2017

# Health behavior tracking via mobile games : a case study among school-aged children

Sormunen Marjorita

Cogent OA


http://dx.doi.org/10.1080/2331186X.2017.1311500

Sormunen & Miettinen, *Cogent Education* (2017), 4: 1311500
**http://dx.doi.org/10.1080/2331186X.2017.1311500**

cogent education

INFORMATION & COMMUNICATIONS TECHNOLOGY IN EDUCATION | RESEARCH ARTICLE

# Health behavior tracking via mobile games: A case study among school-aged children

Marjorita Sormunen[1]* and Hanna Miettinen[1]

Received: 04 November 2016
Accepted: 21 March 2017

*Corresponding author: Marjorita Sormunen, Department of Nursing Science, University of Eastern Finland, P.O. Box 1627, 70211 Kuopio, Finland
E-mail: marjorita.sormunen@uef.fi

Reviweing editor:
Shuyan Wang, The University of Southern Mississippi, USA

Additional information is available at the end of the article

**Abstract:** Mobile devices are increasingly being used, in various ways, to collect data and are also increasingly related to individuals' health behaviors. Because of the paucity of available data about the process of mobile data collection in tracking daily health behaviors among children, we designed this pilot study to determine the possibilities and the enhancing and inhibiting factors of a continuous data collection process using a mobile game. Twenty 10–12-year-old school children from two schools participated in the study. We asked the participants to play a game that recorded their health-related behaviors for seven consecutive days, answering 14–16 questions daily. The questions related to children's eating habits, hygiene habits, hobbies and activities, networks, media use and devices, and sleep. In this article, we describe and discuss the process of data collection with its advances and challenges, including the planning and preparation of the survey according to its content and technicalities, training the pupils and their teacher to use the device and the health game, implementing the survey, and concluding the process. Additionally, we present viewpoints on educating children using collective health data.

## ABOUT THE AUTHORS

Marjorita Sormunen is a university researcher, whose research interests are school health promotion, health education, and social marketing in health promotion. She uses different methodological approaches in her research and is interested in new technological innovations harnessed in research. This study belongs to her research project, where Finnish and French parents and teachers, and Finnish pupils were studied.

Hanna Miettinen is an early stage researcher, and her research interests include young adults' health behavior and health outcomes, specifically with a focus on Internet-use associations. She has worked on research projects regarding children's health behavior. These research interests and work experiences provide a link to the research reported in this paper. Both authors work at the University of Eastern Finland, Department of Nursing Science, and have qualifications and work experience as teachers of health sciences. They belong to the SHE (Schools for Health in Europe) international research group.

## PUBLIC INTEREST STATEMENT

Children learn by watching, by listening, and by doing. Parents have a strong influence on children's physical and social environment through their own decisions and possibilities, and their own behavior serves as a role model for their children influencing children's behavior. School has its own important meaning in children's lives, being an environment, where health issues are learned both formally and informally. These behaviors, and especially behavioral patterns, however, are quite challenging to reveal, especially in children. Cross-sectional data, the collection of information from one point in time, is currently available, but much less is known about health behaviors that occur for longer periods. This study presents an innovative data collection method, which allows for tracking the daily recurrent health behaviors of children through use of a mobile game. In addition to presenting information about the method, several issues related to children as participants in digitally mediated research are discussed.

**Subjects: Childhood and Adolescence; Health Communication; Research Methods in Education; Research methods; Health Education and Promotion**

**Keywords: mobile game; mobile data collection; health behavior tracking; data collection process; school-aged children; health education**

## 1. Introduction

Utilizing mobile technology for data collection is an increasing but already much-used method in research. It has certain advantages, such as the possibility of gathering various types of data, like text-based or visual data (Şahin & Yan, 2013). According to Sugie (2016), it is appropriate in the collection of data from hard-to-reach groups. Moreover, it also allows for the collection of daily or real-time data from individuals over a period of time (Mays et al., 2010; Ravert, Calix, & Sullivan, 2010; Rönkä, Malinen, Kinnunen, Tolvanen, & Lämsä, 2010; Şahin & Yan, 2013). Daily data are collected at multiple points from individuals in their immediate environments, giving researchers the possibility of capturing real-time situations from the lives of participants without being present themselves. As Ravert et al. (2010) mentioned, there are several ways to gather multiple-point data. Participants may be asked to respond at set intervals daily in connection with a recurrent event or may be prompted by research personnel. In addition to advantages related to the research method itself, the costs of daily recording can be minimal compared to studies requiring observers (Raento, Oulasvirta, & Eagle, 2009). However, with device costs and wireless services counted in, expenses can exceed paper-based data collection (Mays et al., 2010).

