 2.0 times per month (or once every two weeks;

s.d.=6.0). The average across active users with two portal logins or more was 3.9 (s.d.=8.5). The high standard deviations and the distribution in Figure 42 demonstrate a high variability in activity level between users, with a significant share of the users being more active than two log-ins per month, and two users even logging in more than 200 times over a 19-week time period (or > 10 times a week).

The average number of logins per month suggests that there is a basic activity level for the vast majority of the users, pointing to the users' commitment towards the portal goals. This is a good result, especially when compared against regular interactions with the water utility that are only comprised of reading the water bill once or twice a year.

In addition to these moderately active users, there are five users outliers who have logged in more than 60 times, of which 2 even more than 200 times. These users are considered lead users. The emergence of lead users is typical for almost all online communities and behavioural change applications. Such lead users are crucial for the vitality of the platform, as they generate activity and engagement e.g. with the gamification features, which encourages the activity of the other users as well.

In addition to these moderately active to very active users, there is a substantial part of the user base who has not been active after registration (53% of the registered users). This results highlights the importance of regularly contacting users through means outside the portal, especially at the start of the behavioural change process. Therefore, as of the next portal and mobile app release, weekly summaries, reminders to log in, and consumption alerts are sent to the users to reactive users who would otherwise remain passive. As a result, portal activity for a growing number of users is likely to increase.

In Figure 43 the total number of actions on the portal is displayed, divided by the portal's functionalities.

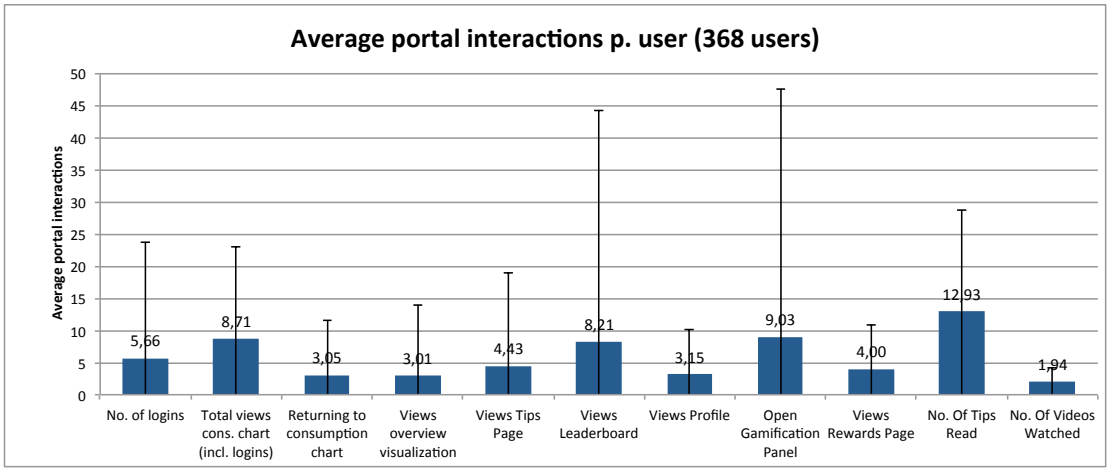


Figure 43. Average no. of portal actions per user, divided by functionality.

The results indicate that the water saving tips were most frequently inspected by the users, followed by a set of actions associated to the gamification functionalities (e.g. the gamification panel, leaderboard, tips for portal actions, rewards page), and the water consumption charts. Results indicate that users make use of all platform functionalities, with particularly emphasis on the gamification features. However, inspection of the standard deviations revealed that there is a high variability among users.
This is in line with the hypotheses behind the incentive model, in which in earlier phases of the behavioural change process we expect the motivational affordances from the gamification elements to be stronger, whereas in later phases of the process the water-related features will become more important once their intrinsic motivation for water conservation has been

strengthened (see D4.3 and [Prochaska & Di Clemente, 1992] for an explanation of the behavioural change model). In the final evaluation of the portal, reported in D7.3, we will review these results and relate portal actions to changes in attitudes and behaviour with respect to water consumption.

Below we will address the specific activities users have undertaken on the portal.

4.4.2 Interaction with gamification elements

In the previous sub section it was shown that users were very positive concerning the motivational effect of the gamification elements. In this sub section we investigate whether their opinions match the behaviour users demonstrate on the portal. We address two pillars of the gamified incentive model: the elements associated to virtual rewards (points, badges, leaderboards), and the physical rewards.
With respect to the first class, we inspected the total number of points users have received. The distribution of the points is displayed in Figure 44.

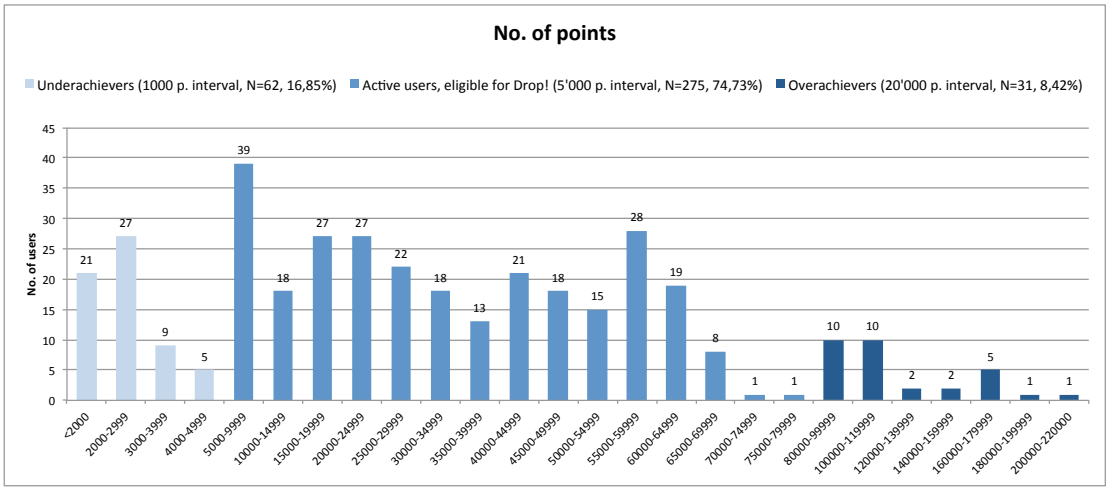


Figure 44. Number of points across users (Spanish case study).

The point distribution demonstrates that the vast majority of the users can be classified as an active user (n=275; 74.73%), defined as those users who did not do the introductory actions that were suggested in the onboarding process. Underachievers make up for 16.8%, while the overachievers form 8.42% of the user base. Overachievers are those users with more than one s.d. above the average no. of points. The high number of active users is – combined with the substantial number of portal logins and the perceived motivational affordance of receiving points – promising in terms of the effectiveness of the incentive model. Both behaviour and perception of the users suggest that users are engaged by collecting points.
Subsequently, we analysed the badges users have received for their activity on the portal. In Figure 45 the distribution of badges per user is displayed. The results demonstrate that 332 of the 368 users (90.2%) have collected one or more badges, while 66.6% have collected three badges or more.

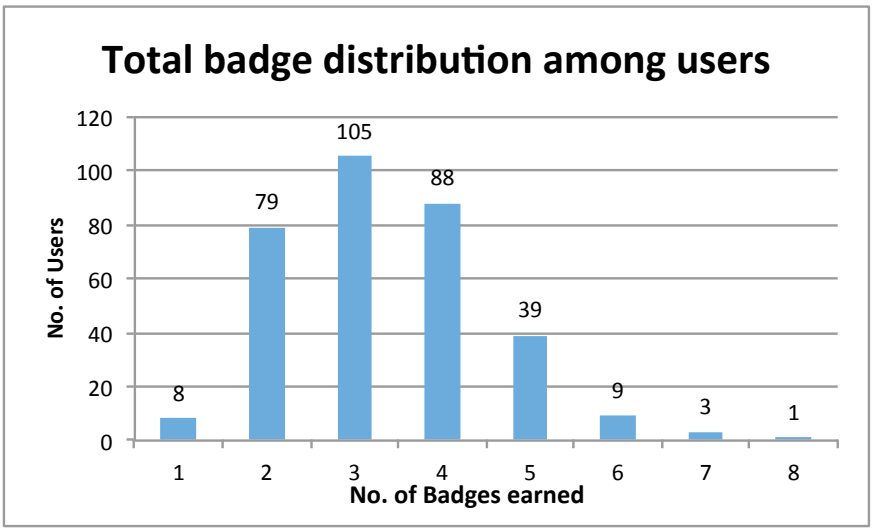


Figure 45. No. of badges per user (Spanish case study).

In the numbers of badges are displayed per type of badge.

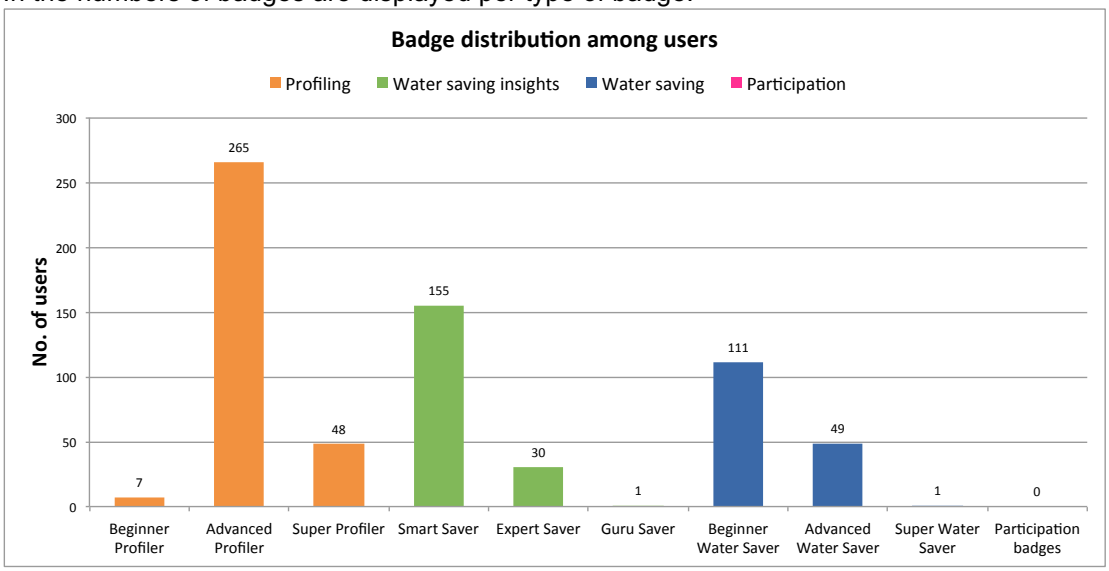


Figure 46. Badge distribution among users (Spanish case study).

The results demonstrate that the advanced profiler badge was assigned to 265 users (72.0%), suggesting that the onboarding process of motivating users to fill out their profile and the sign-up questionnaire for the validation has been successful. Of these users, 48 users have even the super profiler badge, which is awarded when 4000 points have been collected in the profiling area.
A still very substantial 50.3% (n=185) has gained the Smart saver badge, suggesting that they have been reviewing tips and videos to save water. Slightly less at 43.3% (n=160) users have been involved in saving water, by inspecting water consumption statistics and setting goals.

A feature that is based on the virtual rewards is the weekly and overall leaderboard. Weekly leaderboards were reset every week, in order to stimulate continuous platform activity and to provide a stimulus for previously passive users to become active, offering those users a chance

to win a competition after only one week of activity. In total, 36 tickets have been awarded over the course of 20 weekly competitions. In Table 6 the awarded tickets are displayed.

Table 6. Weekly competition results (Spanish case study).

No. of users	No. of tickets won
14	1
1	4

The results demonstrate that 15 users (4.0%) of the user base has won at least one museum ticket. One users was so engaged with the competition that they successfully attempted to win tickets 4 times. This result refines the findings of the questionnaire that suggested that users are more motivated by their own performance and sense of achievement than by engaging in competition with others. While this holds true for the majority of the users, there is a category of users that can be engaged with the SmartH2O portal by means of the weekly competition.
Physical rewards, as a second class of incentives in the gamified incentive model, were awarded to users who have received 5000 points or more. Additionally, tickets to the oceanographic museum were awarded to those users who won the weekly competition. The statistics of users eligible for rewards, rewards claimed, and rewards picked up are displayed in Table 7.

Table 7. Rewards for users in Spanish case study.

	Eligible	Picked up	Claimed	Eligible but not claimed
Drop! (5000p)	236	42	45	149
Tickets (weekly competition winner)	18	13	3	2

The table demonstrates that 236 users were eligible for Drop!, meaning that these users have performed a first basic set of platform actions in different thematic areas. Interestingly, 17.8% of the users eligible for the Drop! Game has picked up the game, whereas 19.0% has claimed the game, but has not picked it up. Thus, 42 users were that much interested in saving water and discussing water consumption in their household that they were willing to physically go to the pick-up point to collect the game. Given this required effort, the high share of users not claiming the game is not surprising.
For the weekly competition winners, the balance is different. A free ticket to a renowned museum seems to be a stronger incentive to take the effort of going to the pick-up point. 72.2% of the winners has picked up their reward, whereas only 2 users (11.1%) have not claimed their rewards, and only three users (16.7%) have claimed the ticket, but have not picked it up.

4.4.3 Interaction with water consumption visualisations and goals

While the behavioural change model suggests that interactions with water consumption information can typically not be expected in the very first phases of the behavioural change process, the log data reveal that a significant number of interactions have already taking place, both with the water consumption chart and with water consumption overview.

The average number of interactions with the different water consumption charts and visualizations is depicted in Figure 47.

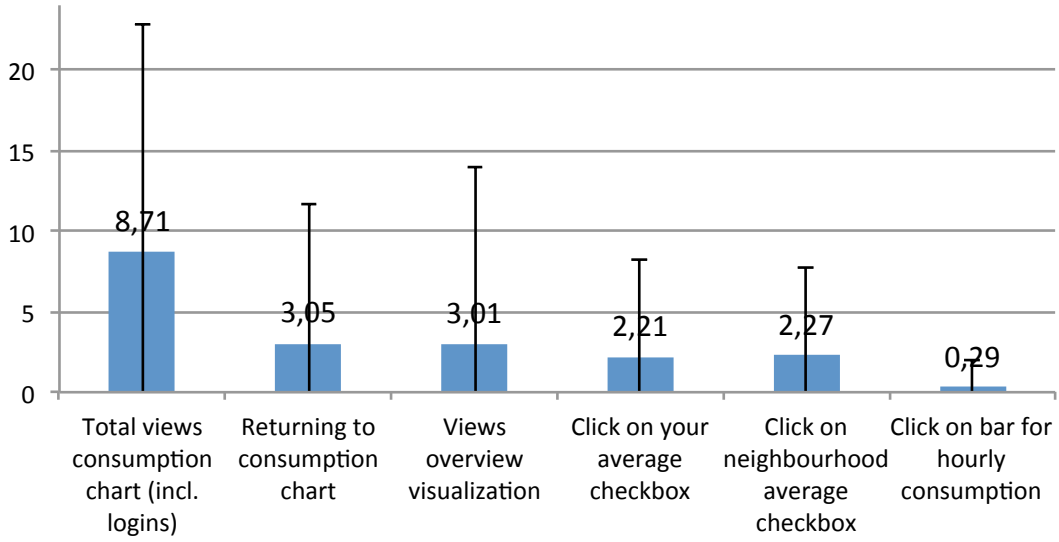


Figure 47. Average number of interactions with water consumption visualisations.

