

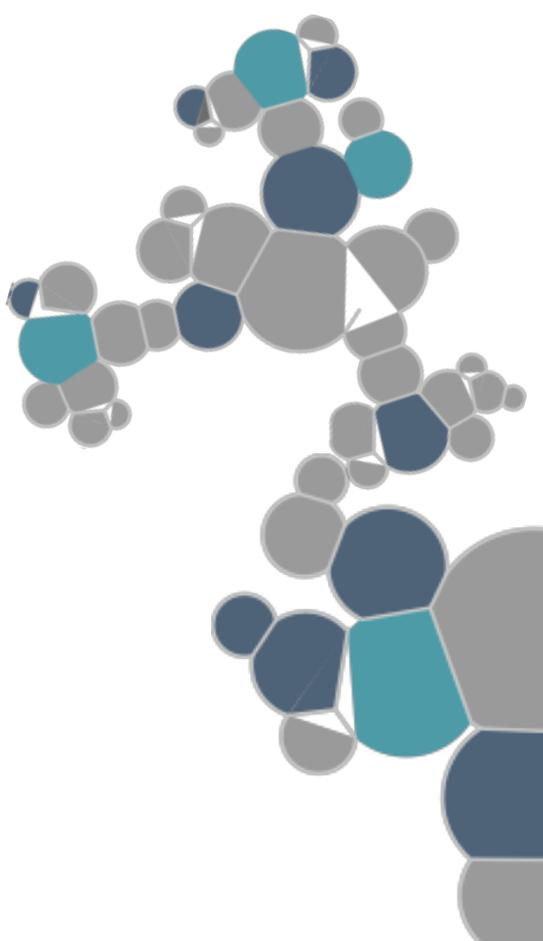
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Elementary school children's motivation and experience toward digital hand hygiene gamification – a mixed-methods approach

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Abstract

Background: Primary prevention of infectious diseases within the community sector remains a challenge. The WHO recommends non-pharmaceutical interventions to prevent infection spread within the public sector, such as promotion of hand hygiene practices. Research indicates that young children are particularly susceptible within semi-closed settings like elementary schools. Existing handwashing interventions have shown to be effective but lack in long-term behavior change. Digital games have been increasingly acknowledged to promote healthy lifestyles. The enjoyable and engaging experience is expected to increase the intrinsic motivation, which is largely studied to be desirable in terms of health behavior change. Based on the concept of participatory development, this research aims to investigate how elementary school children can be motivated to engage in handwashing behavior, amongst others, by means digital gamification.

Methods: Mixed-methods research was carried out by conducting semi-structured focus group interviews with children and teachers, primarily based on the Theory of Planned Behavior's determinants resulting in behavior. Moreover, the intrinsic motivation was measured by adopting the German short-scale of intrinsic motivation (KIM), after introducing children to either a (A) common informative poster or (B) digital handwashing gamification prototype. Latter incorporates persuasive system design elements (PSD) from the PSD-model thought to increase the intrinsic motivation. After completion, user experience interviews focusing on the utilized PSD-strategies within the prototype have been conducted.

Results: In total, seventeen children with a mean age of 8.4 years participated in focus group interviews. Furthermore, five teachers separately attended with a mean age of 44 years. Results show, that the children's motivation toward handwashing is positively influenced by the willingness to stay healthy, fun, instructions and cues to action within the school context whereas an inadequate environment, inappropriate behavior of other, and laziness are reported to negatively influence motivation. On the other hand, the teacher's concerns are outweighing the benefits when thinking of handwashing technology within the school setting, as they are suspecting misuse and disruption of classroom dynamics. However, in total sixteen elementary school children (mean age 8.2 years) completed a survey on intrinsic motivation which showed trends within means that should be further investigated, since all children indicated a positive attitude towards the prototype, especially toward the strategies modelling, simulation, and praise.

Conclusion: The school environment and -context influences the motivation to engage in handwashing and should be considered thoroughly. Moreover, cues to action, fun and instructions as well as normative influences have been identified as potential strategies to motivate children, which can also be embedded in technology. However, based on this research it can be concluded, that persuasive and pervasive technology can be of added value when designing digital interventions to promote handwashing. Furthermore, user and stakeholder should be incorporated in the development process, as their needs and barriers are important to successfully design and implement interventions. Future research should investigate the potential of stimuli (e.g. smell and temperature), personalization as well as PSD-strategies and their combinational influence on the intrinsic motivation, in order to facilitate handwashing behavior by means of digital gamification.

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1. Introduction

1.1 Infectious diseases and the rising threat of antibiotic resistance

Infectious diseases are a major concern with nearly 13 million deaths annually (Bloomfield, Aiello, Cookson, O'Boyle, & Larson, 2007). They are caused by the active and passive entering, remaining and reproduction of pathogenic microorganisms (e.g. bacteria, fungus, and parasites) as well as pathogenic molecules (e.g. virus, prions) in human organisms. Due to proper medical care, only 4% of deaths worldwide occur in developed countries (Bloomfield et al., 2007). Treatment and spread-prevention of bacterial infections frequently comprises the use of antibiotics, which either kill or inhibit the growth of bacteria (Monnier, Eisenstein, Hulscher, & Gyssens, 2018). Effective antimicrobial drugs are estimated to extend the average life expectancy by 20 years (King et al., 2016). However, antimicrobial resistance has risen to high levels in all parts of the world, threatening the ability of antibiotics to treat infectious diseases (WHO, 2014). Moreover, pipelines concerning the development of new antibiotic drugs are running dry (Huttner et al., 2013; Laxminarayan et al., 2013). This highlights the need for primary prevention, which focuses on the containment of infection-spread, devoid of antibiotic drugs.

1.2 Primary prevention in the community sector

Primary prevention in community settings has a major contribution in decreasing infections (Aiello, Coulborn, Perez, & Larson, 2008). Improvements in public health infrastructure and personal hygiene are well established approaches in decreasing the spread of bacteria (Aiello, 2002). The World Health Organization and Center for Disease Control recommend non-pharmaceutical interventions (NPIs) to prevent infections (Bell et al., 2006). Hand hygiene and cough etiquettes are in general appealing NPIs as they are straightforward to implement, inexpensive and inclusive for participants (Stebbins et al., 2011). In today's usage the term 'hygiene' refers to the cleanliness and practice that results in absence or reduction of infectious agents (Jumaa, 2005). This comprises hand hygiene and handwashing as well as cleaning, disinfection and sterilization. A review by Aiello (2002) found that most interventions targeting handwashing report reductions in infections greater than 20%. However, behavior change is often short-lived and therefore not persistent in long-term.

The general definition of handwashing involves great variation. For the purpose of this research, it refers to handwashing with plain or antimicrobial soap (WHO, 2009). This also includes hand drying after following the handwashing procedure (Jumaa, 2005). Proper handwashing for elementary school children takes 20-30 seconds and consists of five steps (Bundeszentrale für gesundheitliche Aufklärung, 2018). Improving hand hygiene compliance remains a challenge in the health-care as well as community sector, especially to developing countries. According to O'Boyle, Henly, & Larson (2001), hand hygiene comprises the interaction of many different factors which cannot reliably be predicted by one behavioral theory. Therefore, understanding the motivation of handwashing behavior is necessary as they vary from culture to culture.

1.3 Primary prevention in elementary school settings

Young children are particularly susceptible to gastrointestinal and respiratory tract infections which are quickly spread in semi-closed settings like schools (Mbakaya, Lee, & Lee, 2017). Approximately 75% of school absences are illness related which causes poor academic performance, high dropout rates, and reduced learning performance (Bener, Kamal, & Shanks, 2007; Kearney, 2008; Lau et al., 2012). In general, health education should be introduced very early to influence healthy behaviors given the fact that behavioral and lifestyle choices are made in childhood (Lee, Loke, Wu, & Ho, 2010). However, compliance of school children to mandatory handwashing procedures tends to be low (Nandrup-Bus, 2009). Research in middle- and upper-school showed that girls washed their hands in 58% compared to 48% of cases in boys (Guinan, McGuckin-Guinan, & Severeid, 1997). Additionally, only 28% of girls and 8% of boys used soap. This trend is visible in treatment of infections, given the fact that 39,1% of children till 15 years of age receive at least one antibiotic drug therapy annually (Augustin, Mangiapane, & Kern, 2012). Due to proper hand hygiene practices, approximately one-third of infections are preventable (Randle et al., 2013). In general, research focusing on children's hand hygiene practices has received less attention. A systematic literature review examining the effect of hand hygiene interventions on infectious disease-associated absenteeism in elementary school children indicates the effectiveness of preventive hand hygiene measures but lacks in the strength of evidence (Wang, Lapinski, Quilliam, Jaykus, & Fraser, 2017).