Software for mobile phones enables individuals to track different kinds of data, including images, text, location, and motion. Tracking one's own behavior is especially popular when it is related to health and a healthy lifestyle, with participants being able to gather information throughout the day in relation to activity, eating habits, or weight, for example. This personal data can either be entirely for a person's own use or can be shared with other people (Shilton, 2012). Information related to health behaviors or health activities can also be gathered and used for research purposes (e.g. Abril, 2016). The data can be rich in content and may generate new data analysis methods and ways of presenting the results.

According to Plowman and Stevenson (2012), finding out young children's daily activities is challenging. In their study, parents were involved in the data collection, taking photos of their children using mobile phones six times during one day of the week when the researchers sent them text messages containing instructions. The researchers organized three rounds of data collection. Furthermore, the parents and children were interviewed based on the pictures and texts. This mobile phone diary technique allowed researchers to gain insights into a toddler's and a family's life. In another study (Christensen, Mikkelsen, Nielsen, & Harder, 2011) focusing on children's (aged 10–13) daily mobility, using a global positioning system (GPS), children carried a tracking device for one week to determine their physical activity. At the same time, a number of the participating children also answered questions about their activity by mobile phone as prompted five times a day. These examples introduce the variation in mobile data collection techniques related to the health and daily activities of children.

Mobile games are much used as entertainment and daily activities and increasingly in education (Kearney, Schuck, Burden, & Aubusson, 2012). The use of games in scientific research and, particularly, in data collection is still very rare. In this study, we used multiple-point data collection to gather 10–11-year-old children's ($n$ = 20) daily activities related to health. We present here the process, benefits, and challenges of seven-day mobile game data collection.

The primary purpose of this study was to test a novel use for mobile data collection to find out its suitability in investigating children's daily health behaviors. The research questions were:

(1) Is a continuous data collection through use of a mobile game a suitable way to collect health behavior—related research data among 10- to 11-year-old children?

(2) What are the enhancing and inhibiting factors that emerge during the data collection process?

Since health behaviors are largely examined by cross-sectional design, this study contributes by presenting a digital research method for continuous data collection. Thus, it extends the existing knowledge about the use of mobile devices in research. Moreover, the study may serve as an inspiration for educators on how to use health data at school as well as what issues have to be considered if doing so.

## 2. Methods

### *2.1. Digitally mediated research*

The research method we used in this study can be categorized as a digital research method. Digital research methods can be further defined as the use of digital devices, such as tablet computers, mobile phones, or certain online platforms, for research purposes. Applying this method, the participant and the researcher have an easy access to the study at convenient times and locations. (Bailey et al., 2015; Roberts, Hine, Morey, Snee, & Watson, 2013.) We believe that this method is well-suited to school-aged children, who mostly are motivated and accustomed to using mobile devices in their everyday lives. In this study, we applied the method for tracking the health behaviors at several time points per day, for seven consecutive days.

### *2.2. Questionnaire development*

In previous intervention studies (Sormunen, Kirilina, Goranskaya, & Tossavainen, 2014; Sormunen, Tossavainen, & Turunen, 2013), researchers aimed to develop collaboration between home and school when examining children's health issues, and this is what guided the development of questionnaires. Since much cross-sectional information about children's daily behaviors have already been collected, more specific information about children's daily health routines is often missing. Therefore, we designed a questionnaire to track children's daily health-related activities for seven consecutive days.

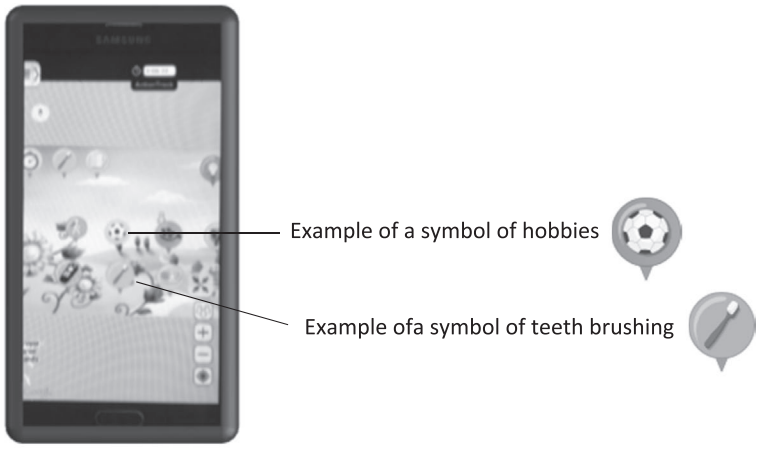
For weekdays, the questions related to wake-up time, teeth brushing in the morning, content of breakfast, journey to school, school lunch, hobbies, use of screen time, content of evening meal, teeth brushing in the evening, place of cell phone during the night, bedtime, washing in the evening, and daily changing health-related questions (quiz) with correct answers to keep children motivated. On Saturday and Sunday, the questions concerned the activities of the day and social networking during the day, with school-related questions left out. Hence, the questionnaire contained 14–16 questions per day. In addition, we included six background questions on children's opinions in relation to whether they liked to go to school or not and about their academic success, home resources (living in two homes, having own room), and parents' education and work status.