Inspection of the results shows that the consumption overview and the consumption chart were used with approximately the same frequency. Note that the total number of views for the chart is substantially higher, since the chart is the first page that is loaded after users log in. Therefore, we consider the users returning to the chart to be a more reliable number. As said, the number of interactions with the charts are encouraging, given the current stage of the behavioural change process.
In terms of the chart's options, the comparison options for the average consumption and the average consumption of similar households in the neighbourhood are used with a similar frequency. The hourly consumption option is used substantially less frequently.
Interestingly, the feedback of the users in the questionnaire revealed that they deemed the neighbourhood comparison option less useful for understanding their water consumption, but the log data reveal that the options are used just as frequently. When more usage data becomes available, it can be observed the usage of this option declines after this initial usage, or that there is a lasting discrepancy between the users' perceptions and their behaviour.

Finally, we have inspected the achieved weekly and monthly savings and the goals users have set for themselves. Results are displayed in Figure 48.

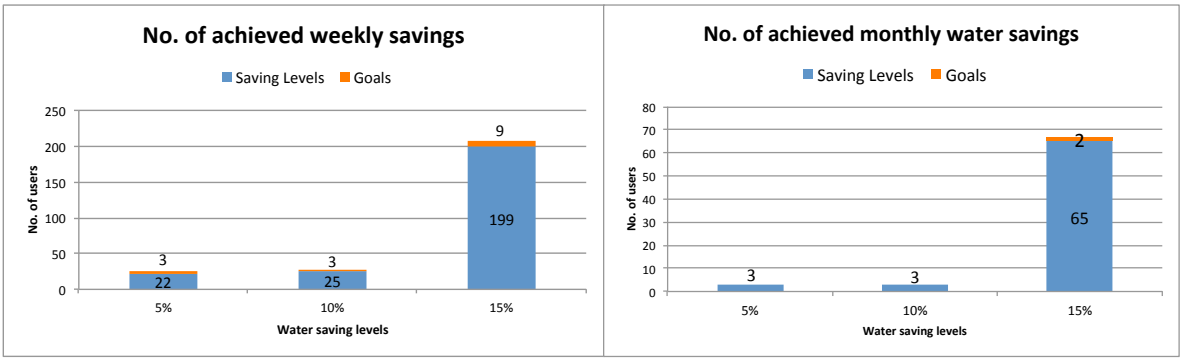


Figure 48. Water saving goals (Spanish case study).

Interestingly, a significant number of users have already received points for reducing their water consumption. However, these results should be interpreted with care, since no longitudinal

water consumption data is yet available and the reductions could be the result of exogenous factors.
Whereas in the incentive model users were expected to set goals in later phases (e.g. in the action phase; see D4.3), over the evaluation timeframe, 15 users have already set a weekly goal, and two users an ambitious 15% water saving goal. These numbers indicate that already a number of lead users are incentivized by the goal setting functionality to reduce their water consumption and to meet their self-set targets.

4.4.4 Lead user analysis

Whereas the analyses reported in the previous sub section provide first indications of the effectiveness of the SmartH2O incentive model, a more detailed inspection of a limited number of active lead users can reveal behavioural patterns that distinguish different types of users. Five users were selected with more than 80.000 points, which is approximately the mean number of points plus one standard deviation.

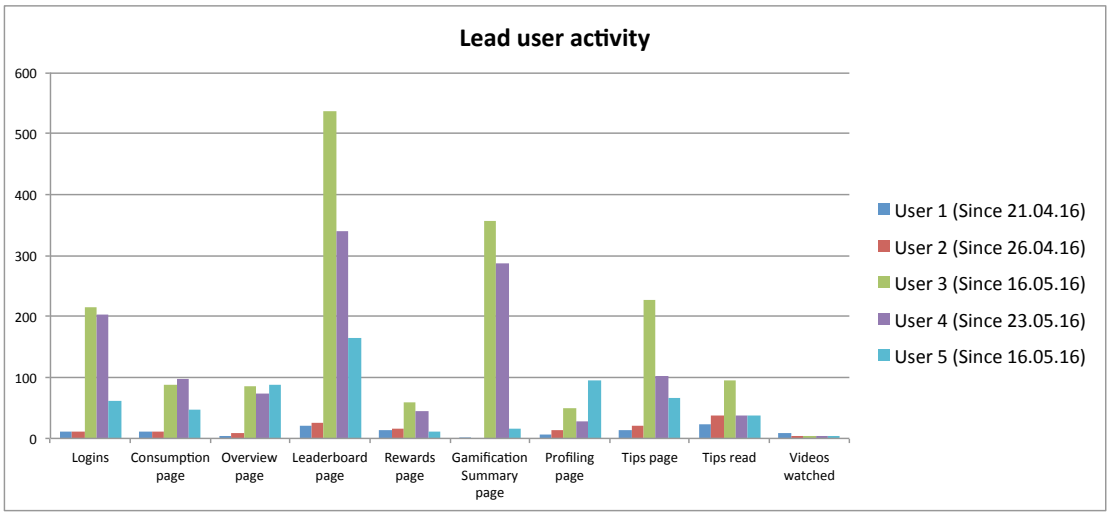


Figure 49. Lead user activity divided by functionalities (Spanish case study).

Inspection of the graph demonstrates that for all users in this analysis most activity is concerned with the gamification functionalities. Second, both the water saving tips and the consumption visualisations attract the attention of these lead users. This pattern is consistent with the pattern that was found for the user base at large, even though the level of activity for these lead users is substantially higher.
User #3 is overall the most active user, but his/her engagement with the gamified features stands out from the rest. This user often visits the leaderboard page, and the gamification summary in the sidebar. S/he seems very interested in the weekly competition, since the leaderboard received more than 500 page views of this particular user. In addition to the gamification features, the tips pages are often read.
User #4 displays a similar pattern of activity, albeit with lower numbers for particularly the leaderboard page and the water saving tips.
User #1 and #2 display overall a lower level of activity than user #3 and #4. Their activities are more evenly spread over the different portal functionalities. Relative to their overall level of activity, they quite frequently read water conservation tips.
User #5 is moderately active on the portal. Two particular actions on the portal stand out. First, the user frequently inspects the consumption overview page, with a similar frequency as user #3 who overall is substantially more active on the portal. Second, the profiling page is frequently visited. This could be the result of the onboarding process that incentivizes users to complete

their user profile, yielding more page views during this initial phase of the process. Subsequent analyses have to reveal whether profiling activities become less prominent over time.
Even though the timeframe for this analysis is too short to have conclusive evidence about the stability of user activity across time, initial patterns can be derived from a longitudinal analysis of the number of logins. Figure 50 depicts the number of user logins for each of the five lead users over time.

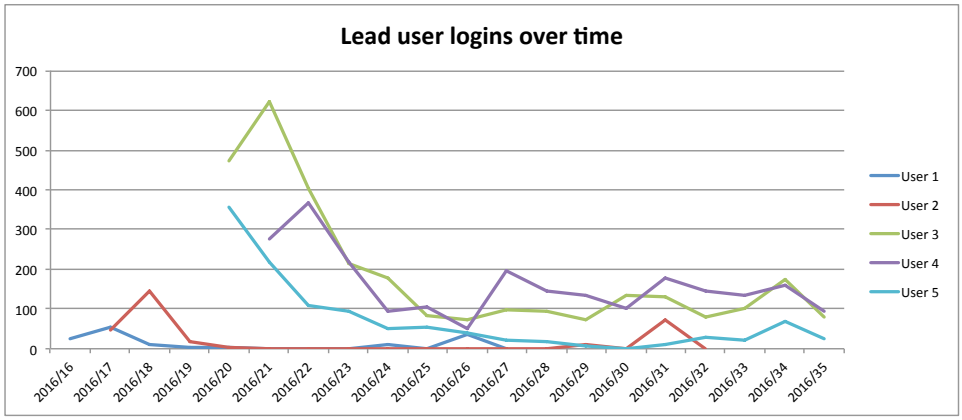


Figure 50. Lead user logins over time (Spanish case study).

The graph demonstrates that - after an initial peak of activity - the lead users return to a lower, but stable level of activity. No strong drops in activity were found, which is surprising, since during the summer period people are often away from their homes for a number of weeks. However, this does not seem to have affected the activity of these lead users.

The shape of the lines differs per user. Whereas after the initial peak, for user #5 the activity is gradually declining, for users #1 and #2 there activity level remains low but stable over time. User #3 and #4 demonstrate a different pattern: after the initial peak, the number of logins drops, but after week 25 (user #3) and 26 (user #4) their activity is slowly increasing again.

The stable level of activity after the onboarding process and initial activities is promising in that it is required to keep users engaged to induce behavioural change. While additional measures to keep users active are already planned and released soon (e-mail notifications, mobile app, Drop!), it is promising to see that even without these measures a basic level of activity persists.

4.5 User behaviour results from the Swiss case study

The log analysis in the Swiss case study focused on users of the advanced gamified portal, as the log analysis as part of the basic portal evaluation has already been reported in D4.3.

4.5.1 Summary of user activity

First, we inspected the registration date for the gamified portal, as shown in Figure 51.

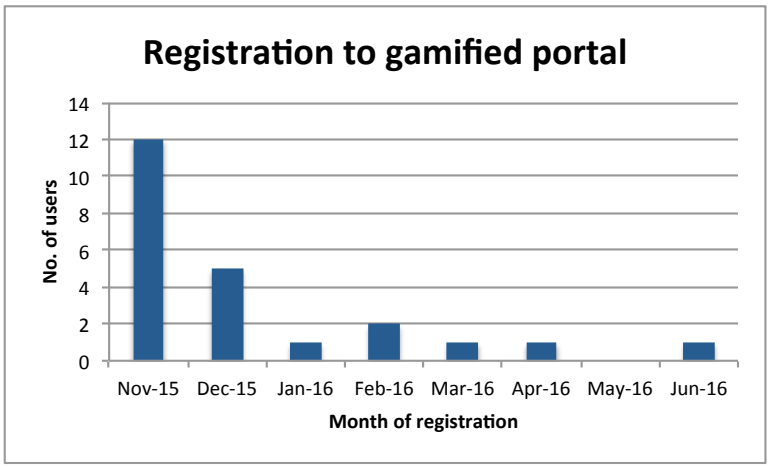


Figure 51. Registration date for the gamified portal (Swiss case study).

Peaks are visible in November '15 – the release of the portal with associated promotion campaign, in December where a Christmas card was sent out, and in in February 2016. The results demonstrate the importance of communication campaigns to recruit new users. Subsequently, we addressed the logins per user. The number of logins are depicted in Figure 52.

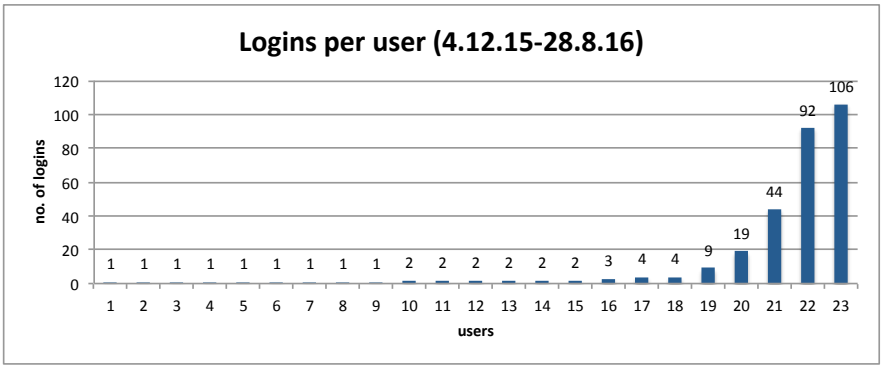


Figure 52. Total number of logins per user (Swiss case study).

The results demonstrate a similar pattern as in the Spanish case study, in the sense that there is a group who only logs into the portal once, there is a group who have a basic level of interaction with the portal, and there is a number of lead users who frequently log in and use the portal. While new portal features are to be released shortly after this deliverable is finalized that attempt to reactivate formerly passive users (e.g. through social sharing, mail reminders, and mobile app notifications), in the Swiss case the level of activity is unlikely to become very high due to the conservative nature of the area (see D2.1). In spite of this nature, a number of lead users have shown to be very active on the portal, embracing the functionalities it offers.

In comparison to basic portal users, gamified portal users log in more frequently (Figure 53), showing that the gamified incentive model does stimulate portal usage to the extent that it becomes visible even in such a small-scale case study.

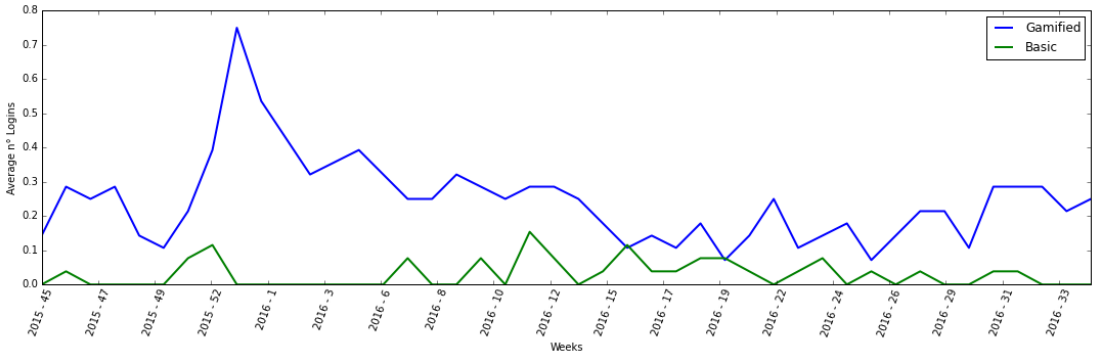


Figure 53. Average no. of logins per week of gamified vs. basic portal users.

As can be seen from the chart, the login pattern follows approximately the same shape, but is at a higher level for the advanced portal than for the basic portal.
Next we inspected the average number of portal interactions per user, divided by the different functionalities in the portal. Results are shown in Figure 54.

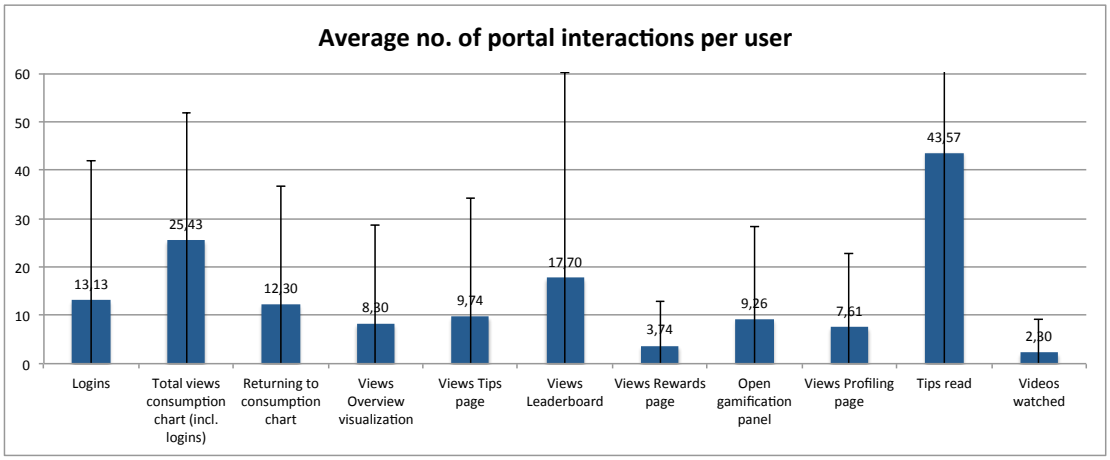


Figure 54. Average number of portal interactions per user (Swiss case study).

