# Children's Health: Evaluating the Impact of Digital Technology

## Final Report for Sunderland City Council

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**EXECUTIVE SUMMARY**

The Children's Health project sponsored by the City of Sunderland Digital Challenge project examined the impact of providing health-focused digital technologies to children aged 11-15 years, in terms of their usage and requirements of such technologies, and their subsequent behavioural changes.

The empirical study ran with three groups of six children over a period of seven weeks for each group. A console-based exercise game and an exercise-focused social website were used in the study and the focus was on opportunistic (unstructured/unplanned) exercise.

The emergent findings are:

- Data collected about physical activity must be more extensive than simple step counts.
- Data collection technologies for activities must be ubiquitous but invisible.
- Social interaction via technology is expected
  - positive messages reinforcing attainments of goals are valued
  - negative feedback is seen as demotivating.
- Participants were very open to sharing information (privacy was not a concern).
- Authority figures have a significant impact on restricting adolescents' use of technologies.

This document reports the how the study was conducted, analyses the findings and draws conclusions from these regarding how to use digital technologies to improve and/or maintain the physical activity levels of children throughout their adolescence and on into adulthood.

The appendices provide the detailed (anonymised) data collected during the study and the background literature review.

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# 1. Introduction

The systematic review of De Meester et al. (2009) indicates that (non-technological) physical activity interventions with adolescents typically have a transient impact. Moreover, it seems that adolescents rarely take a long-term view of how their current lifestyles may affect them in adulthood and as a result they may be less susceptible to persuasion regarding exercise. **Therefore, the challenge from a societal viewpoint is to find interventions that have a long term impact: establishing patterns of exercise behaviour in adolescence that will stay with the individual in later life.** This is the focus of the study commissioned by Sunderland City Council.

There has been limited research into persuasive technologies for children engaging in opportunistic (unplanned, unstructured) everyday activity: this is despite growing evidence of activity levels declining in adolescence, particularly among girls (Sirard & Barr-Anderson, 2008). Therefore this study provided an opportunity to gain insights that might be used to develop beneficial strategies and technologies. Working directly with children in this age group and eliciting their contextualised requirements was key for two reasons:

- the technology that appeals to adults may not appeal to them
- their social environment differs considerably from that of adults (and from that which adults experienced as teenagers themselves).

The project (which ran between July and December 2010) aimed to understand the impact of the provision of a computer game, designed to monitor physical activity, and website, designed to facilitate social support, on the amount of physical exercise taken by children aged 11-15 years. The game application and a social website were used as technology probes to uncover user preferences and requirements for the design of mobile technology to persuade children to engage in more physical exercise.

# 2. Study Design

To investigate the project aim three study groups were identified:

- users of a console based fitness game with activity meter
- users of a console based fitness game with activity meter and a social networking website
- users of a social networking website and a pedometer

For comparison purposes we sought to recruit six members into each group practical purposes: sufficient to give a range of experiences whilst remaining manageable within the project context and resourcing.

## 2.1 Participants[1]

We recruited 18 generally fit and healthy adolescents for the project. Each was required to use a combination of exercise-focused digital technologies on a daily basis over a six weeks period. Their use and reflection on such use was then probed to elicit insights into what would work in terms of persuading them and their peers to establish, and maintain, an active lifestyle (for long-term health benefits).

Recruitment was done through the assistance of a number of voluntary and youth organisations, as well as staff from Sunderland City Council. The Sunderland Volunteer Centre, Sunderland Voluntary Sector Youth Forum and the Youth Strategy Officer in Sunderland City Council all helped by publicising the project to their members and contacts. We contacted more than 50 voluntary youth organisations in the city and provided information about the project (including the incentive of a gift worth £100 as reward for those completing the project). Recruitment began in June 2010 but was slow and the target recruitment figure (of 18) was not reached until September 2010, this may have been due to the impact of the school holidays. The target age range for participants was 11 – 14 years. Ideally, we would have liked to achieve an equal gender split, however the recruitment process revealed that girls, in the main, were reluctant to participate. The final participant group consists of 5 girls and 13 boys, a summary of their details in provided in Table 1[2].

[1] Since we were working with adolescents the researchers had university ethical approval for the study and acquired CRB (Criminal Records Bureau) clearance. We also ensured we had explicit participant and parental/ carer consent once participants were recruited.

[2] Socio-economic data was not collected for the participants.

**Table 1. Participant Details**

| | | | | Residence | |
|---|---|---|---|---|---|
| **Group** | **Participant code** | **Age** | **Gender** | **Post code area** | **Area of Sunderland** |
| A | Ag1 | 14 | Female | NE38 | Washington |
| A | Ag2 | 14 | Female | SR4 | Millfield |
| A | Ag3 | 14 | Female | DH4 | Houghton-le-Spring |
| A | Ab1 | 14 | Male | DH4 | Penshaw |
| A | Ab2 | 14 | Male | NE38 | Washington |
| A | Ab3 | 14 | Male | DH4 | Penshaw |
| B | Bg1 | 13 | Female | SR4 | Grindon |
| B | Bg2 | 13 | Female | SR4 | Grindon |
| B | Bb1 | 15 | Male | SR5 | Hylton Castle |
| B | Bb2 | 13 | Male | SR4 | Pennywell |
| B | Bb3 | 13 | Male | SR4 | Pennywell |
| B | Bb4 | 13 | Male | SR4 | High Barnes |
| C | Cb1 | 13 | Male | SR3 | Doxford |
| C | Cb2 | 11 | Male | DH4 | Shiney Row |
| C | Cb3 | 11 | Male | DH4 | New Herrington |
| C | Cb4 | 11 | Male | SR4 | Pallion |
| C | Cb5 | 11 | Male | SR4 | Pallion |
| C | Cb6 | 11 | Male | SR4 | Pallion |

An additional benefit of recruiting via youth projects was that we also secured access to, and developed relationships with specific youth workers who had existing roles with the participants: this eased aspects of running the project.

Of the 18 participants, 12 teenagers were put into groups (A and B) where they would be required to use a social website (therefore social links were important): the remaining six participants were younger in age (11-13) and operated in an individual manner (in group C). The groups were as follows:

- Group A: users of a console based fitness game with an activity meter and a social networking website. The group members were three girls and three boys, all of whom were 14 years old. They were all friends and attended the same school and youth group.
- Group B: users of a social networking website and a pedometer. The group members were two girls and four boys, five 13 year olds and one boy of 15. They had looser ties, all knew at least two others in the group but they were not all close friends.
- Group C: users of a console based fitness game with activity meter. The group members were all boys, five were 11 years old and one 13 years old. They operated as individuals.

## 2.2 Technology probes

For the study we used different types of technologies for data capture, and for social support as shown in Table 2.

**Table 2. Technologies used**

| | | Group A | Group B | Group C |
|---|---|---|---|---|
| **Data Capture** | | | | |
| Steps | Walk with Me!™ Activity meter | ✓ | | ✓ |
| | Omron Walking Style II pedometer | | ✓ | |
| Other activity | Paper-based log book | | | ✓ |
| | ehealth-elgg website. | ✓ | ✓ | |
| **Social Dimension** | | | | |
| Rewards | Paper-based log book | | | ✓ |
| | ehealth-elgg website. | ✓ | ✓ | |
| Support | "Walk with Me!™ friend | ✓ | | ✓ |
| | ehealth-elgg website social interaction | ✓ | ✓ | |
| Competition | "Walk with Me!™ friend | ✓ | | ✓ |
| | ehealth-elgg website daily and weekly rewards and charts | ✓ | ✓ | |
| Activities | "Walk with Me!™ games | ✓ | | ✓ |
| | Facilities in website | ✓ | ✓ | |

### *2.2.1 The data capture technology*

For Groups A and C the data capture devices were Nintendo's "Walk with Me!™" activity meters. These linked to Nintendo DS-Lite™ consoles and the "Walk with Me!™"[3] game which was used by both groups.

The City Council specifically wanted an evaluation of whether such hand-held devices could have a positive impact on activity and so the use of the consoles by two of the groups was important to investigate this issue.

The activity meters came as a pair, so each member of Group A and C chose a "friend" who would use the other meter. The data for each individual with an activity meter was captured daily through the user wearing/carrying the activity meter from rising until going to bed. The data was subsequently "beamed" up to the console game.

The data capture device used for each member of Group B was an Omron Walking Style II pedometers (with acceleration sensor technology). The researchers investigated a number of pedometers and found these to have acceptable accuracy for this project: since the investigation was not dependent on highly accurate exercise data – but only on indicative values. Moreover, when both an activity meter

[3] The Walk with Me!™ application was chosen since, unlike other reviewed games, it did not emphasise weight loss: we saw this as important in working with adolescents, given the prevalent media focus on unrealistic body images.

and Omron pedometer were worn by a researcher over a full day the data values collected by both were within 5% of each other.

### *2.2.2 The data logging technology*

From the analysis of the literature we had identified a number of design features that needed to be built into data logging technology. These were:

(1) A social dimension: support and competition;
(2) the facility to record:
    (i) daily step counts,
    (ii) additional activities not captured by the data capture device
    (iii) barriers to activity;
(3) the option to keep data private or shared.

The console "Walk with Me!" game provided feature (1) through the pairing-up with a friend and the ability to use the two data sets in a set of mini-games. Feature (2) (i) was provided via the activity meter, but features (2) (ii) and (iii) had to be provided using a different mechanism: for group A that was the elgg website, for group C it was via a paper-based diary. The implementation of feature (3) was under the control of the participant since their data was held within the console and could be kept private or shown to others. In addition there was an option to use their data via the internet with others around the world in a range of related games (" Space Journey" for instance).

We developed a social website that had the required features using the open-source elgg ("facebook-like") environment[4]. An advantage of using this environment was that we could keep the participants within their groups as closed communities: a factor that was essential for child-protection purposes. Standard features within the elgg environment supported a personal presence (via members' profiles and blogs) and social interaction (via personal messages, wall posts and wire posts - short messages to the entire group). In addition, to encourage competition we customised the site to send daily and weekly rewards to those members who achieved their targets and publicised these to the wire. These aspects of the site satisfied feature (1). We also customised the site to enable users to log their daily records of activity, satisfying our feature (2), and provided functionality so that members could keep private or

[4] http://elgg.org

publicise data, satisfying feature (3). Figure 1 shows an example (anonymised) user profile for the site.

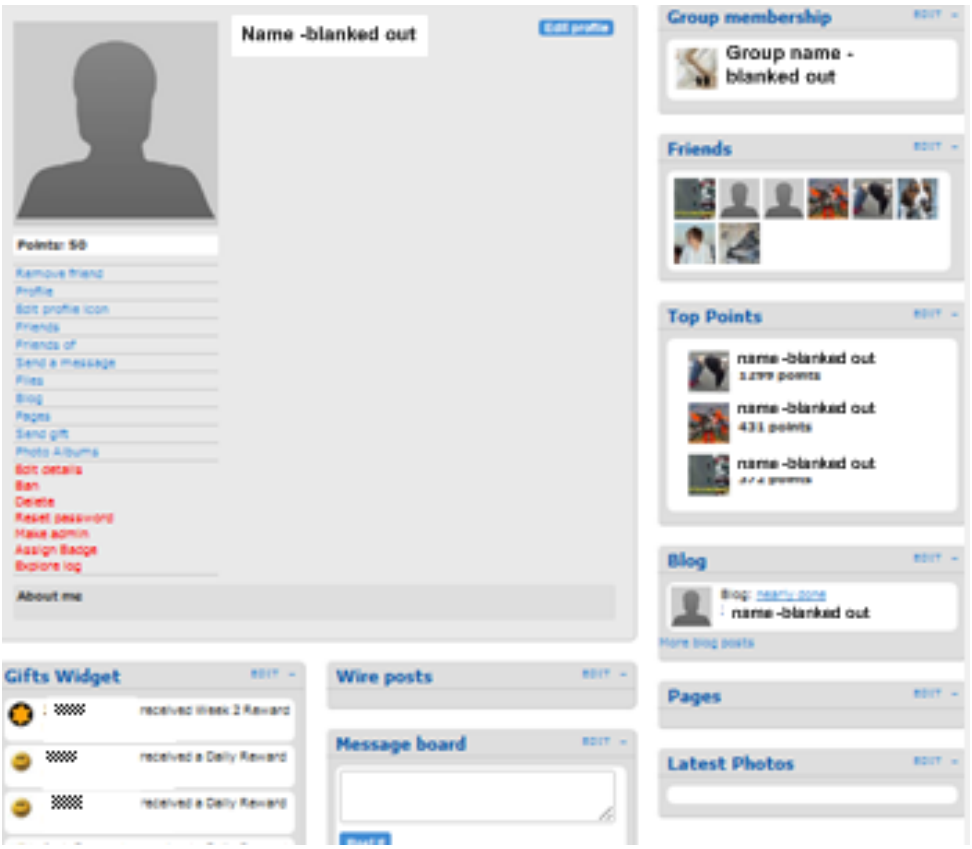


**Figure 1: Profile for a user in the social website**

## 2.3 Process

The study had a baseline week, the six weeks main study (including midpoint innovation workshops for Groups A and B)) and a final assessment session.

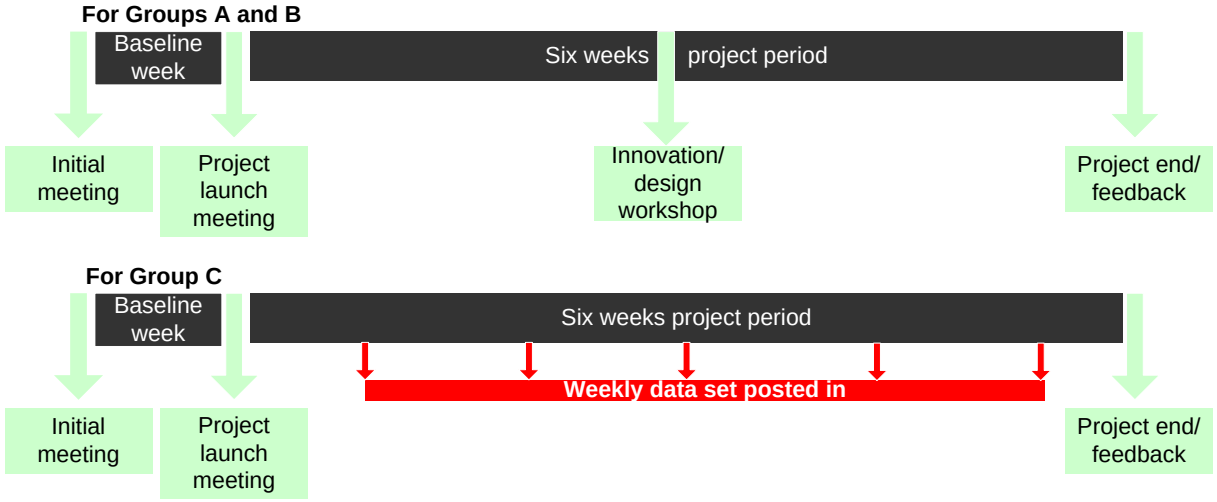


**Figure 2: Timeline for the process for the three groups.**

### *2.3.1 Baseline week*

Each group had an initial meeting where they met the research team, were given some basic information about the project, and were asked to complete a number of questionnaires. These questionnaires assessed each participant's attitudes towards physical exercise and the link with self-image, their technological experience and their views on their current activity levels (the resultant data is provided in Appendices A, B and C). A parents/carers' questionnaire was also used to acquire insight into the family attitudes to exercise (see Appendix D for the data).

The participants were then provided with an Omron pedometer to use over the following week to record their daily steps count. These data were used to determine whether the daily step target (of 10,000) steps would be reasonable during the main study and alert us to any who might need different targets. It also provided a baseline from which to track any changes in activity levels as a result of the intervention. (The data collected are available in Appendix E).

### *2.3.2 Main study phase*

The main study began for each group with a project launch meeting where each group was introduced to the technologies and how to use them, and the study's purpose and their role in it was clarified. We reinforced that the aim of the study was not to try to increase their activity levels, but to help us understand what types of technology would be attractive to typical users of their age. Groups A and B were alerted to the midpoint innovation workshop in which we would seek design ideas for future technologies from them[5].

Over the following six weeks, the participants captured and recorded their daily step count and other physical activities. We also tracked the extent to which Groups A and B used the website and which features were used (see Appendix H), we also had the opportunity to engage with them through the website to maintain their interest and let them see that we were responding to their entries. Group C recorded their data within their individual consoles and paper-based diaries. To avoid feelings of isolation during the project, since they were working on an individual basis, we established a scheme whereby we sent them a weekly letter with a log

[5] The introduction of any technology changes the context, so to minimise the effect we had on the study we made it clear that we had nothing invested in the technologies provided and were just using them as probes. This approach differs from the reviewed studies where technologies had been designed, and were being evaluated, for their effectiveness in changing exercise behaviour.

sheet and stamped-addressed envelope. This established a line of communication and also let us see the emerging pattern of activity during the project[6].

### *2.3.3 Innovation workshop*

An innovation workshop was held with each of Groups A and B (who interacted socially during the project) to explore their experiences and reactions to the technologies, and to elicit design ideas for new technologies that might support, and encourage, opportunistic exercise.

We developed posters to use as probes to representing potential software and hardware artefacts (as shown in Figure 3). These suggested applications that would access step data for a user's benefit within a game. In particular we provided visuals of (i) social games where activity rewards could be used personally or collaboratively, and (ii) applications with a different locus of control where the benefit would enhance the product. A third visual suggested linking activity to existing video games thus binding physical activity into a game of choice for enhanced game-play. The hardware poster focused on what data might be captured, what the devices might look like, and how they might be worn.


**Figure 3: Sample posters and questions used in innovation workshops**

The benefit of providing visual stimulants is that it can promote a rapid generation of ideas for debate, then acceptance or rejection; but the disadvantage is that this can blinker participants into thinking about what has been presented and not what "could be". To account for these issues we operated the two innovation workshops in different orders as shown in Figure 4. Following the workshops we analysed the data to see whether the process adopted had had a significant impact, in practice there was little difference between the two sets of ideas. Within

[6] One participant from Group C withdrew during the project.

both workshops the participants were encouraged to first capture their ideas (either pictorially or textually) and then to engage in group discussions to explore ideas further.