### *2.3. Game development and game content*

The game development process started on May 2015. At the beginning of the process, we participated in a national "Finnish Game Jam" event (Finnish Game Jam, 2015). In the event, we received current information about game development and exchanged experiences on using games for a variety of purposes. After this, we chose a smart device game application to be used for the study's data collection. We reviewed all technical aspects of the game following the necessary practical matters. Together with technical help, we focused on developing the game's layout and content to fit the purpose of the research. We modified the game to fulfill all the required elements for conducting the research.

The modified game layout consisted of different checkpoints, also called symbols (Figure 1). These symbols presented different daily activities and contained four types of answers: taking photos

**Figure 1. Screenshot of mobile game in smart phone including symbol examples.**




(home meals and teeth brushing), writing times (waking, bedtime), multiple selection (school trip, a place for cell phone, quiz), and free writing space (school lunch, hobbies, use of screen time, weekend activities, social network). When the children touched one of these symbols, they received a survey question concerning the symbol topic and were informed to use the answer type as requested. After answering the question, the symbol disappeared from the screen. Only the quiz questions were interactive in terms of offering an explanation for the child after a right or a wrong answer and gave a badge as a reward for a right answer. The application informed the children to select the symbols in a daily function order. A unique daily QR (quick response) code was also used to ensure easy access to the game. We also conducted a pretest of the application with three children aged 10, 14, and 17.

### *2.4. Participants and research setting*

This study was part of a larger, international study, in which the data were collected in Finland and France from elementary school parents and teachers in spring 2015. Among 51 Finnish schools that voluntarily participated in the study, two schools' (A and B) headmasters agreed to continue the study with pupil participation. Since this was considered a pilot study and was intended only for a small group of pupils, we used a convenient sample of two schools. One classroom teacher from each school was responsible for monitoring and supervising the study process in class. In School A, the class size was 23 pupils, and in School B, it was 16 pupils. The sample comprised 20 fifth and sixth grade pupils aged 10–11 years. All participated in the study on a voluntary basis.

### *2.5. Ethical considerations*

The University of Eastern Finland Committee on Research Ethics (statement 19/2014), the head of the education sector in both municipalities, and the schools' headmasters approved the study. Before commencing data collection, we explained the aim and content of the study and the data collection procedures to the parents and the children, and the teacher sent the same information beforehand to homes together with the consent forms for parents and children. We explained the participants' rights to the children, including the fact that their participation was voluntary, that they would keep their anonymity, that they were free to withdraw from the study any time, and that the collected data would be handled with confidentiality. All consenting children gave their permission to use the data for research purposes, including visual data. Each child received an individual number code to play the game.

### *2.6. Data collection process*

In August and October 2015, we (researcher and assistant or technical advisor) visited the two schools, each for two days. On the first day, the parents received information about the study more specifically and gave their consent for their children to participate if a responsible teacher had not yet received the consent previously. On the second day, the teacher and the pupils received detailed

information about the study process, the aims, the methods, and ethical issues. The children who chose to participate to the study and who possessed a permission paper signed by their parents or guardians filled out an informed consent form. The teacher gathered the pupils who were not willing or allowed to participate and left the classroom before the actual initiation of the study.

In School A, the pupils had the opportunity to use their own mobile device or borrow one from the research project. Those who wanted to borrow a device were given a mobile device with a charger and an instruction manual on how to use the device. Two children used their own mobile phone. Those who wanted to use their own device received instructions and help in how to download and install the developed health game application to their device. In School B, all pupils used the school's own mobile devices. Before starting the study with the health game application, we trained the children in how to use the device, and introduced the game with the help of a data projector in the classroom. We guided children systematically and provided time for additional questions. We also instructed them in all technical issues, including research data transfer through the Internet, and gave them a written instruction sheet containing the research team's contact information.