The chart reveals that the water consumption tips have received most attention from the users, judged from the high total number of views. However, standard deviation is very high, indicating that there is a large difference between the users. Apart from the water saving tips, the leaderboard and the water consumption charts are also frequently inspected, suggesting that the users are sensitive to competition with other users.
The rewards page was viewed less frequently. This result is inconsistent with the strong motivational pull from the physical rewards the users have reported in the questionnaire (see Section 4.3.2). The Swiss case study is then too small to draw finite conclusions about the effectiveness of the rewards part of the incentive model.
In the next sub section we analyse the gamification features in more detail.

4.5.2 Interaction with gamification elements

As a first assessment of the users' interaction with the gamified elements, the distribution of the number of points were analysed. In contrast to the Spanish case, in Switzerland points are deducted once you have claimed a reward. Consequently, the total number of collected points is higher than the current total number of points displayed on the portal. Figure 55 displays the current score and the points spent on rewards.

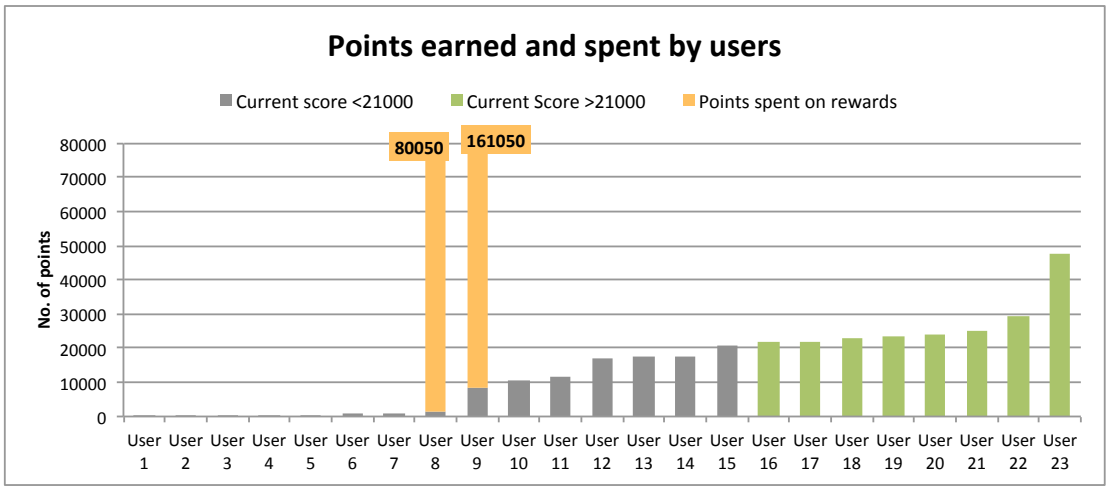


Figure 55. Distribution of points and available rewards (Swiss case study).

Results reveal a typical pattern of a majority that is moderately active in terms of points collected, while two of the lead users collect more than 80.000 points each. There is also a relatively large group of users (User #6-User #23) who have collected a significant number of points, but have not claimed any rewards.
Next, we analysed the assignment of badges. In Figure 56 the number of badges per user is displayed.

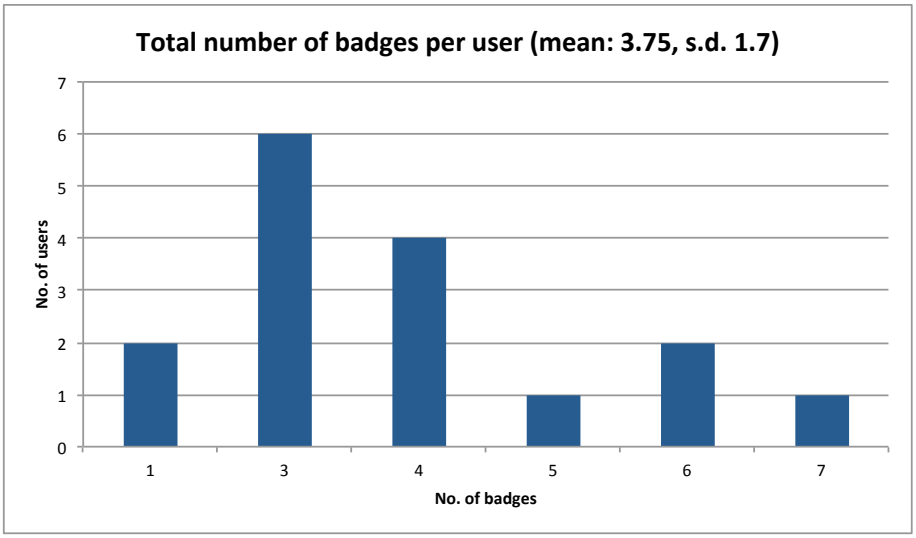


Figure 56. Number of badges per user (Swiss case study).

The chart displays substantial variability between the users in the number of badges they have collected. The relatively large spread in numbers also becomes clear from the relatively high standard deviation. However, most users have collected either three or four badges. Consistent with the pattern we have observed in D4.3, lead users can be identified that collect up to seven different badges.

Next we inspected the assignment of badges, divided by the thematic areas. The results are depicted in Figure 57.

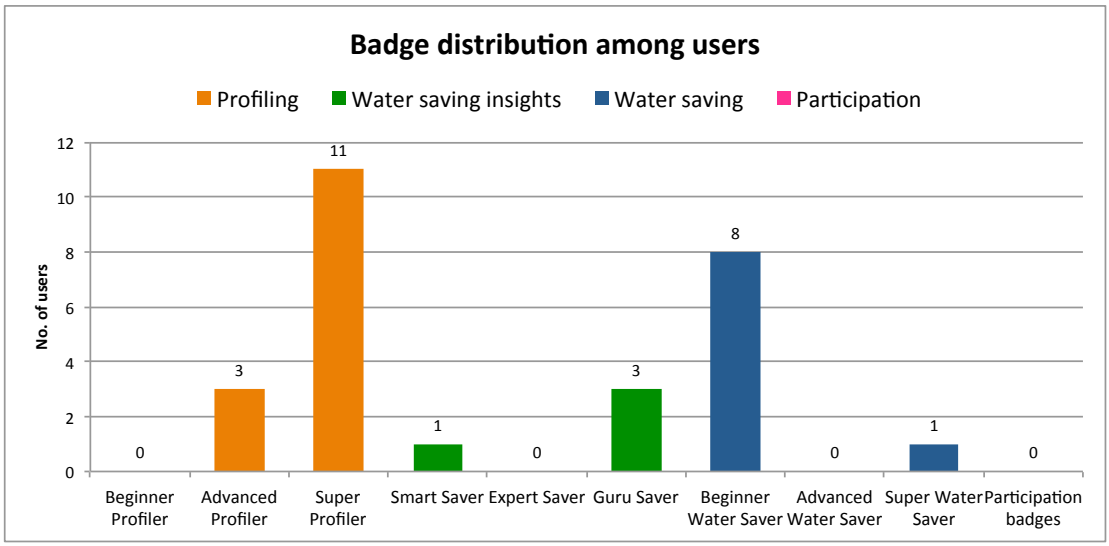


Figure 57. Distribution of badges among users, divided by type (Swiss case study).

As can be seen from Figure 57 most assigned badges are in the profiling thematic area (in total 14), followed by the water saver area (in total 9), and the water saving insights (4). These results suggest that users are actively using the functionalities associated to all thematic areas, with higher numbers for the profiling activities. This is not surprising, since as part of the onboarding process, users are incentivized to complete their user profile and fill out the sign-up questionnaire.

4.5.3 Interaction with water consumption visualisations and goals

In addition to the gamification actions, users' interactions with the consumption visualization were analysed. The average number of interactions with the different water consumption charts and visualizations is depicted in Figure 58.

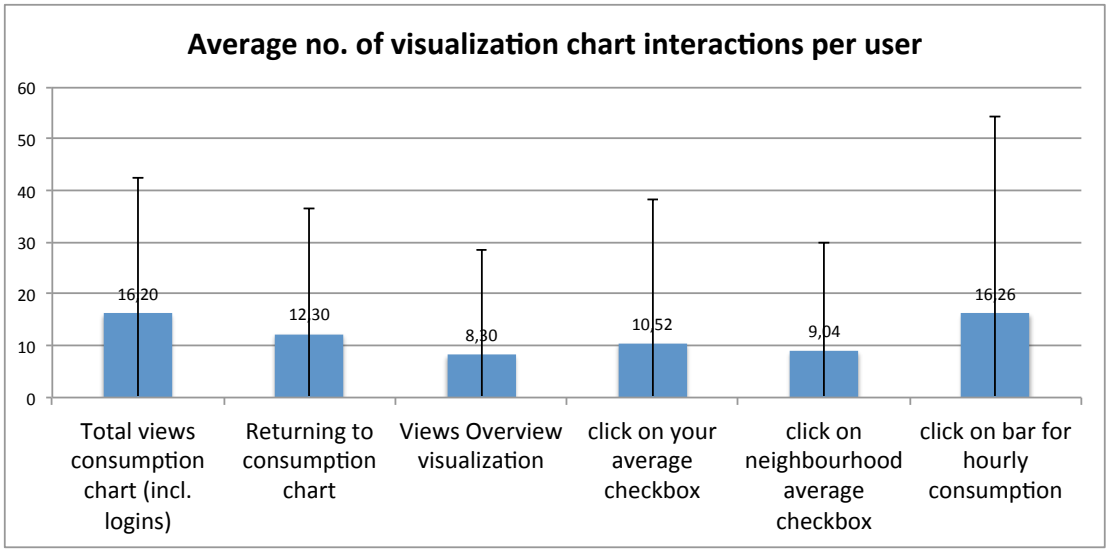


Figure 58. Average no. of visualization chart interactions per user (Swiss case study).

The average no. of visualization chart interactions per user is quite high, while the high standard deviations (Figure 58) also reflect larger variations among users. The fact that returns to the consumption chart are twice as high as overview visualization views may be due to the fact that users in the Swiss case study are generally a bit more conservative and data-oriented when it comes to viewing their consumption, as already described in D2.1. This heightened interest in detailed consumption information is also reflected in the high number of clicks on the hourly consumption chart.
Clicking on the neighbourhood average is also a popular interactive feature, and the relatively small difference to the number of neighbourhood average clicks also shows that comparison of consumption against one's own average and against the neighbourhood average is nearly equally important to users. This is a positive signal towards the upcoming release and its potential effectiveness to further stimulate system usage, since it will introduce the neighbourhood map as another means to compare consumption and gamification achievements with others, drawing on social influences to raise awareness.

As can be seen in Figure 59, half the users have reached weekly water saving levels, with an average of 2.48 weekly water saving levels per user (s.d.=5.27). One user stands out with a significantly large number of weekly water savings of close to 30.

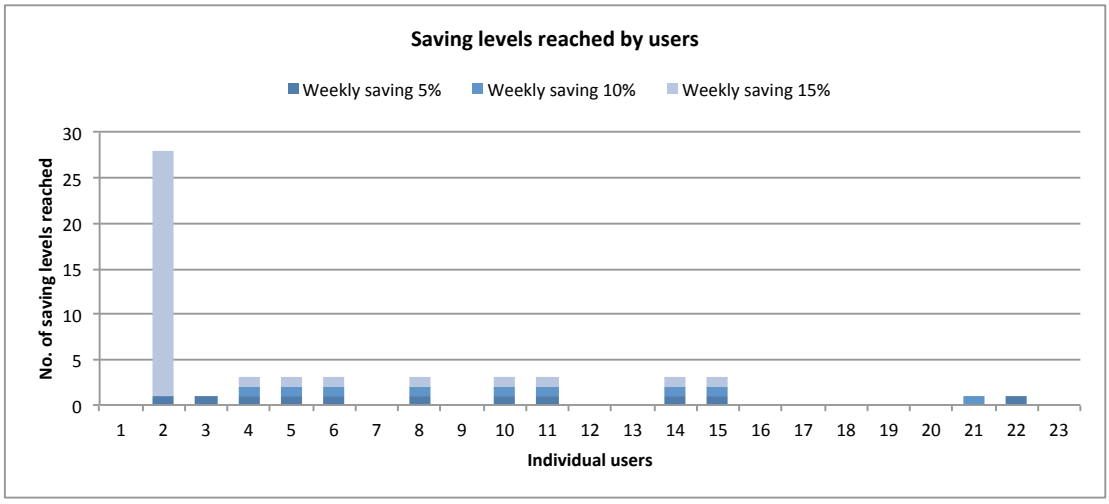


Figure 59. Weekly saving levels reached by users (Swiss case study).

In two cases of achieved weekly water savings, users had set their own water saving goals in advance, once for 5% savings and once for 10% water savings (Figure 60).

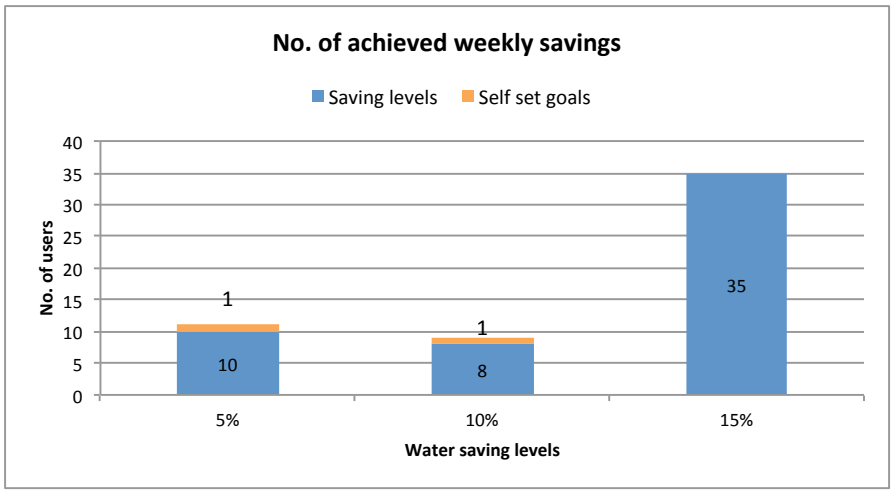


Figure 60. No. of achieved weekly water savings (Swiss case study).

The logs show that two users (about 10%) have used the goal setting mechanisms. Other users have not yet displayed interaction with the goal setting mechanisms. One possible explanation is that users are not so aware of this feature, as it is not a default view. Since the weekly status that will be sent out via e-mail following the upcoming release will put the overview visualization more into focus, this is likely to change. In addition, the new mobile app that will also be released in the Swiss case study features the overview visualization more prominently, too, putting it yet more into focus.

