Article

Reducing Bottled Water Use among Adolescents: A Factorial Experimental Approach to Testing the Components of the "Aquatic" Program

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Abstract: The aim of the current study was to assess the components of the intervention program "Aquatic", targeted at the reduction of bottled water use in adolescence. The Comprehensive Action Determination Model was chosen as a theory of change for the development and evaluation of pro-environmental behavior intervention. We examined the impact of five experimental intervention factors (water bottles, promo video, prompts, goal setting, and feedback) on eight intervention program outcomes: Perceived behavioral control, Social norm, Habit, Awareness of need, Awareness of consequence, Personal norm, Intention, and Behavior. The study sample consisted of 419 adolescents (52.8% girls, M_{age} = 15.21, SD_{age} = .64) from Lithuania. A factorial experimental study design was used, and a Latent change modelling approach was applied for evaluation of individual and combined effects of intervention components. *Promo video, Prompts*, and *Goal setting* had a positive effect on Awareness of consequence, Social norm, and Awareness of need, respectively. Receiving a *Water bottle* in combination with *Promo video* had a positive effect on Perceived behavioral control and in combination with *Prompts* as well as *Goals* – on Awareness of need. *Water bottles*, *Promo-video*, *Prompts*, and *Goals*, but not *Feedback*, had value in the promotion of targeted pro-environmental outcomes.

Keywords: pro-environmental behavior, factorial experiment, adolescence, intervention

1. Introduction

Modern lifestyles and especially ever-increasing consumption leave growing piles of trash that cause dramatic consequences to the Planet and, hence, to the well-being of people [1]. Every year, human beings produce around two billion tons of household waste and this number is gradually increasing [2]. In 2016 only, humanity produced 242 million tons of plastic waste [3]. Despite recycling efforts, every year 150 000 to 500 000 tons of plastic waste from the EU end up in the oceans [4]. It does not only literally threaten lives of sea animals, but also, through a consumption cycle, comes back to people and may end up in their bodies, potentially causing severe health issues [4]. It becomes increasingly obvious that focusing only on recycling is not the solution and the World should move towards drastic reduction of single use plastic such as water bottles [5]. The current study reports on the possibilities for reduction of bottled water use among adolescents by delivering the intervention program "Aquatic" that was developed based on the theory of change grounded in the Comprehensive Action Determination Model (CADM) [6]. The intervention components were chosen based on the review of pro-environmental interventions strategies by Osbaldiston and Schott [7] and include such strategies as making it easy, social modelling, reminder-prompts, goal setting, and providing environment-related feedback.

1.1. Conceptual Models on Promoting Pro-environmental Behaviors

Although national and international strategies are seen as the primary and most effective way of solving the problem of consumption-related waste [4], individual efforts and, especially, changing consumption routines as well as promoting alternative acceptable behaviors within nature's resource constraints, is among the important contributors to the Planet's and human welfare [8]. Less than a decade ago, the Comprehensive Action Determination Model (CADM) [6] was suggested as a theory of a behavioral change, which is claimed to be especially beneficial for pro-environmental behavior interventions. The CADM incorporates such widely known behavior-related theoretical models as the Norm-Activation Model (NAM) [9] and the Theory of Planned Behavior (TPB) [10] and encompasses normative (awareness of consequences, awareness of need, social norm, and personal norm), intentional, situational (perceived behavioral control and access to behavior), and habitual determinants of individual behavior. In the CADM, perceived consequences of behavior (awareness of consequences), perceived need to behave in a pro-environmental manner (awareness of need), as well as perceived social pressure (social norms) lead to a moral obligation to act pro-environmentally (personal norm). Personal norm, in turn, affects intention and habit to perform the behavior. Further, intention may be determined not only by the personal norm but also by the social norm and perceived behavioral control. In CADM, both perceived behavioral control and access to behavior influence the habit and behavior directly. Moreover, habit might act as a direct predictor of behavior.

1.2. Pro-environmental Behaviors Among Adolescents

Although the CADM model has been extensively used in the literature for explaining adult pro-environmental behavior, for example [11, 12], there is a lack of studies that address adolescents' pro-environmental behavior in a CADM framework. Although youth have less influence on household consumption decisions than adults, they still can affect it through their parents [13]. Additionally, by now it has been well acknowledged that adolescents already have considerable spending power, are actively engaged in consumption behavior, and make consumption-related decisions on a daily basis [14]. Moreover, youth is the next generation of adults with consumer power [15] as well as future decision makers that will need to address the nature-related challenges and to deal with the consequences of the behavior of earlier generations. More than a decade ago, the United Nations clearly stated that schoolchildren and adolescents are an important age group for applying pro-environmentally oriented behavioral change [16]. Youth continues to be an important target group for promoting pro-environmental behaviors, especially having in mind that they are at a life stage where they are forming their system of beliefs, morals, and values, including the prosocial ones [17].

Over the last decades, there has been a substantial effort to promote individual pro-environmental behaviors and there is a solid body of literature related to changing adult environmentally friendly behaviors, for a review see [7]. However, the literature on fostering adolescent pro-environmental efforts is rather scarce and focused mainly on knowledge-based educational training, for example [18, 19]. Nevertheless, there is some evidence from research on adolescents that when seeking to influence youth's pro-environmental behavior it would be meaningful to address social norms and perceived behavioral control [20]. Also, when fostering adolescents' behavioral intention, awareness of consequence alongside the personal norm and perceived behavioral control may play an important role [21]. Additionally, in one of the few experimental studies on youth, there has been found that goal-setting-related techniques are the vehicle for behavioral change in adolescence, namely for promoting energy-saving behavior [22].

1.3. The Current Study

The goal of the current study is to test the effectiveness of the components of an intervention program "Aquatic" that aims to promote pro-environmental behavior, namely,

the reduction of bottled water use among adolescents. The development of the intervention was informed by the Multiple Phase Optimization Strategy (MOST) approach [23], as it allowed the comprehensive evaluation of multiple components in the behavioral intervention. We used a factorial experiment for the evaluation of individual and combined intervention components, as it is a comprehensive method that is most appropriate when conducting research to select components for inclusion in a multicomponent intervention and it allows doing it with sufficient statistical power with a reasonable sample size [24, 25].