We trained the teachers privately in a separate room. The teacher's role was to remind pupils daily to use the game, take care that they charge the device in the morning at school, and make sure they were available if any technical problems occurred. We also added them to an online discussion forum where they would receive technical support at any time of the day. As with the pupils, the teachers also received written instructions.

We gathered the children's background information before implementing the survey and asked them to play the game daily for seven consecutive days. The days for tracking were decided beforehand, starting from Thursday afternoon and ending the next Thursday morning, including the weekend. By playing this health game, children's data were transferred and saved in a database. We told the children to complete the playing at the same time each day. We also asked them to behave as usual and not change their behavior during the week.

Children answered the health game questions privately during the day but had an opportunity to ask technical questions of their teachers and the research team. They also received help from their teachers in transferring the responses in the survey through the school's wireless network. We followed the data transfer online and contacted the teacher immediately if any problems occurred.

### *2.7. Data analysis*

The data analysis consisted of two phases. The aim of the first phase was to examine what seemed to arise from the data and to produce an initial overview of how the children had responded in general. After checking all the responses (written text, numbers, photos), we converted them into Microsoft Excel spreadsheet and SPSS (Statistical Package for Social Sciences, version 22.0) forms. We then checked the data again, cleaned them, and coded them for further analysis. We read the written texts thoroughly, printed and examined the photos, and performed a descriptive analysis of the numerical data. In the second phase, we examined the data in more detail to find out if certain behavioral patterns could be identified in relation to individual children. In this article, we present examples primarily of the analysis of the first phase.

## 3. Results

### *3.1. Participants*

Eleven pupils out of 23 in class Grade 5 in School A and 9 pupils out of 16 in combined class Grades 5 and 6 in School B agreed to participate in the study. Thus, the participation rate was 51%. Girls participated more than boys (14 and 6, respectively) did.

**Table 1. Numbers of daily maximum responses and missing responses**

| Day | Maximum number of responses per day | Missing responses *f* (%) |
|---|---|---|
| Monday | 280 | 33 (12) |
| Tuesday | 280 | 41 (15) |
| Wednesday | 280 | 45 (16) |
| Thursday | 260 | 38 (15) |
| Friday | 320 | 17 (5) |
| Saturday | 260 | 29 (11) |
| Sunday | 260 | 33 (13) |

Note: Children ($n$ = 20) answered to 14–16 questions per day.

### *3.2. Missing information*

A total of 5–16% of responses was missing daily (Table 1), and the mean percentage of missing responses was 12%. The children played the game quite regularly throughout the week with no large differences in daily response rate. No dropouts occurred during the week.

### *3.3. Pupils and teachers' experiences*

The motivation for using the health game remained high among pupils during the week. The teachers did not report any complaints from the children, and when we collected the groups' experiences, all expressed their satisfaction in the game. According to the pupils' opinions, the game was easy to use technically, they remembered to play it with minor exceptions, and they found tracking their own behaviors and activities during the week fun and interesting. Similarly, the teachers experienced the pupils' daily use of the game as being easy, and they supported them if any problems occurred.

### *3.4. Visual examples of results*

Below are two examples of descriptive data. In the first example (Figure 2), two children's teeth-brushing habits in the mornings and in the evenings are illustrated. According to these results, Child 1 practiced teeth brushing regularly but only in the evenings. Child 2's teeth-brushing habits were more irregular, and three answers were missing. We chose the data of these two children to illustrate the different habits related to health behaviors, and as an example of a health behavior pattern (Child 1).

In the second example (Figure 3) is a summary of 17 children's bedtimes and length of night's sleep on one weekday and weekend day. Only the children who had responded to both the bedtime and wake-up time questions during these days were included. The data showed that most of the children went to sleep on weekday evening at 10:00 pm and on weekend evening, at 10:00 pm or 11:00 pm. Furthermore, four children went to sleep at midnight or after midnight on weekend. Thirteen children had a one- to three-hour lapse between bedtimes on weekday and weekend evenings. On weekday, the most usual length of night's sleep was 9 or 10 hours and on weekend, nine hours. On weekend, the variation between the lengths of night's sleep was larger than on weekday.