4.6 Conclusions

This section has provided an assessment of the gamified incentive model by reviewing user perceptions that were elicited through a questionnaire and by analysing user behaviour on the SmartH2O portal. Both sources of data were collected and analysed for the Spanish and the Swiss case study. The results provide additional self-reported and behaviour based data to substantiate the very preliminary conclusions that were drawn about the effectiveness of the incentive model, based on a lead user analysis in the Swiss case study and initial log analyses of portal behaviour.

Across case studies, the data have revealed consistently positive user perceptions. Users particularly valued the contribution of the portal to their understanding of their water consumption. Also, they were very positive about the gamified incentives, in terms of the motivation they get from collecting points, badges, and – to a lesser extent – the leaderboard. The behaviour of the users on the portal in both case studies demonstrates that in spite of a decline after the first peak following communication campaigns, activity level remains stable. This result from both case studies indicates that the incentive model is capable of sustainably motivating users.

Nevertheless, continuous communication with users is necessary to keep users engaged and to reactivate users who have become passive over time. The soon to be released social sharing features and weekly reminders sent from the portal and the mobile app are expected to boost platform activity and to dampen the drop in activity level after onboarding, which is commonly found in online behavioural change support systems.

5 References

[Corral-Verdugo et al., 2003] Corral-Verdugo, 2002 V., Frias-Armenta, M., Pérez-Urias, F., Orduña-Cabrera, V., & Espinoza-Gallego, N. (2002). Residential water consumption, motivation for conserving water and the continuing tragedy of the commons. *Environmental management*, *30*(4):527-535.

[Fielding et al., 2012] Fielding, Kelly S, Russell, Sally, Spinks, Anneliese, & Mankad, Aditi. (2012). Determinants of household water conservation: The role of demographic, infrastructure, behaviour, and psychosocial variables. *Water Resources Research, 48*(10).

[Hassenzahl, 2004] Hassenzahl, Marc. (2004). The Interplay of Beauty, Goodness, and Usability in Interactive Products. *Human-Computer Interaction, 19*(4): 319-349.
[Reiss, 2000] Reiss, S. (2000). *Who am I?-The 16 basic desires that motivate our actions and determine our personality*. New York: Tarcher/Putnam.

[Lindenberg and Steg, 2007] Lindenberg, S. and Steg, L. (2007). Normative, Gain and Hedonic Goal Frames Guiding Environmental Behaviour. *Journal of Social Issues, 63*(1):117-137. doi: 10.1111/j.1540-4560.2007.00499.x.

[Prochaska and DiClemente, 1992] Prochaska, J. O. and DiClemente, C. C. (1992). Stages of change in the modification of problem behaviours. *Progress in behaviour modification*, 28:183-218.

[Venkatesh et al., 2003] Venkatesh, Viswanath, Morris, Michael, Davis, Gordon, and Davis, Fred. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly, 27*(3):425-478.

Appendices

A.1 Drop!TheQuestion questions (English version)

	Question	Right Answer	Wrong Answer 1	Wrong Answer 2	Wrong Answer 3
1	Water is made up of which two elements?	One oxygen and two hydrogen atoms that are connected by covalent bonds	Two oxygen and two hydrogen atoms that are connected by covalent bonds	One carbon and two hydrogen atoms that are connected by covalent bonds	Two oxygen and one hydrogen atoms that are connected by covalent bonds
2	What is the largest ocean basin on Earth?	Pacific Ocean	Indian Ocean	Arctic Ocean	Atlantic Ocean
3	What is the longest river in Europe?	Volga	Danube	Thames	Po
4	What is the most efficient way to save water when washing your hands and face?	Putting in the plug, closing the tap and rinsing with the still water	Closing the tap while not using water	Making it super fast	Modulating a small flux of water from the tap
5	Most of the Earth's freshwater is in…	Aquifers	Lakes	Oceans	Man-made reservoirs
6	What does hydrophobic mean?	Not dissolving in water	Dissolving in water	Growing in the water	Fear of water
7	What are hydroponics?	Crops growing soiless, in a mineral nutrient (water) solutions	A kind of rice farming	A particular breed of pony	A variety of cotton
8	In which step of the water cycle does liquid water transform into gas?	Evaporation	Condensation	Solidification	Fusion
9	In which step of the water cycle does liquid water transform into ice?	Solidification	Evaporation	Sublimation	Condensation
10	In which step of the water cycle does water vapor transform into liquid?	Condensation	Solidification	Sublimation	Evaporation
11	In which step of the water cycle does ice water transform into gas?	Sublimation	Fusion	Condensation	Evaporation
12	In which step of the water cycle does ice water transform into liquid?	Fusion	Solidification	Condensation	Sublimation
13	Which state of water cycle characterize clouds?	Solid and/or liquid	Gas (vapor)	There is no water inside clouds	Liquid
14	What property of water makes it bead up on waxy surfaces?	Surface tension	Capillary action	Hydrophoby	Universal solvency
15	Which step in the water purification process allows particles to clump together?	Coagulation	Disinfection	Filtration	Sedimentation
16	Which step in the water purification process gets flocs sinking to the bottom?	Sedimentation	Coagulation	Filtration	Disinfection
17	Which step in the water purification process removes all the smaller particles?	Filtration	Sedimentation	Disinfection	Coagulation
18	Which step in the water purification process	Disinfection	Filtration	Coagulation	Sedimentation

	ensures tha all the microbes are killed?				
19	How does water travel from the treatment plant to the consumers?	Flowing in water supply pipes	Flowing underground and then drawing from wells	Flowing through water lines over the building roofs	Flowing through artificial streams
20	How is water transferred to the consumers from urban pipes?	Exploting the water pressure (given by pumps or gravity)	Using engines under the building	Holding water into a pool on the edge of building	Using pumps from the building
21	Where should water end up after been used in houses and buildings?	In the wastewater treatment plant, through the sewer system pipes	Underground	Evaporating into the atmosphere	Directly into rivers and then into the sea
22	Where is the final destination of water after sewage treating?	Natural water bodies	Urban reservoirs	Underground	Water supply system
23	What does 'water pollution' mean?	Contamination of water bodies by harmful compounds for living beings and ecosystems	Dirty water	Undrinkable water	Sewage water
24	What is water quality?	A measure of chemical, physical, and biological water parameters	A good taste and a transparent colour of waters	The drinkable condition	The origin place of such a water
25	What is an aqueduct?	A network of artefacts built for water supply across a certain distance	A channel of water	A civil engineering to clean water	A tank for water storage
26	Why is water so important to life on Earth?	Because life on Earth would have never begun without it	Because it controls Earth temperature	Because the most important living organisms live in oceans	Because it connects continents
27	Why is seawater so salty?	Because of the massive rate of evaporation, transportation from Earth and biological processes	Salt is rinsed from the scales and skin of ocean animals	Because rain is salty	Because the sea bottom is a mix of salt and sand
28	What is a water-wheel (e.g. in a watermill) used for?	Converting the energy of free-flowing or falling water into useful forms of power	Cleaning the river water	Fishing	Bringing the freshwater into a house
29	How does a hydroelectric power station work?	It produces electrical power through the use of the gravitational force of falling or flowing water	It uses the gravitational force of rain	It produces electricity by coal, releasing water	It produces electricity advantaging of the sea waves
30	What is the most widely used form of renewable energy?	Hydroelectric power	Wind power	Sea waves power	Solar power
31	How did the Egyptians become the most important farmers in ancient times?	Realising mud-brick reservoirs and canals to hold water after each annual Nile flood	Importing slaves and techniques from conquered kingdoms	Inventing the water plow	Draining the Nile water
32	What is the source of energy for the hydrologic or water cycle?	Sun	Rain	Gravity	Wind
33	What is groundwater?	The water found underground in the cracks and spaces in soil, sand and rock	The water flowing into underground rivers	The rain water falling on the ground	The ancient water found in geological deep tanks
34	What is tapped into when digging a well looking for water?	An underground aquifer	An irrigation ditch	An underground river	A sulfur spring
35	What turns water on the Earth into vapor in the water cycle?	The sun	The wind	The geological movements	The global warming

36	Which stage is NOT part of the water cycle?	Discharge	Evaporation	Collection	Condensation
37	In the water cycle, what is it called when water goes up through plants and is turned into a vapor?	Transpiration	Condensation	Filtration	Collection
38	What is the chemical symbol for water?	H2O	2HO2	N2O	H2O2
39	What is acid rain?	Rain that has been made acidic by certain pollutants in the air	Rain that has evaporated from seawater	The rain falling after a volcanic eruption	A particular rain falling on the Polar Circles
40	What is the act of adding water to crops?	Irrigation	Cultivation	Rinsing	Crop dusting
41	When clouds get too heavy to hold water, what happens?	The water falls to the Earth	The clouds expand	Clouds change their form	The water evaporates
42	What is the volume of 1 liter of water at standard temperature and pressure?	1 dm3 (62.5 cu in)	1 m3 (1.3 cu yd)	10 dm3 (625 cu in)	1 cm3 (0.06 cu in)
43	What is the scientific term for rain, snow, sleet or hail?	Precipitation	Falling	Atmosphere	Rainfall
44	What word is used to describe how much water vapor is in the air?	Humidity	Condensation	Rain	Fog
45	What is the movement of water down through the earth's surface and soils?	Infiltration	Irrigation	Percolation	Irradiation
46	What is the name for an area of land that water flows across or under on its way to a stream, river, or lake?	Watershed (or catchment)	Water table	Slope	Aquifer
47	What is it called when water rises higher than the banks of a river or levee?	Flood	Water spilling	Shallow	Drainage
48	What is the longest river in the world?	Nile	Mississipi	Volga	Niger
49	What do you call an artificial lake that is used to collect and store water for human uses?	Reservoir	Pond	Basin	Dam
50	How long can a person live without water?	1 week	1 day	1 month	2 weeks
51	Which food requires less water to grow?	potatoes	wheat	corn	rice
52	Which food contains the least water?	whole milk (87%)	fresh carrots (88%)	fresh celery (94%)	fresh tomatos (95%)
53	Where is the driest pemanently inhabited continent on Earth?	Australia	Africa	South America	Antartica
54	Which product requires the most water to create it?	1 hamburger	1 cotton t-shirt	1 microchip	1 cup of coffee
55	In many rural areas of Australia people have been using a water-saving product for over 100 years. Which product is it?	Rainwater Tank	water windmill	desalination plant	solar water purifier
56	Which country in Europe uses more bottled water ?	Italy	France	Germany	Spain
57	Which sectors worldwide are the most water consuming ones?	Farming and livestock	Industry	Fishing	Energy production

58	How many times per day does the average family turn on a faucet?	70	100	200	50
59	Which food requires more water to be produced?	beef	poultry	potatoes	rice
60	what country has nearly half of the world's large dams?	China	USA	Japan	India
61	What is the percentage of water-related illnesses in developing countries?	80%	50%	10%	30%
62	What is the main goal of water desalination ?	remove salt and mineral from saline water	kill the bacteria in the water	remove the solid and sediments	adjust the ph value
63	On average, how much water is used in the bathroom compared to total indoor water usage?	about two-thirds of total indoor usage	about one-third of total indoor usage	about half of total indoor usage	about one-fourth of total indoor usage
64	What is the hardness of water ?	The content of dissolved Calcium and Magnesium	The content of dissolved salt	The content of dissolved oxygen	The content of dissolved chlorine
65	What is the pH value of pure water?	7	4	5	6
66	Which percentage of human bones is composed of water?	31%	10%	78%	3%
67	How many days can an adult human survive without drinking water?	3	10	1	5
68	What is the water footprint of a given product?	Total volume of freshwater used to produce the product	Total volume of water contained in the finished product	Percentage of liquids in the finished product	Annual consumption of water of the finished product
69	Which of the following foods has the highest water footprint per kilogram?	Beef	Rice	Butter	Pork
70	Which of the following beverages has the highest water footprint per kilogram?	Coffee	Malt beer	Tea	Grape wine
71	The RMS Titanic was a British passenger ship that sunk in 1912 after colliding with an iceberg. What percentage of an iceberg is typically underwater?	90%	70%	30%	50%
72	Who is the Greek god of water?	Poseidon	Apollo	Hermes	Zeus
73	Which of the following activities uses the most water	having a bath/shower	doing a load of loundry	washing the car	teeth brushing
74	Which is the best action for saving water at home?	check toilet valve for leaks and fix them	don't let the tap running when you brush your teeth	apply a high efficiency tap on your shower	rinse vegetables in a pan of water rather than under the tap
75	how much water is contained in cucumbers?	96%	90%	85%	99%
76	which of the following animals does not drink water?	frogs	dogs	elephants	penguins
77	which of the following animals does not drink water?	koala	polar bear	gorilla	cangaroo

78	What accounts generally for the most use of household water?	landscaping	shower	dishwasher	washing machine
79	What percentage of our skin is water?	70%	40%	15%	90%
80	What percent of a watermelon is water?	92%	55%	42%	78%
81	What percentage of a pineapple is water?	80%	50%	25%	90%
82	Why can we see some of the water contained in clouds?	Because it condenses in small droplets.	Because the water vapor is combined with nitrogen that is normally visible.	Because the water vapor molecules expand at high altitudes due to the low pressure.	Because the sunlight is refracted by the water vapor molecules.
83	How can water cut a piece on stanless steel?	By being ejected at more than 20000 PSI (1360 atm) from a little hole	By getting it rusty	By cooling the metal cutting saw	By pushing it at high pressure against a special blade
84	Where is the highest lake of the world?	Between Argentina and Chile.	In Tibet, China.	In Alaska, USA	Between India and China.
85	Why is it dangerous to touch electric devices with wet hands?	Because water is a good electric conductor and you can get electrocuted.	Because they can slip off your hands.	Because the water on your hands can be magnetized and attract other metals.	Because water can get into the devices and break them by causing a short circuit.
86	Why does it rain?	Because droplets contained in clouds become too large and heavy to be sustained by air.	Because different clouds meet and the water molecules of the two collide.	Because there is too much water vapor in the cloud.	Because a change in the air pressure changes also the condensation point of the air.
87	Which of these ancient Roman gods is not related to water?	Saturn	Neptune	Tiberinus	Fontus
88	What is the place with the highest annual precipitation on Earth?	India	Brazil	New Orleans	Nepal
89	The river with the largest drainage area is	Amazon	Nile	Danube	Mekong
90	How much of the worlds water is contained in the oceans?	95%	80%	99999%	65%
91	Which one of the following cities is not situated beside a river?	Milan	Vienna	Paris	Lisbon
92	Which one of the following cities is not situated next to a lake?	London	Geneve	Zurich	Como
93	What is a water smart meter?	A digital device for measuring water consumption	A tool for reducing water consumption	A tool for measuring pressure using water	A tool for measuring distance using water
94	What is a water softener?	An appliance for reducing calcium and magnesium in water	A type of sugar	An appliance for removing salt from water	An appliance for reducing the chlorine in the water
95	What happens if you pour oil over water?	Oil floats on water	Water floats on oil	Water freezes	The two liquids mix
96	What is nebulization?	The separation of water in microscopic droplets	The production of fog	The spilling of water from a container	The pollution of water with chemicals
97	What happens if you put an ice cube into a glass of water?	It floats	It sinks	Water freezes	It melts
98	What is the main diffence between a shark and a dolphin?	The shark is a fish, the dolphin a mammal	The shark is a mammal, the dolphin a fish	There is no practical difference	The shark bites, the dolphin jumps