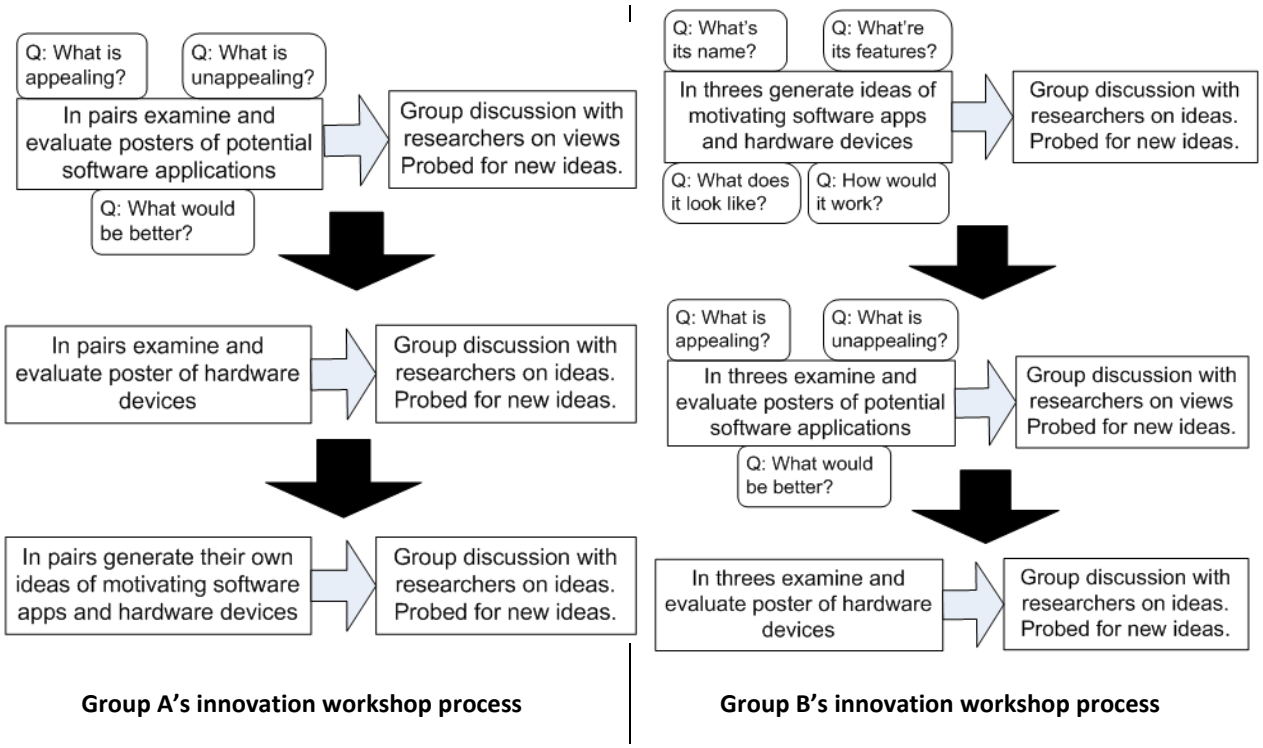


**Figure 4: Processes for the two innovation workshops**

### *2.3.4 Final assessment*

At the end of the study, within a meeting set-up, interviews were held with participants and the baseline questionnaires were re-administered in order to identify any changes to attitudes or exercise levels. Finally the children were given their rewards for participating throughout the full study and thanked for their participation.

# 3. Results

Numerous data sets were collected (as shown in Appendices A to J). These encompassed attitudinal and factual data, qualitative and quantitative data. Questionnaire, interviews, focus groups, probes and digital technologies were used to collect the data. In this section we present the resultant findings.

## 3.1 Perceived activity and attitude (baseline and final assessment comparisons)

### *3.1.1 Technology usage*[7]

All 17 participants who provided data were experienced computer users and had started using computers between the ages of four and eight with at least five years experience; 16 used them at least several times per week, the remaining participant had difficult home circumstances which meant he only used computers several times per month. The main use was social (typically internet-browsing and playing games) with less usage for homework purposes.

16 also owned games consoles which were used less frequently: usage was split between individual and social play with family and friends. Action, sports and music games were the most popular genres, the least popular were strategy games.

All participants owned mobile phones four of Group B and two of Group C knew of mobile applications for tracking physical activity: two of Group B had such apps on their phones.

### *3.1.2 Attitude to exercise*[8]

The attitude to exercise questionnaire was based on existing instruments by Whitehead (1995), Tobe (2005) and Sarkin et al. (2001). Quantitative factual data were collected plus attitudinal data using Likert scale questions (for these the directions of statements were varied to ensure we did not lead the participants in their responses). Using SPSS and a range of non-parametric statistical techniques, we analysed the quantitative data however, there were few results of statistical significance. The items analysed included:

- motivation to exercise,
- enjoyment of exercise,

7 The data on technology usage are provided in Appendix A.
8 The data on attitude to exercise are provided in Appendix B.

- perception of sport,
- physical self perception,
- exercise environment.

The Transtheoretical Model, TTM, (Sarkin et al., 2001) was used to assess commitment to exercise. TTM is a theoretical framework focuses on attitudes and activities over time to assess an individual's intention to make behavioural changes. According to the framework when people make a behavioural change, they progress through a series of six stages (from pre-contemplation to termination).

**Table 3. Stages of the Transtheoretical Model (TTM)**

| Stage | Meaning |
|---|---|
| ***Pre-contemplation*** | No intention to take action in the foreseeable future (the next 6 months). |
| ***Contemplation*** | Serious intention to make a change in the next few months but have not made a commitment to do so. |
| ***Preparation*** | Intention to change in the next 30 days and have taken some small steps toward action. |
| ***Action*** | Successfully made the intended behaviour change but for less than 6 months. |
| ***Maintenance*** | Successfully made the intended behaviour change for more than 6 months. |
| ***Termination*** | The new behaviour has become so habitual that there is no longer any danger of relapse. |

The data in Appendix B.1 shows that at the outset of the study all participants rated themselves quite highly on the TTM (being at least in the preparation stage) and at the end there was some small shift with six participants assessing themselves in on higher stage: only one "downgraded" himself by one stage (from termination to maintenance). This perhaps indicates that they had a more self-aware attitude to their commitment to exercise.

The other data collected (and presented in Appendix B) indicated that the participants had generally positive views on the importance of exercise for health and impact on appearance (providing scores that indicated agreement or strong agreement), and all believed they needed to do exercise. Three were neutral about whether there was a link to a good appearance and two were neutral to the idea of exercise being fun: but all other respondents agreed or strongly agreed with the positive aspects of exercise. Confidence levels were high: 11 believed they did well at any new sport, and assessed themselves as good at sports in general. However, only four expressed a preference for exercise over watching TV.

This age group (11-15) is often considered to be in a state of flux regarding their self-image; therefore we explored their attitudes to confidence and appearance. The results in Appendix B show overall self-confidence and positive self-perception within the groups. 10 claimed to be self-confident (and five of the remaining seven were neutral) similarly nine were happy with the way they did things, (and six of the remaining eight were neutral). The most negative perceptions were for the statements about appearance (as shown in Table 4) but even there more than two-thirds of respondents were positive or neutral in their responses

**Table 4. Perception of their physical bodies.**

| Criterion | Strongly agree | Agree | Neutral | Disagree | Strongly disagree |
|---|---|---|---|---|---|
| Like how my body looks physically | 3 | 4 | 5 | 4 | 1 |
| Don't worry about how I look physically | 1 | 7 | 4 | 3 | 2 |
| Easy to keep my body looking good | 2 | 4 | 7 | 3 | 1 |

We explored the extent to which participants had the motivation and opportunity to maintaining a healthy level of exercise, the data is presented in Appendix B.5. Only four reported that they found it difficult to personally motivate themselves, but nine responded that they only exercised if friends were too. There is symmetry in the spread of answers regarding their commitment to making time to exercise (2:5:3:5:2). The evidence here is not conclusive but perhaps indicates that personal motivation and use of exercise opportunities may be linked to attitudes and what happens within their friendship groups: this is an area warranting further investigation.

We reissued this questionnaire at the end of the study, the data were statistically analysed and no significant changes were identified.

### *3.1.3 Physical activity profile*[9]

To gain an insight into the participants actual levels of activity we used a variant of Kowalski et al's (1997) Physical Activity Questionnaire (developed for children aged 8-14), where popular American sports were replaced by more popular UK sports. The questionnaire focuses on participants recording the previous week's activities to form a snapshot of their typical physical activity. The questionnaire was administered at the outset of the project and thus recorded pre-project activity as shown in Tables C.1 and C.3. The data in Appendix C shows that walking, jogging and football were the most popular activities across the participants and were

[9] The data on the participants' physical activity profile are provided in Appendix C.

undertaken most frequently. These are all examples of exercise that require little equipment and can be adopted opportunistically.

All our participants were school pupils so it was useful to know what opportunities they had for exercise within the school day. The data in C.3 shows that short breaks were rarely used for exercise and even the longer lunch break was, for most respondents a time of little activity. In their free-time the teenagers had more control over their activities, Sunday was their "day of rest" with least strenuous activity whereas their highest level of activity occurred immediately after school.

The questionnaire was administered again at the end of the project to determine whether there had been any changes in behaviour over the duration of the project. Non-parametric statistical analyses showed no significant changes; the change data shown in Appendix C demonstrates this lack of consistent trends across individuals. Some did increase activity levels, whilst other remained constant or decreased. To gain insight into the reasons behind these changes would have required further interviews with individuals, and unfortunately there was not the time within the project parameters for such work.

### *3.1.4 Parents' assessment*[10]

We gathered information from the participants' parents/carers using a (postal) questionnaire. The purpose of this questionnaire was to triangulate the adolescents' view of exercise and also to identify the attitude within the home to exercise. In general the responses were in line with those of the participants. The parents/carers also reported on the main barriers to exercise that they believed affected the participants. Schoolwork was perceived by all parents of those in Group A to be "most likely" or "likely" to affect exercise, this was seen as less as an issue for Group B participants and less again for Group C participants. This issue of level of schoolwork seems to map onto the age groups (and stage of school life) of the groups: those in Group A had all begun their GCSE studies, whereas five in Group B were 13 years old, four in Group C were 11 and one was 13 years old.

Barriers to exercise were perceived by the parents/carers as being:

[10] The data provided by parents are summarised in Appendix D.

- the absence of anyone to exercise with:
  - this was seen as most likely/likely by four Group A parents, three Group B parents and two Group C parents.
- However, in contrast, only one parent (in Group B) believed that his/her child would find the fact that none of his/her friends liked exercise would be a barrier to exercise.
- The final barrier considered was "exercise is physically tiring" and only one parent (in Group C) saw that as being a likely scenario.

The parents confirmed that the normal mode of transport for their children, when a destination was within "walking distance", was indeed walking (and most of the participants normally walked to and from school). Only one was identified as being transported by car in such situations.

## 3.2 Step counts, activity and barriers during the study[11]

Over the course of seven weeks (the baseline week plus six weeks of the study) each participant recorded their daily steps activity plus additional exercise undertaken. For groups A and B this was recorded in their elgg site, for group C it was recorded in a printed log book and within the Nintendo DS "Walk with Me" game. The steps data for each individual is presented in Appendix E.

### *3.2.1 Step counts and activity*

The steps data collected over the longitudinal study, as summarised in Figure 5, suggest a slight downward trend for all three groups, and this pattern is also reproduced within most individuals' data.

[11] The detailed data collected are presented in Appendices E and I.

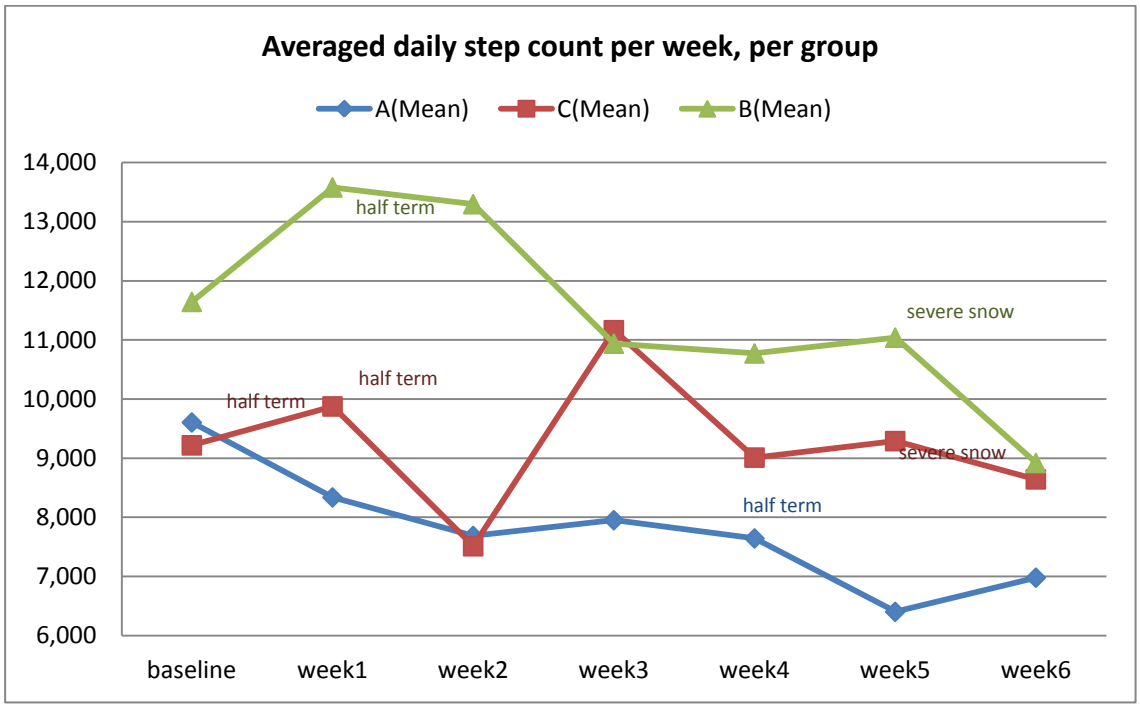


**Figure 5: Mean daily step count by weeks**

During the study there was one week's school holiday which might have affected step rates. However, data analysis showed no significant differences during the holiday period. Group B and C's study period also coincided with two weeks of severe snowfalls, but again, there was no consistent pattern of change in step rates. Looking at the steps data in more detail (in Table 5) we can see variations in the extent to which the participants achieved their daily targets. 12 participants achieved their targets more successfully over the baseline week than over the six weeks of the main study. Perhaps motivation to maintain the steps level over six weeks was a much harder challenge.

**Table 6: Percentage of time steps targets reached.**

| participant | Ag1 | Ag2 | Ag3 | Ab1 | Ab2 | Ab3 | Bg1 | Bg2 | Bb1 | Bb2 | Bb3 | Bb4 | Cb1 | Cb2 | Cb3 | Cb4 | Cb5 | Cb6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| baseline | 14 | 57 | 71 | 29 | 29 | 43 | 43 | 14 | 29 | 71 | 100 | 29 | 14 | 43 | 71 | 100 | 29 | 29 |
| main study | 14 | 52 | 50 | 17 | 10 | 5 | 21 | 17 | 33 | 88 | 90 | 40 | 21 | 29 | 81 | 57 | 14 | 19 |
| weekdays | 20 | 60 | 63 | 17 | 13 | 7 | 13 | 13 | 33 | 93 | 100 | 50 | 20 | 33 | 87 | 77 | 17 | 20 |
| weekend-days | 0 | 29 | 14 | 14 | 0 | 0 | 36 | 21 | 29 | 64 | 57 | 14 | 21 | 14 | 57 | 7 | 7 | 14 |

15 participants achieved their targets more successfully over weekdays than during weekends: indicating perhaps that their school life keeps them active. This is in line with their self-assessed activity levels discussed earlier. Qualitative feedback from interviews indicated that some liked to have "lazy days", but in contrast one teenager considered the weekend to be the only period

when she could devote time to an activity of her choice (which was dance sessions of up to five hours duration). However, she was frustrated that the "Walk with me!™" activity meter design meant that it was impractical to wear during dance, and therefore the steps from this high-level exercise were lost.

### *3.2.2 Self-recorded Activity*

Groups A and B used the elgg website to log any physical activity that they had done during each day. Group C did the equivalent in their log books. This was important particularly since the data capture devices only logged steps-based data – hence there was no accurate way to capture energy expended whilst swimming, cycling, etc. Moreover, even activities such as football and dancing needed to be recorded separately since it was noted that the devices did not accurately record step activity during such exercise. Therefore in looking at the steps data in Appendix E it is important to note that levels of physical activity would frequently have exceeded those that were recorded by the devices. Individually across the three groups we had those who were keen cyclists, girls who regularly attended dancing sessions, and boys who frequently played football whose activity levels were under-reported by the data capture devices.

### *3.2.3 Barriers[12]*

Groups A and B also used the elgg website to log daily barriers that affected them individually in doing **and** monitoring their exercise (Group C captured the equivalent data in their log books). We transcribed these data sets and used them to build an affinity diagram to identify the main barriers that prevented exercise. The key barriers to activity that were reported were:

- illness (9),
- weather (snow and rain) (7),
- homework (4),
- holidays (3),
- choosing to be inactive – having a "lazy day" (3)
- long distance journey (1).

The key difficulties in recording the full number of daily steps accurately were caused by:

- forgetting to wear the device (5),
- inability to wear during an activity (nowhere to keep it) (4),
- ineffective data recording by the device although worn (4),

[12] This data is recorded in Appendix I

- loss of the device (2)
- being prevented from wearing the device by someone in authority (2).

Some of these issues emerged again when the participants were asked for feedback on the technology probes and the study (this is covered in section 3.4).

## 3.3 Final assessments[13]

At the end of the full study the attitudinal questionnaires were issued again and data collected to identify any changes (as discussed earlier) and to capture the individual participants' reaction to the project. Group feedback was then also taken during an informal discussion with Groups A and B (and on an individual, or pairs, basis with participants in Group C).

### *3.3.1 Step activity*

Four of Group A, two of Group B and two of Group C said they would continue to monitor their steps after the project had ended, two of each group were undecided. Only two (from Group B) had definitely decided to **not** continue monitoring their activity. Therefore although there were limitation in the devices used the participants remained interested in tracking what they were doing.

It was interesting that nine (half) of the participants across the groups believed that their physical activity had increased as a result of the monitoring and only two (both in group B) were sure that it had not. This contrasts with the steps data (discussed earlier) which saw a gentle decline in activity.

### *3.3.2 Social support and competition*

Groups A and B used the elgg social website and were encouraged to interact with one another and therefore were asked about this experience. Group C were using the Nintendo DS game (only) and therefore their social exposure was limited to the interaction with their "Walk with me!™" friend.

#### 3.3.2.1 Support and competition within the social website (elgg)

Different views were expressed about willingness to share data. One Group A member preferred not to share his since he felt ashamed that he had not taken as many steps as the others. The other five group members were open to sharing their data, but expressed similar

[13] The full data for this section are provided in Appendix G.

reservations about sharing low step counts *"…depends how many steps I did that day"*. Group B members seemed much less concerned about others seeing their steps *"I don't mind who sees the option", "I'm proud of the steps I did, I want others to see"*. Group A members were more interested than Group B members in seeing their group members' data. A Mann-Whitney test revealed that this difference was significant ($Z = -2.068$, $p<0.04$) Group A (mean 3) were more interested in seeing each other's data than Group B (mean 2.17). This difference in social interaction was also evident in comparing the two groups' activity within the website. The number of communications with the group or individuals for Group A was (for each member) 61, 54, 34, 31, 20, and 1. Whereas the comparable numbers of communications for Group B were 16, 6, 1, 0, 0, 0. This sharing with, and interest in, one another may reflect the stronger friendship ties between Group A than Group B[14].