Moreover, research on children's knowledge about hand hygiene and the connection between germs and health is inconsistent (Cleary, Slaughter, & Heathcock, 2003). Evidence suggests, that an effective long-term behavior change in children can be supported with educational approaches integrated into the target activity (Randle et al., 2013). To improve the efficacy of hand washing behavior, instructions have shown to be an important ingredient (Nandrup-Bus, 2009; Sandora, Shih, & Goldmann, 2008; Stebbins et al., 2011). Moreover, the involvement of children from the early start of developing interventions is highlighted to guarantee success. Convincing evidence by educational and psychological research indicates the potential for visual learning to enhance learning and motivation by providing representations of subjects to be learnt (Ainsworth & Th Loizou, 2003). More recently, trends indicate a shift in pedagogical and teaching approaches trying to increase the engagement of students to improve learning processes (Hamari et al., 2016; Whitley, Walsh, Hayden, & Gould, 2017). A potential strategy is the use of video games, since the provided engagement and enjoyment is thought to improve learning, retention and motivation, especially for low-performing students (Takeuchi & Vaala, 2014; Watson, Mong, & Harris, 2011). Furthermore, behavior change techniques can be embedded to facilitate positive health changes (Baranowski et al., 2016).

1.4 Persuasive technology and the potential of gamification

Behavior change techniques are theory-based methods that influence one or several psychological determinants (Kok, Peters, & Ruiter, 2017). A frequently applied technique is persuasion, which can attempt to influence a person's attitudes, beliefs, intentions, motivations, and behaviors (Gass & Seiter, 2018). Since healthy lifestyle promotion has increasingly been carried out through information technology, it is important that these are designed in a motivating and engaging way for the user, in order to achieve a sustainable behavior change (Alahäivälä & Oinas-Kukkonen, 2016). Persuasive technology is frequently applied in terms of behavior change support systems (BCSSs), by linking psychology with technology (Alahäivälä & Oinas-Kukkonen, 2016; van Gemert-Pijnen, Kelders, Kip, & Sanderman, 2018). By definition, these systems are designed to reinforce, alter, or form behaviors and attitudes as well as acts of compliance without using coercion, deception or inducements (Oinas-Kukkonen, 2013). As the lack of emotional reaction and feeling when interacting with technology is thought to be a major disadvantage in behavior change practice,

this can be compensated by utilizing persuasive design elements (Muntean, 2011). According to the Persuasive System Design model (PSD) by Oinas-Kukkonen (2009), the development of a persuasive system comprises three steps: “understanding the key issues behind persuasive systems, analyzing the persuasion context, and designing the system qualities” (Alahäivälä & Oinas-Kukkonen, 2016, p. 64). The persuasion context, as instrument of analysis, comprises the intent of persuasion, understanding the persuasion event as well as recognizing and/or defining the strategies utilized.

A form of persuasive or motivational design in the domain of BCSSs is gamification, which is defined as the use of game design elements in non-game contexts (Deterding, Dixon, Khaled, & Nacke, 2011; King, Greaves, Exeter, & Darzi, 2013). This includes serious games which are digital games developed for purposes other than pure entertainment, with the majority targeting learning and education (Breuer & Bente, 2010; Susi, Johannesson, & Backlund, 2007). A meta-analysis by DeSmet et al. (2014) showed small positive effects of healthy lifestyle promotion and the related determinants by means of serious gaming. The added value of digital gamification and serious gaming is the enjoyment and engaging experience, which is thought to promote and maintain behavior change, as health behavior change is difficult to achieve and often short lived (Cugelman, 2013; DeSmet et al., 2014). Furthermore, the intrinsic motivation and adherence to use the technology should be improved (Prensky, 2007; Vogel et al., 2006). A pioneer of digital gamification in the domain of hand hygiene in children is the e-Bug website and the related web-based game (Farrell et al., 2011). However, a meta-analysis by Wouters et al. (2013) examined that serious games are more effective in the domain of learning and retention compared to other conventional instruction methods but not more motivating (Wouters, van Nimwegen, van Oostendorp, & van Der Spek, 2013). Therefore, strategies that can maximize the effect of digital gamification on behavior change are important, for instance, by a systematic application of behavior change theories.

1.5 Self-determination theory in health behavior

The self-determination theory (SDT) is an important and widely accepted behavior change theory as well as key framework in health behavior interventions (Marks, Murray, & Estacio, 2018). It comprises, that behavior is either intrinsically or extrinsically motivated (Deci & Ryan, 2012). Intrinsic motivations are done for their own sake, satisfying the basic psychological

needs for autonomy, competence and relatedness. In contrast, extrinsically motivations are done for an outcome separately from the activity (e.g. reward or punishment).

The cognitive-evaluation theory, a sub-theory of the SDT, postulates that the feeling of competence during a task increases the intrinsic motivation. By this mean, the basic human need for competence is fulfilled (Deci & Ryan, 2013). However, competence alone doesn't increase intrinsic motivation. The feeling of autonomy is necessary to keep the task carried out from one's own initiative. However, large numbers of studies have investigated the advantage of intrinsic over extrinsic motivation in the domain of health behaviors, which comprises volition, willingness and enjoyment (Fortier, Duda, Guerin, & Teixeira, 2012; Ng et al., 2012; Patrick & Williams, 2012). As gamification is generally thought to increase the intrinsic motivation through an engaging and enjoyable approach, little is known about the design elements, and their influence on the intrinsic motivation of elementary school children.

1.6 Participatory development to improve the impact and uptake of digital gamification

Recently conducted research has highlighted the value of children engaging in game design (Sparapani, Fels, & Nascimento, 2017). User-centered design is a well-known approach which takes into account the interests, needs, expectations, and motivations of the prospective user in order to improve the impact and uptake of health technologies (van Gemert-Pijnen et al., 2011). Hereby, the user's experience (UX) is important, as positive experiences are attracting players to play and return (Baranowski et al., 2016). UX comprises the experiences, sensations and feelings when interacting with technology, which is highly subjective and dynamic in nature (Jacobsen & Meyer, 2017). Therefore, it is important to investigate the implications of the incorporated game design strategies, as positive experiences are closely linked to adherence and a successful behavior change. Furthermore, stakeholders, which are in first instance the principals and teachers, should be involved to guarantee a successful implementation within the elementary school setting (van Gemert-Pijnen et al., 2018). Thus, a thoroughly conducted contextual inquiry is necessary, to specify the end-user's needs and problems, regulations and conditions. Focusing on hand hygiene, little to nothing is known to what exactly motivates children to engage or disengage in hand washing within the elementary school, as well as which game design ingredients are perceived as motivating, attractive and pleasant to children and could be incorporated in digital gamification approaches (Baranowski et al., 2016; Randle et al., 2013; Thompson, 2017).

Given the fact that user involvement is reported to be low in early stages of game design, this research seeks to be a starting point for future developments with respect to digital hand hygiene technology by investigating, how elementary school children aged 6-10 years can be motivated to engage in handwashing behavior amongst others, by means of digital gamification (Khaled & Vasalou, 2014). In doing so, this research comprises the following points:

- (1) Exploring the attitude of children toward motivational and contextual factors of hand hygiene
- (2) Exploring the attitude of teachers toward motivational and contextual factors of hand hygiene
- (3) How children experience a digital gamification strategy aimed at intrinsic motivation compared to a common informative poster approach

2. Methods

2.1 Focus group interviews

2.1.1 Study Design

Qualitative research was carried out by conducting semi-structured focus group interviews with children and teachers of an elementary school.

2.1.2 Participants

At an elementary school in Germany, a class of twenty-three children attending the third grade and teachers were separately asked to participate in focus groups interviews. Contact was established via a research partner of the university hospital Münster (UKM), who provided information about the purpose and topics of interviews to the responsible teachers together with a researcher of the University of Twente (UT). Participants had to attend the third grade of an elementary school or be employed as teacher as well as being fluent in the German language.

2.1.3 Procedure

Participants were stratified by gender and subsequently randomly assigned to guarantee equal gender allocations within groups. Focus group interviews were conducted consecutively in one classroom within the school setting. Precondition for attendance was an informed consent filled out by the participant or at least one legal guardian since the majority of participants were underaged. After a short introduction about the purpose of the interview and privacy regulations, the moderating researcher explained the discussion-rules. An interview guide was used to ensure that the questions were asked across the groups consistently, allowing flexibility with regard to the topics raised and level of participation within groups; teacher or children (Appendix A and B). Prompts were used to guide in-depth exploring of questions. Interviews were audiotaped using a digital audio recorder. Prior, the moderator trained focus group interviews with an extra group of elementary school children.