Perceived behavioral control and social norm were chosen as the main targets of the intervention, as, based on CADM [6], the two constructs represent the agents (or mediators) of change and are expected to accumulate the processual interplay between the factors important for actualizing the particular behavior and, eventually, should lead to it. To promote these outcomes, we chose five intervention strategies, namely, making it easy, social modelling, prompts, goal setting, and providing feedback [7].

To increase perceived behavioral control, we used one of the proven strategies of pro-environmental behavioral change, namely, *Making it easy*, as the first intervention component. Therefore, we provided the participants with reusable water bottles. As it was found that the current strategy works best when paired with *Prompts* [7], we added prompts as the second intervention condition. Everyday app-based reminders to pour some tap-water were used as prompts. We also expected that prompts will assist in breaking the habit of bottled water use, which, as found by Jovarauskaitė and colleagues [26], is an important predictor of behavior in adolescence. In previous research, when testing the habit discontinuity theory [27], prompts were proven to be an effective strategy for the change of habitual behavior [28]. In our study, receiving a reusable water bottle is seen as a contextual change and, therefore, we expected that prompts would be useful to put them in practice.

To additionally promote perceived behavioral control, we added *Feedback* and *Goal setting* [7] as the third and fourth intervention components. Feedback was found to be effective when given frequently [29], therefore, every time the participants provided information on how much non-bottled water did they drink, they had an opportunity to see how it is related to saving the environment and money. As saving the environment was linked to the use of non-bottled water, we expected that feedback would also affect the awareness of consequence. The self-interest-related feedback was included as a motivator for continuity of relatively low-cost and low-effort behavior [30]. We provided person-level and group-level feedback to accumulate possible intervention effects [31]. The goal-setting is generally an understudied but promising strategy for behavioral change [22, 7]. Therefore, we also asked the participants to indicate how many bottles of water they purchase weekly and to specify what would be the intended goal for the reduction of the bottled water use. The goal was set personally and not imposed, thus allowing individuals to act naturally and for their innate biases to act in congruence with desirable societal outcomes [32, 33].

To promote social norm, we chose *Social modelling* as the fifth intervention component. Social modelling was found to be among the effective strategies for addressing pro-environmental behavior in general [7] and social norm in particular [31]. For modelling the socially acceptable behavior, we used a *Promo video*, where the reusable canteen was suggested as an alternative for purchasing bottled water. As the *Promo video* included some visual elements related to awareness of need and awareness of consequence, we expected additional effects on these constructs.

To our knowledge, no prior experimental study tested the utility of the Comprehensive Action Determination Model in promoting pro-environmental behavior among adolescents. In addition, this study is the first attempt to directly test the effectiveness of each intervention component on the theoretically based mediators of behavioral change. Based on literature analysis, we hypothesized that *Making it easy* alone and combined with *Prompts* would strengthen perceived behavioral control; *Prompts* would promote habit; *Feedback* would foster perceived behavioral control and awareness of consequence; *Goal setting* would promote perceived behavioral control; the *Promo video* would increase social

norms, awareness of need and consequences. However, due to the novelty of the approach and lack of prior empirical evidence, we tested the effects of each of the five intervention components and their two-by-two combinations on all of the eight related CADM constructs (i.e., perceived behavioral control, social norm, habit, awareness of need, awareness of consequence, personal norm, intention, and behavior).

2. Materials and Methods

2.1. Design

We carried out a 2^5 factorial experiment for the evaluation of individual and combined effects of intervention components. We examined the impact of five experimental intervention factors (each evaluated on two levels) on eight possible intervention program outcomes: Perceived behavioral control, Social norm, Habit, Awareness of need, Awareness of consequence, Personal norm, Intention, and Behavior. The experimental factors of interest were *Making it easy* (reusable water bottles provided by the experimenter vs. no bottles), short *Promo video* about the harm of single-use plastic bottles and benefits of reusable water bottles (watched video vs. no video), *Goal setting* to buy less single-use water bottles in an app (yes vs. no), *Prompts* in an app (reminder notification vs. no notification), and *Feedback* (provided in an app vs. no feedback).

2.2. Experimental Factors and Planned Comparisons

In this 2^5 factorial experiment, five experimental factors are being evaluated, each on two levels. The result is a 32-arm factorial experimental design, where the intervention group is defined by the exposure to the particular component (or combination of components), when the control group, despite the exposure to some conditioning, is not exposed to that particular component (see Table 1). Therefore, the intervention and the control groups differ for the evaluation of each component. We have compared the independent effects of each of the five experimental factor levels. In addition, we have evaluated the combined effects of all component pairs on the outcomes to assess the effects of both individual and combined exposure to the intervention components. The factors and the actual implementation of the exposure to the intervention components is described below.

Table 1. 32-Arm randomization scheme.

Arm	Water bottle	Promo video	Prompts	Feedback	Goal setting	n
1	Yes	Yes	Yes	Yes	Yes	15
2	Yes	Yes	Yes	Yes	No	16
3	Yes	Yes	Yes	No	Yes	25
4	Yes	Yes	Yes	No	No	8
5	Yes	Yes	No	Yes	Yes	10
6	Yes	Yes	No	Yes	No	11
7	Yes	Yes	No	No	Yes	12
8	Yes	Yes	No	No	No	13
9	Yes	No	Yes	Yes	Yes	12
10	Yes	No	Yes	Yes	No	11
11	Yes	No	Yes	No	Yes	15
12	Yes	No	Yes	No	No	7
13	Yes	No	No	Yes	Yes	13
14	Yes	No	No	Yes	No	12
15	Yes	No	No	No	Yes	13
16	Yes	No	No	No	No	13
17	No	Yes	Yes	Yes	Yes	20
18	No	Yes	Yes	Yes	No	25

19	No	Yes	Yes	No	Yes	21
20	No	Yes	Yes	No	No	20
21	No	Yes	No	Yes	Yes	12
22	No	Yes	No	Yes	No	14
23	No	Yes	No	No	Yes	15
24	No	Yes	No	No	No	13
25	No	No	Yes	Yes	Yes	11
26	No	No	Yes	Yes	No	13
27	No	No	Yes	No	Yes	8
28	No	No	Yes	No	No	14
29	No	No	No	Yes	Yes	12
30	No	No	No	Yes	No	12
31	No	No	No	No	Yes	9
32	No	No	No	No	No	11

Note. n = number of participants in each arm.