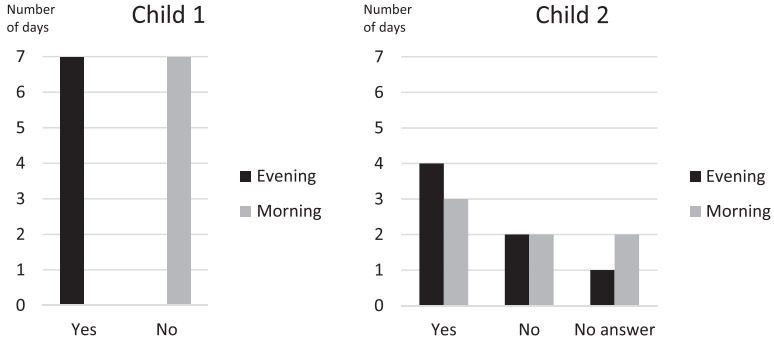



**Figure 2. Two children's teeth-brushing habits during evenings and mornings for seven consecutive days.**

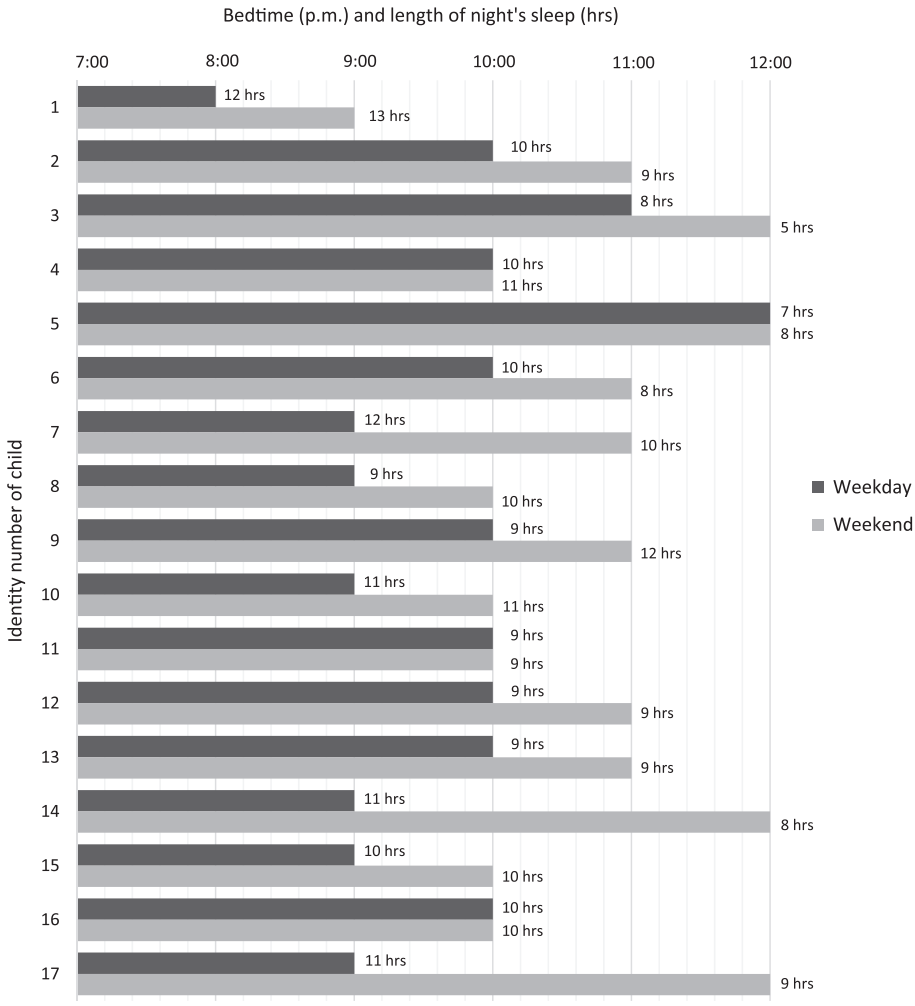



**Figure 3. Children's (*n* = 17) bedtimes and the length of night's sleep in hours on weekday and weekend.**

Note: The numbers have been rounded to nearest full time (e.g. 9:25–9:00 pm, 9:30–10:00 pm, and 12:00 pm or over to 12:00 pm).

### *3.5. Educational viewpoint*

An educational component took place a week after the data collection ended. We pre-analyzed the results and presented them to the participating pupils in a separate session in both schools separately. We presented each result using a data projector; we weighted the "good" and "bad" options together with children with possible explanations and discussed the benefits of related health habits for personal health and for learning. For example, when we discussed variation of bedtimes during the weekdays and weekends, the children gave their opinions and expressed their own experiences of the issue. Furthermore, they discussed given topics related to theme such as, "What issues influence bedtime?" or "What helps the onset of sleep?" In addition to the most common explanations for late bedtimes, several more issues also arose, illustrating the difference in children's home environments and parenting cultures. Many health behaviors were also related to each other, such as bedtime and use of a mobile phone or watching television, and natural discussions occurred based on those connections.