99	What is an amphibious?	An animal that can breathe in water and air	An animal that can breathe in water only	An animal that can breathe from its mouth and the ears	An animal that can breathe in air only
100	What is hydrophilia?	The capacity of a material to absorbe water	A water borne disease	The consequence of drinking too much water	The status of being drunk
101	Why do whales periodically emerge from the water?	Because they are mammals and need to breathe	To see what happens	To soak in the sun	To watch out for fishers
102	What is the Gulf Stream?	A flow of water that crosses the Atlantic Ocean from Mexico to North Europe	The air flow caused by boats	A water current that is found within closed seas	A brand of soda
103	What would happen if the Gulf Stream stopped	The temperature in North Europe would drop	Nothing	All bees would disappear	The city of New York would sink
104	What is climate change?	A global variation of conditions on earth affecting metereological phoenomena	When the sun comes after the rain	A sudden rainpour	When the rain comes after the sun
105	What is global heating?	An increase of the temperature on earth	The heating system of a condominum	The increase of temperature produced by volcanic eruptions	A way to share the expenses of hot water
106	What are greenhouse gases?	Gases in the athmosphere that absorb and emit infrared radiation and thus increase the temperature of Earth	Gases produced by flowers	Gases that make you laugh if you inhale them	Gases produced by fish
107	What is the effect of greenhouse gases?	The increase of the temperature on earth	Flowers grow better	More earthquakes	None
108	What is ice?	Water in the solid state	A substance frequently added to whiskey in the US	The cause why dynosaurs disappeared	Carbon dioxide in the solid state
109	Why does water on fire boil?	Because heat turns water into vapor which escapes in the form of bubbles	Not to get burnt	Because the heat produced by fire must be absorbed in some way	To cook pasta
110	Why is ice slippery?	Because pressure melts it into a thin layer of water that reduces friction	Because otherwise skating would be impossible	Because you do not pay attention	Because penguins like to ride on it
111	Why do some materials float?	Because their density (weight/volume) is smaller than that of the water, which cannot sustain them	Because they want to stay on top	Because they have the right shape	Due to moon attraction
112	Why do some materials sink?	Because their density (weight/volume) is greater than that of the water, which can sustain them	Because they cannot swim	Because they repell water	Due to earth's gravity
113	Why is surfing possible?	Because waves produced by winds in the open sea get bigger when they meet a sudden slope near the shore	Because it is fun	Because earthquakes produced very big waves	Because ancient Polynesians had a lot of time to waste
114	Can you move a train using only water and fire?	Yes, exploiting the pression of vapor generated by heating the water	No because water smothers the fire	Yes, with a little help from my friends	No, because water evaporize
115	What is a hydrophone?	A microphone used underwater	An appliance for drying wet hairs	An appliance for listening to musin underwater	A cellular phone resistant to water

116	Who interprets the syren in the Splash movie?	Daryl Hannah	Scarlett Johansson	Uma Thurman	Kim Basinger
117	What is the name of the bad guys in the Waterworld movie?	Smokers	Waters	Players	Gangsters
118	From what clue do scientists think that there was water on Mars?	From signs of salty water on slopes	From prints of wet feet	From erosion of rocks	From craters having the shape of ponds
119	Does water cool more quickly or slowly than air?	More slowly	More quickly	It requires the same time	It depends on the weather conditions
120	Why temperature is milder in coastal regions?	Because water stores and releases slowly the heat accumulated during the day	Because there is no snow	Because winds are less strong	Because humidity in the air increases the temperature
121	Why water is considered a universal solvent?	Because it dissolves many elements	Because water is at the origin of life in the universe	Because it mixes with many elements	Because it is present universally on earth
122	Does the Gulf Stream move from East to West or from West to East?	West to East, from the Gulf of Mexico to Canary Islands and North Europe	East to West from Canary Islands and North Europe to the Gulf of Mexico	West to East, from the Gulf of Mexico to South Africa	East to West from South Africa to the Gulf of Mexico
123	Is the Mediterranean Sea saltier or less salty than the Atlantic Ocean?	Saltier	Less salty	They have the same concentration of salt	Saltier in winter, less salty in summer
124	Which one of the following elements is not a constituent of sweat?	Fats	Water	Sodium ions	Potassium ions
125	What is the main function of perspiration in humans?	To lower the body temperature, due to the heat loss caused by evaporation	To regulate the concentration of salt in the blood	To regulate the density of the blood	To make people feel embarrassed
126	Can you drink sea water?	No, it's toxic because kidneys cannot get rid of all the salt it contains	No, because it tastes bad	Yes, but only "on the rocks"	No, it toxic because it may contain arsenic
127	Do fish sweat?	No, they are cold blooded their temperature regulated by the external environment	No, because water cannot pass through their scales	Yes, but you do not notice it	No, because pressure of the external water is higher than that of water inside their body
128	What is a Cirrus?	A type of cloud found at high altitudes	A type of cloud found at low altitudes	A Persian king	A type of cloud produced by aircraft engines
129	What is a condensation trail?	A type of cloud produced by the exhaust of aircraft engines	A by-product of the production of condensed milk	An animal's trail in the snow	A type of cloud produced by hail storms
130	What is a water organ?	A musical instrument that made sound using pressure generated by falling water	Another name for the kidney	A type of water mill	A component of the speedboat engine
131	Is lightning more dangerous to someone swimming in a pool than in the ocean?	Yes, because salty ocean water is more conductive and thus better drives electricity away from the body	No, because salty ocean water is less conductive than pool water	No because lightning never hits swimming pools	It depends on whether the swimming pool is roofed
132	Why has the city of Bath such a name?	Due to the Roman baths that still exist there	Because it was a seaside touristic destination since the antiquity	Due to the extreme hygiene of its dwellers	Because it is the first town in the world to have established public baths open to all citizens
133	Which Renaissance artist and scientist said	Leonardo da Vinci	Michelangelo	Botticelli	Brunelleschi

	that water is the vehicle of nature?				
134	In Ancient Egypt, what the hieroglyphic sign for water?	A horizontal zigzag line	A vertical zigzag line	A stick with a circle at one end	A fish shape
135	What is Water Music?	A collection of orchestral movements by Handel, premiered in a concert on the River Thames	The sound of rain falling in a spring morning	Music played with water instruments, such as the water organ	The name of a pop band
136	Which painter used to paint the water lilies of his garden?	Monet	Manet	Cezanne	Picasso
137	Which one of the following animals can walk on the water?	The basilisk	The wasp	The lizard	The rat
138	Which country has the longest coastline?	Canada	Italy	Spain	China
139	Which country has the largest number of lakes?	Canada	Finland	China	United States
140	What is a sentinel organism?	A species that accumulates pollutants in the organism and thus acts as a sentinel of the environment health	An animal that alerts his mates when predators arrive	An animal that never sleeps	A species that lives in abandoned military buildings
141	Why is water so dangerous near electrical appliances?	Because it is a good conductor of electricity, which increases the risk of electric shock if an electrical device gets wet	Because water can produce a short circuit	Because water can damage any electric appliance	Because water can rust any electric appliance
142	Which animal spends life in water but reproduces on the ground?	Turtle	Dolphin	Newt	Manatee
143	How long does a cigarette butt take to decompose?	1-5 years	1 month	10-20 years	More than 100 years
144	What does the term Amphibian mean?	With a double life (from ancient Greek)	Fish with lungs	Reptile with lungs	Fish that breathes
145	Why does sugar dissolve faster in hot water than in cold water?	Because hot water molecules move faster and make bigger gaps where more sugar molecules can fit	Because heat melts the sugar	Because hot water accelerates the precipitation of sugar	Sugar dissolves faster in cold water
146	Why is hot water more effective for washing dishes?	Because the heat helps chemical action of detergents in removing dirt	Because cold water damages the dishes	Because hot water makes the dishes absorbe the detergent better	Because cold water may freeze one's hands
147	What species is Nemo in the "Finding Nemo" movie?	Clownfish	Angelfish	Surgeonfish	Pufferfish
148	In "The Birth of Venus" painting by Botticelli, what is Venus standing on?	A scallop shell	A dolphin	A star	A water lily
149	What species is Dory in the "Finding Nemo" movie?	Surgeonfish	Octopus	Clownfish	Pufferfish
150	What is a hydrometer?	An instrument used to measure the relative density of liquids; that is, the ratio of the density of the liquid to the density of water	An instrument used to measure lengths underwater	An instrument used to measure the density of water	An instrument used to measure humidity of air

151	What is a hair tension hygrometer?	An instrument for measuring the moisture in the atmosphere, which uses human or animal hair under tension whose length changes with humidity	An instrument for flattening curly hairs	A weather forecasting instrument based on the tension of human or animal hair	An instrument for measuring electric tension (voltage) by injecting a current in the human hairs
152	What is turbidity?	A measure of the relative clarity of a liquid, from the amount of light scattered by material in the water when a light is shined through it	A measure of water hardness, from the mineral content present in the water	A measure of the propensity a liquid to produce whirls when shaken	A measure of the resistance of a liquid to compression
153	Is water present in the universe?	In huge quantity, for example the APM +525508279 quasar seems surrounded by 140 trillion times the water of Earth's oceans	No, water has been found only on the Earth	Yes, but only on planet Earth and on the comets, in the form of ice	No, water cannot exist without the athmosphere
154	Which ones of the following Australian sites are in the UNESCO World Heritage list?	Both Shark Bay and the Great Barrier Reef	None of them	The Great Barrier Reef, in the north-east coast of Australia	Shark Bay, in Western Australia
155	What is a mudflat?	Also known as tidal flat, a coastal wetland formed when mud is deposited by tides or rivers	A flat full of mud	The layer of mud deposited by a river after a flooding	An ancient type of building made of clay
156	What is a butterfly valve?	A valve, with a closing mechanism in the form of a disk, used for regulating flow	A species of butterlfy with large wings similar to valves	A valve, with a closing mechanism in the form of a ball, used for regulating flow	A trap used by ecologists for capturing insects
157	What is syzygy?	The astronomical alignment of the earth, moon and sun, that is the time of maximum tide force	A world useful for crossword puzzles	An Egyptian water deity	The Polish word for "fresh water"
158	Where can you find the largest concentration of geysers	In the Yellowstone National Park, (Wyoming, USA), which contains more than 10,000 geothermal features	In the Haukadalur Valley, Iceland	In the Valley of Geysers ("Dolina Geiserov" in Russian) in the Kamchatka Peninsula of Russia	In the Taupo Volcanic Zone, New Zealand
159	How many other species can the Thaumoctopus mimicus octopus imitate?	16, including the sea snake, jellyfish, sand anemone, and sea cucumber	All other octopus species living in the same habitat	None	Any marine species, provided that it stands still enough time for the octopus to learn how to mimik it
160	What are palafittes?	Houses raised on piles over a body of water	Houses of limestone	Houses carved in a mountain's rocky sides	A type of boat houses
161	Which color extinguishes first when light penetrates underwater?	Red	Blue	Orange	Green
162	What is Plancton?	Organisms that live in water and are transported by currents	Organisms that live in water and can swim against a current and control their position	Small algae that fluctuate in the oceanic water	Organisms that constitute the main food of sea mammals
163	Diatoms are a group of algae found almost anywhere there is	They are sensitive to water quality and their presence in layers of	Because they are funny	They existed for millions of years and their absence	Because they have fantastic shapes that inspire artists

	water; why is their study important?	mud allows reconstructing past environmental conditions		from layers of mud denotes past catastrophic events	
164	What activity uses the most water at home	Taking a bath	Taking a shower	Washing your teeth	Flushing the toilet
165	At which temperature the water becomes ice?	0	1	10	100
166	Where you can read the story of Noah s ark?	In the Genesis book	Don Quixote	New Testament	The Americans constitution
167	What is the concentration of salt in the saline water?	From 10 to 100 g/L	From 0.1 to 1 g/L	From 1 to 10 g/L	From 10 to 300 g/L
168	How many inhabitants live under water stress conditions in Europe during winter?	30 millions	1 million	5 millions	10 millions
169	Which is normally most expensive source of water supply?	Desalinated water	Surface water	Groundwater	Regenerated water
170	How many atoms of hydrogen form a molecule of water?	2	1	3	0
171	Which river does not have a delta?	Rio de la Plata	Nile	Amazonas	Mississippi
172	How many islands are there in the Philippine arcipelago?	about 7500	75	750	750000
173	Which of these words is not a translation of water in a european language?	watt	wasser	ilma	????
174	"... on the water", famous 70s song	Smoke	Fire	Man	Fireworks
175	Which river flows in Paris?	Seine	Rhone	Loire	Rhine
176	Which animal is a dam builder?	the beaver	the chimpanzee	the termite	the cuckoo
177	Which country is partially below sea level?	the Netherlands	Belgium	Finland	Lithuania
178	How is it called when ice falls from the sky, inslead of liquid drops?	hail	blizzard	snow	dew
179	Which river flows in a desert?	the Nile	the Congo	the Zambezi	the Mississipi
180	how much of the earth water is drinkable?	1%	10%	60%	70%
181	How many liters of water needs an apple?	18	6	50	30
182	How much water is needed to produce a cup of coffee?	140 l	10 l	80 l	250 l
183	At which temperature the water boils?	100	0	56	25
184	In what form you can drink water?	liquid	solid	gaseous	plasma
185	Why is solid water floating?	ice is less dense than liquid water	ice contains helium	water is denser than ice	water is blue, ice is white, so ice floats
186	What is an aquifer?	A reserve of water which is underground	A poisonous fish	A water borne diseae	A water pipe
187	How many people in the world have no access to drinking water?	2.9 billion	50 million	500 million	50 billion
188	Where you can read the story of Noah's ark?	In the Genesis book	Don Quixote	New Testament	The American's constitution
189	What is the range of water use from public water supply among the EU Member States?	From 26 to 150 m^3 per inhabitant	From 10 to 50 m^3 per inhabitant	From 100 to 500 m^3 per inhabitant	From 10 to 20 m^3 per inhabitant

190	What is a water quality parameter that must be controlled to urban water supply?	DBO5	CO2	Solar radiation	humidity
191	Why water in rivers, lakes and seas appears to be blue while being colorless in a glass?	It is because water reflects the sky	Untreated water is blue, it lossses its colour after making it drinkable	Water is always blue if you put together more than 10 L	It is because water has natural pollutants that turn it blue
192	Which is the most common water pollutant in Spain?	Nitrates	Clorides	Fluorides	Conductivity
193	Which of the following historic figures was not a sea captain?	Genghis Khan	Columbus, Christopher	Drake, Francis	da Gama, Vasco
194	Which of these fruits has the highest content of water per volume?	strawberries	orange	kiwi	pineapple
195	"Water under the ...", idiom used to describe something that happened in the past and cannot be changed	bridge	boat	tree	blood
196	Which of these fruits has the highest content of water per volume?	Danube	Loire	Rhine	Po
197	Which cereal grows in fields inundated with water?	rice	wheat	barley	corn
198	What is the building that transported drinking water in the ancient Roman Empire?	an acqueduct	a water wheel	a forum	the thermae
199	Of these four animals, which is a fish?	the shark	the whale	the dolphin	the beluga
200	On which continent are the Great Lakes?	North America	South America	Asia	Africa
201	Why do dragonflies need to live near ponds or rivers?	Because their larvae hatch in the water	Because they are often thirsty	Because they like to swim	Because they eat fish
202	What does sea water taste like?	salt	nothing - it has no taste	fish	sugar
203	How many 1-Liter-water bottles do you need to fill a bath tub?	140	10	300	500
204	What can be found in drinking water?	minerals	sugar	pepper	diamonds
205	What can usually not be found in drinking water?	gold	sodium	iron	calcium
206	An average rain drop is as big as	a louse	a wasp	a lady bug	a butterfly
207	Which animal can sleep under water?	a hippo	a lion	a dog	a cat
208	In which type of water can you float the best?	salt water	mineral water	cold water	bathwater
209	What happens to rain drops, when the temperature drops below 0° C?	the rain turns into snow	the rain stops	nothing	the drops get bigger
210	Water is becoming a scarce resource on Earth. Is this true?	Yes, but not everywhere – it depends on the region	Yes, everywhere	No	Yes, except Europe
211	Which countries have already had serious conflicts related to water?	Sudan and Egypt	USA and Canada	Germany and France	Italy and Switzerland
212	How many litres of water fit into one cubic meter?	1000	10	500	100
213	How much water we consume in one year?	4000 cubic km	1 billions cubic meters	4 billions cubic meters	500000 cubic meters