2.2.1. Reusable water bottle (Making it easy) component.

The reusable water bottle was given to half of the study sample. We expected that adolescents would carry the water bottle with them and use tap (or well, or spring) water for everyday use. For that purpose, the water bottle had to meet some criteria: a) it should be functional (lightly weighted, optimal size, etc.), and b) acceptable (likable) for the adolescents. Therefore, to consult same age adolescents, we organized two focus groups from different schools that were not the same as the ones chosen for the intervention implementation. The adolescents evaluated 12 different reusable water bottle designs. After consulting the adolescents, clear white PET bottles were chosen.

2.2.2. Promo video (*Social modelling*) component.

A short promotional video created by the team of United Nations Environment Program (unenvironment.org) was used. The video was targeted to increase the awareness of the harm of single-use plastic and modelling possible alternatives to it. The particular video was chosen as it has a humorous component as well as the message is brought through the imitation of romantic relationships what makes it more attractive to adolescents. Prior to the intervention, during the focus groups, we showed the intended Promo video to the adolescents and asked to share their emotional reactions to it as well as their thoughts that came to mind after watching it.

We cleaned the video of excess information about other sorts of single-use plastic, leaving only parts about single-use water bottles, resulting in the video duration of 1 min., 21 sec. A Lithuanian translation was added in the form of subtitles to ensure that all participants would understand the content (video is available on request). To minimize possible distractions and ensure individual attention, the video was shown on tablet computers with earphones. To additionally assure that the video was not shared between participants with different experimental conditions, the Promo video was not available online, and the tablets had no internet access during the exposure.

For delivering the *Prompts*, *Goal setting*, and *Feedback* components (described in the following three subsections), we developed the mobile application for both iOS and Android. We chose simple water-like design for the mobile application. Different versions of the mobile app were created and distributed to the participants, based on the randomized conditions they were assigned to. Each version of the app had a password for the registration. All app users could designate in the app how much non-bottled water they drink and follow the statistics of consumed water. Therefore, even the participants who were not exposed to any of the *Prompts*, *Goal setting*, or *Feedback* components, installed the app onto their mobile phones.

2.2.3. Prompts component.

The prompt message contained the short word "pour" together with water drop emoji. Four *Prompts* messages were tested, and the frequency of the delivery was discussed during the two focus groups with adolescents. Therefore, during the intervention, adolescents could choose the timing of the prompts by themselves. They could setup up to five different times during the day when they prefer to receive the reminder. The default unremovable setting included one reminder per day. The reminder appeared on the participant's phone on the chosen times as a notification.

2.2.4. Feedback component.

The *Feedback* contained three information elements. The kilograms of CO_2 saved, the kilograms of plastic waste not produced, and money saved by not buying bottled water. This information was provided in four levels: 1) what is the personal progress of all indicators from the beginning to use mobile application (based on how much of non-bottled water consumed is registered up to date by the user), 2) what would be the personal progress of all indicators after a year if a user would keep drinking tap (or alternatively well or spring instead of purchasing bottled water) water at the same pace (Level 1 / days app used * 365 days), 3) what would be the progress of all indicators from the beginning of use of the mobile application if the whole school would keep drinking tap water (or alternatively well or spring instead of purchasing bottled water) at the same pace as the user (Level 1 * number of school participants), 4) what would be the progress of all indicators after a year if the whole school would keep drinking tap water (or alternatively well or spring instead of purchasing bottled water) at the same pace as the user (Level 3 / days app used * 365 days).

2.2.5. Goal setting component.

The *Goal* is to be set immediately after the installation of the app as the first step of the setup. The participants entered the amount of single-use plastic bottles they are purchasing on average during the week. Afterwards, they entered the lower number of water bottles they would like to reach for their weekly use. The difference between current and intended use reflected a goal to what amount the participants would like to reduce their weekly purchase of plastic bottles after the program. Adolescents were free to enter any lower number, therefore the goal for the reduction varied across the sample. The participants could see their set up goal in the app all the time. In addition, they could register the amount of single-use water bottles purchased and see how successful they are in keeping up with their goal.

2.2.6. Recruitment, screening, randomization, and enrollment.

The study protocols were approved by the ethical committee of the Department of Psychology of [BLINDED, decision No. 2/-2020]. The experiment was implemented in a school setting. Schools in Lithuania were selected based on the size of the school and size of the city they are located to maximize the resemblance between the intervention participants. Six schools meeting selected criteria were contacted prior to the intervention. Participants of the intervention were recruited from two high schools which agreed to participate in the experiment. All 9th and 10th graders were eligible to participate in the experiment. Intervention for the optimization purposes and the evaluation (pre-test and post-test) occurred from September 2018 through November 2018. The written parental consents and consents from the adolescents themselves were obtained prior to the first pre-test.

The randomization of the factors was conducted in three levels: school, classroom and individual, due to different levels of factors. First, due to possible spillover effects and contamination by social modelling, the reusable water bottles were distributed at the school level. Meaning that all participants from one school received water bottles, and participants from the other school – did not. Out of the two selected schools, the school

which received water bottles was selected randomly by flipping a coin. Second, promo video and prompts conditions were randomized at the class level. The class in which to show the video was selected randomly by flipping a coin. For prompts, classes, were randomized by flipping a coin separately in promo video groups (those who watched and those who did not watched the video), resulting half of the classes getting prompts and half of them not. For the feedback condition, participants were randomized on the individual level within each of the four groups in both schools resulting from the randomization of previous two conditions (i.e., video/prompts: Yes/Yes, Yes/No, No/Yes, and No/No). For each of the groups, an alphabetical participant list was created and randomized using a random number sequence generated by a computer algorithm. Each sequence then was split in half, one half were exposed to the feedback option in their version of the app and the other one was not. Half that received feedback was decided by flipping a coin. Resulting eight groups (based on video/prompts/feedback exposure/non-exposure) then were again split in half (every group separately) for the goal setting condition applying the same randomization procedure as for the feedback condition. To balance the age in each condition, the randomization of participants was performed in each cohort (9 and 10 grades) separately, applying the same rules as described above. To balance the number of participants in each condition, the quota of classes in promo video condition was set to reflect approximately half of classes in cohorts; when coin reached the quota of classes in one of the two conditions, all remaining classes were automatically assigned to the other condition. The total numbers of participants in each condition are presented in Table 2.