2.1.4 Focus group questions

In total, eleven open-questions were developed by the researcher based on the Theory of Planned Behavior's determinants resulting in behavior (TPB) (Ajzen, 1991). One question assessed the overall intention to comply with the hand washing behavior at the beginning of

the interview serving as icebreaker. Five questions were exploring the attitude toward different aspects of handwashing, three questions regarding the subjective norm and normative beliefs and two examining control beliefs and perceived behavioral control. With respect to the teacher's focus group, questionnaires focusing on the TPB were adapted to get insight in the perceptions of teachers with regard to the hand washing behavior in their classes. Beside this, five questions concerning Rogers Diffusion of Innovation (1995) have been integrated in the focus group to explore the relative advantage and contextual factors, focusing on implementation possibilities in school settings (Rogers, 1995). All interviews were audio-taped with the permission of the study's participants.

2.1.5 Data analysis

Focus group interviews records were transcribed verbatim and themes and categories were subsequently coded via deductive and inductive coding based on Mayring's structured content analysis (Mayring, 2014). Occurring themes were categorized based on the Theory of Planned Behavior (Ajzen, 1991). By categorizing, fragments with the same variable were clustered into one code.

The interview transcripts were analyzed by one coder using the qualitative data analysis program MAXQDA (v. 18.2.0) and thoroughly discussed with the two supervising researchers from the UT. First, quotes were attributed to the three main determinants of behavior: attitude, normative/subjective norm as well as control beliefs/perceived behavioral control. Subsequently, inductive analysis was applied to search for subcategories and themes until no new codes were found. Afterwards, all transcripts were assessed again to make sure that the coding process has been done properly and all categories are representations of the information given by the participants.

2.2 User experience test

2.2.1 Study Design

Mixed-method research was carried out by a qualitatively driven approach of conducting semi-structured, explorative user experience interviews with children attending an elementary school.

2.2.2 Participants

Similar to the focus group interviews, twenty-three children attending the third grade at an elementary school in Germany were asked to participate in semi-structured user experience interviews. Contact was established via a research partner of the UKM, who provided information about the purpose and topics of interviews to the responsible teachers together with a researcher of the UT. Participants had to attend the third grade of elementary school as well as being fluent in the German language.

2.2.3 Description of experimental interventions

The intervention comprises either a poster (A) or digital gamification approach (B), aiming to increase the intrinsic motivation toward handwashing. The poster (A) comprises the steps (1) keep hands under running water, (2) rub your hand with soap, (3) between the fingers (20-30 sec.), (4) remove soap under running water, and (5) dry your hands thoroughly, which are based on the German Federal Center for Health Education's guideline (Appendix C). The digital gamification approach (B) was delivered by means of a tablet computer. The digital prototype simulates a story, subdivided into five levels, which are equal to the five handwashing steps on the poster (Appendix D). However, the digital gamification approach involves persuasive system design elements and behavioral change techniques, which are matched with the theory-based mechanisms described in the cognitive evaluation theory (Table 1). First, the *need for autonomy* involves two characteristics: experience of task meaningfulness and experience of decision freedom. The latter is offered by the selection of a role-model, since the procedure of proper hand washing is not individually changeable (Sailer, Hense, Mayr, & Mandl, 2017). Storytelling provides a story to the player, connecting the five levels with representations of bacteria, soap, and water while simulating cause and effect (Oinas-Kukkonen & Harjumaa, 2009). This is intended to make the player's experienced actions more meaningful and volitional while playing the game, fulfilling the second characteristic of the

cognitive evaluation theory (Rigby & Przybylski, 2009). Secondly, the *need for competence* shall be positively influenced by praise messages of the chosen role-model (Henderlong & Lepper, 2002). Since role-modeling is a generally appealing behavior change technique, praise messages by this means are intended to be more effective (Bartholomew Eldrigde, Markham, Ruitter, Fernández, Kok, & Parcel, 2011). Additionally, self-monitoring visually displays the player’s progress by means of green points in order to support the user in achieving the goal (Oinas-Kukkonen & Harjumaa, 2009). Thus, the sustained feedback by the system is meant to provide the feeling of competence to the player. Overall, liking provides a visually attractive surface, since interest and enjoyment are incorporated within the utilized KIM-inventory to directly influence intrinsic motivation (Wilde, Bätz, & Kovaleva, 2009).

Table 1

Theory-based mechanisms based on the German short-scale of intrinsic motivation (KIM) with matching game design elements

Theory-based mechanisms	Strategy (PSD/BCT)	Game design element
Need for autonomy	Modelling	Choice of role-model
	Simulation	Storytelling
Need for competence	Self-monitoring	Green lights
	Praise	Messages
Intrinsic motivation	Liking	Surface

Note: Content adapted by Sailer et al. (2017)

2.2.4 Procedure

Participants were stratified by gender and subsequently randomly assigned to guarantee equal gender allocations within the informative poster (A), or prototype (B) group. Subsequently, participants were individually invited to the test-setting where a use-case scenario is presented. The basic setting comprises a sink, faucet, and soap-dispenser which are installed as part of the standard school equipment in every classroom (Appendix E). The use-case scenario includes a story in which the participant has recently used the toilet and is now exposed to either the poster or digital prototype within the basic setting. After this, the participant is asked to engage in the handwashing procedure using the provided intervention. Only after finishing the task with the digital prototype, open-questions concerning the user’s experience while interacting were asked by retrospection of the different steps to be

completed by means of a storyboard (Appendix D). Since the interview was semi-structured, explorative questioning concerning the children's attitude focusing on utilized PSD and BCT was applied (Appendix F). After completion, both groups of children (A and B) were asked to complete the adapted short-scale of intrinsic motivation (KIM) questionnaire (Appendix G). Precondition for attendance was an informed consent filled out by at least one legal guardian since the participants were underaged. A second researcher was present during the whole study to observe and help arranging the setting.

2.2.5 Instrument

The German short-scale of intrinsic motivation (KIM) was adapted to measure the intrinsic motivation after interacting with the prototype, based on the cognitive evaluation theory (Wilde, Bätz, & Kovaleva, 2009). The KIM consists of 12 items, covering four different subscales (Interest/enjoyment, perceived competence, perceived choice, pressure/tension). Each category counts three items. Elementary school children respond by completing a five-point Likert-scale, ranging from 1 (totally disagree), 2 (disagree), 3 (don't agree, don't disagree), 4 (agree), 5 (totally agree), and the mean score of its items were calculated to subscale scores.

2.2.6 Data analysis

User experience interviews records were transcribed verbatim and themes and categories were subsequently coded via deductive coding based on PSD and BCT strategies utilized (Mayring, 2014). By categorizing, fragments with the same theme were clustered into one code. Revision of categories and coding agenda was carried out as a formative check of reliability. Afterwards, all transcripts were assessed again to make sure that the coding process has been done properly. The interview transcripts were analyzed by one coder using the program MAXQDA (v. 18.2.0) and thoroughly discussed with the two supervising researchers. The extraneous verbiage was left out for a clearer and more concise data.

Quantitative data of the adapted KIM 12-item short-scale of intrinsic motivation was analyzed using the Statistical Package Social Science (SPSS, v.24). Standard deviation and means of the subscales were calculated to provide insights in differences between the intervention groups (A and B). The Mann-Whitney-*U*-Test was applied to test for statistical significance between groups.

3. Results

In total, seventeen elementary school children participated in focus group interviews, eight males and nine females. All children visited the third grade of an elementary school, located in a rural setting of Western Germany, with an average age of 8.4 (\pm 0.6) years. Beside this, five elementary school teachers separately participated in a focus group interview, all female. Four class teachers of third graders and the principal with an average age of 44 (\pm 7.4) years. Table 2 provides an overview of the number of participants in the different focus groups, mean ages and gender distribution.

Table 2

Description of focus group constellation and participants

Focus group	Participants (N)	Male	Female	Mean age (SD)
1. Children	6	3	3	8.3 (\pm 0.5)
2. Children	5	2	3	8.2 (\pm 0.4)
3. Children	6	3	3	8.5 (\pm 0.8)
4. Teachers	5	-	5	44 (\pm 7.4)

3.1 Focus group interviews with children

3.1.1 Children's attitudes concerning handwashing in the elementary school

The reported attitudes toward handwashing comprise several factors that have been identified and categorized in order to explore elementary school children's motivation for compliance and non-compliance.

The motivation for compliance (Table 3), reported by the elementary school children, comprises the factors: *healthiness and germ prevention* (17 quotes), *fun* (16 quotes), *cues to action* (14 quotes), *cleanliness* (12 quotes), and *instructions* (12 quotes). *Healthiness and germ prevention* comprise the avoidance of sickness, pain, staying in bed and contamination by bacteria in order to stay healthy and be active. The children reported to have a very clear idea of the importance of handwashing, as pointed out by the following quote:

'It is very important to wash your hands because otherwise you are transferring bacteria and then you get very sick.'

Fun while handwashing was reported to be a part of everyday life, e.g. singing songs, splashing around and making bubbles, even if this is prohibited within the toilet rules. Beside these factors, *cues to action* serve as triggers for handwashing, for example after using the toilet, after touching dirty objects or before eating. Likewise, bathroom fittings are reminding, as clarified by the following quote:

‘When I walk past the sink, I think of the bacteria and then I know: aha, now I have to wash my hands.’