#### 3.3.2.2 Rewards and motivation within the social website

Participants using the website were asked to indicate if it had created a sense of competition, a Mann-Whitney test revealed ($Z= -2.142$, $p<0.032$) that Group A indicated that the site created competition significantly more (mean rating 3.83) than Group B (mean rating 2). The competition did not appear to stem from the rewards issued for achieving targets as there were no differences between the two groups in terms of the impact of rewards on motivation to be active. Again, it may be that the existing social bonds between members of Group A was the overriding factor here.

#### 3.3.2.3 Social support and competition within the Nintendo "Walk with me!™" game

The participants in Groups A and C used the Nintendo "Walk with me!™" activity meter, uploaded their data to the game and then had access to a range of "mini-games" to use within the device. Each participant also chose someone to be a "Walk with me!™" friend, using the second activity meter. This enabled a sense of one-on-one support and competition. These participants reported sharing their data with their friend to different extents: four shared the data every day, two shared once or twice a week, three shared less than once per week and one participant's friend lost the activity meter. The effect of the friends on the participants' daily step count was perceived by only one participant as being high, however four participants did report a high increase in their friend's activity as a result of the using the game.

[14] The elgg website data usage data is presented in Appendix H

Participants were asked if they would value comparing their step/life rhythm graphs with their Walk With Me friend's:

- seven said yes (in addition, six of these thought it would motivate/provide competition).
- four said no
- one thought however that it might motivate
- one believed he'd be in the losing position.

Informal verbal feedback from one of the friends to the research team confirmed anecdotally that the use of the game could have an impact in generating a level of competition. It also raised the awareness of activity levels and motivation to do more exercise for this particular friend (a parent).

#### 3.3.2.4 Rewards and motivation within the Nintendo "Walk with me!™ game

The five "mini-games" that are provided in the "Walk With Me" game aim to both report activity and motivate individuals to undertake exercise. Of the mini-games the "Walk the World" game was highly rated by all the participants) the supporting comments all referred to the motivation it provided. It rewarded participants for their achievements with images and information about places they reached as they achieved certain targets. These images changed as they earned them and this issue (of need for variety) was a theme that re-emerged during the innovation workshops. In contrast the mini-games least liked were "Ranking" and "Illuminate" which presented the basic step data in different formats: they were seen as "boring". The use of stamps for achievements (as also used within Nintendo's wii products) were seen as motivational by three participants but six disagreed.

## 3.4 Feedback on technology probes[15]

In the innovation workshops we not only gathered design ideas but also feedback on the technology probes used in the study. The data sets were analysed using card sorts and affinity diagrams. Similar data were collected from Group C participants in interview sessions.

### *3.4.1 Feedback on data capture devices*

The emergent themes for the activity meter were:

[15] See Appendices G and J for detailed data

- Wearability: flexibility was needed in positioning the device around the body
- Lack of accuracy in recording step counts (one girl reported *"the activity meter is only picking up steps from one leg!"*)
- Data visibility: for those using activity meters step counts could only be seen once data had been uploaded to the console.
- Integration with other technologies such as the wii.

### *3.4.2 Requirements of activity devices*

Our participants wanted activity devices to record data from a range of activities (such as bicycling, badminton, swimming). Although it can be argued that the devices used could record during some of these activities (such as running, tennis) problems were experienced with wearing and keeping devices in place during strenuous activities *"… I tried keeping it in my goalie gloves"*. 10 participants had typically kept the device in a pocket, six a clip, and one in a bag, but this was not always suitable. 11 wanted redesign for wear-ability, six wanted more discreet devices.

Not all exercise can be measured via steps therefore 10 participants suggested heart rates could be measured and the five girls plus three boys wanted to know the calorific value of their activities. Other functionality that was of interest included calculation of the average walking speed (eight participants), calculation of distance covered (all of group A, the two girls in group B and three boys in Group C) and a record of routes walked (six participants).

## 3.5 Design ideas for future devices and applications

The participants' evaluation of the research team's ideas generated the following themes.

### *3.5.1 Linking steps to standard digital games*

Using step counts as rewards for existing digital games was generally an appealing concept which generated the following themes:

- Game content and genres: for this to appeal widely various genres would need to be included from action-based to collaborative games. *"…girls don't really like war and action games so you've got to make them unisex"*
- "It's cheating": the positive view of this was that advantages in a game would be won through physical activity, but some worried that a it might undermine the point of playing the game.

### *3.5.2 Linking steps to virtual pet game:*

Here the emergent themes were:

- Competition: "*guilt-tripping*" participants into more exercise when comparing their pet to others'.
- Target audience: this would only attract a subset of people, *" … girls, under eights"*.
- Boredom: variety is needed otherwise users would abandon the game.
- Value of the pet: there is emotional buy-in which may have a positive impact (in that the pet benefits from users' activity); but there are demotivating costs "…*if I'm too busy my dog might die*".

### *3.5.3 Link steps to social games*

This idea was generally highly rated, although one boy commented "*… I'm not bothered what my friends are doing as long as I'm doing well"*. The emergent themes were:

- Social Collaboration: communication needs to built in, friends can work together *"… I like to be able to share with friends".*
- Appropriate content: variety is needed, suggestions include farms, restaurants, building hotels, building an army.
- Negative consequences (such as crops withering) need to be avoided as they demotivate.
- Rewards are desirable: to convert activity into points for "*buying things*".
- Platform accessibility: it is important that any game is accessible so it was suggested that is it would be better on a gaming console than being reliant on access to the Internet.

### *3.5.4 Participants' own design ideas for future devices and applications*

All of the features that emerged from reviewing their experiences and evaluating the research teams' probes re-emerged when the groups were probed for their novel ideas. However, there were some additional emergent concepts. These were:

- Integration into existing objects (items already used – e.g. mobile phone, keys).
- Use of "negative" persuasion - sufficient exercise is needed to unlock something that is wanted *"… play your ipod music but only when you do activity",*
- Use of "positive" persuasion - rewards link to energy levels "…a text sent to your phone saying a sport and a length of time, if the person does it, there will be phone credit topped up on the phone"
- Use of "kinetic" persuasion – exercise powers some physical appliance "… the more steps, the *more battery power you have for your phone"*
- Individualistic – egocentric approaches focusing on recording the individual and broadcasting to others
- Real world rewards – providing discounts, "*freebies*", financial rewards.

# 4. Discussion

The technology probes enabled us to learn about the requirements adolescents have of supportive technology for exercise and activity through focusing on them as "users in context", field testing the technologies, and inspiring users to think about new technologies. In this section we present our discussion under these headings.

## 4.1 Users in context

The data collection devices provoke different reactions in different people. For instance, on receiving the Omron pedometers the boys in Group A immediately started running and jumping around the room to test their accuracy and compete with one another in generating steps totals on the pedometers. Whereas the girls sat in a social group investigating the features of the device and how to use it. In everyday use the devices needed to be able to adapt to the context in which they were being used; and this context can change within a day (for instance from walking to cycling). Participants in the reviewed studies (for instance Consolvo et al. (2006), Lin et al. (2006), Toscos et al. (2008)) identified the same themes of wear-ability, visibility, inaccuracy, and inability to record non-step based activity.

The social context within which the teenagers operate differs from that of many adults in terms of viewing themselves as individuals, members of friendship and family groups, and members of society at large. As individuals the "ordinary" teenagers in this study did not have significant concerns about their self-image and were generally self-confident. Moreover, they belong to a generation that sees sharing the minutiae of their daily lives via various media as the norm (in contrast to most adults); and this sharing, tends to go beyond close circles of friends, thus privacy is not a concern.

Most of our participants liked seeing the group members data displayed but were not interested in the rankings: social competition was not high on their agenda. Toscos et al's (2008) teenagers (existing friends) saw sharing of achievements as providing healthy competition and motivation: although there were concerns that over the long term this might be an unhealthy obsession. Whereas in Arteaga et al.'s (2010) study the teenagers shared achievements with their choice of people, but no particular effect was identified. Toscos et al. (2008) also identified a positive effect of social support amongst their participants (provided

via text messages), however this was affected by the quality of the messages sent. For the adult study groups social support has been assessed as having an overall positive impact in those studies where social bonds already existed (Ahtinen et al., 2010; Consolvo et al., 2006). In contrast Lin et al's (2006) participants, who were not friends rarely used the anonymised social chat facility. However, in each of the adult studies reviewed, social competition has been assessed as having an overall positive impact (Ahtinen et al., 2010; Consolvo et al., 2006; Lin et al., 2006).

The family played an important role in our study. Support from family members (or a significant adult in their lives) was important in maintaining the participants' involvement in our study. Moreover, the engagement of family members as "Walk with me!™" friends acted as a catalyst in some families increasing their overall exercise levels.

However, there are factors outside these social groups that affected their exercise levels and their freedom to monitor their performance. For our groups the factor that most significantly inhibited exercise was the school workload that accompanied their two-years GCSE study (from 14-16), and which begins to build in the pre-GCSE year (around age 13). The second key factor was the existence of different authority figures in their lives who impacted on what devices they could and could not use, and when they could do so (for instance mobile phones are banned during school hours).

## 4.2 Field testing the technology

As a result of the participants using the technology probes for a substantial time period (six weeks for the main study) it was apparent that for users to retain motivation in collecting and logging data they needed to be confident that the devices they used were accurate and reliable. Moreover, they needed to be able to capture more than just steps data. For those using the Nintendo "Walk with me!™ activity meter there was a mix of reactions between those who were pleased that their activity meter did **not** display the steps count, and those who were frustrated by this feature: this indicates the need for customisation of devices. The wearability of the data capture devices is a key concern. Moreover, the mechanism for effectively uploading and storing the captured data needs to be seamless and automatic in order to generate user satisfaction.

During the study some participants had a one-week school holiday which we thought might affect step rates. However, the data analysis showed no significant differences for individuals during the holiday period. Groups B and C's study period also coincided with two weeks of severe snowfalls, but again, there was no consistent pattern of change in step rates. It might be expected that exercise levels would drop for school children during holidays and periods of snowy weather. However, although there was a drop in activity for some individuals, others increased their levels of activity (for instance taking advantage of the snow to do those things that can only be done in such conditions: snowball fights, sledging etc). The only research that we identified that took the impact of the season into account was Consolvo et al's (2008) where they explicitly examined how it had affected participants. Their study included Thanksgiving, Christmas, New Year, poor weather and dark nights; rather than reducing the exercise done (as they had expected it might) their participants reported that use of the specific software (UbiFit Garden) had motivated them to overcome seasonal inertia. Whereas there was no feedback from our participants to indicate that the technology probes used had acted as a motivational prompt in this way.

As a research team we discovered that working with users of this age group is very different from working with adults, either in the field or lab. We were not perceived as authority figures (unlike teachers or youth leaders) so the substantial support provided by the youth leaders and parents/carers was key in keeping the participants engaged and the project running smoothly. However the smooth running of the project was unexpectedly affected by the recurrent loss of equipment (pedometers and activity meters) and contingencies were needed to deal with such issues.

### 4.3 Inspiring users to think about new technologies

The technology probes provided a baseline for the participants to work from in proposing new design ideas; and the innovation workshops were successful in generating user-centred design ideas. Moreover, the field testing feedback, the innovation workshops and the individual interviews provided consistent messages about the design ideas that emerged. Which were that:

- Success with opportunistic exercise technologies will be dependent upon the extent to which they incorporate ubiquitous wearable technology (where data is visible when wanted, and hidden when not). For preference these data capturing devices should be embedded in existing products that are already carried by the users, to reduce need to remember and care for an additional object. However the nature of such gadgets needs to be able to adapt to the context in which they are being used.
- In providing support and motivation for the users the feedback needs to keep their interest: therefore, rewards and messages linked to their performance need have variation built in to maintain a sense of excitement and anticipation. The motivational messages need to be positive in tone; negative feedback linked to little exercise is seen as demotivating and likely to lead to avoidance.

# 5. Conclusions

This study of has been valuable in providing an insight into some issues that need to be considered to ensure digital technologies with a health and well-being focus which are aimed at adolescents effectively engages them in exercise and/or maintain their levels of physical activity.

We saw differences between the participants' attitudes to, and uses of, technologies in comparison to the adult participants discussed in the literature. For instance, one aspect of the technology probes that seemed to have little impact on the participants was the use of persuasion (through the provision of rewards and positive messages for activity done). This differs from the studies of adults that we reviewed. In contrast, in this study there is some evidence to suggest that, for adolescents, personal motivation and use of exercise opportunities may be linked to the attitudes of, and what happens within, their friendship groups (rather than being stimulated by technological devices). This suggests that strategies for **structured** exercises might be beneficially developed to work within these peer groups rather than with individuals or structured teams.

The evidence from both the participants and their parents/carers would suggest that walking is the most common mode of transport (for walkable distances) and most participants walked to school. Therefore if looking for opportunities to integrate **opportunistic** exercise into daily life this would be the most beneficial area from which to start.

However, the relationships between personal attitude and desire to change, motivation and persuasion is unclear. Therefore, until the mechanisms at play here are better understood it seems that novel technologies designed to engage users in opportunistic exercise may be ineffective since the fundamental question of what, and who, needs to be designed for remains unanswered.

Finally, the participants in our study were all in good general health and were relatively active. Therefore, they did not need to engage actively in a study like ours for specific health benefits. It may be that adolescents who are already exhibiting health problems (because of lack of

exercise) would react differently to the technology probes and identify different needs. This is an area to explore further.

## 6. Acknowledgements

We would like to thank Sunderland City Council for funding this project and the participants in our study for their contribution. In particular we would like to thank the youth leaders, Pat Garrigan, Martin Robson and Katrina Spurs, for their liaison role between ourselves and the participants over the course of the study.

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# Appendix A: Participants' Self-reported Technology Profile

## A.1 Use of Computers

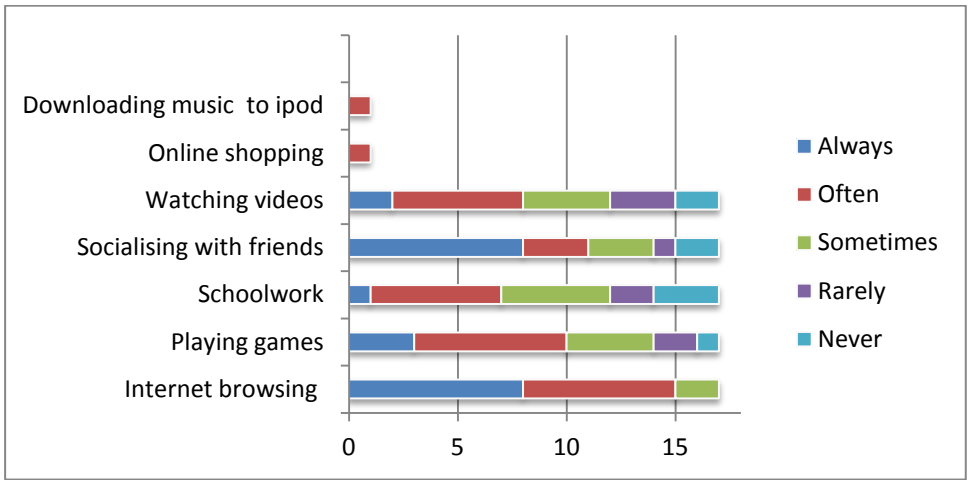
**Age at which started using computers.**

| Group \ Starting Age | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|
| Group A | 6 | | | | |
| Group B | | | | 4 | 2 |
| Group C | 2 | | | 3 | |

**How often the participants use a computer**

| | Every day | Several times a week | Several times a month | Less than once a month |
|---|---|---|---|---|
| Group A | 3 | 3 | | |
| Group B | 6 | | | |
| Group C | 3 | 1 | 1 | |

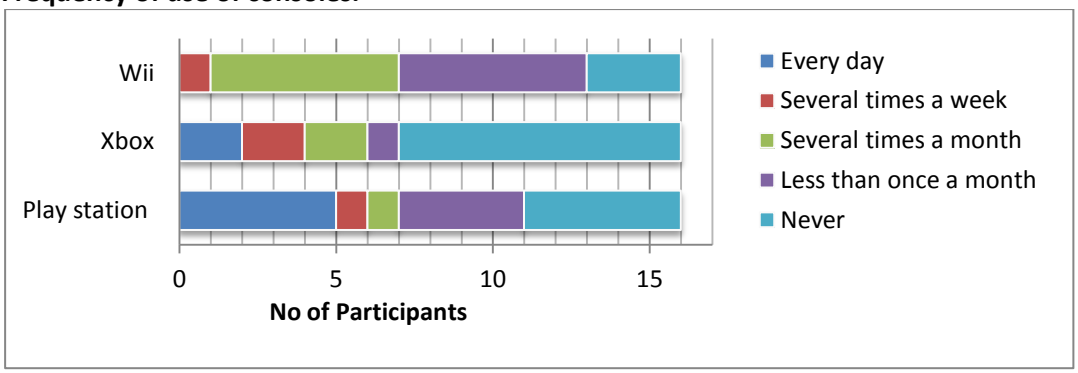
**What computers are used for**




## A.2 Games consoles

Before the start of the project 16 of the 17 participants owned games consoles

**Frequency of use of consoles.**

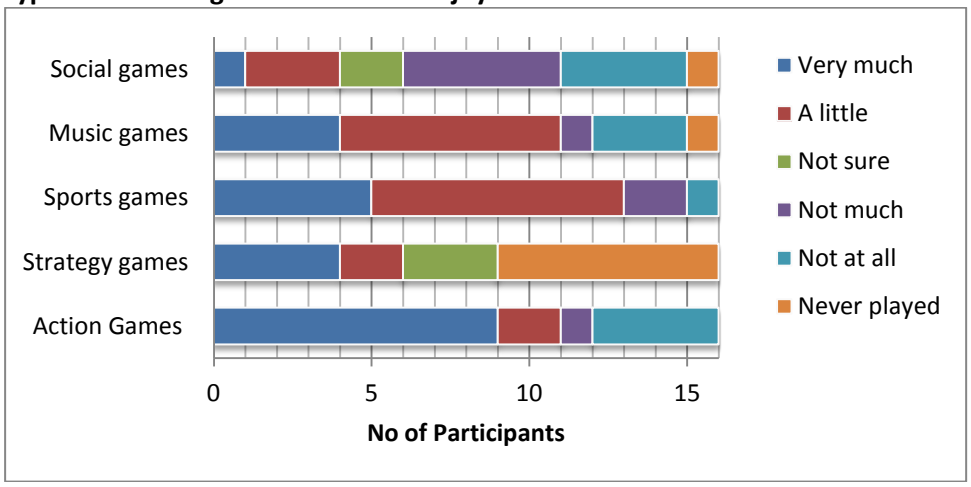


**Where and how the participants mainly use consoles**

Some participants provided multiple answers for these questions. None chose the option of "at youth club" or identified anywhere else.

| | Where | | Mainly with whom | | |
|---|---|---|---|---|---|
| | At home | At friend's | On my own | With friends | With family |
| Group A | 6 | 1 | 3 | 2 | 1 |
| Group B | 5 | 2 | 2 | 3 | 3 |
| Group C | 5 | 1 | 2 | 4 | |

**Types of console games that were enjoyed.**




**Other technology participants owned**

In both groups A and B one boy owned both a Nintendo DS and a Sony PSP. In group B two boys and one girl owned Apple iPods. In group C two boys owned Apple iPods, one owned a Nintendo DS and the other owned a Sony PSP.