Table 2. Participants in each condition

	Yes	No
	n	
Reusable Water bottle		
9th grade	94	131
10th grade	112	99
Total	206	230
Promo video		
9th grade	118	107
10th grade	132	79
Total	250	186
Prompts		
9th grade	119	106
10th grade	122	89
Total	241	195
Feedback		
9th grade	110	115
10th grade	109	102
Total	219	217
Goal setting		
9th grade	115	110
10th grade	108	103
Total	223	213

2.3. Intervention

The intervention program "Aquatic" was developed by the team of the research project "Understanding the psychological mechanisms of the development of pro-environmental behavior in the context of longitudinal intervention (GOGREEN)". Consistent with the CADM, the program was designed to promote the bottled water use-related pro-environmental means by targeting mainly Perceived behavioral control, Habit, Social norm, and Awareness. The intervention implementation consisted of three steps. First, the viewing of the short *Promo video* (assigned classrooms only). Second, the installation and the setup of the mobile application, which contains different combinations of functionality regarding *Prompts*, *Feedback* and *Goal setting* (all participants). And third, the distribution of the reusable water bottles (assigned school only). For the installation of the app, each participant was provided with a registration code for the assigned version of the mobile application. All versions of the mobile app had functionality where users could register how much water they drank every day from the tap, well, or spring, meaning, not bought in a single-use bottle, and track these statistics. In addition to that, each participant had the functionality they were assigned at the randomization stage (e.g. if they fell in the group with "No" on all conditions: they had only the basic functionality of water consumption registration, if they fell in the group with "Yes" on all conditions, they had the basic functionality of water consumption registration and all three conditions: Prompts, Feedback, and Goal setting).

2.4. Procedure

During the September – December 2018 period, there were six meetings with participants in schools. First, presentation of the forthcoming experiment was organized for students in every participating class and for teachers separately. We explained that the purpose of the experiment was to find out what means are effective when promoting environmentally friendly behavior among adolescents. We have also distributed printed forms of parental consent and introduced the schedule of our following visits.

The measurements (pre-test and post-test) were conducted during school hours in the classrooms using tablet computers. Depending on the agreement with the schools, either researchers came to designated classrooms and distributed tablets for filling in surveys, or participants came to the classrooms where researchers were waiting for them with prepared tablets. Pre-test was organized in two weeks after presentation of the experiment. Five days after the pre-test measurement, the intervention was implemented by presenting all components to the participants in the classrooms. The Promo video was shown first (for assigned classes only), then participants were asked to download the app and register with a code assigned to each participant earlier within the randomization stage. It was explained to the participants that all of them have individual entry codes, so functions of the app may differ, and they were asked not to share information and experience with each other. Finally, reusable water bottles were distributed to the participants from the assigned school as a component of the experiment. To the other school water bottles were given as a gift after final measurement. Post-test measurement was carried out one month after the beginning of intervention implementation. Results of the experiment were presented to participants and school community three weeks after final measurement.

2.5. Participants

This study is part of the longitudinal research project GOGREEN conducted in Lithuania. All 9th and 10th graders of two schools participated in the factorial experiment. In total, 478 students from both schools were eligible for the study (136 ninth graders and 98 tenth graders from one school, 129 ninth graders and 115 tenth from other school). All students participated in the presentation of the experiment and together with the information about the experiment they received a paper form of parental consent. Students who were not at school on the day of presentation still had a chance to participate in the experiment as teachers were asked to provide them all the relevant information and the

paper form of parental consent as well. Parents of 35 children refused participation in the study, 7 students refused to participate themselves; resulting 436 participants were included in the randomization stage. If participants were not at school when the conditions of the experiment were administrated they still had a chance to participate as teachers who had constant support from the researchers were asked to provide participants with relevant personalized information (if assigned – reusable water bottle and assigned app code along with instructions). Four participants had no suitable mobile device, thus, they were excluded from the study. If participants were not at school on the days of the measurements, they were given the link of the questionnaire and could fill it in at home or the other day at school.

The attrition (2 %) was mainly due to the non-participations in the measurements. However, data was missing completely at random ($\chi^2(27) = 18.37$, *p* = .89). Only the participants with available data on at least one measurement point were included in the analysis. Therefore, the final study sample consisted of 419 participants (52.8% girls, M_{age} = 15.21, SD_{age} = .64). The numbers of the participants in each condition for every intervention component are provided in the Results section.

2.6. Measures

As the study assessed components of the behavioral intervention designed to promote pro-environmental behavior (reduction of bottled water use), all outcome variables were specifically related to this particular behavior. To measure the CADM constructs: Perceived behavioral control, Social norm, Habit, Awareness of need, Awareness of consequence, Personal norm, and Intention, we used single item questions based on wording of Klöckner and Blöbaum [6]. Using single item indicators for the measurement of behavioral change-related constructs is a common practice in the field, for example [34]. Items were formulated specifically around bottled water purchasing behavior, namely, "People who are important to me expect that I would not buy bottled water" (*social norm*), "Buying bottled water causes many environmental problems" (*awareness of need*), "If I reduce buying bottled water, I contribute to environmental protection" (*awareness of consequences*), "I feel morally obliged not to buy bottled water" (*personal norm*), "I am used to buying bottled water" (*habit*), "It is completely up to me whether I will buy bottled water in the next four weeks" (*perceived behavior control*), "I intend not to use bottled water in the next four weeks" (*intention*). All mentioned items were rated on a 5-point Likert scale from 1 (*completely disagree*) to 5 (*completely agree*). Bottled water purchasing behavior was also measured with a single item ("I bought bottled water in the last four weeks"), which was rated from 1 (*never or almost never*) to 5 (*constantly*). In the initial measurement, for Habit and Behavior, lower score stood for less frequent behavior. However, in the data analysis, the items were recoded so that in all items higher score represent more desirable outcomes.