Beside this, the general *cleanliness* in order to remove dirt from one’s hands was named by the children to be a factor to wash their hands. During the school, this has been reported to be more practically motivated after breaks or art classes. In addition to the self-established rules by the school, *instructions* which are provided via posters from the German Federal Center for Health Education, have been reported by children.

Table 3

Motivation for compliance concerning handwashing in elementary schools

Factor	No. of quotes	Example quote
Healthiness and germ prevention	17	<i>‘I want to stay healthy and not be infected by bacteria that make me sick.’</i>
Fun	16	<i>‘Because you can play with water and that is great. But normally that is not allowed.’</i>
Cues to action	14	<i>‘After visiting the toilet and when the hands are simply dirty.’</i>
Cleanliness	12	<i>‘So that the dirt comes off the hands.’</i>
Instructions	12	<i>‘One can look at a poster and then you know how to wash your hands.’</i>

The reported factors that influence the motivation for non-compliance (Table 4) comprise: *Inadequate environment* (32 quotes), *inappropriate behavior of others* (12 quotes), *lack of perceived importance/laziness* (11 quotes), *lack of fun* (8 quotes), and *lack of time* (3 quotes).

According to the children, the *inadequate environment* is the major motive for non-compliance. Especially cold water and bad smells are frequently reported as well as dirty bathroom fittings and empty soap dispenser. This is also illustrated by the following quotes:

'I do not like the cold water.'

'I think it is stupid that it always stinks, and I do not like when other kids come in.'

'When the soap is empty and you think that there is still enough of it in there and you keep trying forever, until finally something comes out.'

Beside this, the *inappropriate behavior of others* may result in unsanitary beliefs when they leave their feces in the sink or without flushing the toilet. Interestingly, when children recall situations where someone has left their feces in the sink, even though cleaned by the facility manager, they perceive it as still dirty which is also gossiped. Furthermore, the lack of *perceived importance/laziness* is recognized to be a factor for non-compliance by simply being ignorant and missing background knowledge. However, the *lack of fun* was reported by the children to influence their motivation, since handwashing is stated to be boring. Moreover, the *lack of time* during breaks should be acknowledged.

Table 4
Motivation for non-compliance concerning handwashing in elementary schools

Factor	No. of quotes	Example quote
Inadequate environment	32	<i>'I do not like it when the water is splashing, or it is dirty. Or when people leave something on the toilet.'</i>
Inappropriate behavior of others	12	<i>'I just think is disgusting that some kids do their business in the sink.'</i>
Lack perceived importance/laziness	11	<i>'They do not care and do not know that it can make them sick. And they do not care that the hands are dirty then.'</i>

Furthermore, contextual factors and preferences in handwashing have been identified, which may provide a starting point for future interventions: *role models* (11 quotes), *preferring soaping* (10 quotes), and *preferring drying* (7 quotes). Interestingly, traditional *role models* like action heroes and princesses are still popular, but there are also new types such as YouTube broadcasters. Moreover, the participants want to be *role models* for younger children. Using *soap* and *dryer* are generally preferred elements as they are perceived as fun, which is pointed out by the following quote:

| 'I like to soap and dry my hands. Drying is fun because of the warm air.' |

3.1.2 Children's normative beliefs concerning handwashing in elementary schools

Normative factors have been reported to influence the handwashing motivation of elementary school children (Table 5). Within the focus groups, two different beliefs can be distinguished: *normative desirability* (20 quotes) and *normative pressure* (14 quotes).

The *normative desirability* identified is reported to be either altruistically- or egoistically motivated. The altruistic beliefs involve the concern for teachers, friends and classmates whereas the egoistic beliefs are self-interested, i.e. staying healthy. Typically, normative pressure can arise, when a child is apparently not compliant. This may result in a verbal order to wash the hands or lastly end in avoidant and aversive behavior, for example, not engaging in handshaking.

Table 5

Normative beliefs concerning handwashing in elementary schools

Normative beliefs	No. of quotes	Example quote
Normative desirability	20	'Handwashing is very important because otherwise all the children get sick. And that's not what the kids want.'
Normative pressure	14	'I have seen it so many times and told them to wash their hands, they just do not care.'

3.1.3 Children's control beliefs concerning handwashing in elementary schools

Control beliefs comprise the individual's perception that the behavior is under one's control (Table 6). All children agreed upon the *perceived ease* (17 quotes) of handwashing, which was reported to be simple. When it comes to *determined handwashing* (12 quotes) this is mainly formed by teachers and parents. Nonetheless, *voluntary handwashing* (8 quotes) by elementary school children is conducted in order to stay healthy and comply with the norms of others (parents, teachers, other children). Interestingly, one child reported how they changed the motivation of one's siblings:

'If my sister forgets it, my dad always reminds her. My sister always complains that she has no desire and then we established such a dispenser, there were animals on top, and so she has voluntarily spent the time and washed her hands.'

Table 6

Control beliefs concerning handwashing in elementary schools

Control beliefs	No. of quotes	Example quote
Perceived ease	17	<i>'You just have to wet it, soap, rinse and dry afterwards.'</i>
Determined handwashing	12	<i>'If I touch dirt, for example, then I have to wash my hands quickly, according to my mother. Otherwise we will get many bacteria.'</i>
Voluntary handwashing	8	<i>'I think that's just great if I wash my hands and do not get sick or the teachers.'</i>

3.2 Focus group interviews with teachers

3.2.1 Teacher's role concerning handwashing in the elementary school

The teachers form the basis of everyday school life, when teaching and engaging with their pupils. Thus, their attitudes toward motivational and contextual factors of handwashing are essential when intervening in a school setting. The five interviewed teachers state to have a *low motivation to intervene* (3 quotes) within the school setting. Accordingly, children's behavior should be formed in the kindergarten as well as at home by parents or legal guardians. A class teacher stated:

'I expect previous knowledge, to be honest.'

(Class teacher, 52)

However, when it comes to *handwashing promotion* (5 quotes) within the school setting, teachers indicate their function as role models. During high infection seasons, sick children are advised to go home, and other children instructed to wash their hands to avoid transition. In addition, flyers are provided to the children's parents or legal guardian, informing them about necessity of preventive measures. Interestingly, despite that teachers do not perceive this as their role, like earlier indicated, they are somehow well engaged in infection prevention:

'Role model functioning and again and again the funny saying: "After the toilet and before eating, do not forget to wash your hands". Yes, that is indeed, always automating, that the children repeat and internalize that again and again.'

(Class teacher, 42)

3.2.2 Contextual and organizational factors concerning handwashing in the elementary school

The elementary school as the organization and context forms the basis for everyday school and may influence the handwashing behavior (Table 7). When it comes to organizational factors, *handwashing rules* (5 quotes) are established by the school itself. To visit the toilet, children have to ask for permission, which is at this age given at any time. Beside this, the teachers indicate that the children are being held to wash their hands before eating and after visiting the toilet. Furthermore, they describe *educational television* (Table 3) as contextual factor that forms the representations and beliefs of elementary school children.

Table 7

Contextual and organizational factors concerning handwashing in elementary schools

Contextual	No. of quotes	Example quote
Handwashing rules	5	<i>'By asking, "May I go to the bathroom, please?" And that's what elementary school children at this age are allowed to at any time.'</i>
Educational television	3	<i>'Depending on how complex the programs are, the bacteria then have eyes, nose, mouth and ears. Or you know what they look like and have seen it under a microscope. That depends on the quality of educational television.'</i>

With respect to persuasive technology within the school setting (Table 8), teachers indicate their *concerns* (11 quotes) may outweigh the perceived *benefits* (3 quotes). Accordingly, the automatism to wash hands within the school context should not be depended on the 'event management' within the school. Consequently, they suspect an organizational problem, since the attractiveness might interrupt the normal processes and promote misuse of the technology. This is illustrated in the following quote:

'I believe that the attractiveness is so great that this daily routine, the matter of course will be disturbed (...) resulting in going every hour, because it is so nice. I believe that the balance would not be fair. I realize that the toilet gets a great meaning that it should not have.'

(Principal, 48)

However, the *benefits* of technology, that have been mentioned by the teachers, comprise the increased attractiveness due to automatization as well as hygienic benefits, when using automated dispensers and faucets. Beside this, several teachers perceive technology and visualization to be an opportunity to motivate children, when comparing it with prominent teeth prevention programs aiming to color plaque, in order to link cause and effect. This is pointed out in the following quote:

'If you foam the soap up long enough that a certain color develops. That would just be a motivation that you foam particularly long and thoroughly.'