## 4. Discussion

This study served three purposes by (a) testing a novel use of mobile data collection method, (b) investigating children's daily health habits in their immediate environments, and (c) acting as an educational component. For this article, we report the process of data collection more specifically, but we also obtained interesting and promising viewpoints in two other areas. For example, in the area of investigating children's daily habits, a lot of information can be obtained using mobile devices as described in this study. It is possible to examine children's social networks, home or school

environments, hobbies, or behavioral, repeated/recurrent habits in general. Furthermore, the change between two or more time points can be measured, and authentic data can be gathered from longer periods than when using a cross-sectional design. Looking at the educational points in this study, the findings illustrated the importance of examining one's own health habits and comparing these habits to those of one's peers. In any case, the children played a large role in analyzing their own responses and giving explanations or speaking in the group. Working in a group evidently raises questions about the number of participants; not all children are confident in expressing their opinions in a large group. The groups in this study contained 9 and 11 pupils, which were large enough to create discussion and small enough to encourage pupils to ask or talk about their own experiences if they wished. One of the benefits of organizing educational sessions based on self-monitoring is the possibility to correct inaccurate or even incorrect beliefs about certain health-related activities. For example, discussions about whether to brush one's teeth before or after breakfast or whether to take a cell phone to bed or place it in another room during the night were very lively and certainly brought out new ideas for the children to consider.

Since the responsible teachers were interested in joining the study voluntarily, they also showed a strong commitment to it. They took responsibility for the study's progress with oral and written instructions from the research team. We did, however, experience some technical difficulties after our research team left the first school, but these were quite easily solved after a few instructional phone calls and messages. Even though the teachers were not highly advanced technology users, they were interested in bringing new technology into their classrooms. In addition, both teachers were very motivated to connect the technology with health education, giving a high priority to health issues. Our experience of visiting the schools was wholly positive, and we easily achieved a mutual understanding of the objectives of the project.

The health game proved to be workable and was able to record health-related activities at several points during the day. A positive aspect compared to "traditional" mobile data collection, whether prompted or gathered at pre-set intervals, was the autonomy of the children in relation to their playing. No previous research justified the use of a data collection period of seven days in a row, but some good experiences were found in previous literature (Christensen et al., 2011), in which a seven-day period was deemed long enough to be able to capture patterns of certain behavior or identify unusual activity. Daily mobile data collection periods of even 30 days have been reported previously, but with older participants and related to only one health-behavior assessment daily (Mays et al., 2010). In this study, the children experienced a week of continuing data collection as appropriate.

As Sugie (2016) mentioned, frequent collection of detailed data by smartphones may cause the problem of missing data. Even though recording health activities 14–16 times a day could be seen as a large task, response rates per day were very high compared, for example, to the study of Christensen et al. (2011), in which the response rate for the prompted text messages was 66%. Most likely, this is suggestive of the children's motivation to use the game, and the game content can thus be judged as interesting. The game itself cannot be described as addictive, so the reason for using it can be assumed to result from pupils' own motivation and interest. Moreover, the pupils were instructed to use the game preferably only once in the morning and once in the evening, limiting the actual daily data collection to two points in the day. Using the game twice or five times a day was, however, solely a decision of the child, and was not monitored by adults. Independence and responsibility may have affected the pupils positively, increasing their motivation to play the game regularly. Another motivator might have been the variation in response possibilities; in addition to written text, short multiple-choice response options and photo shootings were included as data collection methods. Generally, the children were satisfied in the easiness of the game and liked to complete the daily questions. The easy use and good experiences of using the game are consistent with findings reported by Mays et al. (2010) among college students.

In any technical situation, technical expertise is a requirement for success. The problems experienced during the study were mostly due to issues that had not been recognized before the study started. In School A, the school's wireless network was not tested properly beforehand, and therefore, the QR codes did not work as expected. As a result, after an unsuccessful attempt to download the daily game base, we decided to download the game for the pupils for the entire week. For pupils who used their own devices and data services, no problems in connections occurred. In School B, the game was downloaded to schools' devices for the entire week before the study started, and we observed no problems. As with the children in Christensen et al.'s (2011) study, the children in this study were responsible for the devices they borrowed, and they were very careful with them.