## A.3 Mobile Phones and exercise applications

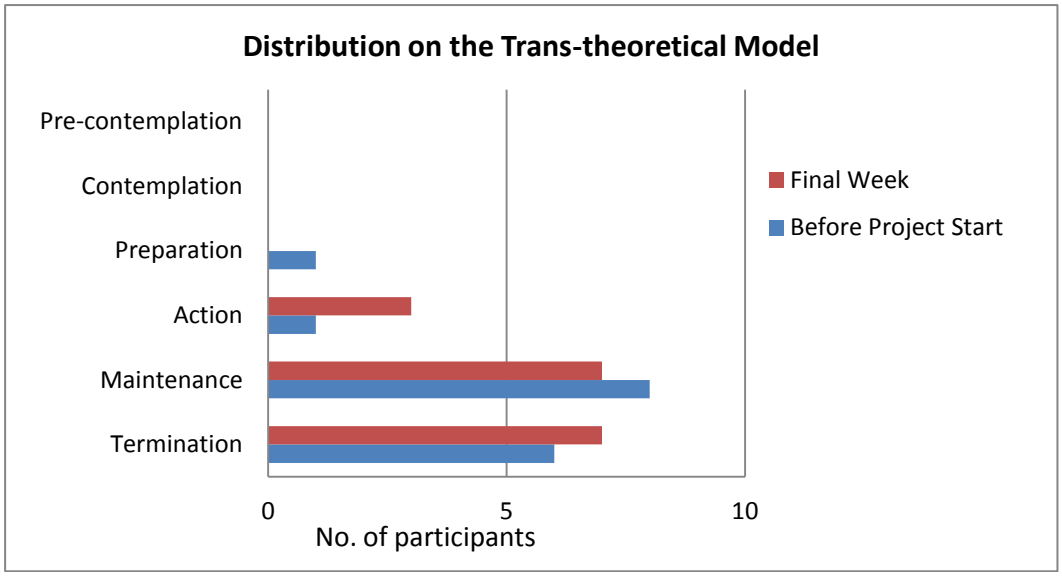
All 17 participants owned a mobile phone. Four in group B and two in group C knew that there were applications for mobiles that could help track physical activities, two in group B had such an application on their phone.

# Appendix B: Participants' Self-reported Attitude to Physical Activity

## B.1 Self-assessment on the Trans-theoretical Model

| TTM Stage | Meaning |
|---|---|
| ***Pre-contemplation*** | No intention to take action in the foreseeable future (the next 6 months). |
| ***Contemplation*** | Serious intention to make a change in the next few months but have not made a commitment to do so. |
| ***Preparation*** | Intention to change in the next 30 days and have taken some small steps toward action. |
| ***Action*** | Successfully made the intended behaviour change but for less than 6 months. |
| ***Maintenance*** | Successfully made the intended behaviour change for more than 6 months. |
| ***Termination*** | The new behaviour has become so habitual that there is no longer any danger of relapse. |

**Comparison of Self-Assessed Ratings on the TTM: Final week v. Pre-project**

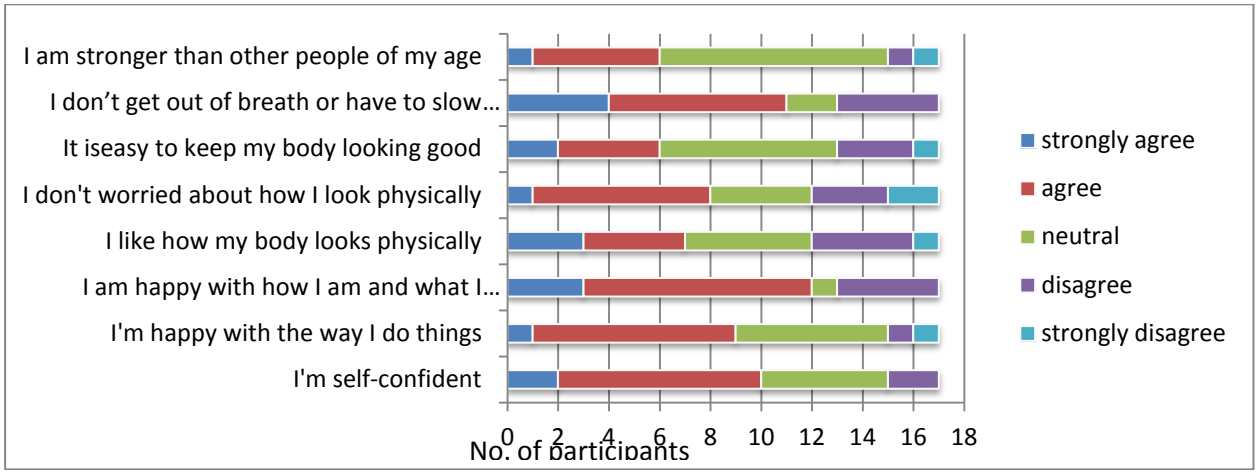



**Overall Change in Self-Assessed Ratings on TTM: Final week v. Pre-project**

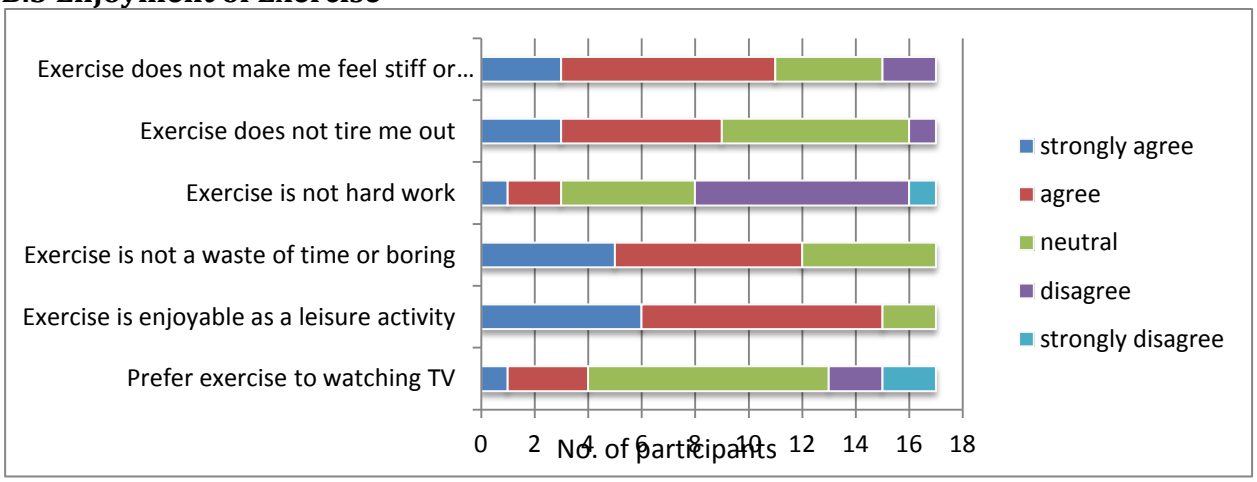
| | Group A | Group B | Group C |
|---|---|---|---|
| **Increase** | Ag1, Ag3, Ab1, Ab3 | Bb1 | Cb3 |
| **No Change** | Ag2 | Bg1, Bg2, Bb2, Bb3, Bb4 | Cb1, Cb2, Cb4 |
| **Decrease** | Ab2 | | |

*N.B. Where change was recorded it was by one stage up or down*

## B. 2 Motivation for Exercise



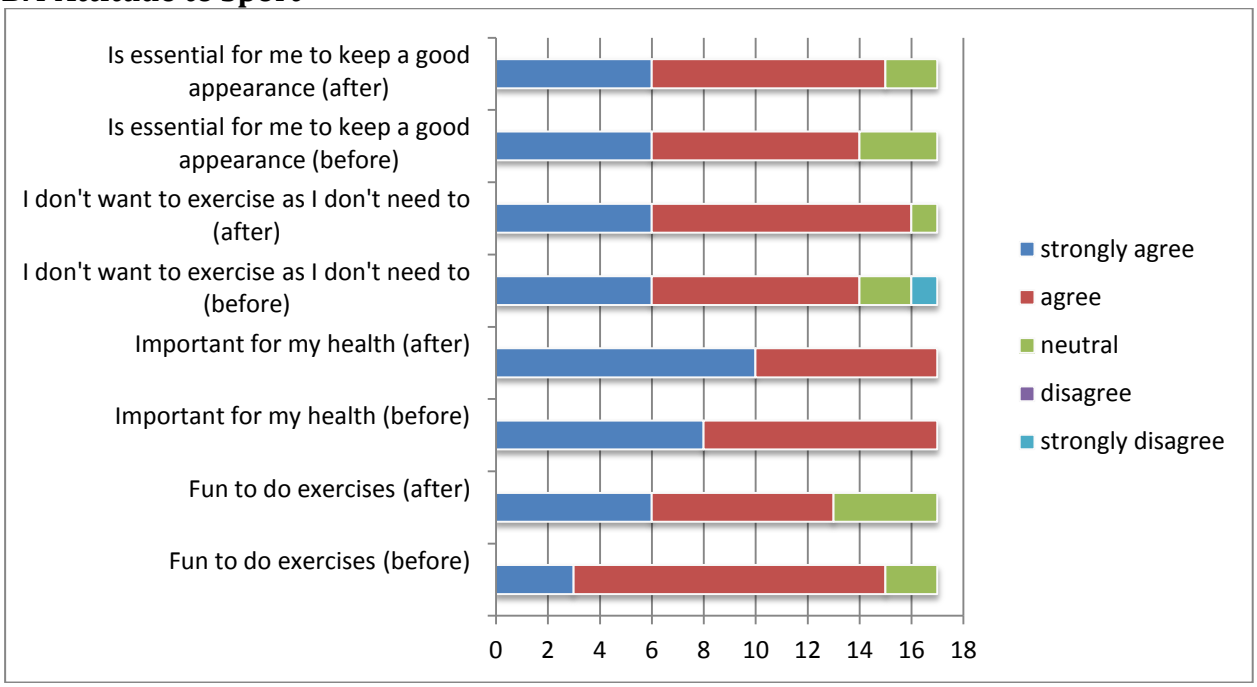

## B.3 Enjoyment of Exercise

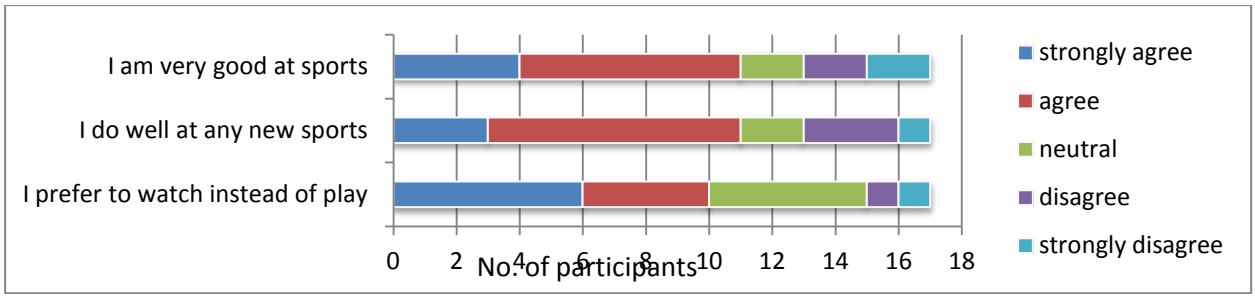



**Overall Change in Self-Assessed Enjoyment of Exercise: Final week v. Pre-project**

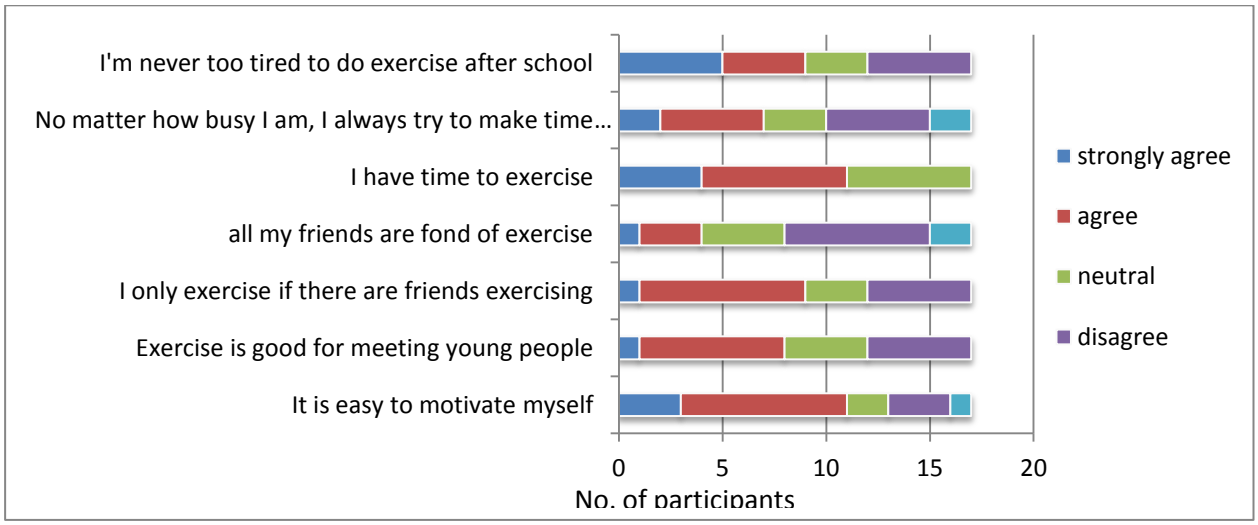
| | Group | Prefer exercise to watching TV | Exercise is enjoyable as a leisure activity | Exercise is not a waste of time or boring | Exercise is not hard work | Exercise does not tire me out | Exercise does not make me feel stiff / sore |
|---|---|---|---|---|---|---|---|
| agree more | A | 1 | 1 | 2 | 0 | 2 | 1 |
| | B | 2 | 0 | 2 | 3 | 1 | 1 |
| | C | 1 | 0 | 1 | 2 | 0 | 1 |
| | **Total** | **4** | **1** | **5** | **5** | **3** | **3** |
| same | A | 4 | 4 | 3 | 4 | 3 | 3 |
| | B | 2 | 4 | 3 | 1 | 2 | 4 |
| | C | 0 | 2 | 3 | 1 | 3 | 3 |
| | **Total** | **6** | **10** | **9** | **6** | **8** | **10** |
| agree less | A | 1 | 1 | 1 | 2 | 1 | 2 |
| | B | 2 | 2 | 1 | 2 | 3 | 1 |
| | C | 3 | 2 | 0 | 1 | 1 | 0 |
| | **Total** | **6** | **5** | **2** | **5** | **5** | **3** |

## B.4 Attitude to Sport




## B.5 Exercise environment

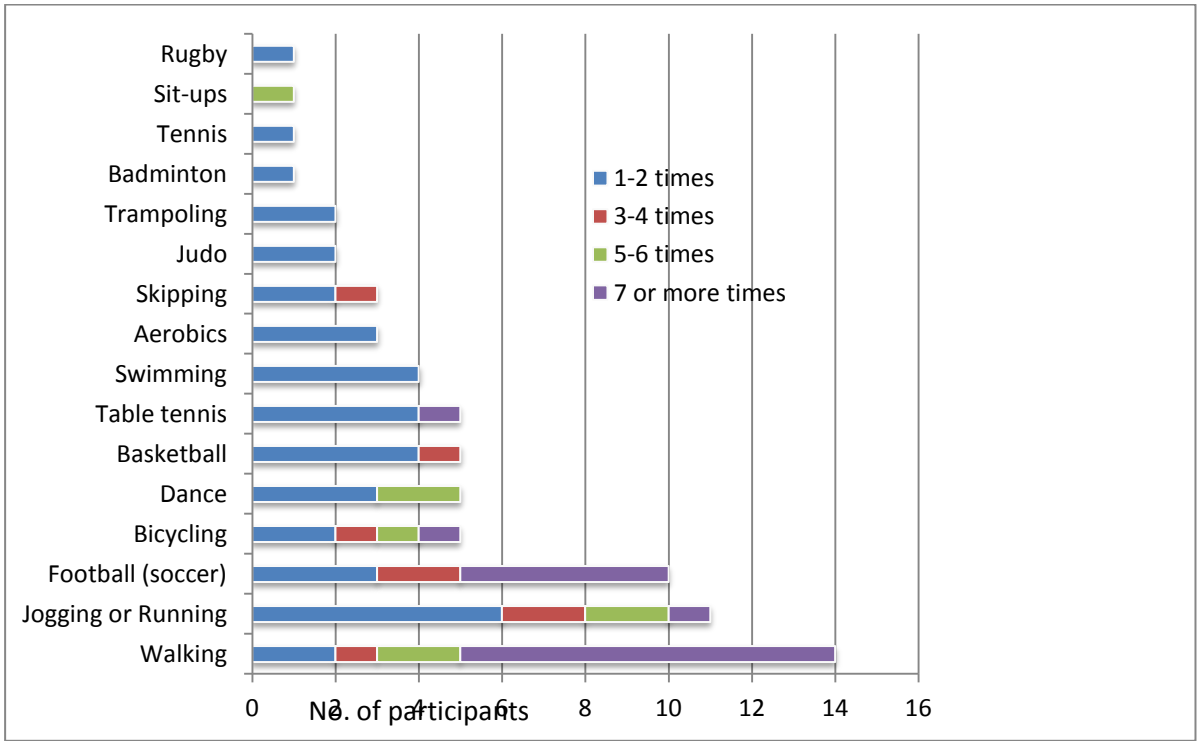


# Appendix C: Participants' Self-reported Engagement in Physical Activity

N.B Participant Cb5 withdrew from the study and provided no data.