2.7. Data analysis

To examine the changes in program outcomes, we used the latent change approach. Latent-variable models provide the possibility to model the measurement error and provide more robust estimates of change over time [35]. In latent change models with two measurement points, the intercept represents the mean level of the measure and the slope represent the change from baseline to post-test. To have the model identified, we fixed the residuals to zero. To compare the effects of each program component, we dummy-coded the exposure to the intervention component to 1 and non-exposure to 0. We did the same for the combinations of conditions: if the participant was exposed to both of the components, we coded it 1 and if to none of the two components – 0; participants who were exposed to either one of the two components were excluded from the analysis. We then regressed each of the exposure to intervention component variable on the intercept and the slope of the outcome variables. The regression path from dummy-coded variables to intercept enabled testing the baseline differences among the intervention and the control conditions. The regression paths from dummy-coded variables to the slope provided the

indication whether the change in the intervention condition differs from the one in the control condition. Additionally, to contrast the change in the intervention and the control conditions, we ran multi-group latent change models. As the participants of the study were nested into classrooms, to ensure the correctness of the effect sizes calculation [36], the analysis was performed by applying the complex data approach. Based on this approach, the standard errors are computed taking into account complex sampling features [37], namely, participants' clustering in different classrooms. To compare the magnitude of the effects, we computed the Cohen's d effect sizes for the mean change differences in the intervention group and the control group. Based on the guidelines of Gignac and Szodorai [38], the effect size of $\geq .1$ and $< .2$ was considered as small, $\geq .2$ and $< .3$ as moderate and $\geq .3$ as high. All latent difference and multiple group analyses were conducted in Mplus 7.4 [39]. No data imputation was applied. Full information maximum likelihood (FIML) estimator was used in all analyses as a method for taking into account the missing data [40].

3. Results

3.1. Individual Program Components' Effects on the Intervention Outcomes

We tested the effect of five intervention components, namely, Making it easy (providing a reusable water bottle), Promo video, Prompts, Goal setting, and Feedback on eight outcome measures, that is, Perceived behavioral control, Social norm, Habit, Awareness of need, Awareness of consequences, Personal norm, Intention, and Behavior. The individual effectiveness results are presented in Table 3. The mean intercepts and slopes for each condition in the intervention and the control groups as well as the baseline comparison between groups can be found in the Supplementary material table S1. Further we will present all study results and will indicate whether our hypotheses were supported, where applicable.

Our hypothesis that receiving water bottle would strengthen Perceived behavior control was not supported as the results indicated that receiving water bottles fostered no improvements in any of the program outcomes. Additionally, receiving the water bottle had a reverse effect on Social norm. Specifically, youth who were not provided with water bottles reported an increase in Social norm, when this was not the case for those who did receive water bottles. The baseline level of the Social norm was higher in the intervention group, compared to the control group.

Table 3. Individual program components' effects on the intervention outcomes.

	Social norm		Awareness on need		Awareness consequence		of Personal norm		Habit		Perceived behavioral control		Intention		Behavior	
	β	d [95% CI]	β	d [95% CI]	β	d [95% CI]	β	d [95% CI]	β	d [95% CI]	β	d [95% CI]	β	d [95% CI]	β	d [95% CI]
Water bottle	-.12*	-.24 [-.43, -.05]	.10	.19 [-.01, .38]	-.13	-.10 [-.29, .09]	-.19	-.15 [-.34, .04]	-.04	.08 [-.11, .28]	.09	.17 [-.02, .36]	-.01	-.02 [-.22, .17]	-.002	.00 [-.20, .19]
n_i = 198 n_c = 221																
Promo video	-.02	.04 [-.23, .16]	.02	.03 [-.23, .16]	.09*	.19 [-.01, .38]	.02	.04 [-.16, .23]	-.06	.12 [-.08, .31]	.07	.12 [-.08, .31]	-.01	.15 [-.05, .34]	-.05	-.09 [-.29, .10]
n_i = 237 n_c = 182																
Prompts	.12*	.24 [.05, .44]	.09	.17 [-.02, .36]	.08	.17 [-.02, .36]	.01	.02 [-.17, .21]	.09	.17 [-.02, .36]	.04	.08 [-.12, .27]	-.05	-.10 [-.29, .10]	-.09*	-.19 [-.38, .00]
n_i = 229 n_c = 190																
Goal setting	.04	.07 [-.12, .26]	.11**	.22 [.03, .41]	.05	.10 [-.09, .29]	.08	.15 [-.04, .35]	-.05	.10 [-.09, .29]	.02	.05 [-.14, .24]	.01	.03 [-.17, .22]	.07	.13 [-.06, .32]
n_i = 216 n_c = 203																
Feedback	-.03	-.06 [-.26, .13]	-.10	-.19 [-.39, .00]	-.11*	-.22 [-.41, -.03]	.004	.01 [-.18, .20]	.02	-.04 [-.24, .15]	.01	.02 [-.17, .22]	-.12*	-.24 [-.43, -.04]	-.14**	-.28 [-.47, -.09]
n_i = 210 n_c = 209																

Note. *p < .05, **p < .01, ***p < .001. n_i = number of participants in the intervention group; n_c = number of participants in the control group. Standardized regression coefficients are provided.

Watching the Promo video promoted a significantly bigger increase in Awareness of consequence, compared to the non-exposure group, which is in line with our hypothesis. This was the only significant effect of the Promo video, thus, our hypothesis regarding the potential of the Promo video to foster Social norms and Awareness of need was not confirmed. No baseline differences of Awareness of consequence were found among groups.