(Class teacher, 32)

Table 8

Implementation of persuasive handwashing technology in elementary schools

Relative advantage	No. of quotes	Example quote
Concerns	11	<i>'The attractiveness of this automatism would be too great in everyday life, and I only go when I have to and not every hour because it is so fun. I believe that the balance would not be fair. I think that the toilet gets a great attention, that it should not have.'</i>
Benefits	3	<i>'Anything that happens automatically, through any movement, certainly makes the whole thing somehow more attractive than it does itself. In any case.'</i>

3.3 User's experience and intrinsic motivation in digital handwashing gamification

In total, sixteen elementary school children completed the survey on intrinsic motivation after executing the handwashing steps with either the prototype or poster. Additionally, user experience interviews of the eight participants within the prototype group have been conducted. All children visit the third grade of the elementary school and the average age was 8.2 years (± 0.4). Table 9 provides an overview of the experimental groups:

Table 9

Description of experimental groups

Experimental group	Participants (N)	Male	Female	Mean age (SD)
1. Prototype	8	3	5	8.0 (± 0.0)
2. Poster	8	4	4	8.4 (± 0.5)

3.3.1 Intrinsic motivation in experimental groups

After conducting the Mann-Whitney-U-Test (Table 10), it can be concluded that the subscale (1) interest/enjoyment in the prototype group was not statistically significantly higher than in the poster group ($U = 22, p = .328, r = .27$). The same applies to the subscales (2) perceived competence ($U = 24.5, p = .442, r = .20$), (3) perceived choice ($U = 24, p = .442, r = .21$), and (4) pressure/tension ($U = 23, p = .382, r = .24$). Nevertheless, trends, especially in interest and enjoyment are visible and should be further investigated.

Table 10

Results of the Wilcoxon-Mann-Whitney-Test including Means and Std. Deviation

Subscales-KIM	prototype (mean, SD) N = 8	poster (mean, SD) N = 8	p-value
Interest/enjoyment	4.3 (0.6)	3.3 (1.5)	.328
Perceived competence	4.2 (0.4)	3.9 (0.6)	.442
Perceived choice	3.4 (1.1)	2.9 (0.8)	.442
Pressure/tension	3.1 (1.0)	2.5 (0.9)	.382

Note: Subscale items were scored on a 5-point Likert-scale, ranging from 1 (totally disagree), 2 (disagree), 3 (don't agree, don't disagree), 4 (agree), 5 (totally agree).

3.3.2 User experience interviews focusing on PSD and BCT strategies

Since the approach of digital handwashing gamification to motivate elementary school children is predominantly unexplored, this analysis focuses on the positive and negative attitudes concerning the PSD and BCT principles utilized (Table 11). Five of the eight tested participants reported to have a *positive first impression* (5 quotes) and being curious about engaging with the technology. Furthermore, two participants reported to have a *negative first impression* (2 quotes), comprising concerns about the difficulty and procedure.

Table 11

User's attitudes and experiences when interacting with the digital handwashing prototype

Strategy	No. of quotes	Example quote
<i>Modelling</i>		
Positive attitude	8	<i>'Actually cool, I found the princess most beautiful.'</i>
<i>Self-monitoring</i>		
Negative attitude	5	<i>'I would always leave that out. And when it comes to the end, just display it.'</i>
Positive attitude	3	<i>'I actually liked it.'</i>
<i>Praise</i>		
Positive attitude	7	<i>'That was really cool because that was the first time for me. It was good to know when you do it correct.'</i>
Negative attitude	1	<i>'I would have said: super great! Continue now.'</i>
<i>Simulation</i>		
Positive attitude	7	<i>'Cool!'</i>
Negative attitude	1	<i>'Was there a story?'</i>
Correctly remember simulation	6	<i>'When I used the soap there were so many bubbles. When there is water on it the germs disappear.'</i>
<i>Liking</i>		
Positive attitude	8	<i>'I actually liked everything.'</i>
Role model	4	<i>'That one may choose the character.'</i>

With respect to *modelling*, all eight participants reported to have a positive attitude toward the displayed role models (8 quotes). Male participants indicated to prefer action heroes, whereas the female participants tended to choose princesses and animals.

Mainly negative attitudes were reported by five participants concerning *self-monitoring* (5 quotes). The children did not notice the progress and perceived it as useless. However, three children indicated that they have observed progress, resulting in a positive attitude. (3 quotes).

Praise messages are perceived positively (7 quotes) by seven of the children. They indicated to have profited from the feedback because it was their first time using such technology. However, one child with a negative attitude (1 quote) described the messages as strange and proposed a more enthusiastic approach.

The *simulation* within the prototype comprises a story which is positively rated (7 quotes) by seven children. Just one child is holding a negative attitude (1 quotes) and did not notice a story within the handwashing steps. When the children were asked to recall what happened within the game, six out of the eight children were able to correctly remember (6 quotes) the basic principles. All eight children reported that they perceive the game as *appealing (liking)*, thus holding a positive attitude. (8 quotes). The favorite game design element reported is the choice of a *role model* (4 quotes). The children did not specify what exactly causes their liking any further.

Lastly, the elementary school children were asked to rate the *difficulty* when engaging with the prototype and disclose their obstacles. Five of the children reported an easy difficulty (5 quotes) with no obstacles. On the contrary, three children stated to have had difficulties (3 quotes), mainly while reading the different steps in the predetermined time, for example, a child stated the following difficulty:

‘The question with the task to be carried out has always disappeared so fast and the new came.’

4. Discussion

4.1 Main findings

This research reveals that the elementary school children's motivation toward handwashing is influenced by the school environment and -context. A remarkable result to emerge from the data is, that cues to action and instruction are stated to be motivating to engage in proper handwashing, as the importance is well known in terms of germ prevention and cleanliness. In contrast, children perceive an inadequate environment within the elementary school to be a barrier and main reason to obviate handwashing behaviors along with the inappropriate behavior of others. In addition, children indicate the lack of perceived importance and laziness to be an important factor influencing the motivation. Nevertheless, handwashing is reported to be of normative desirability. When apparently not engaging in the expected behavior after using the toilet, children indicate normative pressure to be emerging. Although children state the procedure to be perceived as easy, control beliefs indicate that determined may outweigh voluntary handwashing. However, the elementary school teacher's attitudes illustrate, that educating hand hygiene behavior and infection prevention measures is not the perceived role of teachers. Therefore, their motivation to intervene is reported low, although they are actively engaged, for example when establishing handwashing rules within the school setting, or directly promoting behavior. Despite stating not having the proper resources to intervene, concerns regarding persuasive health technology and gamification are high, as teachers suspect misuse and disruptions within everyday life, due to the high attractiveness. However, the intrinsic motivation based on the cognitive-evaluation theories determinants revealed, that no significant differences have been found when testing for intrinsic motivation between the digital gamification prototype and poster. Nonetheless, trends within means should be investigated more thoroughly, especially within interest and enjoyment, which is stated to directly influence the intrinsic motivation. This can be supported with the conducted user experience interviews, which indicate that children reported a positive attitude toward the digital handwashing gamification prototype. Likewise, the majority of used game design elements are perceived as positive, especially the choice of a character, storytelling and praise messages based on this research. These findings offer vital evidence to how children can be motivated toward handwashing, amongst others by means of digital gamification:

First, the children indicated an inadequate environment and inappropriate behavior of others to be the main factor to obviate handwashing (Table 4), which is plausible, since ecological influences on health are well investigated and prominent in behavior change (Bartholomew et al., 2011). Thus, removing negative stimuli (e.g. bad smell and cold water) to enhance motivation as well as creating positive feelings should be considered (Kowalski et al., 2011). This is in good agreement with the health belief model, which postulates that stimuli must be present to trigger health-promoting behavior (Morrison & Bennett, 2016). Moreover, Fogg's (2003) behavioral model indicates, that motivation and ability together with a trigger must be present at the same time for a behavior to occur, which can be delivered by means of persuasive technology. This is in line with the findings, which indicate that cues to action influence the handwashing motivation. Since the children reported handwashing to be easy, the determinants motivation and trigger should be highlighted to successfully persuade. Thereby, triggers can serve as spark in order to motivate children that are lazy and perceive handwashing as unimportant, resulting in an increased engagement (Muntean, 2011). Devoid the application of persuasive technology, bathroom fittings within the elementary school should be continuously cleaned and soap filled up regularly.

Secondly, the children stated handwashing to be of normative desirability. A systematic literature review by Huis et al. (2012) indicates that social influence, attitude and self-efficacy are less prevalent approaches in handwashing interventions. Nevertheless, normative influences on health behavior are well investigated (Marks et al., 2018). Since the toilet is normally used alone, social support features could be motivating when designing interventions within semi-closed settings, especially when incorporating technology (Oinas-Kukkonen & Harjumaa, 2009). Likewise, these findings indicate a potential for pervasive technology, for example by connecting sensor technology with a display in order to match the individual user's needs and decrease contamination of bathroom fittings (Edmond et al., 2010). Moreover, it can be used to utilize advanced persuasive design elements, for instance, in terms of social comparison or -facilitation, as self-monitoring is reported redundant by the children (Oduor, Alahäivälä, & Oinas-Kukkonen, 2014). However, since normative influences are assumed to decrease the intrinsic motivation through evoking pressure, these strategies should be delivered in a positive manner when developing digital gamification strategies (Deci & Ryan, 2012; Oduor et al., 2014).