## C.1 The Number of Participants Engaged in Specific Activities, and their Frequency (in Pre-project Week)

| Activity (Ranked by Popularity) | 1-2 times | 3-4 times | 5-6 times | 7 or more times | Total |
|---|---|---|---|---|---|
| Walking | 2 | 1 | 2 | 9 | **14** |
| Jogging or Running | 6 | 2 | 2 | 1 | **11** |
| Football (soccer) | 3 | 2 | | 5 | **1** |
| Bicycling | 2 | 1 | 1 | 1 | **5** |
| Dance | 3 | | 2 | | **5** |
| Basketball | 4 | 1 | | | **5** |
| Table tennis | 4 | | | 1 | **5** |
| Swimming | 4 | | | | **4** |
| Aerobics | 3 | | | | **3** |
| Skipping | 2 | 1 | | | **3** |
| Judo | 2 | | | | **2** |
| Trampoling | 2 | | | | **2** |
| Badminton | 1 | | | | **1** |
| Tennis | 1 | | | | **1** |
| Sit-ups | | | 1 | | **1** |
| Rugby | 1 | | | | **1** |



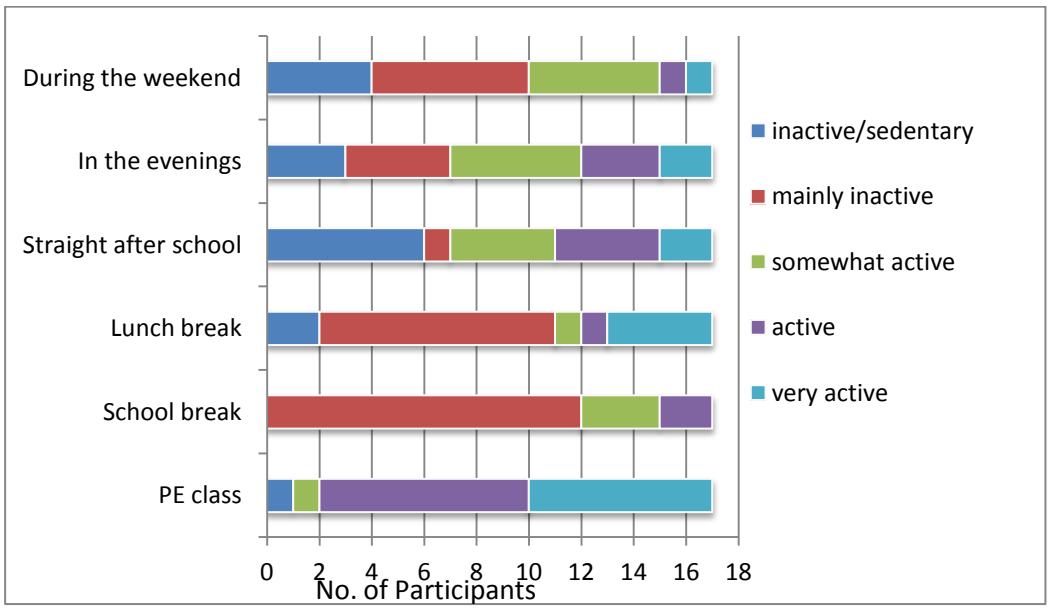
## C.2 Change in Exercise Levels for Different Activities: Final week v. Pre-project

(increases highlighted in green, decreases in pink)

| | Walking | Jogging or running | Football | Bicycling | Dance | Basketball | Table tennis | Swimming | Aerobics | Skipping | Badminton | Tennis | Rowing | Netball | Volleyball | Hockey | Roller/Ice skating | overall change |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ag1** | 3 | -1 | | | 1 | | | | -1 | 1 | | | | | | | 1 | 4 |
| **Ag2** | | | -1 | | 2 | | | | | | | | | | | | 1 | 2 |
| **Ag3** | 2 | -1 | | | | | | | | 1 | | | | | | | 1 | 3 |
| **Ab1** | -1 | | 1 | | | | | | -1 | -1 | 1 | | | | | | 1 | 0 |
| **Ab2** | | 2 | -1 | | | | | | | | | | | | | | | 1 |
| **Ab3** | -3 | 2 | -1 | -1 | | -2 | -1 | | | | | -1 | | | | | | -7 |
| **Bg1** | | | | -1 | | | | | 1 | -2 | | | | | | | | -2 |
| **Bg2** | | -1 | | | -2 | | | | | | 1 | | | | | | | -2 |
| **Bb1** | -2 | | 1 | 1 | | | -1 | | | | | | | | | | | -1 |
| **Bb2** | 1 | | -1 | -2 | | | | -1 | | | | | | | | | | -3 |
| **Bb3** | | | 1 | -1 | | | | | | | | | | | | | | 0 |
| **Bb4** | -4 | | | | | | | | | | | | | | | | | -4 |
| **Cb1** | -2 | | -2 | | | 1 | 1 | -1 | | | | | | | | | | -3 |
| **Cb2** | 1 | | 1 | 1 | -1 | -1 | | | | | | | | | | | | 1 |
| **Cb3** | 3 | 1 | | 2 | | 1 | 4 | 3 | | 1 | 1 | 3 | 1 | 1 | 3 | 2 | | 26 |
| **Cb4** | 1 | 1 | | | | | | 1 | | | | | | | | | | 3 |
| **Cb6** | | | | | | | | | | | | | | | | | | 0 |

## C.3 Activity Levels Across of School Day

### Activity Levels Across Different Parts of the Week Before the Project Start



**Change in Activity Levels Across Different Parts of the Day/Week: Final week v. Pre-project**
(increases highlighted in green, decreases in pink)

| | PE class | School break | Lunch break | Immediately after school | Evenings | At Weekends |
|---|---|---|---|---|---|---|
| **Ag1** | -2 | | | 1 | 2 | 2 |
| **Ag2** | -3 | | | | 1 | 2 |
| **Ag3** | -1 | | | | | 1 |
| **Ab1** | | 1 | 1 | 1 | 2 | 1 |
| **Ab2** | 1 | -1 | -1 | 1 | | -1 |
| **Ab3** | | -1 | -1 | 2 | -1 | |
| **Bg1** | | | | -1 | -1 | 1 |
| **Bg2** | | | 1 | -2 | -3 | |
| **Bb1** | | | | | | |
| **Bb2** | -1 | -1 | -1 | | | 1 |
| **Bb3** | | | | -2 | | 1 |
| **Bb4** | 3 | | | | | |
| **Cb1** | | | 1 | -1 | 1 | |
| **Cb2** | | | 1 | -1 | | |
| **Cb3** | | | | 1 | | |
| **Cb4** | 1 | 1 | 1 | -2 | -3 | -2 |
| **Cb6** | 1 | -1 | -1 | -1 | -1 | |

## C.4 Change in Use of Spare Time for Physical Activity: Final week v. Pre-project

**Overall Change in Use of Time for Physical Activity Daily Levels Compared: Final week v. Pre-project**

| | Group A | Group B | Group C |
|---|---|---|---|
| **Increase** | Ag1, Ag2, Ab2 | Bb1 | Cb2, Cb6 |
| **No Change** | Ag3, Ab3 | Bg1, Bb1, Bb3, Bb4 | Cb4 |
| **Decrease** | Ab1 | Bg2 | Cb1, Cb3 |

**Change in Use of Time for Physical Activity Daily Levels Compared: Final week v. Pre-project**
(increases highlighted in green, decreases in pink)

| | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday | Total |
|---|---|---|---|---|---|---|---|---|
| **Ag1** | 1 | 1 | 1 | 1 | 1 | 2 | | 7 |
| **Ag2** | 1 | 1 | 1 | -1 | 1 | 2 | | 5 |
| **Ag3** | | -1 | -2 | | -1 | -2 | | -6 |
| **Ab1** | -1 | | 2 | | | -1 | | |
| **Ab2** | -2 | -1 | -2 | | | -3 | -1 | -9 |
| **Ab3** | -2 | -1 | -1 | -1 | | -2 | -1 | -8 |
| **Bg1** | -1 | -3 | -2 | -2 | 3 | 2 | | -3 |
| **Bg2** | -2 | -2 | -2 | -1 | -1 | -1 | -1 | -1 |
| **Bb1** | | | | | | 2 | | 2 |
| **Bb2** | -1 | -1 | | 1 | 2 | 1 | 1 | 3 |
| **Bb3** | 1 | 1 | | | -2 | 1 | 1 | 2 |
| **Bb4** | | -1 | | | -1 | | | -2 |
| **Cb1** | | | | | | 1 | -1 | |
| **Cb2** | | -1 | | | | | | -1 |
| **Cb3** | -1 | 1 | | | | | | |
| **Cb4** | -1 | -1 | -1 | | | -1 | -2 | -6 |
| **Cb6** | | 2 | -1 | -1 | -2 | 1 | 3 | 2 |

# Appendix D: Parents/Carers' Questionnaire Responses

## D.1 Family Environment for Exercise

### How often family members exercise

| | Nearly every day | At least once a week | About once a month | Once every few months | Hardly ever |
|---|---|---|---|---|---|
| **Group A** | | 6 | | | |
| **Group B** | 3 | 3 | | | |
| **Group C** | | 5 | | | |

### How often the family engages in sport together

| | Nearly every day | At least once a week | About once a month | Once every few months | Hardly ever |
|---|---|---|---|---|---|
| **Group A** | | 1 | 1 | 1 | 3 |
| **Group B** | | 3 | 1 | | 2 |
| **Group C** | | 2 | 1 | 2 | |

### How much the family enjoy taking part in sports

| | We all like taking part in sports | Some of us like sports, some of us don't. | None of us are particularly interested in sports. |
|---|---|---|---|
| **Group A** | 3 | 3 | |
| **Group B** | 3 | 3 | |
| **Group C** | 2 | 3 | |

## D.2 Focus on the Participating Adolescent

### How the participant usually travels when going somewhere within walking distance.

| | Walking | Bus or metro | Cycling | Car |
|---|---|---|---|---|
| **Group A** | **6** | | | |
| **Group B** | **5** | | | 1 |
| **Group C** | **5*** | | 1* | |

*"Cycling or walking" chosen by one participant

### How often the participant exercises

| | Nearly every day | At least once a week | About once a month | Once every few months | Hardly ever |
|---|---|---|---|---|---|
| **Group A** | 4 | 2 | | | |
| **Group B** | 4 | 1 | | | **1** |
| **Group C** | 4 | 1 | | | |

### How good the participant is at most sports

| | Good at most sports | Good at some sports | Not good at sports |
|---|---|---|---|
| **Group A** | 2 | 4 | |
| **Group B** | 4 | 2 | |
| **Group C** | 3 | 1 | 1 |

## D.3 Perceived Barriers to Exercise for the Participating Adolescent

**Nobody to exercise with**

| | Most likely | Likely | Not sure | Unlikely | Least likely |
|---|---|---|---|---|---|
| **Group A** | | 4 | | 1 | 1 |
| **Group B** | 1 | 2 | | 3 | |
| **Group C** | | 2 | | 3 | |

**Too much schoolwork**

| | Most likely | Likely | Not sure | Unlikely | Least likely |
|---|---|---|---|---|---|
| **Group A** | 2 | 4 | | | |
| **Group B** | | 3 | 1 | 2 | |
| **Group C** | | | 1 | 4 | |

**Exercise is physically tiring**

| | Most likely | Likely | Not sure | Unlikely | Least likely |
|---|---|---|---|---|---|
| **Group A** | | | 1 | 4 | 1 |
| **Group B** | | | 1 | 4 | 1 |
| **Group C** | | 1 | | 3 | 1 |

**None of his/her friends like exercise**

| | Most likely | Likely | Not sure | Unlikely | Least likely |
|---|---|---|---|---|---|
| **Group A** | | | 3 | 2 | 1 |
| **Group B** | | 1 | 1 | 4 | |
| **Group C** | | | 1 | 2 | 2 |

## D.4 Additional Comments Made

Parents/carers had the option to add comments that they though relevant. These are presented here:

**Ag3** *Was very active and exercised at least 4 times per week until began GCSEs. Now difficult to fit in mid week exercise other than PE. Exercises on Saturday (dance) for 5 hours.*

**Ab2** *Very active and good at sports. Spends too much time playing x box live.*

**Bg1** *A little shy, not very confident. Enjoys exercise, but need encouragement, sometimes hard to find motivation.*

**Bg2** *Has confidence, good at sports.*

**Bb3** *Fit and enjoys exercise, has a paper round, very active.*

**Bb4** *Sometimes does swimming, rugby, bicycling, basketball.*

**Cb1** *Enjoy sports very much.*

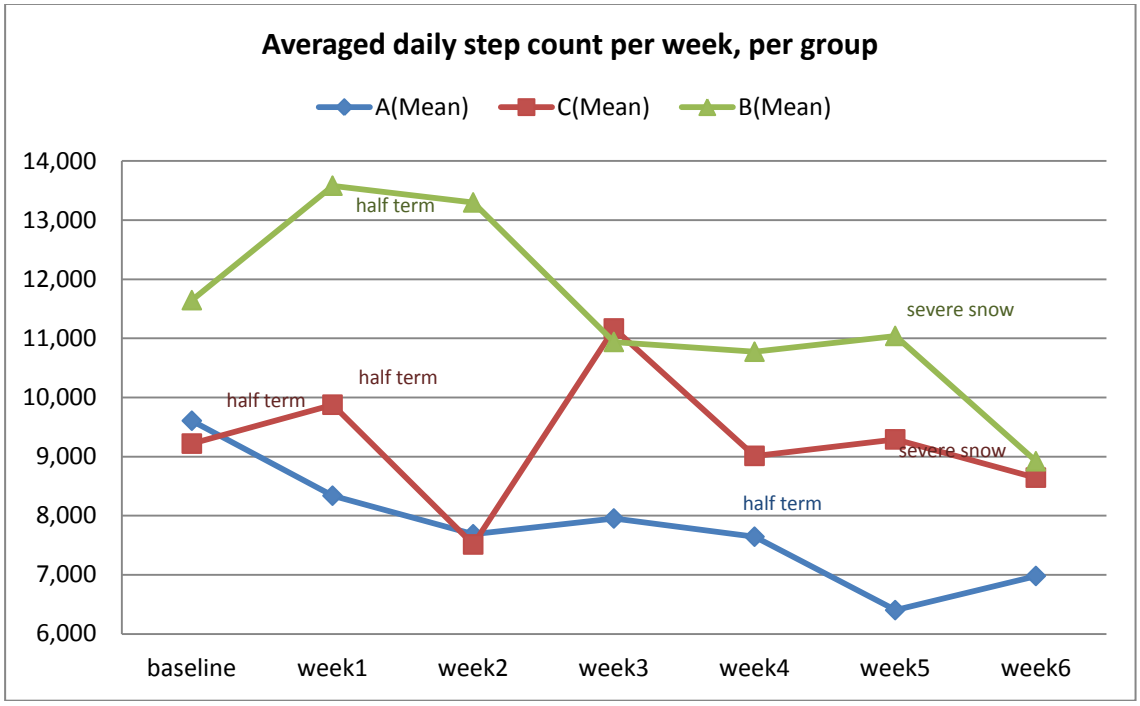
**Cb3** *Enjoy sports very much and never stops.*

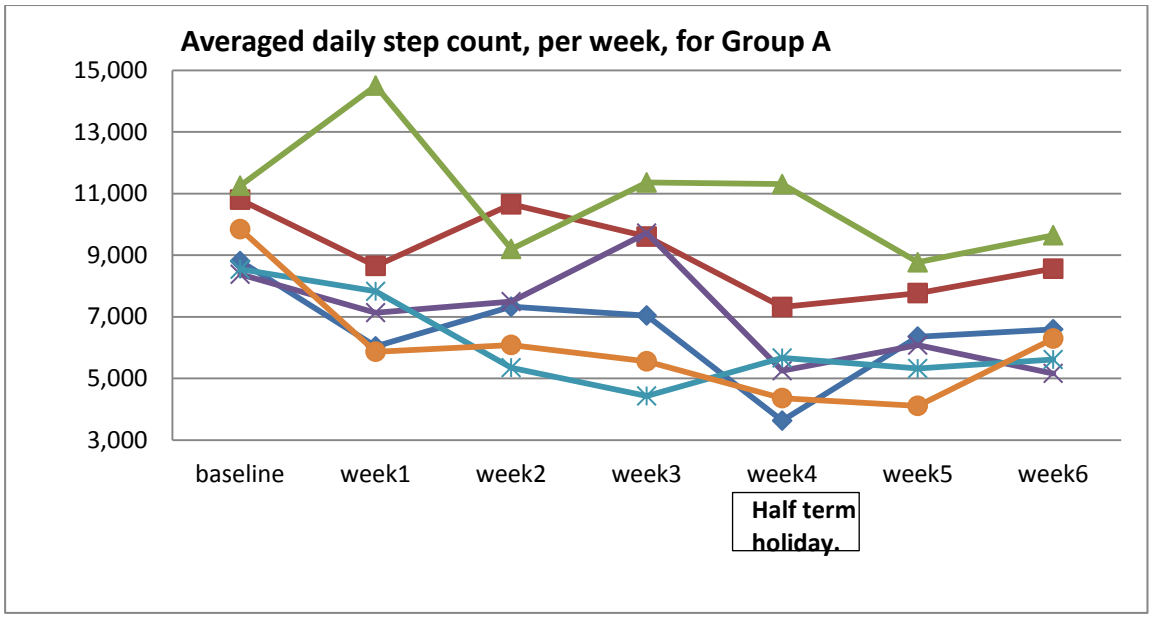
**Cb4** *Plays football, very active.*

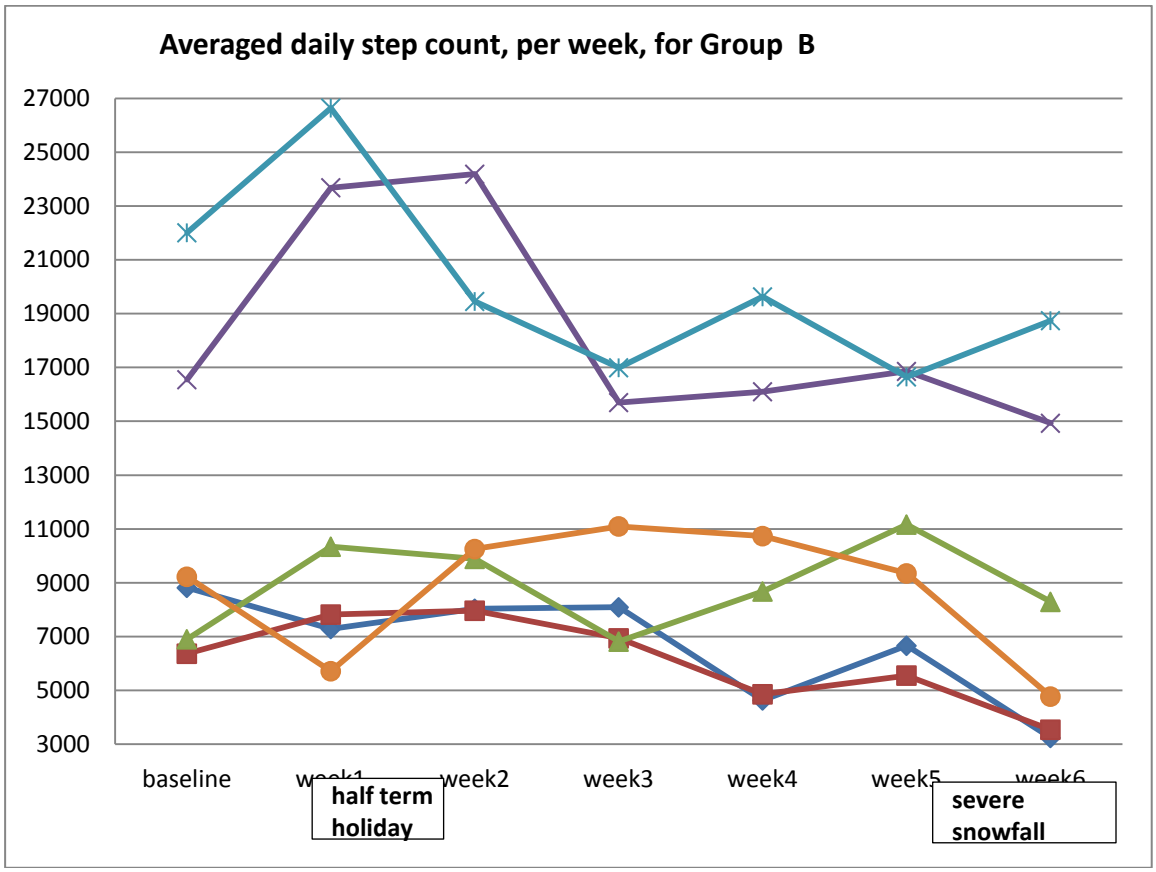
**Cb6** *Enjoys football and playing with friends, good attitude towards exercise.*