The Prompts to fill the water bottle fostered an increase in Social norm in the intervention group, while the control group demonstrated no effect. Additionally, Prompts had a reverse effect on self-reported Behavior. Specifically, the decrease of bottled water use was bigger in the group that was not exposed to Prompts, compared to the one that was. Intervention and Control groups did not differ in terms of Social norm and Behavior at the baseline. No other significant effects of Prompts were found, therefore our hypothesis that Prompts should strengthen Habit was not supported.

Setting up the Goal regarding the reduction of buying bottled water resulted in a bigger increase in Awareness of need compared to the group that did no set up the goal. The control group reported higher initial levels of Awareness of need compared to the intervention group. No other significant effects of Goal setting were revealed. Therefore, the hypothesis that Goal setting should promote Perceived behavioral control was not supported.

Finally, we found that exposure to the Feedback on how much plastic, CO_2, and money one saves, had reverse effects on Awareness of consequence, Intention, and Behavior. Specifically, for all three program outcomes, expected positive change was bigger in the group of youth who did not receive feedback, compared to the one that did. No positive effects of feedback as well as no baseline differences were found. These findings indicate that our hypotheses regarding the positive effects of Feedback on Perceived behavior control and Awareness of consequences were not supported.

3.2. Combined Effects of Program Components on the Intervention Outcomes

We also tested the combined effects of the intervention components on all of the program outcomes to investigate whether the combination of components is meaningful. In this approach, the participants who were exposed to the combination of the components are treated as an intervention group and the ones who were not exposed to either of components as a control group. Therefore, the participants who were exposed to some components but not to others, were excluded from the analysis. Due to the decreased sample size and, therefore, the decreased statistical power, we only tested the two-by-two component effects. The combined effectiveness results are presented in Table 4. The intercepts and slopes for each condition in the intervention and the control groups as well as the baseline comparison between groups for the combined effects can be found in the Supplementary material table S2.

Table 4. Combined (two by two) program components' effects on the intervention program outcomes.

	Social norm		Awareness need		on Awareness consequence		of Personal norm		Habit		Perceived behavioral control		Intention		Behavior	
	β	d [95% CI]	β	d [95% CI]	β	d [95% CI]	β	d [95% CI]	β	d [95% CI]	β	d [95% CI]	β	d [95% CI]	β	d [95% CI]
Water bottle + Promo video $n_i = 105$ $n_c = 89$	-.14	-.28 [-.57, .00]	.11	.20 [-.08, .48]	.04	.20 [-.20, .37]	-.06	-.13 [-.41, .16]	.11	.21 [-.07, .50]	.18*	.36 [.07, .64]	-.02	-.05 [-.33, .24]	-.05	-.11 [-.39, .17]
Water bottle + Prompts $n_i = 105$ $n_c = 97$	.001	.00 [-.28, .28]	.17*	.35 [.07, .63]	.03	.06 [-.22, .33]	-.07	-.12 [-.40, .15]	-.04	-.08 [-.35, .20]	.11	.22 [-.06, .49]	-.07	-.14 [-.41, .14]	-.10	-.21 [-.49, .07]
Water bottle + Goal setting $n_i = 113$ $n_c = 118$	-.08	-.15 [-.41, .10]	.19**	.38 [.12, .64]	-.003	-.01 [-.27, .25]	.00	.00 [-.26, .26]	.09	.17 [-.09, .43]	.10	.20 [-.06, .46]	-.001	.00 [-.26, .26]	-.06	.12 [-.14, .38]
Water bottle + Feedback $n_i = 96$ $n_c = 107$	-.16*	-.31 [-.59, -.04]	.004	.01 [-.27, .28]	-.17*	-.34 [-.61, -.06]	-.06	-.13 [-.41, .14]	.02	.04 [-.23, .32]	.10	.19 [-.08, .47]	-.13	-.25 [-.53, .02]	-.13*	-.27 [-.54, .01]
Promo video + Prompts $n_i = 140$ $n_c = 93$	.09	.17 [-.09, .44]	.08	.15 [-.11, .42]	.14**	.28 [.01, .54]	.02	.04 [-.23, .30]	-.03	-.07 [-.33, .19]	.09	.18 [-.09, .44]	-.06	-.12 [-.38, .15]	-.13*	-.27 [-.54, -.01]
Promo video + Goal setting $n_i = 124$ $n_c = 89$	.002	.00 [-.27, .28]	.13	.26 [-.02, .53]	.12	.26 [-.01, .53]	.08	.16 [-.12, .43]	.12	.24 [-.04, .51]	.10	.20 [-.07, .47]	.01	.02 [-.25, .29]	.01	.03 [-.24, .30]

Promo video + Feedback $n_i = 117$ $n_c = 89$	-.05	-.02	[-1.81, 1.77]	-.09	-.03	[-1.75, 1.69]	-.03	-.01	[-1.78, 1.76]	.01	.01	[-1.78, 1.79]	.03	.01	[-1.69, 1.71]	.08	.03	[-1.72, 1.78]	-.13	-.06	[-1.87, 1.75]	-.17*	-.06	[-1.76, 1.64]
Prompts + Goal setting $n_i = 120$ $n_c = 94$	.15*	.30	[.03, .57]	.19**	.38	[.10, .65]	.13*	.26	[-.01, .54]	.09	.19	[-.08, .46]	-.05	-.10	[-.37, .17]	.06	.13	[-.14, .40]	-.03	-.07	[-.34, .20]	-.03	-.06	[-.32, .21]
Prompts + Feedback $n_i = 115$ $n_c = 95$	.09	.17	[-.10, .44]	-.01	-.02	[-.30, .25]	-.02	-.05	[-.33, .22]	.02	.01	[-.26, .29]	-.11	-.23	[-.50, .05]	.06	.11	[-.16, .39]	-.17*	-.34	[-.61, -.07]	-.24***	-.49	[-.77, -.22]
Goal setting + Feedback $n_i = 102$ $n_c = 95$	.003	.01	[-.27, .29]	.01	.03	[-.25, .31]	-.06	-.12	[-.40, .16]	.08	.16	[-.12, .44]	.03	.06	[-.22, .34]	.04	.08	[-.20, .36]	-.11	-.22	[-.50, .06]	-.08	-.16	[-.44, .12]

Note. *p < .05, **p < .01, ***p < .001. n_i = number of participants in the intervention group; n_c = number of participants in the control group. Standardized regression coefficients are provided.