Contrary to expectations, children indicated fun to be present when engaging in handwashing behavior. Reportedly, this pleasure arises from singing familiar songs and playing independently constructed games, which is in line with existing approaches in handwashing education aiming to teach the practice through play (Geiger, Artz, Petri, Winnail, & Mason, 2000). Accordingly, splashing around with water and making bubbles was named by the children, which is normally prohibited within the toilet rules in order to facilitate cleanliness. Thus, specifically deploying playful elements within the handwashing context may be of added value to enhance the motivation as well as the cleanliness of the environment, by providing behavioral rules and instructions within a pleasurable context (Roger, 2018).

However, the teachers perceived barriers when thinking of persuasive technology and gamification are in agreement with the barriers described by Sánchez-Mena & Martí-Parreño (2017). Likewise, teachers expect class room dynamics to be disturbed. Therefore, the compatibility with the existing context is important, as innovations that consider social patterns and preexisting technology require less behavior change and therefore diffuse more quickly (Cain & Mittman, 2002). Additionally, a teacher's workload is not required when implementing BCSSs, since a lack of resources and time is reported to be a barrier for proper preventive measures within the elementary school. Hereby, preexisting rules as stated within the results should be acknowledged (Table 7). However, Aldunate & Nussbaum (2013) examined that teacher's adoption towards technology is depended on early adopters, regardless of the complexity of technology. Moreover, research indicates that the barriers of teachers to adopt technology are mainly their own attitude and beliefs towards technology as well as a lack of skills and knowledge (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). Therefore, teachers should be included as key stakeholders within the value specification phase when developing persuasive technology, in order to determine and rank their values when elaborating on the contextual inquiry (van Gemert-Pijnen et al., 2011). Moreover, their increasing knowledge and contact with regard to persuasive- and gamification technology might influence attitudes positively (Ertmer et al., 2012).

The user experience interviews indicate that children especially like to choose a character within the game. This is in line with the Elaboration Likelihood Model which states that attractive and likeable characters are more persuasive (Petty & Cacioppo, 1986). Beside this, six out of the eight children have positively recalled the simulation intended to link cause and effect, which supports the potential for digital education (Oinas-Kukkonen & Harjumaa, 2009).

However, praise messages are perceived mainly positively and should be further emphasized. Nonetheless, formulation should not be inflated, as reverse effects are likely to occur, especially in children with low self-esteem (Brummelman, Thomaes, Orobio de Castro, Overbeek, & Bushman, 2014). In contrast, the self-monitoring feature which visualizes the user's progress with respect to the five steps has been reported redundant. Moreover, the main findings reveal a necessity toward automatization and text-free instructions, since timing and unobtrusiveness are very important in everyday life (van Gemert-Pijnen et al., 2013). Therefore, it is necessary to meet the cognitive and executive functioning of elementary school children, which is in line with the findings of Baranowski et al. (2016). In conclusion, the persuasive and motivational strategies modelling, simulation and praise messages are particularly acknowledged to be attractive and pleasant to children.

4.2 Limitations

There are several limitations within this research that should be taken into account thoroughly. First, qualitative research was conducted which comprised questioning techniques that might influence the outcome (Dooley, 2009). Nevertheless, this method is widely accepted to understand the user context within the field of technology development (Jacobsen & Meyer, 2017). Conclusively, these findings should not be generalized too narrowly, as this might diminish the creativity when developing approaches to motivate children toward handwashing. Furthermore, the tested digital gamification approach comprised a lo-fi prototype, that is quickly to make, cheap, and easy changeable in nature, which is reported to be a benefit in early design stages despite it is limiting the choice of integrated design elements as well as their advancedness. Thus, the utilized elements and theory-based mechanisms tested could be replaced by other techniques, which indicates a lack in variation and the lack of multiple levels. Furthermore, it did not fit the individual's pace, which resulted in obtrusiveness while playing. Notwithstanding these limitations and a relatively small sample size of eight participants in each group, the digital gamification approach showed trends within means of intrinsic motivation, that should be further investigated, as they could not be proven statistically significant within this qualitatively driven study.

4.3 Future research

The explored motivational and contextual factors toward handwashing within the elementary school setting as well as the user's experience while engaging with the developed digital gamification approach, comprise challenges that must be taken into account thoroughly.

First, future research should investigate the influences of stimulants like the smell and feeling of temperature within the handwashing context more carefully, since cold water and bad smells have been reported to influence the children's motivation toward handwashing. This is in line with a study by Holland, Hendriks, & Aarts (2005), which found scent to be unconsciously influencing behavior. Hence, it is important to study the influence of different smells on handwashing behavior as well as preferred water temperatures during summer and winter by means of quantitative approaches. Moreover, a study focusing on the influence of olfaction and unpleasant reminders in hand hygiene discovered, that olfactory disgust which was released by means of sensors when being not compliant was the most effective in order to engage people in handwashing behaviors (Pellegrino, Crandall, & Seo, 2016). This highlights the potential of the smell on the human behavior and the possibility to change behavior by means of pervasive technology (Edmond et al., 2010). Pervasive technology, or ubiquitous computing, is the use of intelligent devices in everyday life to support the end-user, for example, by the use of sensor technologies (Hansmann, Merk, Nicklous, & Stober, 2013). Focusing on children's hand hygiene within the elementary school context, effective possibilities to embed pervasive technology should be investigated as future potential to increase the effectiveness of preventive handwashing measures and motivate health behavior (Arnrich, Mayora, Bardram, & Tröster, 2010).

Secondly, cues to action should be further investigated as they are frequently reported by the children to motivate their handwashing behavior. This is in line with the research by Ford et al. (2014), which points out that simple visual cues increased the towel usage by 22,6% and soap by 13,3%. However, the previously mentioned study from Pellegrino et al. (2016) examined, that disgusting visual and auditory cues have shown to be more effective than traditional visual cues that are frequently utilized. Focusing on persuasive handwashing technology, this could be a potential strategy to motivate children to engage more frequently and increase the usage of soap as well as towels, which has been reported low within the school setting (Guinan et al., 1997). However, behavior change frameworks like the COM-B model by Michie, van Stralen, & West (2011) postulate, that motivation, ability and

opportunity influence behavior. Thereby, opportunity can be described as the factors outside the children that prompt toward the behavior, for example the earlier introduced cues to action. Likewise, Fogg's behavioral model incorporates that a trigger must be present at the same time for a behavior to occur (Fogg, 2003). Therefore, future research should develop and test trigger and cues that go beyond visualizations in a quantitative way in order to study, which cues are effective as well as appealing to elementary school children. Moreover, the mentioned frameworks should be incorporated when developing future interventions targeting to increase the handwashing behavior in elementary school children.

Thirdly, the persuasive design elements within handwashing gamification as well as health gamification in general should be investigated more standardized within the implementation environment, as contextual factors are important for a successful gamification (Alahäivälä & Oinas-Kukkonen, 2016). The choice of a character, which has been reported to be appealing to children within this research, has been thought to increase the motivation within online games by making them customizable (Dickey, 2007). Thus, personalization should be acknowledged as potential strategy to increase intrinsic motivation, for example, integrating avatars for children that can be customized (Birk, Atkins, Bowey, & Mandryk, 2016). Additionally, the educational potential due to game-based storytelling and simulations should be highlighted, which is in line with previous findings by Oinas-Kukkonen & Harjumaa (2009). However, the effectiveness of the persuasive design elements in order to increase the intrinsic motivation by means of digital handwashing gamification is lacking. The persuasive strategies can be identified as a single component within the behavior change system. Therefore, applying the MOST-framework to optimize interventions is suggested, which involves a preparation-, optimization-, and evaluation phase, since behavioral interventions as well as their underlying theories should be continuously optimized (Collins, Murphy, & Strecher, 2007). Hereby, factorial design experiments should be pointed out, as they allow to test the different strategies and combinations in order to investigate their effectiveness and combinational potential on intrinsic motivation. The findings within this research indicate the need to identify the active ingredients and their combinations influence on the intrinsic motivation of elementary school children that goes beyond the utilized strategies in this research.

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Appendix

Appendix A: Interview guide - focus group interview children

Einleitung

Hallo zusammen! Ich bin Simon Langener (ihr könnt mich gerne Simon nennen) und möchte mich heute mit Euch über das Thema „Hände waschen“ in der Schule unterhalten. Ich habe mir dazu ein paar Fragen überlegt, die ich gerne mit euch besprechen möchte. Wenn man etwas Neues sagen möchte oder zu dem was ein anderer gesagt hat, muss man warten bis der andere ausgesprochen hat und den Sprechball weitergibt.