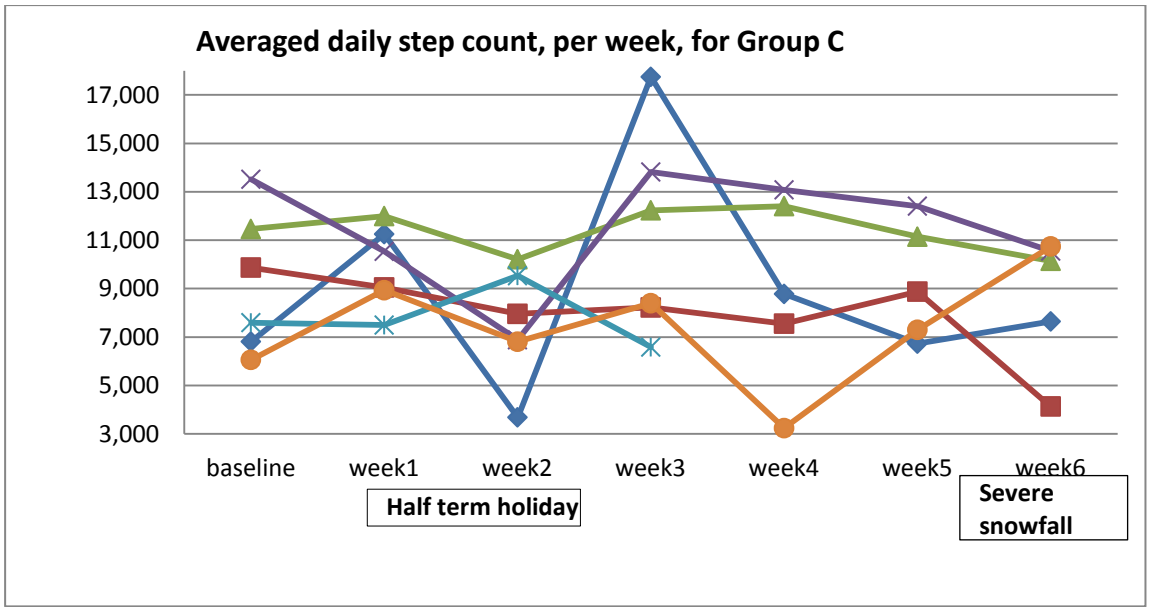
# Appendix E: Daily Steps Data

## E.1 Averaged Daily Steps Data, per Week, for Groups A, B and C

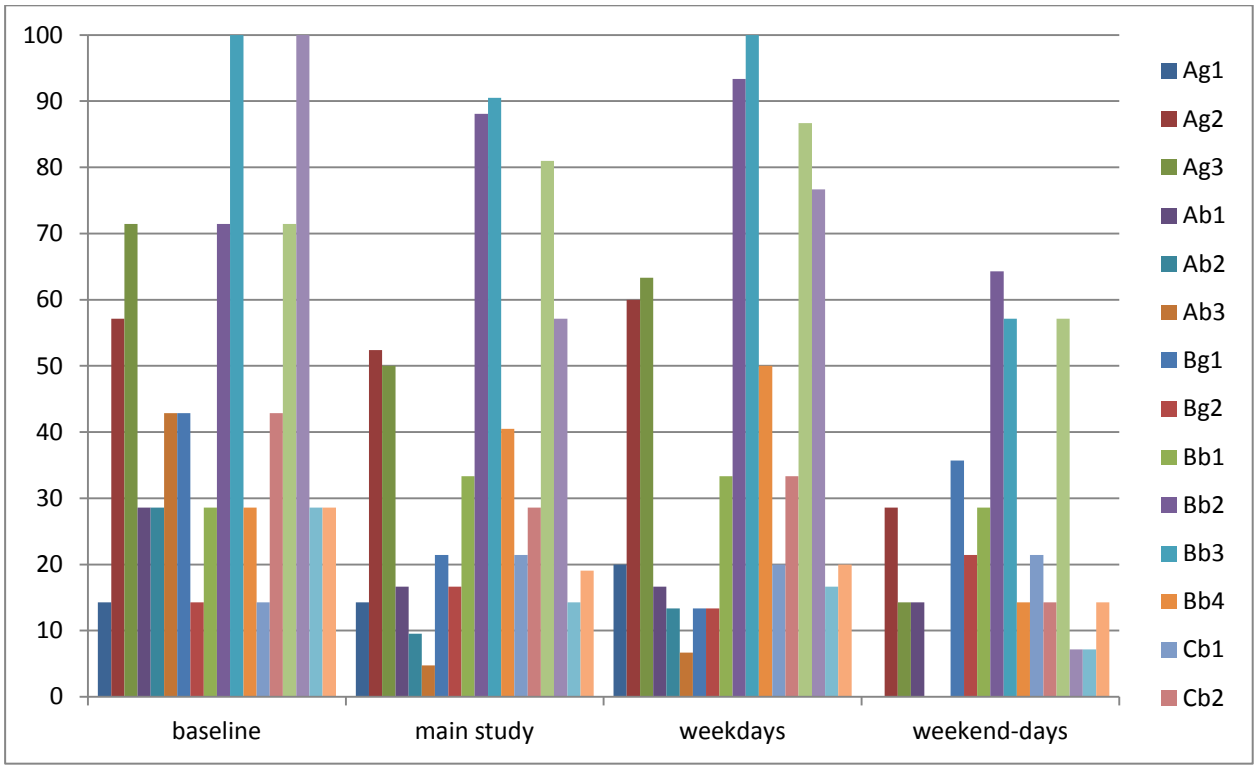


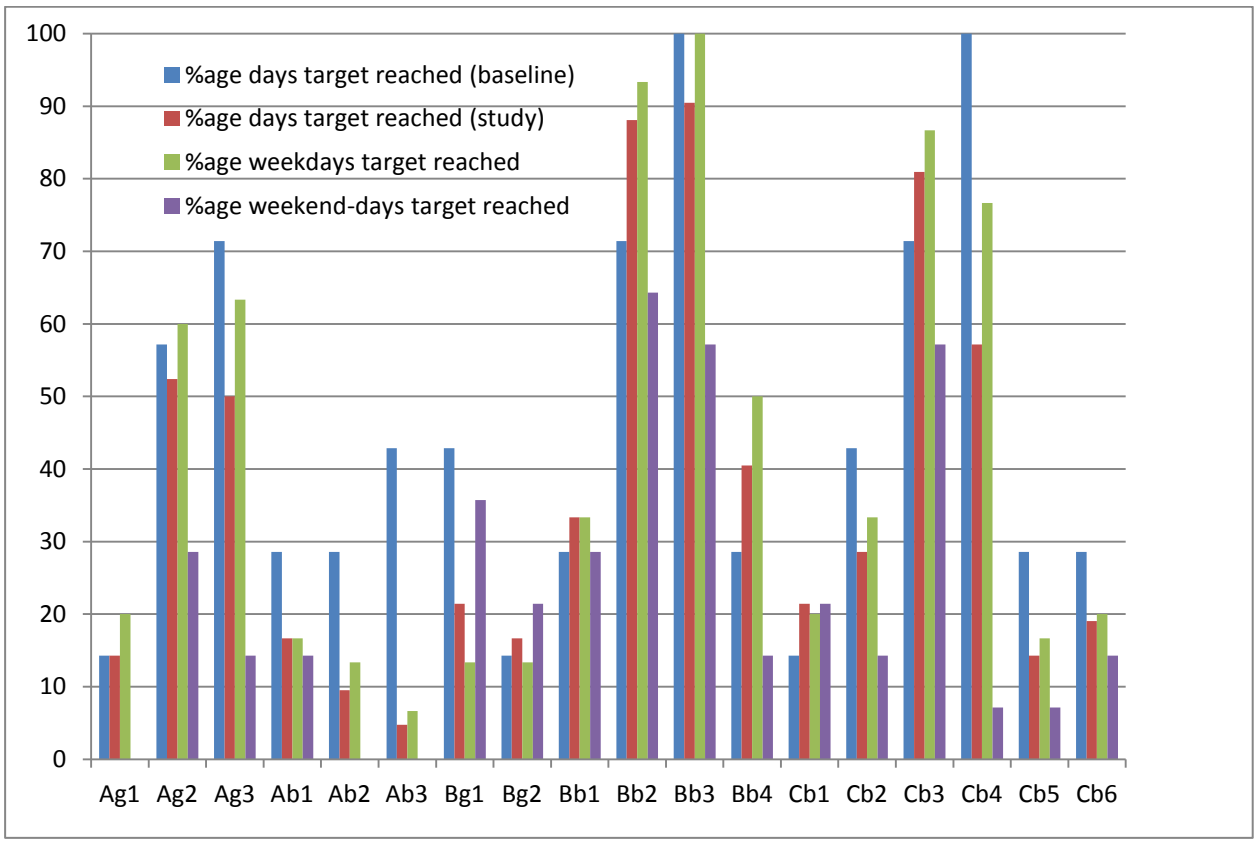

Averaged daily step count, per week, for Group B
27000
25000
23000
21000
19000
17000
15000
13000
11000
9000
7000
5000
3000
baseline
week1
week2
week3
week4
week5
week6
half term holiday
severe snowfall


Averaged daily step count, per week, for Group C
17,000
15,000
13,000
11,000
9,000
7,000
5,000
3,000
baseline
week1
week2
week3
week4
week5
week6
Half term holiday
Severe snowfall

## E.2 Percentage of Days Target Achieved for Baseline week, study weeks, weekend and weekday of study. Per Individual




## E.3 Percentage of Days Target Achieved by Individuals for Baseline week, study weeks, weekend and weekday of study.

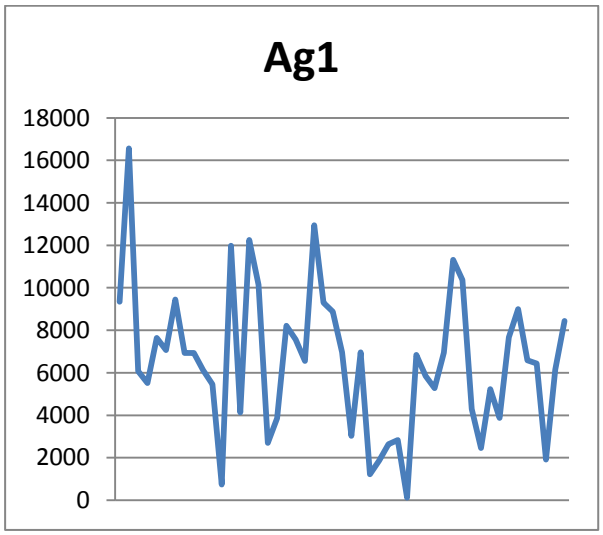


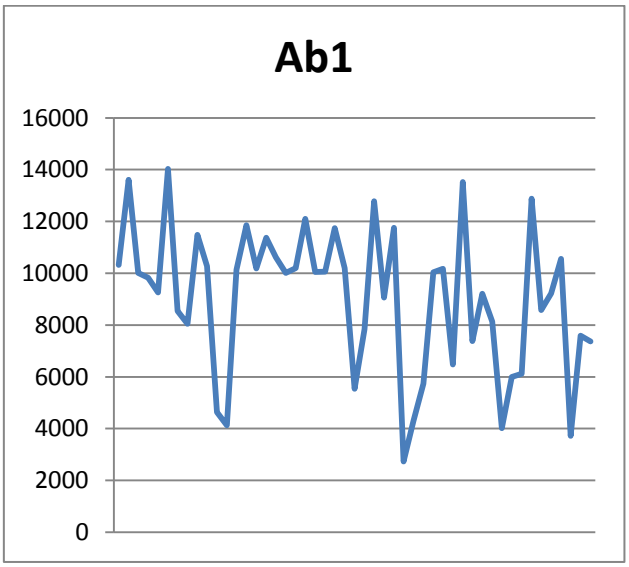
## E.4 Group A: Daily Steps Data

| | | | Ag1 | Ag2 | Ag3 | Ab1 | Ab2 | Ab3 |
|---|---|---|---|---|---|---|---|---|
| | Age | | 14 | 14 | 14 | 14 | 14 | 14 |
| | Gender | | f | f | f | m | m | m |
| baseline | b-day 1 | W | 9,337 | 6,460 | **13,114** | **10,326** | **11,242** | 9,546 |
| | b-day 2 | Th | **16,566** | **13,190** | **16,566** | **13,616** | **16,400** | **14,113** |
| | b-day 3 | F | 6,067 | 6,537 | 9,353 | **10,018** | 9,897 | **10,282** |
| | b-day 4 | S | 5,517 | 7,748 | 7,552 | 9,824 | **13,075** | 4,913 |
| | b-day 5 | Su | 7,647 | 7,278 | 4,910 | 9,262 | 3,346 | 3,182 |
| | b-day 6 | M | 7,065 | **11,435** | **10,220** | **14,026** | **14,269** | 8,057 |
| | b-day 7 | T | 9,449 | 7,163 | 7,200 | 8,544 | **10,557** | 8,555 |
| Week1 | day 1 | W | 6,938 | 7,940 | 0 | 8,047 | **10,385** | 8,023 |
| | day 2 | Th | 6,927 | **12,490** | 6,930 | **11,486** | **23,089** | **17,042** |
| | day 3 | F | 6,113 | 7,404 | 5,059 | **10,275** | 9,137 | 6,877 |
| | day 4 | S | 5,456 | 9,861 | 6,425 | 4,636 | **16,969** | 620 |
| | day 5 | Su | 744 | 336 | 5,289 | 4,134 | 2,561 | 2,560 |
| | day 6 | M | **11,975** | **10,279** | 1,323 | **10,136** | **23,096** | 8,102 |
| | day 7 | T | 4,126 | 6,465 | **10,181** | **11,853** | **16,284** | 6,718 |
| Week2 | day 8 | W | **12,257** | **13,391** | 7,694 | **10,183** | 8,779 | **11,510** |
| | day 9 | Th | **10,140** | 6,969 | 8,172 | **11,374** | **17,118** | **15,206** |
| | day 10 | F | 2,702 | 36 | 4,197 | **10,624** | 8,995 | 6,354 |
| | day 11 | S | 3,856 | 4,563 | 5,673 | **10,007** | 1,753 | 435 |
| | day 12 | Su | 8,207 | 2,453 | 5,009 | **10,204** | 3,283 | 562 |
| | day 13 | M | 7,568 | 4,994 | 4,522 | **12,105** | **13,068** | 8,393 |
| | day 14 | T | 6,554 | 5,043 | 7,345 | **10,054** | **11,429** | 9,993 |
| Week3 | day 15 | W | **12,944** | 7,256 | **10,632** | **10,059** | **14,003** | 9,522 |
| | day 16 | Th | 9,303 | 4,349 | 7,685 | **11,748** | **22,495** | 5,561 |
| | day 17 | F | 8,872 | 6,228 | 6,664 | **10,200** | **10,487** | **18,542** |
| | day 18 | S | 6,957 | 371 | 5,603 | 5,535 | 2,034 | 8,051 |
| | day 19 | Su | 3,029 | 2,785 | 3,182 | 7,842 | 4,250 | **14,888** |
| | day 20 | M | 6,969 | 4,994 | 1,617 | **12,783** | 6,589 | 2,332 |
| | day 21 | T | 1,227 | 5,042 | 3,512 | 9,056 | **19,653** | 9,126 |
| Week4 | day 22 | W | 1,861 | 6,377 | 5,901 | **11,756** | 8,939 | 5,055 |
| | day 23 | Th | 2,642 | 4,396 | 2,476 | 2,737 | **12,322** | 3,482 |
| | day 24 | F | 2,835 | 3,812 | 1,622 | 4,303 | 7,531 | 2,995 |
| | day 25 | S | 119 | 5,824 | 5,605 | 5,736 | **17,076** | **10,378** |
| | day 26 | Su | 6,842 | 4,466 | 6,818 | **10,036** | 6,612 | 1,364 |
| | day 27 | M | 5,842 | **10,284** | 4,230 | **10,175** | **14,883** | 0 |
| | day 28 | T | 5,276 | 4,495 | 3,881 | 6,481 | **11,768** | 8,219 |
| Week5 | day 29 | W | 6,943 | 7,641 | 4,909 | **13,519** | **11,039** | 8,660 |
| | day 30 | Th | **11,317** | 6,383 | 6,557 | 7,381 | **17,370** | **12,520** |
| | day 31 | F | **10,375** | 3,308 | 3,418 | 9,206 | 7,540 | 5,339 |
| | day 32 | S | 4,294 | 4,264 | 1,242 | 8,137 | 4,297 | 2,069 |
| | day 33 | Su | 2,462 | 0 | 1,379 | 4,022 | 871 | 1,933 |
| | day 34 | M | 5,233 | 5,016 | 3,986 | 6,000 | **11,745** | 4,736 |
| | day 35 | T | 3,874 | 0 | 7,286 | 6,123 | 8,522 | 7,304 |
| Week6 | day 36 | W | 7,665 | 4,407 | 6,798 | **12,880** | 7,972 | 6,715 |
| | day 37 | Th | 8,996 | 5,025 | 9,427 | 8,577 | **21,534** | 6,037 |
| | day 38 | F | 6,580 | 9,963 | 4,052 | 9,227 | 7,368 | 6,636 |
| | day 39 | S | 6,431 | 8,287 | 6,980 | **10,557** | 1,507 | 1,320 |
| | day 40 | Su | 1,915 | 224 | 1,841 | 3,724 | 6,449 | 3,934 |
| | day 41 | M | 6,145 | 4,655 | 8,471 | 7,592 | **13,072** | 6,214 |
| | day 42 | T | 8,433 | 6,734 | 6,498 | 7,373 | 9,630 | 5,292 |

| Averaged daily step | Ag1 | Ag2 | Ag3 | Ab1 | Ab2 | Ab3 |
|---|---|---|---|---|---|---|
| baseline | 8,544 | 9,845 | 8,807 | 10,802 | 11,255 | 8,378 |
| week1 | 7,825 | 5,868 | 6,040 | 8,652 | 14,503 | 7,135 |
| week2 | 5,350 | 6,087 | 7,326 | 10,650 | 9,204 | 7,493 |
| week3 | 4,432 | 5,556 | 7,043 | 9,603 | 11,359 | 9,717 |
| week4 | 5,665 | 4,362 | 3,631 | 15,651 | 11,304 | 5,249 |
| week5 | 5,322 | 4,111 | 6,357 | 7,770 | 8,769 | 6,080 |
| week6 | 5,614 | 6,295 | 6,595 | 8,561 | 9,647 | 5,164 |

| | |
|---|---|
| Half term weeks | Pink shading |
| Week affected by heavy snow fall | Blue shading |