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Receiving a water bottle and watching a Promo video, fostered an increase in Perceived behavioral control, while this was not observed in the control group. From the effect sizes (above .2) and also significant within-group effects in the intervention group, compared to non-significant effects in the control group, we can also see that combining a water bottle and a Promo video has a potential for breaking the Habit of purchasing bottled water. The initial level of habit to drink bottled water was higher in the control group, compared to the intervention group. Receiving a water bottle and Prompts to fill the water bottle as well as receiving a water bottle and setting up a Goal resulted in a bigger increase in Awareness of need, compared to non-exposure groups. From the effect sizes (above .2), we can also see that combining a water bottle and Prompts has potential for the promotion of Perceived behavioral control, therefore our hypothesis regarding the combined effect of Making it easy and Prompts could not be fully rejected. Moreover, we found that when exposed to Prompts in addition to receiving water bottles, the reverse effect of receiving water bottles on Social norm becomes non-significant. From the analysis of the combined water bottle and Feedback effects we can see that the reverse effects on Social norm, Awareness of consequence, and Behavior, sustain.

We also discovered that the exposure to Prompts to fill the water bottle in addition to Promo video reinforced the effect on Awareness of consequence, as the combination of the two components resulted in higher effect size, compared to the individual Promo video effect. However, when combining the two components, the reverse effect on Behavior sustains. No significant effects were found when combining the Promo video and Goal as well as Promo video and Feedback. However, from the effect sizes (above .2) we may expect that the combination of Promo video and Goal setting has potential for promoting Awareness of need and consequences as well as breaking the bottled water use Habit. Also, when combining Promo video and Feedback, the negative effects on Awareness of consequence and Intention become non-significant, when on Behavior it sustains.

Receiving Prompts in combination with setting up Goals promoted an increase in Social norm as well as Awareness of need and Awareness of consequence, when it was not the case for the control group. The initial levels of both types of awareness were higher in the control group, compared to the intervention group. Additionally, when combining Goal setting and Prompts, the reverse effect on Behavior becomes insignificant.

The combination of Prompts and Feedback as well as Goal setting and Feedback did not yield any significant positive effects on any of intervention outcomes. However, when combining Prompts and Feedback as well as Goal setting and Feedback, the negative effects on Awareness of consequence become non-significant. Moreover, when combining Goal setting and Feedback, the reverse effects on Intention and Behavior become insignificant, when it is not the case for the combination of Prompts and Feedback. In fact, the exposure to both Prompts and Feedback resulted in even bigger reverse effects on Intentions and Behavior.

In summary, four out of five intervention components had either individual or combined positive effects on at least one of the important program outcomes. Also, we found that reverse effects of providing water bottles on Social norm as well as reverse effects of Prompts on Behavior become insignificant when combined with other intervention components. Moreover, both water bottles and Prompts had clear value for promotion of targeted outcomes, especially in combination with other intervention components. From the five intervention components, Feedback was found not to have any positive effects neither alone, nor paired with other components. Furthermore, feedback yielded undesirable effects that in most cases did not become insignificant with exposure to other intervention components.

4. Discussion

The present study employed a factorial experimental design [24, 25] in order to test which components of an intervention "Aquatic" aimed at reducing bottled water use are the most effective when presented to a sample of adolescents. Most intervention components show promise to promote factors associated with the reduction of bottled water use.

However, not all components of the intervention were found to be equally effective and some components were found to be effective only when combined with other components. Further we will discuss the findings and their theoretical implications as well as ways forward in improving the "Aquatic" intervention. Significant individual effects will be discussed first, followed by the discussion of combined effects.

Receiving water bottles had a negative effect on social norm, meaning that those individuals who did not receive water bottles tended to assume that using bottled water is more prevalent than those individuals, who received water bottles as a part of the intervention. This, however, should not be interpreted as a negative outcome. Receiving a water bottle likely drew the participants' attention to the contrary social norm and thus led to the decrease in the perceived prevalence of individuals using refillable canteens for water. These findings, however, highlight that it may not be effective to implement the intervention in small groups and the intervention has the most potential if implemented universally inside a given group (e.g. the whole school, rather than just a few groups of students). Universal distribution of water bottles would potentially have a positive effect on social norms, since everyone in the reference group would be using canteens for drinking water.

Contrary to what was expected, providing participants with reusable canteens for drinking water did not affect their perceived behavioral control, nor their declared habits. It may be that participants overestimated their behavioral control prior to the intervention and receiving the means for behavioral change did not affect their perceptions because of a ceiling effect. Additionally, it might be that more time is needed for the intervention to translate into significant changes in reported habits.

The effects of the Promo video were only partially as expected. While the video was primarily intended to target social norms by providing social modelling, this effect was not statistically significant, nor was the additional effect on Awareness of need significant. The video, however, as expected, had a significant positive effect on the participants' awareness of consequences of their bottled water use. It must be stressed that the video used for the intervention contained a multitude of scenes and therefore its effect might not be as straightforward as one would hope.

Providing Prompts urging to fill in the canteen with water had a twofold effect. While those who received prompts reported higher social norms, indicating that they were more likely to believe that using canteens and refilling them with tap water was prevalent, the self-reported behavior for this group showed a smaller increase in environmentally friendly behavior, compared to no-prompts group. It is possible that prompts elicit contrarian behavior [41], which is typical of the investigated age group and perhaps the frequency and contents of the prompts should be reviewed and further tailored to the age group that receives them. This could be also the reason why we did not observe the expected Prompts effect on habit to buy bottled water.