214	Of the global consumption of water, how much is used for agriculture?	70%	50%	30%	90%
215	Of the global consumption of water, how much is used for in manufacturing?	20%	50%	30%	70%
216	Of the global consumption of water, how much is used by privates?	10%	20%	30%	60%
217	How many litres of water can absorb a baobab tree during the rainy season?	120'000	1'000	10'000	700
218	The greatest amount of rain ever fall was recorded in Madagascar in 1952: how many liters per m2 fell in just 24 hours?	1870	670	1200	1350
219	The Mariana Trench is the deepest seafloor, up to how many meters it sinks?	10916	5785	3544	2879
220	In just the last 40 years how much of the natural water resources has been destroyed?	More than 50%	20%	10%	30%
221	What percentage of urban waste water are poured into rivers, lakes and seas without being treated?	80%	30%	20%	10%
222	What is the largest glacier in the world?	Lambert, in Antarctica	The Perito Moreno, Argentina	The Aletsch, in the canton of Valais, Switzerland	The Vatnajokull glacier in Iceland
223	What is the highest waterfall in the world?	Angel Falls, in Venezuela	James Bruce Falls, Canada	Baläifossen, Norway	Niagara Falls, USA
224	What is water made of?	Hydrogen and Oxygen	Oxygen and Nitrogen	Carbon and Oxygen	Cola and Lemonade
225	What percentage of the world population lives without access to a water treatment system?	39 %	10 %	60 %	5 %
226	An Oasis is a fertile place in the desert. But how does the water get there?	Via a water-bearing layer below the surface or a river near the oasis	In an oasis, it rains at least once per week	Via canals that connect the oasis with regions outside the desert	Via camels that transport the water from regions outside the desert
227	What is not true about deserts?	Deserts only exist near the equator	Deserts do not always just consist of sand, but also of stone, gravel or salt	Deserts can be dry, cold, or polar deserts	The temperature in a desert can differ greatly beween day and night

	Question	Right Answer	Wrong Answer 1	Wrong Answer 2	Wrong Answer 3
228	Why does water expand when it freezes?	The hydrogen bonding gets stronger and the distance between the molecules increases	The volume of a liquid always increases when icing.	Because ice contains more water	The oxygen percentage increases
229	Why does water boil at a lower temperature at high altitudes?	Because the pressure exerted upon it from the atmosphere is lower at high altitudes.	Because the pressure exerted upon it from the atmosphere is higher at high altitudes.	Because the sun is closer.	Because the air temperature is colder at high altitudes
230	What is the largest daily use of water at home?	Personal washing	Dishwasher	Gardening	Drinking

231	What is pH?	A scale (0-14) measuring how acidic or basic an aqueous solution is	The content of solutes in drinkable water	The acidity of wet skin	A chemical substance dissolved into wastewater
232	What percentage of the human body is composed of water?	66%	50%	30%	90%
233	What percentage of the Earth's surface is covered by water?	70%	50%	10%	30%
234	What is your water footprint?	The water you use directly and indirectly (to produce food, products, energy etc).	A daily need of water	The footprint left in a water body	All the water you can drink at once
235	How much water is lost by a tap leaking one drop every two seconds?	6000 liters in one year	600 liters in one year	50 liters in one year	100000 liters in one year
236	How much water can you save by turning off the tap while brushing your teeth?	Up to 30 liters per day	Up to 10 liters per day	Up to 100 liters per day	Up to 1 liters per day
237	Where is the largest lake by volume in Europe?	Russia	Italy	United Kingdom	Finland
238	How many liters does the average washing machine use per load?	155 liters	30 liters	242 liters	95 liters
239	How much water does an ordinary 5-minutes shower use on average?	35 liters	100 liters	10 liters	80 liters
240	How much water does a full bath use on average?	80 liters	100 liters	10 liters	35 liters
241	How much water can an average familiy save placing a Save-a-Flush device in their toilet?	7500 liters a year	1000 liters a year	20 liters a year	350 liters a year
242	How much water can you save on average using a bowl when washing up instead of a running tap?	5 liters each time	3.8 liters each time	none	1 liter each time
243	How many liters are wasted in an average home each year due to leaky household pipes?	41600 liters	19000 liters	11400 liters	34000 liters
244	What can we fill up by collecting the wasted water from leaky pipes of an average home in one year?	A common backyard swimming pool	A bathtub	A small pond	A pot 1000 times
245	Who are the most common culprits for wasting water due to leaky household pipes?	Toilets & faucets	Dishwasher & washing machine	Garden hose & sprinkler	Boiler & heaters
246	Why does water in the pot boil faster with the lid on?	Because the heat doesn't get out to the room due to the water convection	Because the pressure increases	Because water cannot evaporate	Because the temperature increases
247	Why do ice cubes float in water ?	Thanks to hydrogen bonding, ice density is lower than water density	Because of their gas content	Because when water ices the oxygen is lost in the atmosphere	Every iced substance floats in its own liquid form
248	How many people in the world do not have access to clean water?	More than 1 bilion	100 milions	Everyone has at least some clean water to drink	100 thousands
249	What property of water allows it to stick to itself?	Cohesion due to hydrogen bonding	Adhesion due to hydrogen bonding	The content of dissolved organic matter	Coagulation due to hydrogen bonding
250	What is the water hydrogen bond?	The linkage between water molecules, due to positive charge on hydrogen and negative of oxygen	The chemical bond between atoms of the same water molecule	A particular chemical agent	The chemical bond between two atoms of hydrogen

251	How can hydrogen be produced by water?	Running a low voltage current through the water	Burning water	Blowing oxygen into the water	Adding chemical agents to water
252	What is the most important function of water in the human body?	Regulating the body temperature	Making the blood	Hydrating skin	Helping the exchanging between cells
253	Where does the purification process of dirty water take place?	In the water treatment plant	In the water supply pipes	At the City Hall	Into a pond or a reservoir
254	Where and when was the first aqueduct (supposedly) built?	Mesopotania 2000 BC	Greece 700 BC	Europe 1000 AC	Rome 0 AC
255	When was the 'human right to water' officially recognized?	2010	1945	1592	1978
256	Who invented the first water-wheel?	Romans	Chineses	Celts	Egyptians
257	What is the water or hydrologic cycle?	A physical description of how water moves on, in, and above the Earth	The water running among the sky and the earth	The power moving the oceans when the moon is close to the earth	The process of sea evaporation and raining
258	Where is the purest water on Earth?	Glaciers and ice caps	Sulfur springs	Rivers and streams	Lakes and ponds
259	Where are the oldest storages of water on Earth, in the water cycle?	Ice caps	Deep aquifers	Oceans	Great lakes
260	About how much does one gallon (3.8 liters) of water weigh?	3.6 kg	4.5 kg	9 kg	0.45 kg
261	About how much does one liter of water weigh?	1 kg	2 kg	0.1 kg	0.5 kg
262	What common chemical is found in acid rain?	Sulfur	Carbon dioxide	Oxygen	Nitrogen
263	Why is water a good conductor of electricity?	Because of the minerals (metallic solids) and ions already dissolved	Because water molecules are polarized	Because hydrogen carries electrical current	Because oxygen atom is a good conductor
264	What is the capacity of porous materials (e.g sand and gravel) to transmit water?	Permeability	Portability	Transmittance	Potability
265	How much time would it take an average residence (in developing countries) to use the same amount of water that flows over the Niagara Falls in one second?	90 months	9 months	19 years	19 months
266	How much water is lost due to leakages in the New York City water supply system?	136 million liters/day	136,000 liters/day	136,000 liters/month	136 million liters/month
267	How much water has been lost when a person feels thirsty?	1% of total water amount	0.1% of total water amount	33% of total water amount	10% of total water amount
268	How much of a tomato consists of water?	95%	99%	50%	70%
269	How much of a chicken is water?	75%	90%	66%	50%
270	How much water can be saved by replacing a 15-year-old dishwasher with a new one?	57%	20%	70%	40%
271	how much water can be saved by using a new dishwasher instead of washing dishes by hand (for 15 minutes)?	80%	25%	75%	50%

272	How much tap drinking water is used to brew coffee in North America?	33% of total drinking consumption	10% of total drinking consumption	50% of total drinking consumption	25% of total drinking consumption
273	How much water is used to produce a bottle of mineral water?	1.39 liters	1 liter	10 liters	7.5 liters
274	how much water is used to produce a bottle of soda?	2.02 liters	1 liter	10 liters	7.5 liters
275	How much water is used to produce a bottle of alcohol?	34.55 liters	3.55 liters	345.5 liters	3455 liters
276	How much water worldwide would we save if we halve the waste of food?	450 cubic km	300 cubic km	1000 cubic km	2 cubic km
277	Which country, in 2008, inserted water as an unanlienable right in its Constitution?	Ecuador	Norway	Egypt	Gabon
278	How may people in the world still lack access to freshwater?	880 million people	300 million people	1 million people	2 billion people
279	How many kilometers, on average, do women travel in some developing countries to reach a freshwater source?	6 per day	3 per day	50 per day	10 per day
280	How many cubic meters of water does an Olympic-sized swimming pool contain?	2500	1000	5	30000
281	How much water do Europeans consume at home compared to Americans?	50%	the same	200%	150%
282	How much water do Sub-saharan residents in Africa use campared to Europeans?	10%	25%	75%	50%
283	How much water do Sub-saharan residents in Africa use campared to Americans?	5%	50%	25%	10%
284	How long are all the water pipelines and aqueducts in North America combined?	40 times the Earth circumference	5 times the Earth circumference	20 times the Earth circumference	10 times the Earth circumference
285	Which material was used to make the first water pipes in the US?	wood	iron	steel	copper
286	Which country granted rivers inalienable rights in its constitution in 2008?	Ecuador	Lesotho	Vietnam	Finland
287	how much water is contained in clouds and water vapor wrt the one in all world's rivers?	6 times more	the same	2 times more	50%
288	How many people in Africa lack access to drinking water?	36%	52%	11%	24%
289	What percentage of people worldwide doesn't have running water in their home?	46%	5%	70%	22%
290	Which century in the last millennium was the wettest?	20th	12th	19th	16th
291	In how many years will 1.8 billion people be living	15	50	100	35

	in regions of severe water scarcity?				
292	Which range of pH value is acceptable for drinking water quality ?	6.5-9.5	4.0 - 7.0	must be around 7.0	8.0 - 10
293	Which level of dehydration of the human body is life-threatening?	more than 15% to 20% decrease in body water	3% to 4% decrease in body water	10% to 14% decrease in body water	5% to 8% decrease in body water
294	Which cause of water intoxication in the following options is correct?	drinking too much water	drinking dirty water	drinking inadequate water	drinking salty water
295	Which of the following is a normal ph value for the human tear ?	6,7	4,3	5,2	8,7
296	What is the percentage of fresh water in the world that is easily accessible?	1%	2,50%	75%	10%
297	How many countries does the Danube River flow through ?	10	9	7	8
298	At one drip per second, how much water will be wasted by a leaking faucet in a year ?	12000 litres	4000 litres	100 litres	400 litres
299	Which of the following options does not represent a natural carbon reservoir?	livestocks	ocean	terrestrial plants	soil
300	What is the percentage of water contained in the bone of a normal person?	31%	15%	60%	6%
301	How much of the world's wetlands have we lost since 1900?	50%	10%	30%	100%
302	The tallest waterfall in the world is 979 meters high. Where is it?	Angel Falls, Venezuela	Yosemite Falls, United States	Niagara Falls, United States	Tugela Falls, South Africa
303	What is the largest river in the world by discharge?	The Amazon	The Nile	The Ganges	The Congo
304	What is the deepest river in the world?	The Congo	The Nile	The Hudson	The Amazon
305	What is the capacity in litres of an Olympic-size swimming pool?	2.5 million	0.5 million	5 million	1 million
306	What percentage of Earth’s water is in frozen glaciers?	2%	5%	10%	20%
307	What is the volume of water necessary to manufacture an average car?	400,000 litres	200,000 liters	100,000 liters	1,000,000 liters
308	Which of the following is not considered a dangerous water containment?	Sodium	Lead	Selenium	Arsenic
309	What is the longest river in Australia?	Murray river	Darling river	Cooper creek	Warrego river
310	What percentage of Earth's water is salty?	97%	87%	30%	55%
311	Which country consumes the most bottled water per capita?	Italy	The UK	Germany	France
312	How much water can be saved by reducing evaporation through garden mulching?	75%	50%	30%	90%
313	Which animal can survive the longest without water?	rats	dogs	camels	cats

314	Which of the following elements is contained in water?	none of them	fats	carbohydrates	proteins
315	how far can an elephant smell water?	5km	1km	10km	500m
316	how much lighter is frozen water than liquid water?	9% lighter	3% lighter	they are equal	6% lighter
317	how much is the water expansion when it freezes?	9%	3%	1%	6%
318	How old could the water in glaciers and ice caps be?	millions of years	billions of years	hundreds of years	thousands of years
319	How thick is the ice covering the Antartic?	4000 meters	1000 meters	100 meters	400 meters
320	what is the pH value of seawater?	8	7	9	6
321	how much is the pressure at 10 meters below the sea surface?	twice that of the surface	equal to the surface	4 times that of the surface	half of that of the surface
322	how much of the household energy consumption is due to heating water?	2nd largest	the largest	3rd largest	the lowest
323	how much water must a dairy cow drink to produce 4 liters of milk?	15 liters	10 liters	4 liters	20 liters
324	what are the expected impacts of a 10 m sea level rise?	flooding 25% of US population	flooding 5% of US population	flooding 50% of US population	flooding 15% of US population
325	how much time does an average US residence take to use the amount of water required to fill an Olympic-sized swimming pool?	6.5 years	3.5 years	10 years	1 year
326	how many brands of bottled water are sold in the US?	800	500	350	1000
327	how much water can be hold by an elephant trunk?	9,5 liters	6,5 liters	13,5 liters	3,5 liters
328	how much can an Atlantic salmon jump out of water?	4.5 meters	2.2 meters	1.8 meters	6.7 meters
329	how long can a hippopotamus remain underwater?	25 min	5 min	35 min	15 min
330	how much water do hippos drink in 24 hours?	250 liters	100 liters	750 liters	500 liters
331	how much water can a camel drink in 3 minutes?	95 liters	65 liters	35 liters	50 liters
332	How many litres of water does it take to produce a litre of bottled water?	3	1	10	5
333	How much does the average American pay for water each day?	25 cents	50 cents	1,50$	1$
334	What is the total amount of water used to manufacture a new car, including new tires?	15000 liters	300000 litres	8000 litres	50000 litres
335	how many litres of water must a dairy cow drink to produce one litre of milk?	4 litres	2 litre	0,2 litres	10 litres
336	How much water is needed to produce one egg?	454 litres	826 litres	160 litres	87 litres
337	What percentage of blood is water?	82%	93%	32%	65%