Ag1
18000
16000
14000
12000
10000
8000
6000
4000
2000
0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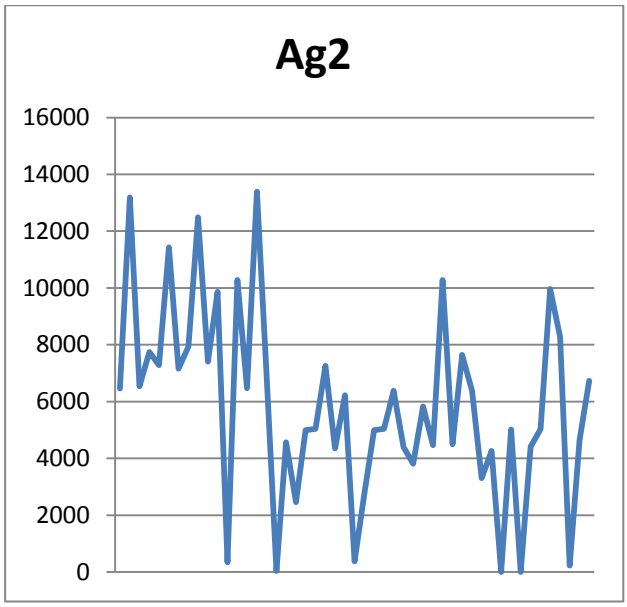
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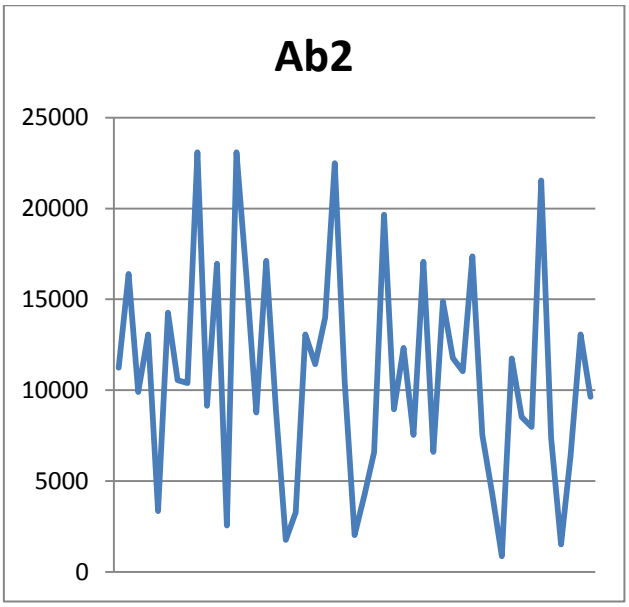
Ab2
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10000
5000
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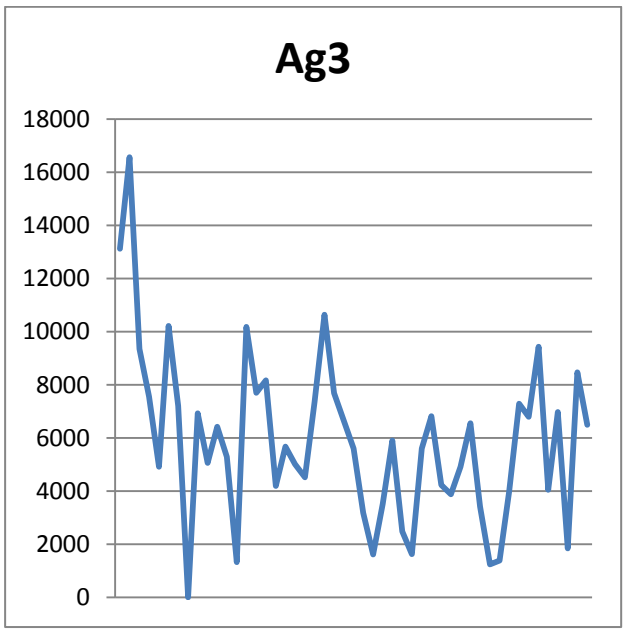
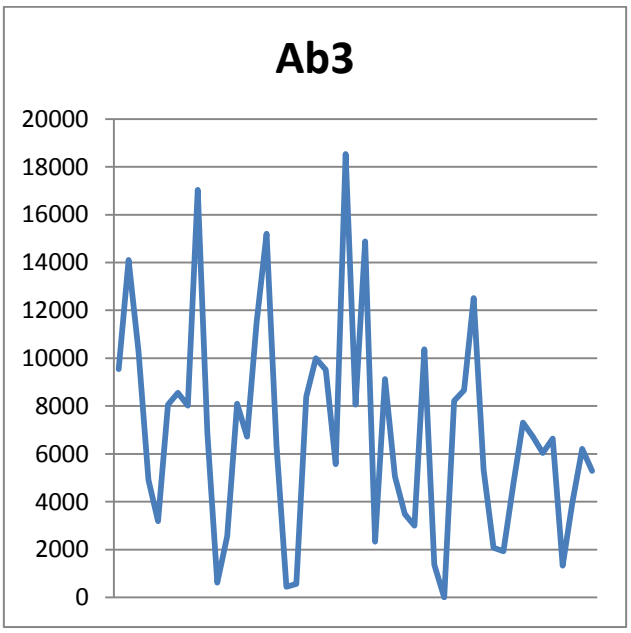

Ag3
18000
16000
14000
12000
10000
8000
6000
4000
2000
0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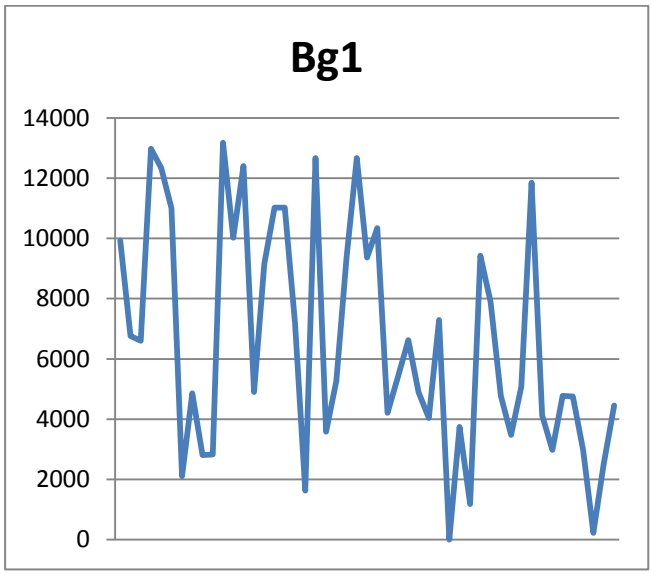
## E.5 Group B: Daily Steps Data

| | | | **Bg1** | **Bg2** | **Bb1** | **Bb2** | **Bb3** | **Bb4** |
|---|---|---|---|---|---|---|---|---|
| | Age | | **13** | 13 | 15 | 13 | 13 | 13 |
| | Gender | | **f** | f | m | m | m | m |
| baseline | b-day 1 | T | 9,925 | 5,452 | 4,541 | 19,281 | 17,997 | 8,421 |
| | b-day 2 | W | 6,760 | 6,769 | 6,519 | 25,943 | 31,469 | 9,460 |
| | b-day 3 | Th | 6,605 | 6,171 | 10,056 | 20,070 | 23,745 | 0 |
| | b-day 4 | F | 12,976 | 12,243 | 14,215 | 23,664 | 28,601 | 11,708 |
| | b-day 5 | S | 12,342 | 6,769 | 6,045 | 1,750 | 13,295 | 15,489 |
| | b-day 6 | Su | 11,002 | 5,452 | 48 | 9,005 | 19,366 | 7,365 |
| | b-day 7 | M | 2,108 | 1,711 | 0 | 16,135 | 19,583 | 2,910 |
| Week1 | day 1 | T | 4,863 | 3,622 | 10,974 | 24,348 | 17,105 | 1,833 |
| | day 2 | W | 2,808 | 6,514 | 8,762 | 32,008 | 33,128 | 2,910 |
| | day 3 | Th | 2,830 | 4,198 | 16,215 | 20,666 | 28,466 | 7,144 |
| | day 4 | F | 13,181 | 11,777 | 5,126 | 31,689 | 30,412 | 2,996 |
| | day 5 | S | 10,018 | 12,078 | 7,690 | 15,027 | 25,710 | 8,058 |
| | day 6 | Su | 12,403 | 12,400 | 7,876 | 16,878 | 20,035 | 4,196 |
| | day 7 | M | 4,903 | 4,158 | 15,764 | 25,161 | 31,616 | 12,878 |
| Week2 | day 8 | T | 9,152 | 8,575 | 13,238 | 23,397 | 17,084 | 8,253 |
| | day 9 | W | 11,022 | 11,316 | 10,867 | 31,876 | 30,061 | 10,583 |
| | day 10 | Th | 11,022 | 11,318 | 11,426 | 26,120 | 21,270 | 11,929 |
| | day 11 | F | 7,185 | 8,579 | 7,185 | 22,844 | 17,654 | 0 |
| | day 12 | S | 1,628 | 1,451 | 5,733 | 23,269 | 17,160 | 0 |
| | day 13 | Su | 12,671 | 11,386 | 13,579 | 16,259 | 8,437 | 0 |
| | day 14 | M | 3,584 | 3,127 | 7,219 | 25,514 | 24,527 | 0 |
| Week3 | day 15 | T | 5,266 | 2,983 | 9,158 | 17,039 | 15,062 | 11,535 |
| | day 16 | W | 9,359 | 11,386 | 7,519 | 18,647 | 31,242 | 11,912 |
| | day 17 | Th | 12,671 | 8,891 | 5,846 | 17,762 | 21,588 | 4,311 |
| | day 18 | F | 9,359 | 8,891 | 5,789 | 2,712 | 11,000 | 18,588 |
| | day 19 | S | 10,343 | 5,890 | 7,819 | 27,182 | 5,258 | 15,271 |
| | day 20 | Su | 4,214 | 5,204 | 4,457 | 4,400 | 24,085 | 4,010 |
| | day 21 | M | 5,422 | 5,314 | 7,130 | 22,148 | 10,712 | 12,056 |
| Week4 | day 22 | T | 6,627 | 6,977 | 4,804 | 24,004 | 22,633 | 12,056 |
| | day 23 | W | 4,893 | 3,681 | 7,190 | 16,823 | 23,410 | 13,945 |
| | day 24 | Th | 4,045 | 3,810 | 10,973 | 22,625 | 24,174 | 11,377 |
| | day 25 | F | 7,297 | 8,722 | 9,956 | 18,005 | 18,604 | 11,463 |
| | day 26 | S | 0 | 13 | 15,312 | 233 | 9,397 | 3,661 |
| | day 27 | Su | 3,748 | 2,602 | 3,329 | 13,665 | 23,542 | 7,106 |
| | day 28 | M | 1,185 | 8,214 | 9,194 | 17,355 | 15,633 | 15,548 |
| Week5 | day 29 | T | 9,433 | 6,022 | 6,193 | 14,831 | 15,089 | 10,920 |
| | day 30 | W | 7,885 | 6,998 | 18,281 | 14,155 | 15,967 | 4,037 |
| | day 31 | Th | 4,776 | 4,053 | 6,220 | 14,676 | 16,160 | 11,366 |
| | day 32 | F | 3,481 | 3,705 | 11,414 | 15,145 | 20,710 | 11,476 |
| | day 33 | S | 5,087 | 5,186 | 17,189 | 17,066 | 8,120 | 11,479 |
| | day 34 | Su | 11,853 | 8,214 | 4,705 | 20,301 | 23,453 | 9,790 |
| | day 35 | M | 4,121 | 4,707 | 14,160 | 21,818 | 17,063 | 6,382 |
| Week6 | day 36 | T | 2,983 | 2,944 | 4,909 | 22,244 | 30,077 | 4,545 |
| | day 37 | W | 4,776 | 4,053 | 2,923 | 1,222 | 10,847 | 6,040 |
| | day 38 | Th | 4,749 | 4,481 | 4,909 | 16,000 | 10,385 | 4,767 |
| | day 39 | F | 2,983 | 2,944 | 9,058 | 17,547 | 19,764 | 4,993 |
| | day 40 | S | 231 | 4,121 | 19,670 | 27,834 | 18,938 | 6,038 |
| | day 41 | Su | 2,492 | 1,961 | 0 | 9,339 | 24,309 | 4,908 |
| | day 42 | M | 4,460 | 4,299 | 0 | 10,316 | 16,873 | 2,131 |

| **Averaged daily step** | | **Bg1** | **Bg2** | **Bb1** | **Bb2** | **Bb3** | **Bb4** |
|---|---|---|---|---|---|---|---|
| | baseline | 8817 | 6367 | 6904 | **16550** | **22008** | 9226 |
| | week1 | 7287 | 7821 | **10344** | **23682** | **26639** | 5716 |
| | week2 | 8038 | 7965 | 9892 | **24183** | **19456** | **10255** |
| | week3 | 8091 | 6937 | 6817 | **15699** | **16992** | **11098** |
| | week4 | 4633 | 4860 | 8680 | **16101** | **19628** | **10737** |
| | week5 | 6662 | 5555 | **11166** | **16856** | **16652** | 9350 |
| | week6 | 3239 | 3543 | 8294 | **14929** | **18742** | 4775 |

| | |
|---|---|
| Half term weeks | Pink shading |
| Week affected by heavy snow fall | Blue shading |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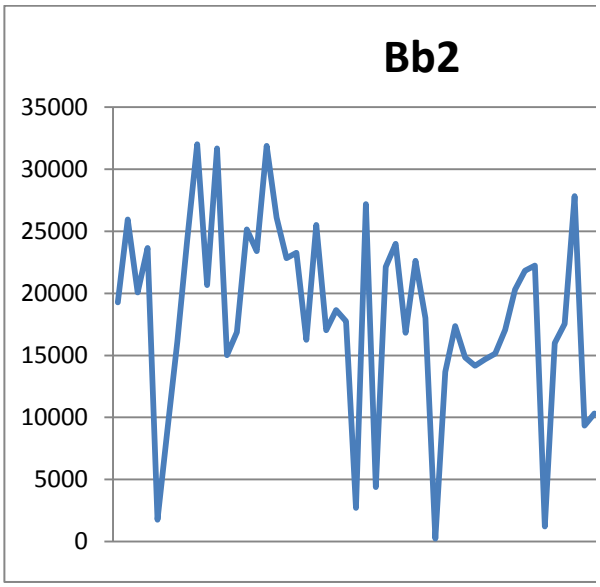
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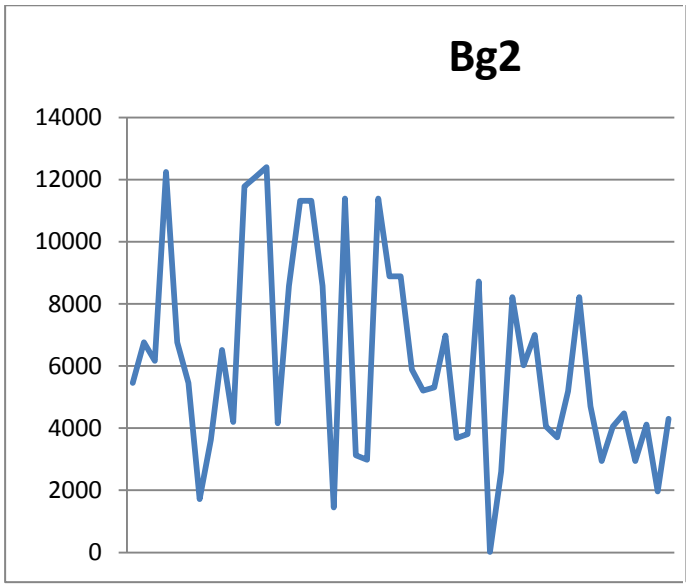
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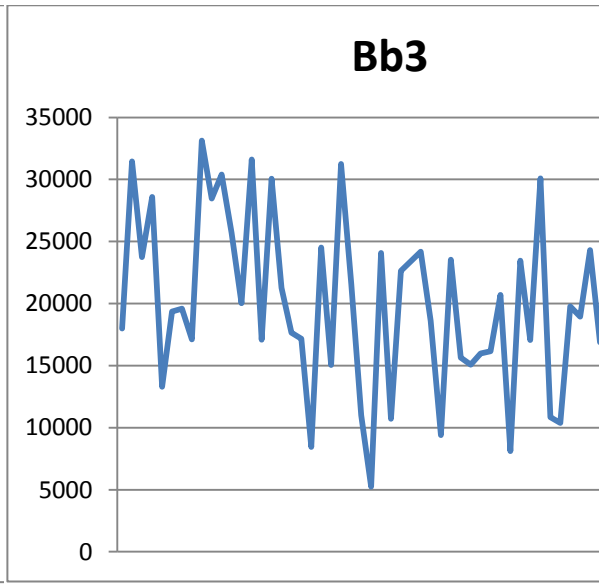
Bb3
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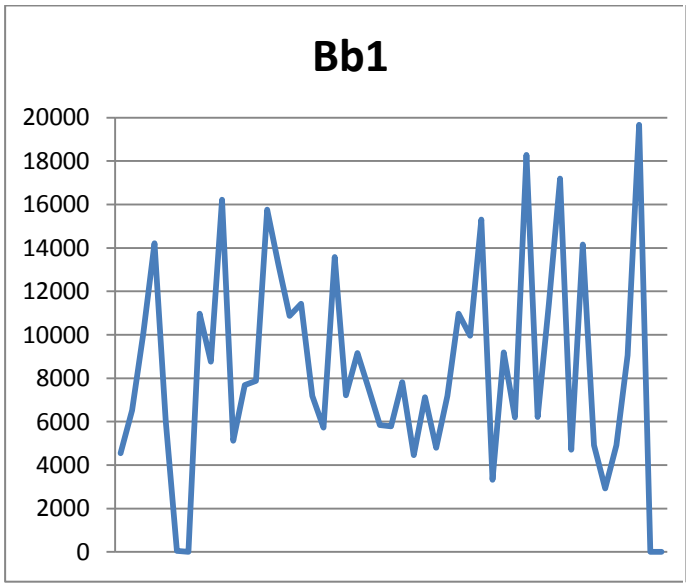
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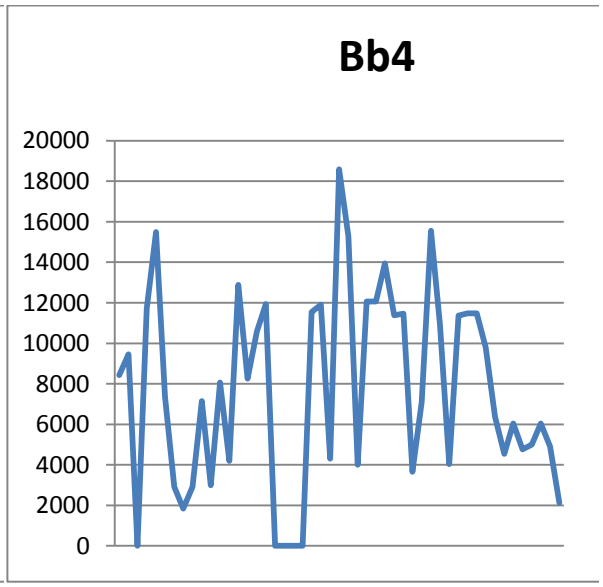
Bb4
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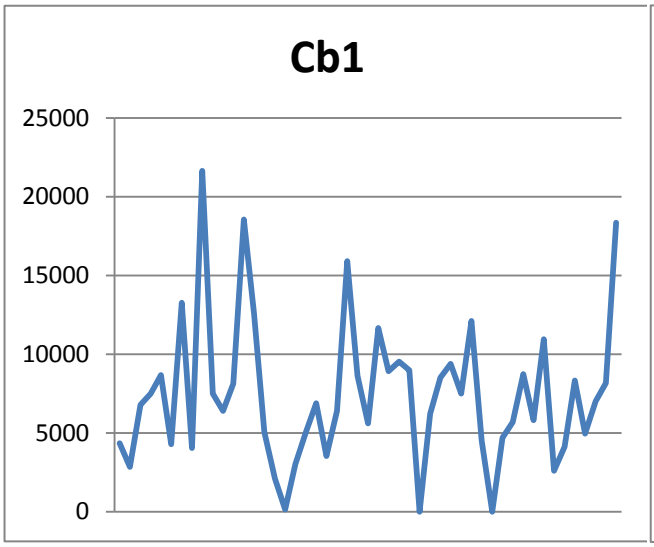
## E.6 Group C: Daily Steps Data