Setting a Goal had a significant positive effect on participants' awareness of need for the reduction of bottled water use. It is likely that by setting a goal, one internalizes it and thus to resolve the resulting cognitive dissonance between a goal and a lack of external proof of its need, one seeks out confirmatory evidence for one's goal. In a sense, by allowing participants to set their goals we make use of their confirmation bias which leads them to seek out other reasons for their behavior [42]. Although, contrary to what was expected, we failed to provide evidence that goal setting has a direct effect on perceived behavioral control, it still could be seen as a promising strategy for targeting phenomenon related to behavioral change [7, 22].

Providing Feedback, however, had an unexpected significant negative effect on intention, and behavior. Moreover, the effect of Feedback on awareness of consequences was contrary to what was expected. Also, Feedback did not have a hypothesized effect on Perceived behavioral control. In particular, those who did not receive feedback showed a bigger increase in intention, behavior, and awareness of consequences, compared to the feedback exposure group. The most likely reason for this is the contents of the feedback, which highlighted the amount of money saved, carbon-dioxide reduction, and plastic

waste reduction. All of these metrics, while related to bottled water use and societally relevant, are not necessarily individually relevant, these metrics might be too distant or too individually unimpactful [33], which leads them to having the opposite effect than intended. The Savannah principle proposes that we are not adapted to think in global terms and things that are too vast or too slow tend not to concern [43]. It is most likely that participants, when exposed to this particular feedback, were made aware of the hard to comprehend and distant outcomes of their behavior, thus discouraging them from acting pro-environmentally. Additionally, providing feedback about money saved might elicit behaviors that are simple monetary decisions, where a person decides that they can afford to waste that amount of money or even engage in costly signaling by using bottled water [44, 45]. Those who did not receive feedback likely found personal and more proximal and individually relevant reasons for their behavior, hence the positive increase in their awareness of consequence, intention, and self-reported behavior. In essence, the findings strongly suggest that the Feedback component of the intervention will need to be thoroughly reworked for future applications.

The combined effects of receiving a water bottle and other components of the intervention lend further insight into the functioning of the "Aquatic" intervention. While providing refillable canteens did not have a positive effect on any of the outcome variables, it was revealed that having a canteen resulted in significant additive effects that strengthen the effects of some of the other components of the intervention. This illustrates that the availability of behavior, while not necessarily perceived as creating change, is a catalyst for other factors affecting behavior. Receiving a canteen strengthened the negative effect of Feedback, further showing that having the means of a behavior pushed together with individually irrelevant consequences results in contrary behavior. On the other hand, enabling water refilling behavior directed the effect of the Promo video toward the perceived control of own behavior and the effect of Prompts to positively affect awareness of need, as well as strengthened the positive effect of Goal setting. These findings overall show a synergy between internal (e.g., goals, beliefs) and external (e.g., access to a behavior, ease of behavior) forces affecting pro-environmental behavior, highlighting that effective change requires both.

While on their own Prompts may elicit contrarian behavior, they have a positive effect if coupled with either Promo video, or a Goal setting, suggesting that if one already is invested in pursuing a certain behavior, then reminding one to perform that behavior is effective. This type of reminder likely is not perceived as nagging, but as helping, thus it is not perceived as external pressure, but external help. However, when Prompts are coupled with Feedback, participants likely perceive both these factors as nagging and pressure to behave. The result is that adolescents refuse to follow the suggested behavior as an act of defiance, because they have no personal reason for doing so [40].

To sum up, enabling behavior appears to be a crucial part of an intervention targeted at reducing bottled water use. However, along with enabling, one needs to provide tangible and personal reasons for acting in a certain way, creating a synergy between internal and external determinants of behavior. Pressuring individuals into behavior, providing intangible information and personally unimportant feedback tends to have an opposite effect, thus individuals should not be pressured into behavior, but rather provided personally relevant reasons for behavior.

4.1. Strengths, Limitations, and Implications,

Using a factorial experiment for the evaluation of the intervention components is among the obvious strengths of the current study, as it is both a comprehensive and a cost-effective strategy for optimizing behavioral interventions [25]. Second, the current study is among the firsts that aim to explain adolescents' pro-environmental behavior change within the CADM [6] approach. Finally, the study uses the Latent change approach [35] addressing the multilevel structure of the data that allows the precise evaluation of the intervention effects.

Using the single item indicators for the CADM constructs is a limiting factor in this study. In the CADM-related literature, it is common to use multiple indicator measures, as it allows to encompass the multimodality of such constructs as, for example, social norm [6]. On the other hand, it can be argued that, for example, personal norm could be adequately measured with a single 'obligation' item [9]. Due to time restrictions, in the current study we chose single item indicators for all constructs. However, in future research we would advocate using latent variables with multiple indicators for measuring the constructs of the CADM.

Second, we used self-report measures for evaluating environmentally friendly behavior instead of observing an actual behavior. Although this approach is common for studies within the CADM framework [6], observed measures would strengthen the conclusions regarding the intervention effects on reduction of bottled water use. Therefore, whenever possible, we encourage trying to find ways to observe actual behavior instead of limiting findings to self-report measures.

Third, as we fully randomized the assignment to four out of five intervention conditions, one of them, particularly, the distribution of reusable water bottles, was performed on a school level by randomly choosing one of two available schools. Randomized at school level potentially could have affected the baseline level differences in some CADM constructs (e.g., Social norm and Habit) as well as intervention effects, as it is very hard to fully match school-level contexts for the intervention implementation. Our strategy was chosen to avoid spillover effects when the intervention indirectly affects people who have not participated in the program but had a contact with people who did [46], however, for future research we would advise full randomization for all intervention components.

Despite these limitations, the current study provides the evidence basis for promotion of pro-environmental behavior in adolescence. It implies that there are some means of addressing adolescents' bottled water use that could be relatively easily applied in school, family, or community contexts. However, the current study addresses the optimization stage of the intervention in development. Therefore, as a future step, first, based on the results, we plan to adjust the components of the intervention program "Aquatic" (e.g., Feedback should potentially be removed from the combined set of intervention components). Second, we plan to assess the short-term as well as long-term full intervention effects both on primary and secondary pro-environmental outcomes. Finally, we would expect presenting the developed intervention to a broader community to further evaluate intervention outcomes in different socio-cultural contexts.

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