### *4.1. Ethical issues, limitations, and future directions*

It was not possible to have all the children play the game due to parents refusing to give their consent and the fact that some children did not want to participate. As in any data collection process, participation was voluntary. Parents expressed some of their concerns about playing the health game to the teacher or the research team, including uncertainty about whether the game application would save geographic locations into the mobile devices as the children brought them home or whether children would record family specific information while at home. Other concerns related to issues of privacy in the use of mobile data collection, as reported previously (Shilton, 2012; Sugie, 2016), and they are very important to note in the planning phase. Not all parents came to the information session where these issues were clarified, and no one asked the research team about these issues beforehand. At one of the schools, some families were not very familiar with mobile devices, and their children did not have one of their own. Therefore, the parents might have had negative attitudes toward the game. However, some children who did not own a phone received permission and participated in the study. Even though they did not have a phone, they were skilled in using the school's device, because they had used it in school for studying purposes. Moreover, children in general cannot avoid seeing their peers using mobile phones, and therefore, the novelty value may not be very large.

In addition to parents' refusal, a few pupils refused to participate in the study. For example, the teacher at one of the schools explained that a group of girls had decided together to stay out of the study, and all the boys had. Therefore, the boys were underrepresented in this study, which may have influenced the actual research findings. Nevertheless, refusing to participate in the study is a decision that has to be respected.

It is possible that the Hawthorne effect changed the children's health routines during the study week, as in any research involving behavior monitoring. This has been reported previously among adults using mobile data collection (Raento et al., 2009; Sugie, 2016). We tried to avoid this effect by repeatedly reminding the children and their parents, both orally and in written text, not to change anything about their living environment or habits during the week. As in Christensen et al.'s (2011) study, in which the researchers feared that children's routines might be affected by carrying a GPS device despite children reporting no effect of wearing the device, the children in this research study reported no changes in their normal daily behaviors or environments due to the tracking.

Since some pupils, especially girls in early adolescence, might be vulnerable in relation to their appearance and excessive self-monitoring (Helfert & Warschburger, 2013), using a game to monitor one's own behavior for a week was a critical issue to acknowledge after the study ended and in the planning phase. Therefore, after pre-analyzing the results, we went back to the study school, gathered the group who had participated in the study, and concretely ended the study. We collected the borrowed devices, made the health game inactive, and discussed with the pupils how it felt to record their own behavior and to stop recording it. The visit took place one week after the data collection ended. The teacher did not participate in the session.

During the education session in which the study was officially ended and the preliminary results introduced, we had to be aware of the nature of the topics under discussion. Although no deeply

sensitive topics were included in the health game, some areas might still have been embarrassing or difficult to discuss or manage for 10–11-year-old children. Some issues the children pointed out were, for example, the late bedtimes of one of their classmates or photos of their breakfasts. They did, however, discuss these things positively and openly; when only one child indicated very late bedtimes every night, she mentioned it herself, and other children mentioned that this issue had already been discussed with her previously. Similarly, when the photos of breakfasts were presented, the children wanted to show what breakfast was their own, whereas others, whose photos were not available, hoped that their photos were presented too. Thus, the children were obviously very used to talking about their own habits and commenting on others with positive intentions.

Since the finalizing education session was based on the research results and was offered only to the study participants, the other classmates did not have the possibility of receiving health education from us. That option could have been offered to them using a different setup, even when the personal experience of tracking their own behaviors was lacking. In terms of equality, offering a tailored health education session to all available pupils at school in this age group would have been a good option, since all the children are in a relatively similar phase in their lives.

## 5. Conclusions

Based on this study, real-time data collection using a mobile game for children has a clear advantage for several reasons. First, the majority of the children were familiar with mobile devices, especially with mobile phones, and they were interested in using them in their free time. Compared to other situations, in which paper questionnaires are given to children each day, using a mobile devices is presumably much more intriguing. Second, the children normally carried their device with them, and therefore, they were able to play the game during the day in their everyday environments. Therefore, they did not have to go to a different setting to fill in the questionnaire, and their parents and school teachers did not have to be involved at all. This gave the children autonomy in relation to their own time. Third, the game application motivated children to play the game daily, even we did not consider it very motivating. Electronically taking photos, writing up one's own activities, and choosing the "correct" choice on multiple-choice questions was experienced as fun.

As a conclusion, multiple-point data collection using a smart phone or tablet game is a modern and innovative method for gathering data from children. However, the process is long and involves collaboration between many professionals. Additionally, it requires ethical considerations not only involving the children taking part in a time-consuming study but also to ensure that all the children have equal opportunities to participate in the study. When applied appropriately, it offers a variety of possibilities and a platform that children like to use and are able to use largely independently of adults.

**Funding**

This study was supported by grants (Marjorita Sormunen) from Finnish Foundation for Nursing Education, Finnish Association of Nursing Research, and Finnish Cultural Foundation. The authors wish to thank the children, their parents, and school teachers for their cooperation in taking part of this study.