338	About how many litres of water does the average person use to brush their teeth?	8 litres	15 litres	25 litres	2 litres
339	What percentage of water in homes is used for drinking purposes?	2%	15%	25%	10%
340	About how many litres of water will run down the drain if you leave a faucet on for one minute?	19 litres	5 litres	32 litres	50 litres
341	Where is the rainiest spot on earth?	Maysynram, Meghalaya, India	Cropp River, New Zeland	Mount Emei, Sichuan province, China	Big Bog, Maui, Hawaii
342	The total water use since 1940 has …	quadrupled	doubled	halved	tripled
343	What percentage of an elephant is water?	70%	92%	20%	34%
344	how much water does a single tree give off every day in evaporation?	265 litres	534 litres	26 litres	92 litres
345	Why pasta does not cook well at high altitudes?	Because water boils at lower temperature due to lower pressure.	Because it's more difficult to find the water needed.	Because water evaporates too fast.	Because it's impossible to provide enough heat while cooking.
346	What is the name of the ancient greek god of water?	Poseidon	Ares	Aphrodite	Zeus
347	What is the name of the longships that Norsemen used to rule over North Seas in 12th-13th century?	Drekkar	Skeid	Karvi	Snekkja
348	What is the proportion of an iceberg that can be seen above water?	One tenth	One third	It depends on the type of ice the iceberg is made of.	One hundreth
349	Which of the following is not an alternative name for water?	Hydrogen dioxide	Dihydrogen monoxide	Hydrogen hydroxide	Hydroxylic acid
350	Virtual water imports describe how much water is required to produce an imported good or service. Where is Europe importing most its water from?	Brazil	USA	Russia	China
351	Each year, 12 mio hectares of land are lost to desertification. This equals the size of which country?	Greece	Luxemburg	Lichtenstein	California
352	Which animal goes all his life without drinking?	Kangaroo Rat	Crocodiles	Red bellied lizard	Dromedars
353	What could you do with the water needed to produce one cotton T-shirt?	Fill a whirlpool	Whash a car	Take a bath	Make ten cups of tea
354	The highest snow fall ever recorded in one season was 31.5 m. Where was this?	Mount Rainier USA	Nuuk, Greenland	Tibet	Vladivostok, Russia
355	Producing beef requires lots of water. The equivalent of how many showers is required to produce one Burger?	16	2	9	0,5
356	The longest river is 6800 km in length. Which river is it?	Nile	Colorado	Rhine	Amazon

357	The drainage area of the largest river system equals the size of	The European Union	Russia	Australia	USA
358	The deepest lake in Europe is depeer than which building	Empire State Building	One world trade center	Chrysler Building	Eiffel Tower
359	The total lenght of sewage pipes in Zurich equals the distance from Zurich to	Teheran (4000 km)	Moscow (2200 km)	New York (7000 km)	Nairobi (6000 km)
360	Water consumption in Europe per capita per day is 150 l. In the USA, it is…	295	600	125	175
361	What is runoff water?	Water produced by intense precipitation	Water that moves fast	Water added to cocktails to lower their alcoholic content	Non drinkable water
362	How many people in the world lack access to clean water?	01-ago	gen-15	gen-50	gen-30
363	How many liters of water does the average dish washer use per load?	20	30	242	95
364	Approximately how many people die from a water bourne disease each year	800000	50000	10000	250000
365	How long does a plastic bottle take to decompose?	450 years	1 year	10 years	100 years
366	What is a hydrophite?	An aquatic plant that has adapted to living in saltwater or freshwater	A fish living in tropical waters	A variety of vegetable that grows with roots in the water	A material that absorbs humidity
367	Who designed the Fallingwater house?	Architect Frank Lloyd Wright	Architect Frank Gehry	Architect Oscar Niemeyer	Architect Renzo Piano
368	The Adventures of Tom Sawyer by Mark Twain is a novel set on the banks of which river?	Mississippi	Colorado	Hudson	Missouri
369	In natural conditions, what are the minimum and maximum sea water temperatures?	From - 2 degrees Celsius in arctic regions to 30 in tropical regions	From - 10 degrees Celsius in arctic regions to 40 in tropical regions	From 0 degrees Celsius in arctic regions to 20 in tropical regions	From 2 degrees Celsius in arctic regions to 30 in tropical regions
370	What is the thermocline, in the sea or in a lake?	A layer of water in which temperature changes more rapidly with depth than it does in the layers above or below	A layer of water in which temperature suddenly raises	The level at which the water temperature becomes const ant	The depth at which the water temperature reaches 10 degrees Celsius
371	How does pressure vary with depth in the sea?	It increases of 1 atmosphere every 10 metres	It increases of 0,5 atmosphere every 10 metres	It increases of 2 atmosphere every 10 metres	It remains constant
372	What happens to a balloon full of air if you bring it underwater at a depth of 10 metres?	Its volume shrinks to a half, because the pressure of water doubles from 1 to 2 atmospheres	Its volume doubles, because the pressure of water halves from 1 to 0,5 atmospheres	It blows up	Its volume shrinks to one third, because the pressure of water increases from 1 to 3 atmospheres
373	Which plant can expand and grow in size to store up to 5 cubic meters of water when it rains?	The Saguaro Cactus (Carnegiea gigantea), found in the Sonora desert in Mexico and Arizona	The Baobab tree (Adansonia digitata), commonly found in Madagascar	The Echinocactus grusonii, popularly known as golden barrel or mother-in-law's cushion	The Eucalyptus tree, native of Oceania
374	What percentage of all the world's fresh water (except glaciers and polar	An estimated 20%	More than half	Less than 10%	Around 5%

	ice) does Lake Bajkal contain?				
375	When did Surtsey, an island near the south coast of Iceland, form?	During volcanic eruptions that took place from 1963 to 1967	In the Mesozoic era, about 252 to 66 million years ago	In 1638, after the impact of an asteroid on the Iceland's shore	In the Paleozoic era, 541 to 252.17 million years ago
376	Where is the the largest continuous system of intertidal sand and mud flats in the world?	In the Wadden Sea, which spans an area among Germany, Denmak, and the Netherlands	On Stewart Island, New Zealand	At Cape Cod Bay, Massachusetts, United States	At Moreton Bay, Queensland, Australia
377	What is the intertidal zone?	The coastal area that is above water at low tide and under water at high tide	The coastal area that is above water at high tide and under water at low tide	The land area between two parallel rivers	The part of a riverbed that is exposed during drought periods
378	What is laminar flow?	In fluid dynamics, when a fluid flows in parallel layers that slide past one another like playing cards	In fluid dynamics, when a fluid flows with rapid variation of pressure and velocity	In fluid dynamics, when a fluid flows produces vortices	In geology, the imprint of water flow in sedimentary rocks visible as fine layers
379	Which is the deepest lake in the world?	Lake Bajkal (Russia)	Lake Tanganika (Africa)	Lake Superior (USA and Canada)	Lake Victoria (Africa)
380	Which was the first movie to use computer software to simulate the properties of water?	Antz	Waterworld	Finding Nemo	Up!
381	What is reverse osmosis?	A water purification method that uses a semipermeable membrane to remove particles from drinking water	The opposite of direct osmosis	A water purification method that uses an electric current to remove particles from drinking water	A water purification method that uses membranes with nanometer sized cylindrical pores to remove particles from drinking water
382	What did marathon runner Richard Quartermaine (UK) dress up as in the 2014 Virgin Money London Marathon?	As a tap/faucet	As a toilet	As a bath tub	As a watering can
383	Which is the longest of the bony fish or "true" fish (Osteichthyes)?	The oarfish, also called the "King of the Herrings". A 7.6-m-long one weighing 272 kg was fished in Maine (USA).	The anaconda, which can grow to sizes exceeding 5 metres.	The blue whale (Balaenoptera musculus), which can exceed 30 metres	The whale shark, for which the largest confirmed length was 12.65 metres
384	Osteichthyes and Chondrichthyes are two groups of fish. What is the difference?	Osteichthyes have a bony skeleton, Chondrichthyes a cartilaginous one	Osteichthyes have a cartilaginous sk eleton, Chondrichthyes a bony one	Osteichthyes are deep sea fish, Chondrichthyes live at low to medium depth	Osteichthyes live in the Atlantic Ocean, Chondrichthyes in the Pacific and Indian Oceans
385	What is the name of the island where the descendants of the Mutiny of the Bounty still live?	Pitcairn	Tuvalu	Haiti	Malpelo
386	What is the literal meaning of the word Tsunami (from Japanese)?	Harbor wave	Very large wave	Seismic wave	Sea earthquake
387	How much water can human kidneys filter per hour?	About 800 to 1,000 milliliters	About 1.5 liters	More than 2 liters	About 300 to 500 milliliters
388	In which island of the Mediterranean was Aphrodite (Venus) born?	Ciprus	Malta	Kos	Rhodes

389	What is the decompression sickness that may affect scuba divers?	A condition arising from dissolved gases coming out of solution into bubbles inside the body during ascent	A condition of sea sickness arising from wave motion	The loss of underwater orientation due to insufficient light	The dizziness caused by a prologed immersion
390	What fraction of the solar light is lost due to absorption at a depth of 0.5 meters in the sea?	50%	10%	30%	1%
391	To what depth does the infrared radiation of the solar light penetrate in sea water?	A few centimetres	1 meter	10 meters	50 meters
392	To what depth does the ultraviolet radiation of the solar light penetrate in sea water?	A few centimetres	1 meter	10 meters	50 meters
393	What range of temperature can tardigrades, invertebrates found in hot springs and in solid ice, survive?	From near absolute zero (-273°C) to more than 150°C	From - 60°C to 50°C	From - 160°C to 150°C	From -10°C to 50°C
394	Where do the Uros people of Lake Titicaca live?	On self-made floating islands made of dried totora reeds	In stilt houses near the shore of the lake	In wooden barns built with logs carried to the lake by affluent rivers	On boat houses anchored on the lake shores

	Question	Right Answer	Wrong Answer 1	Wrong Answer 2	Wrong Answer 3
395	Why do water drops take a spherical shape?	Because of the surface tension of the water	The force of attraction between the molecules is higher than between gases	All liquids shape as spherical drops	Because of the gravity force
396	What is water hardness?	Concentration of cations, expecially solved calcium and magnesium, in the water	The value of pH	The content of gas in the water	The specific gravity of water
397	Why does ice water/snow melt when adding salt?	Because salt lowers the freezing/melting point of water.	Because of friction between salt and ice, heat is produced to melt the ice	Because salt releases heat	Because salt breaks water bonds
398	Why is water transparent?	It doesn't absorb in the wavelength range of visible (sun) light, roughly 400-700 nm.	To be compatible with life on Earth, water has evolved into transparent color	Because its molecular structure is like the glass one	Water is a (solvent) liquid with no solutes
399	Why is water compatible with life on Earth?	Because it is transparent	Because it is the most diffuse matter in the world	Because it can easily change its temperature	Because it is liquid
400	Why is water of indoor and white-bottom swimming pools blue?	The red component of the visible spectrum of reflected light is absorbed through a deep column of water	Because variuos chemicals give water the blue color	Because the roof is blue and it is reflected by the water	Because water is a blue liquid
401	Why does pure water have no smell or taste?	Because humans don't have smell or taste receptors for it	Because it is made up by hydrogen and oxygen which have no smell nor taste.	Because it doesn't contain anything	It depends on its temperature at liquid state

402	What percentage of the water on Earth is freshwater?	2,50%	20%	50%	0,50%
403	What percentage of the water on Earth is readily available for human use, especially for drinking?	Approximately 0.007%	Approximately 1%	Approximately 30%	Approximately 10%
404	What percentage of water at home is used on average for drinking in Europe?	2%	10%	70%	50%
405	What is the average household consumption of tap water in Europe?	150 liters per person a day	100 liters per person a day	20 liters per person a day	50 liters per person a day
406	What is the average consumption of available water in developing countries?	10 liters per person a day	30 liters per person a day	200 liters per person a day	100 liters per person a day
407	How long is the longest European river?	3692 km	1430 km	346 km	12550 km
408	In a water molecule, how is the charge distributed?	Positively on the hydrogen side and negatively on the oxygen side	Positively on the oxygen side and negatively on the hydrogen side	Water is nonpolar molecule	Water molecule has an evenly distributed positive charge
409	How much water is used to process a 100g hamburger?	almost 4 liters	almost 1 liter	almost 20 liters	almost 10 liters
410	How much water is necessary to make four new tires?	7500 liters	750 liters	75000 liters	75 liters
411	How much water does an acre (4000 m2) of corn give off per day in evaporation?	15000 liters	150 liters	1500 liters	150000 liters
412	How much water is used to process one can of fruit or vegetables?	35 liters	3.5 liters	350 liters	0.35 liters
413	How much water is used to process one barrel of beer (120 liters)?	5600 liters	56 liters	5.6 liters	560 liters
414	How much water is used to produce 450 g of rice?	900 liters	90 liters	45 liters	450 liters
415	How much water is used to produce 450 g of grain fed beef?	6300 liters	630 liters	4500 liters	450 liters
416	How much water is used to produce a bottle of wine?	4.74 liters	74 liters	7500 liters	7.5 liters
417	How much drinking water is produced by desalination plants in a day?	60,000 M liters	300 M liters	30,000 M liters	1,500 M liters
418	Where is the largest volume of ice outsied the polar region?	Tibetan Plateau (Asia)	South Island (New Zeland)	Andes Mountains (South America)	Rocky Mountains (USA)
419	How much has the surface area of Lake Urmia in Azerbaijan decreased by 2014 compared to 1973?	around 90%	60%	30%	40%
420	What is the amount of silt (mud) carried by one cubic meter of water in the Yellow River (China)?	around 34 kg	around 10 kg	around 3 kg	around 1 kg
421	What is 'virtual water' ?	water that is carried in the form of food or other commodities	clean liquid water	waste water	water vapor
422	What is the approximate amount of water stored in the atmosphere?	140 million billion litres	20 million billion litres	20 billion litres	4 thousand billion litres
423	What is the angle of H-O-H bound in a normal water molecule ?	104,5	109,05	150	120