Es gibt keine richtigen oder falschen Antworten.

Dauer: 30 Minuten

Intention to comply (Eisbrecher, captain obvious)

- Was glaubt ihr, wie viele Kinder sich nach dem Toilettengang die Hände waschen?
 - a) Wer von Euch denkt, dass es alle machen?
 - b) Wer von Euch denkt, dass es nur manche machen?
 - c) Wer von Euch denkt, dass es keiner macht?

Attitude hinsichtlich „Hände waschen“

- Wie wichtig ist es sich die Hände zu waschen, nachdem man auf der Toilette war?
 - a) Warum wäscht man sich die Hände?
 - b) Was sind Bakterien und Viren?
- Wie viel Spaß macht euch das Händewaschen?
 - a) Warum macht euch das Händewaschen Spaß?
 - b) Warum macht euch das Händewaschen keinen Spaß?
 - c) Welche Spiele beim Händewaschen kennt/spielt Ihr?
- Was mögt Ihr am Hände waschen auf der Schultoilette?
 - a) Welche Gegenstände mögt ihr? Zum Beispiel: Wasserhahn, Becken, Seifenspender
 - b) Was macht ihr am liebsten? Zum Beispiel: Einseifen, Abwaschen oder Abtrocknen
- Was mögt Ihr nicht am Hände waschen auf der Schultoilette?
 - a. Welche Gegenstände mögt ihr gar nicht?
Zum Beispiel: Wasserhahn, Becken, Seifenspender
 - b. Was macht ihr nicht gerne? Zum Beispiel: Einseifen, Abwaschen oder Abtrocknen
- Was motiviert Euch die Hände zu waschen nachdem Ihr auf der Toilette wart?
 - a) Wer von euch hat ein Vorbild?
 - b) Welche Rituale habt ihr?

Subjective norm hinsichtlich „Hände waschen“

- Wie wichtig denkt Ihr ist es den anderen Kindern, dass Ihr euch die Hände wascht?
 - a) Warum könnte es den Kindern wichtig sein?

- Wie wichtig denkt Ihr ist es den Lehrern, dass Ihr euch die Hände wascht?
 - b) Warum ist es den Lehrern wichtig?

- Was denkt ihr würden die anderen Kinder sagen, wenn sie wüssten, dass jemand sich nicht die Hände gewaschen hat?

Perceived behavioral control hinsichtlich „Hände waschen“

- Wer von euch wäscht sich freiwillig die Hände? Warum?
 - a) Wer sonst bestimmt darüber wann die Hände gewaschen werden?

- Wie schwer findet ihr es die Hände zu waschen?
 - a) Was findet ihr schwer?
 - b) Warum findet ihr (...) schwer?

Abschluss

Danke, dass Ihr mir geholfen etwas über das „Hände waschen“ in Eurer Schule herauszufinden. Ich habe Euch noch eine Kleinigkeit als Dankschön mitgebracht. -> Süßigkeiten verteilen

Für statistische Zwecke:

Bestandsaufnahme

Wie viele?
Geschlechter-Verteilung?
Welches Alter?
Welche Klasse?

Appendix B: Interview guide - focus group interview teachers

Einleitung

Hallo zusammen! Ich bin Simon Langener und möchte mich heute mit Ihnen über das Thema „Hände waschen“ in der Grundschule eine Fokusgruppen Diskussion durchführen. Ich habe mir dazu ein paar Fragen überlegt, die gemeinsam besprochen werden sollen. Wenn man etwas erzählen möchte zu dem was ein anderer gesagt hat, muss man warten bis der andere ausgesprochen hat und derjenige den Sprechball weitergibt.

Zunächst möchte ich herausfinden wie Sie die Einstellung der Kinder zum Händewaschen einschätzen:

Attitude hinsichtlich „Hände waschen“

- Warum denken Sie könnten die Kinder es als sinnvoll erachten sich die Hände zu waschen, nachdem sie auf der Toilette waren?
 - a) Welche Vorstellungen denken Sie haben die Kinder von Bakterien und Viren?
 - b) Welcher Einfluss von außen wirkt auf die Kinder innerhalb der Schule ein?
- Was denken Sie mögen Kinder hinsichtlich des Händewaschens auf der Schultoilette?
 - a) Welche Elemente innerhalb der Toilette werden durch Kinder bevorzugt?
 - b) Welche Elemente des Prozesses werden gemocht?
- Was denken Sie mögen Kinder nicht hinsichtlich des Händewaschens auf der Schultoilette?
 - a) Welche Elemente innerhalb der Toilette werden durch Kinder tendenziell abgelehnt?
 - b) Welche Elemente des Prozesses werden nicht gemocht?
- Inwiefern denken Sie, dass das Händewaschen den Kindern Spaß macht?
 - a) Welche Elemente des Prozesses machen den Kindern Spaß?
 - b) Welche spielerischen Elemente/Attraktionen befinden sich auf den Toiletten?
- Was denken Sie könnte Kinder motivieren die Hände zu waschen nachdem sie auf der Toilette waren?
 - a) Welche Vorbilder haben Ihre Schüler?
 - b) Inwiefern denken Sie könnten: eine Geschichte, ein Wettkampf oder Belohnungen die Motivation verstärken?

Da ich nun Ihre Einschätzung zur Einstellung der Kinder erfahren habe, bin ich interessiert, wie Sie die den relativen Vorteil, die Kompatibilität und Komplexität in der Nutzung von Technologien zur Verbesserung der Handhygiene im Kontext der Schule einschätzen:

Begriffserklärung: Gamification

Relativer Vorteil hinsichtlich „Händewaschen mit Game-Technologien“

- Was könnte der Vorteil sein das Händewaschen technologisch zu Gamifizieren?
- Was könnte der Nachteil sein das Händewaschen technologisch zu Gamifizieren?
- Was denken Sie über den relativen Vorteil nach Abwägung der genannten Vor- und Nachteile?

Kompatibilität hinsichtlich „Händewaschen mit Game-Technologien“

- Wie sind die aktuellen sozialen Muster innerhalb des Händewaschens?
 - a) Welche Regeln werden genutzt?
- Wie bringen Sie den Kindern das Händewaschen bei?
 - a) Welche Seminare oder Unterrichtseinheiten werden diesbezüglich bereitgestellt?
 - b) Welche Techniken/Materialien nutzen Sie, um den Kindern das Thema näher zu bringen?

Abschluss

- Was möchten Sie mir noch zum Thema Händewaschen bei Grundschulkindern sagen, was bisher noch nicht angesprochen wurde?

Bestandsaufnahme

- Wie viele?
- Geschlechter-Verteilung?
- Welches Alter?
- Fächer?

Danke, dass Ihr mir geholfen etwas über das „Hände waschen“ in Ihrer Schule herauszufinden. Wir hoffen mit dieser Forschung Erkenntnisse für die Zukunft zu gewinnen und diese praxisbezogen einzusetzen. Ich habe Euch noch eine Kleinigkeit als Dankschön mitgebracht. -> Süßigkeiten verteilen

Appendix C: Handwashing poster

Wasser marsch!
Ärmel hoch und Hände richtig nass machen.

Einseifen!
Mit einer ordentlichen Portion Seife.

Zeit lassen!
Gründlich einschäumen, auch zwischen den Fingern und an den Fingerspitzen. Das dauert 20 bis 30 Sekunden.

Runter damit!
Hände von allen Seiten unter das Wasser halten. Den Seifenschaum gut abspülen.

Trocknen!
Am besten mit einem Einmaltuch.

**RICHTIG
HÄNDE
WASCHEN**

Geht ganz einfach!

Nicht vergessen!
Auf den Händen sitzen sie: Viren und Bakterien.

Deshalb:
Nicht mit den Händen ins Gesicht fassen und Hände mehrmals täglich waschen.

Immer:

- ▶ vor dem Essen
- ▶ nach dem Klo
- ▶ wenn du von draußen kommst
- ▶ wenn du dir die Nase geputzt hast
- ▶ wenn du ein Tier gestreichelt hast

Und noch ein Tipp: Bei Schnupfen häufig Hände waschen!

infektionsschutz.de
Wissen, was schützt.