**Author details**

Marjorita Sormunen[1]

E-mail: marjorita.sormunen@uef.fi

Hanna Miettinen[1]

E-mail: hanna.miettinen@uef.fi

[1] Department of Nursing Science, University of Eastern Finland, P.O. Box 1627, 70211 Kuopio, Finland.

**Citation information**

Cite this article as: Health behavior tracking via mobile games: A case study among school-aged children, Marjorita Sormunen & Hanna Miettinen, *Cogent Education* (2017), 4: 1311500.

**References**

Abril, E. P. (2016). Tracking myself: Assessing the contribution of mobile technologies for self-trackers of weight, diet, or exercise. *Journal of Health Communication, 21*, 638–646. doi:10.1080/10810730.2016.1153756

Bailey, J., Mann, S., Wayal, S., Hunter, R., Free, C., Abraham, C., & Murray, E. (2015). Sexual health promotion for young people delivered via digital media: A scoping review. *Public Health Research, 3*, 73–83. doi:10.3310/phr03130

Christensen, P., Mikkelsen, M. R., Nielsen, T. A. S., & Harder, H. (2011). Children, mobility, and space. *Journal of Mixed Methods Research, 5*, 227–246. doi:10.1177/1558689811406121

Finnish Game Jam. (2015). *Finnish Game Jam*. Retrieved from http://www.finnishgamejam.com/2015/

Helfert, S., & Warschburger, P. (2013). The face of appearance-related social pressure: Gender, age and body mass variations in peer and parental pressure during adolescence. *Child and Adolescent Psychiatry and Mental Health, 7*, 16. doi:10.1186/1753-2000-7-16

Kearney, M., Schuck, S., Burden, K., & Aubusson, P. (2012). Viewing mobile learning from a pedagogical perspective. *Research in Learning Technology, 20*, 14406. doi:10.3402/rlt.v20i0.14406

Mays, D., Cremeens, J., Usdan, S., Martin, R. J., Arriola, K. J., & Bernhardt, J. M. (2010). The feasibility of assessing alcohol use among college students using wireless mobile devices: Implications for health education and behavioural research. *Health Education Journal, 69*, 311–320. doi:10.1177/0017896910364831

Plowman, L., & Stevenson, O. (2012). Using mobile phone diaries to explore children's everyday lives. *Childhood, 19*, 539–553. doi:10.1177/0907568212440014

Raento, M., Oulasvirta, A., & Eagle, N. (2009). Smartphones: An emerging tool for social scientists. *Sociological Methods & Research, 37*, 426–454. doi:10.1177/0049124108330005

Ravert, R. D., Calix, S. I., & Sullivan, M. J. (2010). Research in brief: Using mobile phones to collect daily experience data from college undergraduates. *Journal of College Student Development, 51*, 343–352. doi:10.1353/csd.0.0134

Roberts, S., Hine, C., Morey, Y., Snee, H., & Watson, H. (2013). *Digital methods as mainstream methodology. Building capacity in the research community to address the challenges and opportunities presented by digitally inspired research*. Retrieved from: http://eprints.ncrm.ac.uk/3156/3/DMMM_NCRM_paper.pdf

Rönkä, A., Malinen, K., Kinnunen, U., Tolvanen, A., & Lämsä, T. (2010). Capturing daily family dynamics via text messages: Development of the mobile diary. *Community, Work & Family, 13*, 5–21. doi:10.1080/13668800902823581

Şahin, F., & Yan, Z. (2013). Mobile phones in data collection. *International Journal of Cyber Behavior, Psychology and Learning, 3*, 67–87. doi:10.4018/ijcbpl.2013070106

Shilton, K. (2012). Participatory personal data: An emerging research challenge for the information sciences. *Journal of the American Society for Information Science and Technology, 63*, 1905–1915. doi:10.1002/asi.22655

Sormunen, M., Kirilina, V., Goranskaya, S., & Tossavainen, K. (2014, October). Intervention tulokset: Lapset, vanhemmat ja opettajat. [Intervention results: Children, parents, and teachers]. *Oral presentation at the Karelia Medical Seminar*, Polvijärvi.

Sormunen, M., Tossavainen, K., & Turunen, H. (2013). Finnish parental involvement ethos, health support, health education knowledge and participation: Results from a 2-year school health intervention. *Health Education Research, 28*, 179–191. doi:10.1093/her/cyt005

Sugie, N. F. (2016). Utilizing smartphones to study disadvantaged and hard-to-reach groups. *Sociological Methods & Research. Advance online publication*. doi:10.1177/0049124115626176