424	What is the date of the World Water Day established by the United Nations?	March 22th, 2015	June 05th, 2015	Jannuary 01st, 2015	August 15th, 2015
425	In which year was the World Water Day first designated by the UN General Assembly?	1993	2000	1985	2010
426	How much human waste is disposed everyday in water courses, worldwide?	2M tons	3 tons	150 kg	200M tons
427	How many litres of water are needed to produce one kilo of rice?	1000-3000	50-100	10000-20000	100-300
428	Which is the tallest dam in the world?	Jinping-I Dam (China)	Inguri Dam (Georgia)	Xiaowan Dam (China)	Tehri Dam (India)
429	What is the water footprint of bovine leather? (litre/kg)	17	65	580	3,8
430	In which two countries is water provision privatised?	UK, Chile	USA, Russia	France, Israel	USA, UK
431	What is the main driver for movement of underground water?	Differences in water pressure	Differences in salt content	Differences in storage space in rocks	Differences in gravity
432	How many liters of fresh water can be polluted by a drop of oil?	100 litres	10 litres	50 litres	1 litres
433	how much wetlands have been lost worldwide since 1900?	50%	25%	10%	75%
434	where was the first municipal water filtration works opened?	Scotland	England	Spain	France
435	when was the first municipal water filtration works opened?	1832	1874	1904	1781
436	how much water is used to produce a single day's supply of US newsprint?	1 billion liters	500 million liters	100 million liters	2 billion liters
437	how much water is used for producing one cotton T-shirt?	2700 liters	2300 liters	2100 liters	3000 liters
438	how much water per day is expelled by a full-grown oak tree through its leaves?	7 tons	3 tons	5 tons	10 tons
439	How many litres of drinking water a day are produced by desalination plants?	60 billion litres	1.5 billion litres	300 million litres	30 billion litres
440	How much water is needed to produce a portion of french fries?	23 litres	7 litres	50 litres	2 litres
441	How much water is needed to grow one orange?	52 litres	12 litres	5 litres	26 litres
442	How much water is needed to grow one watermelon?	378 litres	123 litres	624 litres	57 litres
443	How much water is needed to grow one tomato?	11 litres	32 litres	58 litres	5 litres
444	How deep is lake Como in North Italy?	416 meters	56 meters	336 meters	166 meters
445	How much water is contained in one hamburger of 300 grams?	about 2400 liters	about 0,2 liters	it depends on the type of the cow	it depends on how is cooked
446	How much water carried the Apollo 11 when it was launched?	none, because the water needed was produced as a fuel-cell	150 liters	none because as system of distillers and filters allowed	about 40 liters

		by product only after the launch		astronauts to recycle their urine	
447	How many gods of the river Nile did the ancient Egyptians have?	Four or more	Three	One	Two
448	Which lake contains the largest island?	Huron lake	Caspian Sea	Victoria lake	Michigan lake
449	Which is the only substance that has higher heat capacity than water?	Ammonia	Iron	Carbon	Porcelain
450	What is the world record for the heaviest 48-hour rainfall?	2,493 mm	4,293 mm	535 mm	1,459 mm
451	What is the record of rain fall in one minute?	38 mm	13 mm	25 mm	45 mm
452	The highest dam is as high as which building:	The Eiffel Tower	Sant. Peter, Rome	Petronas Buildings (Kuala Lumpur)	The Empire State Building
453	the residence time of a drop of water in the ocean is	3200 yrs	100 yrs	100000	2 million years
454	The river with the highest discharge is the amazon, the river with the second highest discharge (Kongo), carries only	20%	60%	12%	80%
455	Worldwide, women and children spent approximately how many hours a day to collect water from remote sources?	140 Million	15 million	950 mio	2 million
456	How much water is needed to produce a glass of wine?	120 litres	2 litres	10 litres	0,5 litres
457	How much water is used during the growing/production of 100g of almonds?	45 liters	4 liters	450 liters	100 liters
458	How much water is needed to produce a loaf of bread (from field to table)?	567 litres	200 litres	900 litres	80 litres
459	The most expensive bottle of water sold at auction (for $60,000) was made by an Italian artist? Who?	Amedeo Modigliani	Giorgio De Chirico	Lucio Fontana	Umberto Boccioni
460	In 2013 Kurt Steiner seized the world's record for the most consecutive skips of a stone on water. How many?	88	45	123	57
461	The oldest message in a bottle made a short travel in the Scottish North Sea. But how long did it remain at sea?	99 years and 43 days	10 years and 31 days	More than 500 years	5 years and 22 days
462	What are Nekton?	Organisms that live in water and can swim against a current and control their position	Organisms that live in water and are transported by currents	A subclass of Crustaceans	Organisms that float near the surface of the water
463	What are Benthos?	Organisms which live on, in, or near the seabed	Organisms that live in water and are transported by currents	Organisms that live in water and can swim against a current and control their position	Organisms that float near the surface of the water

A.2 Questionnaire items

Construct	Item no.	Item	Measurement	Source
Technology acceptance on application level				
UTAUT – Performance expectancy	1	I find the Smart H2O portal useful in my daily life.	5-point Likert scale (1=Strongly disagree; 5=Strongly agree)	[Venkatesh et al., 2003]
UTAUT – Performance expectancy	2	Using the Smart H2O portal increases my chances of achieving things that are important to me.	5-point Likert scale (1=Strongly disagree; 5=Strongly agree)	
UTAUT – Effort expectancy	1	Learning how to use the SmartH2O portal is easy for me.	5-point Likert scale (1=Strongly disagree; 5=Strongly agree)	[Venkatesh et al., 2003]
UTAUT – Effort expectancy	2	My interaction with the Smart H2O portal is clear and understandable.	5-point Likert scale (1=Strongly disagree; 5=Strongly agree)	
UTAUT – Effort expectancy	3	I find the Smart H2O portal easy to use.	5-point Likert scale (1=Strongly disagree; 5=Strongly agree)	
UTAUT – Effort expectancy	4	It is easy for me to become skilful at using the SmartH2O portal.	5-point Likert scale (1=Strongly disagree; 5=Strongly agree)	
UTAUT-Attitude towards technology	1	Using the Smart H2O portal is a bad/good idea	5-point Likert scale (1=Strongly disagree; 5=Strongly agree)	[Venkatesh et al., 2003]
UTAUT-Attitude towards technology	2	The system makes work more interesting.	5-point Likert scale (1=Strongly disagree; 5=Strongly agree)	
UTAUT-Attitude towards technology	3	Working with the system is fun.	5-point Likert scale (1=Strongly disagree; 5=Strongly agree)	
UTAUT-Attitude towards technology	4	I like working with the system.	5-point Likert scale (1=Strongly disagree; 5=Strongly agree)	
Hedonic quality (stimulation)	1	Typical—original	7-point semantical differential	[Hassenzahl, 2004]
Hedonic quality (stimulation)	2	Standard—creative	7-point semantical differential	
Hedonic quality (stimulation)	3	Cautious—courageous	7-point semantical differential	
Hedonic quality (stimulation)	4	Conservative—innovative	7-point semantical differential	
Hedonic quality (stimulation)	5	Lame—exciting	7-point semantical differential	
Hedonic quality (stimulation)	6	Easy—challenging	7-point semantical differential	
Hedonic quality (stimulation)	7	Commonplace—new	7-point semantical differential	
Pragmatic quality	1	Technical—human	7-point semantical differential	[Hassenzahl, 2004]
Pragmatic quality	2	Complicated—simple	7-point semantical differential	
Pragmatic quality	3	Impractical—practical	7-point semantical differential	
Pragmatic quality	4	Cumbersome – direct	7-point semantical differential	
Pragmatic quality	5	Unpredictable—predictable	7-point semantical differential	
Pragmatic quality	6	Confusing—clear	7-point semantical differential	
Pragmatic quality	7	Unruly—manageable	7-point semantical differential	
Social awareness about water consumption (i.c. water consumption determinants)				
TPB: Attitude towards water saving	1 2 3	Engaging in everyday actions to save water around the house and garden is: extremely bad/extremely good;	7-point semantical differential	[Fielding et al., 2012]

	4	extremely harmful/extremely beneficial; extremely worthless/extremely valuable; extremely unpleasant/ extremely pleasant		
TPB: subjective norm	1	It is expected of me that I save water around the house and garden	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)	[Fielding et al., 2012]
TPB: subjective norm	2	I feel like there is social pressure to save water around the house and garden	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)	
TPB: subjective norm	3	People who are important to me want me to save water around the house and garden	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)	
TPB: perc. beh. control	1	I am confident that I could save water around the house and garden if I wanted to,	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)	[Fielding et al., 2012]
TPB: behavioural intention to save water	1	I expect I will engage in everyday actions to save water around the house and garden in the next six months	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)	[Fielding et al., 2012]
TPB: behavioural intention to save water	2	I intend to engage in everyday actions to save water around the house and garden in the next six months,	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)	
TPB: behavioural intention to save water	3	I want to engage in everyday actions to save water around the house and garden in the next six months	7-point Likert scale (1=Strongly disagree; 7=Strongly agree)	
TPB: behavioural beliefs (utilitarian)	1	There is much water in [area name]. We just have to conduct it to our cities	Four-point Likert scale (1= completely disagree; 4=completely agree)	[Corral-Verdugo et al., 2002]
TPB: behavioural beliefs (utilitarian)	2	Science surely will solve the problem of water scarcity	Four-point Likert scale (1= completely disagree; 4=completely agree)	
TPB: behavioural beliefs (utilitarian)	3	Drinkable water is an unlimited resource	Four-point Likert scale (1= completely disagree; 4=completely agree)	
TPB: behavioural beliefs (utilitarian)	4	Drinkable water will exhaust very soon if we do not save it	Four-point Likert scale (1= completely disagree; 4=completely agree)	
TPB: beh. Beliefs (ecological)	5	A way of preventing water exhaustion is using it when absolutely necessary	Four-point Likert scale (1= completely disagree; 4=completely agree)	
Gamification elements				
Perception of incentive		I feel motivated to use the SmartH2O portal, because I can… …collect points through my actions on the portal (no.1). …collect points by saving water. …get badges for my collected points (no.2). …get suggestions of what kind of actions I can do on the portal (no.3). …compare myself to others on the leaderboard (no.4). …get rewards for my collected points (no.5). …get rewards for winning against others (no.6).	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Perception of competitive incentive		After checking the leaderboard, I feel motivated to make it to the top. When I'm checking the leaderboard, I do it because I want to know whether I do better than other people I know.	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Water consumption chart				

Perceived usefulness	The water consumption chart… …is useful.	Five-point Likert scale (1=complete disagree; 5=completely agree	Success criteria
Perception of awareness increase	…makes me think about water conservation more often than before. …helps me understand how much water my household consumes	Five-point Likert scale (1=complete disagree; 5=completely agree	Success criteria
Perception of incentive	…motivates me to keep using the SmartH2O portal. …motivates me to save water.	Five-point Likert scale (1=complete disagree; 5=completely agree	Success criteria
Perception of awareness increase	How much do the following options help you understand your water consumption? …display your average (no. 1). …display the neighbourhood average (no. 2). …adjust the displayed data to days, weeks, or months (no. 3). …open hourly consumption data (no. 4).	Five-point Likert scale (1=very little; 5=very much)	Success criteria
Water consumption overview			
Perceived usefulness	The water consumption overview… …is useful.	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Perception of incentive	…motivates me to keep using the SmartH2O portal. …motivates me to save water.	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Perception of awareness increase	…makes me think about water conservation more often than before. …helps me understand how much water my household consumes.	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Perception of awareness increase	How much do the following elements help you understand your water consumption? The comparison of your current consumption to your historical base value (no. 1). The comparison of your consumption to the suggested water saving levels (no. 2). Your expected consumption for a full year (no.3).	Five-point Likert scale (1=very little; 5=very much)	Success criteria
Water consumption alerts			
Perceived usefulness	Getting water consumption alerts for high consumption is useful.	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Water consumption goals			
Perceived usefulness	Being able to set my own goals… …is useful.	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Perception of awareness increase	…makes me think about water conservation more often than before.	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Perception of incentive	…motivates me to keep using the SmartH2O portal. …motivates me to save water.	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Perception of incentive to set/achieve goal	I am motivated to reach my water saving goal because I can… …receive more points if I do (no. 1). …compare my current consumption to my goal (no. 2). …see how much water I can save in one year if I do (no. 3).	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Water saving tips			
Perceived usefulness	The water consumption tips (textual, videos, infographics)… …are useful.	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria

Perception of awareness increase	…make me think about water conservation more often than before. …motivate me to keep using the SmartH2O portal.	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Perception of incentive to take action	…motivate me to save water.	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Perception of incentive to take action	The SmartH2O portal motivates me to put water saving tips into practice.	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Perception of incentive to take action	I was able to put most water saving tips into practice.	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Household profile			
Perception of incentive to provide information	The SmartH2O portal motivates me to fill out my household profile.	Five-point Likert scale (1=complete disagree; 5=completely agree)	Success criteria
Drop!			
Perception of joy	It is fun to … …play the Drop! board game (no. 1). …play with the Drop!TheQuestion mobile app (no. 2). …play the Drop! board game connected to the Drop!TheQuestion mobile app (no. 3). …earn points on the SmartH2O portal with the Drop!TheQuestion mobile app.	Five-point Likert scale (1=complete disagree; 5=completely agree) + "I haven't played this version"	Success criteria
Ease of use	It is easy to… …scan monster cards with the mobile app (no. 3). …earn points on the SmartH2O portal with the Drop!TheQuestion mobile app.	Five-point Likert scale (1=complete disagree; 5=completely agree) + "I haven't played this version"	Success criteria
Effort expectancy (UTAUT)	Learning how to play Drop!TheQuestion is easy for me. My interaction with Drop!TheQuestion is clear and understandable. I find Drop!TheQuestion easy to use. It is easy for me to become skilful at playing Drop!TheQuestion.	Five-point Likert scale (1=complete disagree; 5=completely agree)	[Venkatesh et al., 2003]
Attitude towards technology (UTAUT)	I like playing Drop!TheQuestion. Playing Drop!TheQuestion is a good idea. Playing Drop!TheQuestion makes water conservation more interesting.	Five-point Likert scale (1=complete disagree; 5=completely agree)	[Venkatesh et al., 2003]
Social influence (UTAUT)	People who are important to me think that I should play Drop!TheQuestion.	Five-point Likert scale (1=complete disagree; 5=completely agree)	[Venkatesh et al., 2003]

A.3 Recruitment messages

The following text was used for the recruitment of users:

Subject: Your opinion is important to us
Message body:

Dear SmartH2O user,

Great to see that you have been using SmartH2O (*add in Tegna:* with all the advanced features) for some time now. To improve your experience, we need your feedback – how do you like the SmartH2O portal and what can we do to make it better?

Your feedback supports our efforts and research on sustainable water consumption in Valencia (Tegna). But there is more reason to help us out: you can earn an additional **2100 points on the SmartH2O portal** (*add in Valencia:* and increase your chances to win the weekly and overall competition)**!**.

The only thing you have to do is to spend about 10 minutes filling out a questionnaire. You can find it here [add link to 'here'].

Many thanks in advance for your support!

The SmartH2O team

Five days after the initial e-mail, a reminder was sent with the following text:

Subject: Earn 2100 extra points on SmartH2O
Message body

Dear SmartH2O user,

Great to see that you have been using SmartH2O (*add in Tegna:* with all the advanced features) for some time now. Do you want to earn **2100 points** in only 10 minutes of your time?

Please help us by filling out a brief questionnaire [link to questionnaire]. Our first invitation might have escaped from your attention. Your feedback is crucial to improve the portal and to learn about how we can save water in Valencia!

So **earn 2100 points** and increase your chance to win the weekly and overall competition. If you win this week's competition, you get one free ticket for the Oceanogràfic Museum!

You can find the questionnaire here [add link to 'here'].

Many thanks in advance for your support!

The SmartH2O team

TO QUESTIONNAIRE-