BZgA Bundeszentrale für gesundheitliche Aufklärung

BZgA Bestellnummer: 6251 (09/00)

Figure C: Handwashing poster by the German Federal Center for Health Education

Appendix D: Digital handwashing prototype storyboard

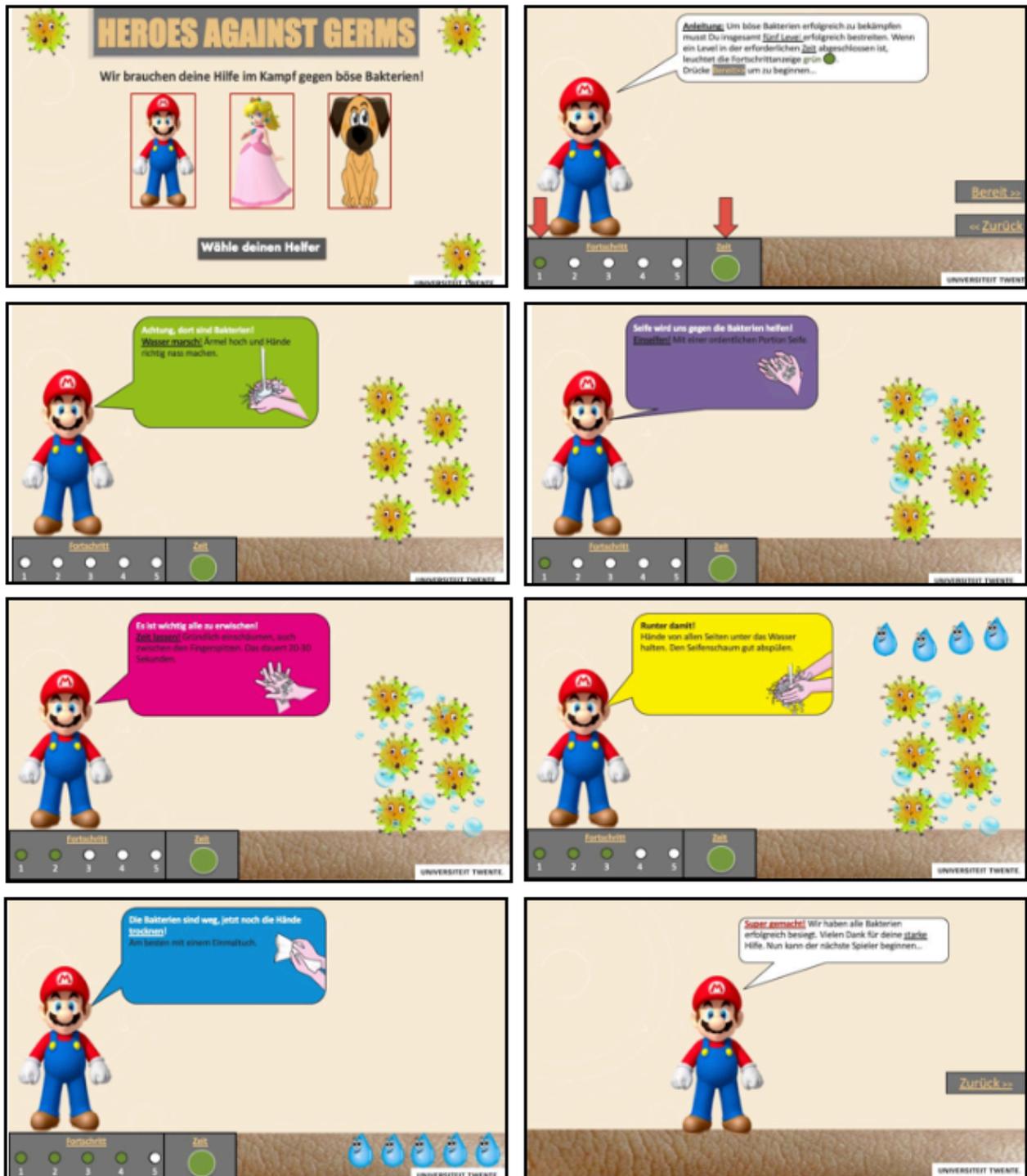


Figure D: Digital handwashing gamification storyboard

Appendix E: Experimental setup

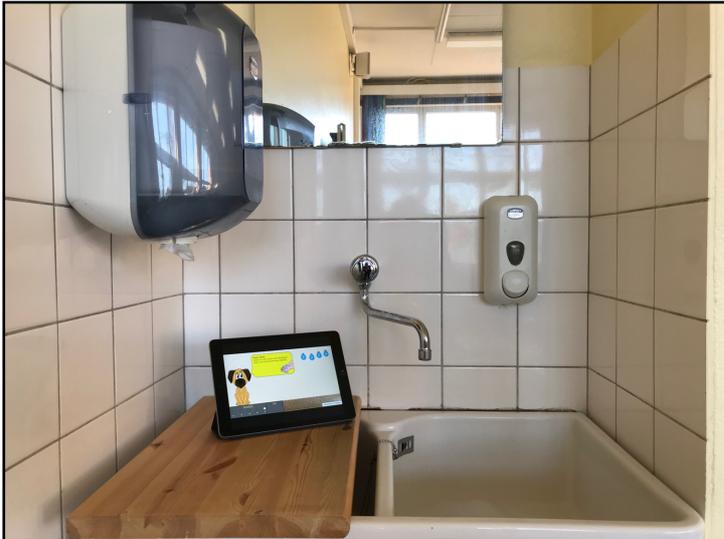


Figure E1: Digital gamification prototype in the basic setting



Figure E2: Handwashing poster in the basic setting

Appendix F: User experience interview guide

Use-case scenario

Hallo (Name des Kindes)! Stell dir vor, du warst gerade auf der Schultoilette. Nun verlässt du die Toilette und sollstest deine Hände waschen. Ich möchte dich nun bitten, deine Hände an diesem Waschbecken zu waschen.

Es gibt keine richtigen oder falschen Antworten.

Handwashing steps (in total: 2 mins) distributed via prototype or poster based on BZgA's recommendations

- 1) Wasser marsch! Ärmel hoch und Hände richtig nass machen (10 Sekunden)
- 2) Einseifen mit einer ordentlichen Portion Seife (10 Sekunden)
- 3) Zeit lassen (20 Sekunden)
- 4) Runter damit! Hände von allen Seiten unter das Wasser halten und gründlich abspülen (10 Sekunden)
- 5) Trocknen! Am besten mit einem Einmalhandtuch (10 Sekunden)

User experience questions (Prototype)

- Was war Dein erster Eindruck von dem Spiel?
- Was fandst Du schwer während des Spiels? Warum?
- Wie fandst Du die verschiedenen Helden, aus denen du am Anfang wählen durftest? Warum?
- Wie findest du die grünen Lichter, die deinen Fortschritt anzeigen?
- Hat dir das Spiel gefallen?
 - a. Ja: Was genau hat dir besonders gefallen?
 - b. Nein: Warum hat es dir nicht gefallen?

Nach der Befragung wird das Kind gebeten, den Fragebogen auszufüllen und ihn ehrlich zu beantworten:

Abschluss

Danke (Name des Kindes), dass Du mir geholfen etwas über das „Händewaschen“ bei Grundschulkindern herauszufinden. Ich habe Euch noch eine Kleinigkeit als Dankschön mitgebracht. -> Süßigkeiten verteilen

Bestandsaufnahme

Teilnehmernummer?

Welcher Aufbau?

Welches Geschlecht?

Welches Alter

C2) Short-scale intrinsic motivation (KIM)

Bitte beantworte, wie **du** das Händewaschen in der Grundschule **mit dem iPad** einschätzt:

Appendix G: Adapted German short-scale intrinsic motivation (KIM)

→ Umkreise die richtige Antwort.

Nr.	Frage	Stimmt gar nicht	Stimmt wenig	Teils-teils	Stimmt ziemlich	Stimmt völlig
1	Das Händewaschen in der Grundschule hat mir Spaß gemacht	1	2	3	4	5
2	Ich fand das Händewaschen in der Grundschule sehr interessant	1	2	3	4	5
3	Das Händewaschen in der Grundschule war unterhaltsam	1	2	3	4	5
4	Mit meiner Leistung während des Händewaschens bin ich zufrieden	1	2	3	4	5
5	Beim Händewaschen in der Grundschule stellte ich mich geschickt an	1	2	3	4	5
6	Ich glaube, ich war beim Händewaschen in der Grundschule ziemlich gut	1	2	3	4	5
7	Ich konnte das Händewaschen in der Grundschule selber steuern	1	2	3	4	5
8	Beim Händewaschen in der Grundschule konnte ich wählen, wie ich es machen	1	2	3	4	5
9	Beim Händewaschen in der Grundschule konnte ich so vorgehen, wie es wollte	1	2	3	4	5
10	Beim Händewaschen in der Grundschule fühlte ich mich unwohl	1	2	3	4	5
11	Beim Händewaschen in der Grundschule fühlte ich mich angespannt	1	2	3	4	5
12	Ich hatte Bedenken, ob ich das Händewaschen in der Grundschule gut hinbekomme	1	2	3	4	5

Zum Schluss noch einige Fragen zu dir selbst:

13	Wie alt bist du? (Jahre)	6	7	8	9	10
14	Welches Geschlecht hast du?	Junge	Mädchen			