This group of participants operated as individuals with a range of different start dates/days

| | | | Cb1 | Cb2 | Cb3 | | Cb4 | Cb5 | Cb6 |
|---|---|---|---|---|---|---|---|---|---|
| | Age | | 13 | 11 | 11 | | 11 | 11 | 11 |
| | Gender | | m | m | m | | m | m | m |
| baseline | b-day 1 | S | 4,339 | 9,512 | 9,352 | T | **14,482** | **12,030** | 732 |
| | b-day 2 | Su | 2,847 | 9,736 | 9,535 | W | **13,442** | 9,628 | 940 |
| | b-day 3 | M | 6,789 | 9,621 | **10,546** | Th | **14,902** | **13,129** | 3,900 |
| | b-day 4 | T | 7,498 | **11,129** | **14,337** | F | **14,563** | 0 | 5,800 |
| | b-day 5 | W | 8,664 | 6,685 | **11,239** | S | **12,751** | 2,846 | **12,309** |
| | b-day 6 | Th | 4,275 | **10,582** | **15,229** | Su | **12,839** | 4,962 | **13,412** |
| | b-day 7 | F | **13,271** | **11,820** | **10,000** | M | **11,624** | 2,965 | 5,314 |
| Week1 | day 1 | S | 4,036 | **10,183** | **13,338** | T | **14,027** | 6,904 | 8,636 |
| | day 2 | Su | **21,635** | 5,516 | **12,044** | W | **12,921** | 5,810 | **14,204** |
| | day 3 | M | 7,483 | 7,777 | **10,006** | Th | 9,547 | **10,154** | 3,795 |
| | day 4 | T | 6,388 | **11,001** | **11,247** | F | 8,243 | 3,468 | **11,700** |
| | day 5 | W | 8,130 | **13,934** | **10,667** | S | 6,037 | **11,133** | 9,393 |
| | day 6 | Th | **18,549** | **10,165** | **10,327** | Su | 0 | 0 | 7,084 |
| | day 7 | F | **12,531** | 4,757 | **16,346** | M | **12,448** | 0 | 7,715 |
| Week2 | day 8 | S | 5,056 | 140 | 9,538 | T | **14,697** | **12,696** | 7,104 |
| | day 9 | Su | 2,097 | 5,769 | **12,476** | W | **12,990** | **15,660** | 126 |
| | day 10 | M | 129 | 6,517 | 5,226 | Th | **11,346** | 7,264 | 6,885 |
| | day 11 | T | 3,027 | **14,320** | 7,949 | F | 1,340 | **10,182** | 7,609 |
| | day 12 | W | 5,056 | 7,406 | 8,566 | S | 7,715 | 4,032 | **13,359** |
| | day 13 | Th | 6,888 | **11,008** | 9,083 | Su | 85 | 0 | 2,904 |
| | day 14 | F | 3,521 | **10,537** | **18,653** | M | 17 | 7,351 | 9,657 |
| Week3 | day 15 | S | 6,397 | 5,456 | **11,000** | T | **12,694** | 2,008 | 4,113 |
| | day 16 | Su | **15,914** | 5,469 | **13,000** | W | **12,435** | 0 | 6,767 |
| | day 17 | M | 8,630 | 7,511 | **10,538** | Th | **13,449** | 0 | 8,045 |
| | day 18 | T | 5,594 | 8,876 | **12,000** | F | **12,599** | **11,156** | **17,253** |
| | day 19 | W | **11,660** | **11,690** | **14,000** | S | **17,289** | Withdrew | 0 |
| | day 20 | Th | 8,912 | 7,653 | **14,000** | Su | 0 | Withdrew | 6,722 |
| | day 21 | F | 9,534 | **10,886** | **11,100** | M | **14,435** | Withdrew | 7,475 |
| Week4 | day 22 | S | 8,978 | 3,270 | **11,124** | T | **13,208** | Withdrew | 0 |
| | day 23 | Su | 0 | 4,936 | **14,000** | W | **12,237** | Withdrew | 3,235 |
| | day 24 | M | 6,216 | 6,613 | **11,000** | Th | **12,632** | Withdrew | 0 |
| | day 25 | T | 8,503 | 6,657 | **12,730** | F | **14,456** | Withdrew | 0 |
| | day 26 | W | 9,390 | 9,563 | **12,000** | S | 0 | Withdrew | 0 |
| | day 27 | Th | 7,486 | 5,796 | **14,000** | Su | 0 | Withdrew | 0 |
| | day 28 | F | **12,103** | **16,030** | **12,000** | M | **12,868** | Withdrew | 0 |
| Week5 | day 29 | S | 4,511 | **11,710** | **11,129** | T | **12,788** | Withdrew | 8,663 |
| | day 30 | Su | 0 | 7,568 | 3,578 | W | **13,167** | Withdrew | 7,490 |
| | day 31 | M | 4,688 | 6,011 | **10,660** | Th | **11,014** | Withdrew | 5,656 |
| | day 32 | T | 5,678 | **11,823** | **12,404** | F | **12,653** | Withdrew | 7,381 |
| | day 33 | W | 8,725 | 9,566 | **11,104** | S | 0 | Withdrew | 0 |
| | day 34 | Th | 5,811 | 8,845 | **17,242** | Su | 0 | Withdrew | 0 |
| | day 35 | F | **10,939** | 6,605 | **11,894** | M | 0 | Withdrew | 0 |
| Week6 | day 36 | S | 2,588 | 1,645 | 6,850 | T | 0 | Withdrew | 4,373 |
| | day 37 | Su | 4,111 | 4,023 | 1,893 | W | 9,314 | Withdrew | **17,786** |
| | day 38 | M | 8,334 | 0 | **13,286** | Th | **15,181** | Withdrew | **12,826** |
| | day 39 | T | 4,949 | 876 | **12,143** | F | **15,308** | Withdrew | **18,690** |
| | day 40 | W | 7,006 | 9,780 | **11,430** | S | 723 | Withdrew | **11,622** |
| | day 41 | Th | 8,164 | 7,999 | **15,000** | Su | 7,440 | Withdrew | 5,648 |
| | day 42 | F | **18,355** | 468 | **10,438** | M | **15,325** | Withdrew | 4,254 |

| **Averaged daily step** | | **Cb1** | **Cb2** | **Cb3** | **Cb4** | **Cb5** | **Cb6** |
|---|---|---|---|---|---|---|---|
| | baseline | 6,812 | 9,869 | **11,463** | **13,515** | 7,593 | 6,058 |
| | week1 | **11,250** | 9,048 | **11,996** | **10,537** | 7,494 | 8,932 |
| | week2 | 3,682 | 7,957 | **10,213** | 6,884 | 9,531 | 6,806 |
| | week3 | 9,520 | 8,220 | **12,234** | **13,817** | 6,582 | 8,396 |
| | week4 | 8,779 | 7,552 | **12,408** | **13,080** | Withdrew | 3,235 |
| | week5 | 6,725 | 8,875 | **11,144** | **12,406** | Withdrew | 7,298 |
| | week6 | 7,644 | 4,132 | **10,149** | **10,549** | Withdrew | **10,743** |

| | |
|---|---|
| Half term weeks | Pink shading |
| Week affected by heavy snow fall | Blue shading |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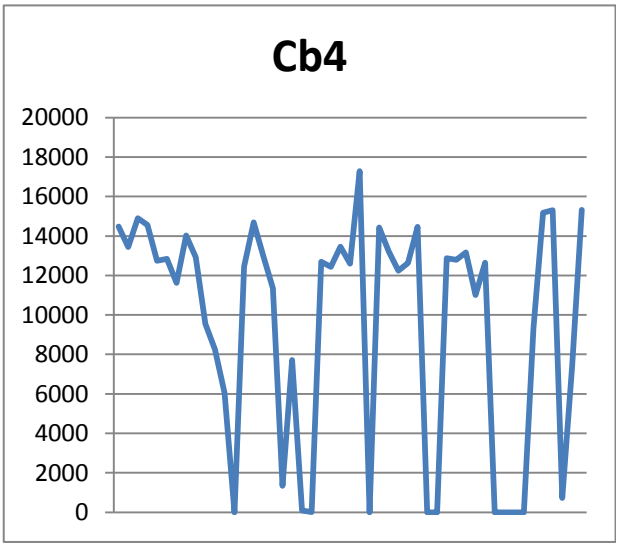
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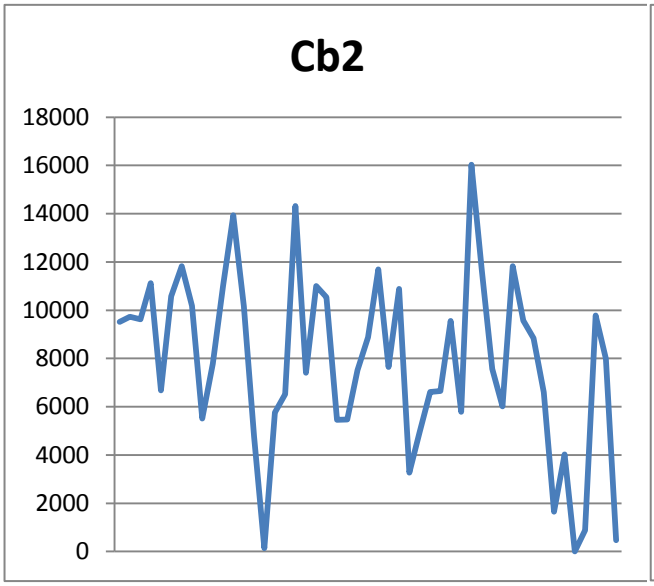
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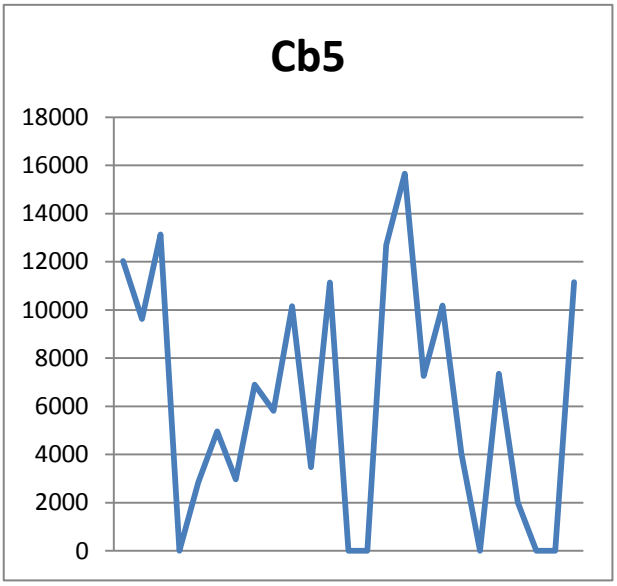
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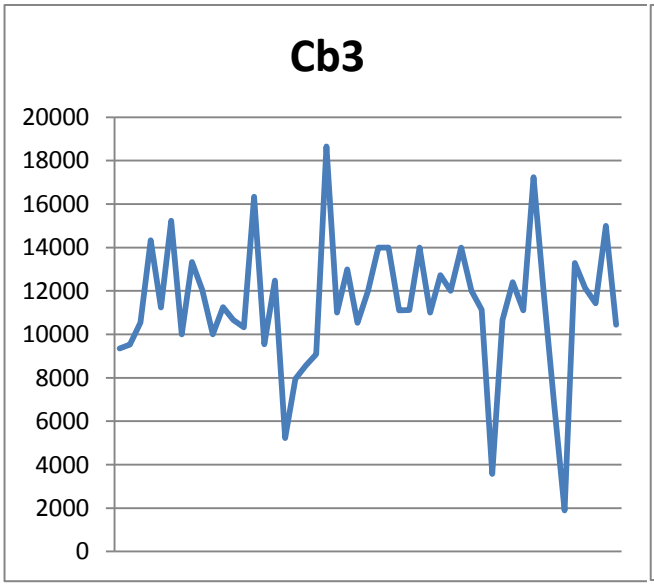
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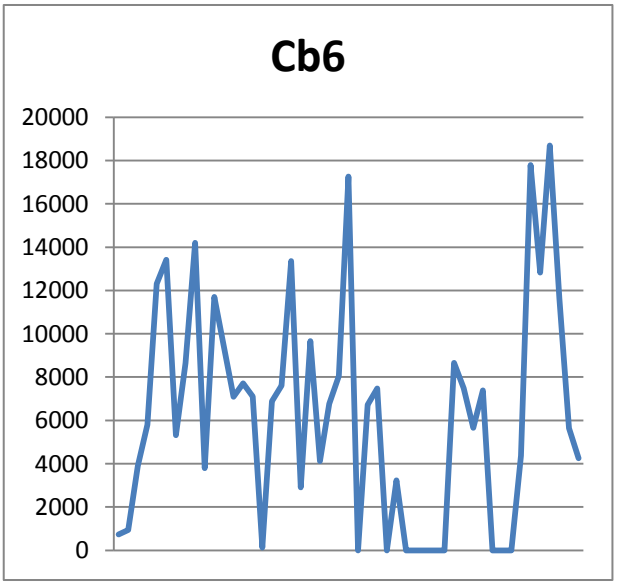
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# Appendix F: Choice of "Walk with Me" Friend

The Nintendo DS "Walk With Me" game had two activity meters for recording steps. Those participants using them were asked to give the second meter to someone of their choice.

## F.1 Choice of "Walk With Me" friend

| | Same-age female friend | Mother | Father | Grandfather | Younger brother |
|---|---|---|---|---|---|
| **Ag1** | y | | | | |
| **Ag2** | y | | | | |
| **Ag3** | y | | | | |
| **Ab1** | | | | y* | y* |
| **Ab2** | | y | | | |
| **Ab3** | | y | | | |
| **Cb1** | | | y | | |
| **Cb2** | y | | | | |
| **Cb3** | | | y | | |
| **Cb4** | | | y | | |
| **Cb5** | | | | | y |
| **Cb6** | | y | | | |

*Ab1 chose his grandfather as his friend but then felt he had to give to give it to his younger brother as he wanted it.

## F.2 Reasons for choice of "Walk With Me" friend

**Family member**

Family members were chosen because they were "**always around**".

| | | | | | Reasons: | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mother | Father | Grand-father | Younger brother | very close | help become closer | will make the game more fun | Keep me motivated | walks a lot | He wanted it (pressure) | won't lose it, can easily return it (trust) |
| **Ab1** | | | y | | | | | y | | | |
| | | | | y | | | | | | y | |
| **Ab2** | y | | | | | | | | | | |
| **Ab3** | y | | | | y | y | y | | | | |
| **Cb1** | | y | | | | | | | y | | |
| **Cb3** | | y | | | | | y | | | | |
| **Cb4** | | y | | | | | | | | | y |
| **Cb5** | | | | y | y | | | | | | y |
| **Cb6** | y | | | | | | | | y | | |

**Same-age female friend**

The three Group A girls and one group C boy gave meters to female friends of their age.

| | very close friends | she is very competitive, which motivates me to perform | will make the game more fun |
|---|---|---|---|
| **Ag1** | | | y |
| **Ag2** | y | y | y |
| **Ag3** | | | y |
| **Cb2** | y | | |

# Appendix G: Post-Intervention Questionnaire

## G.1 Impact of Project on Individuals

**Self-assessed change in activity levels**
From 16 respondents the feedback was:

- Nine respondents believed they had increased their activity levels.
- Five respondents believed they had maintained their activity levels.
- Six respondents believed they had decreased their activity levels.

**Likelihood of continued monitoring of activity after project end**
From 16 respondents the feedback was:

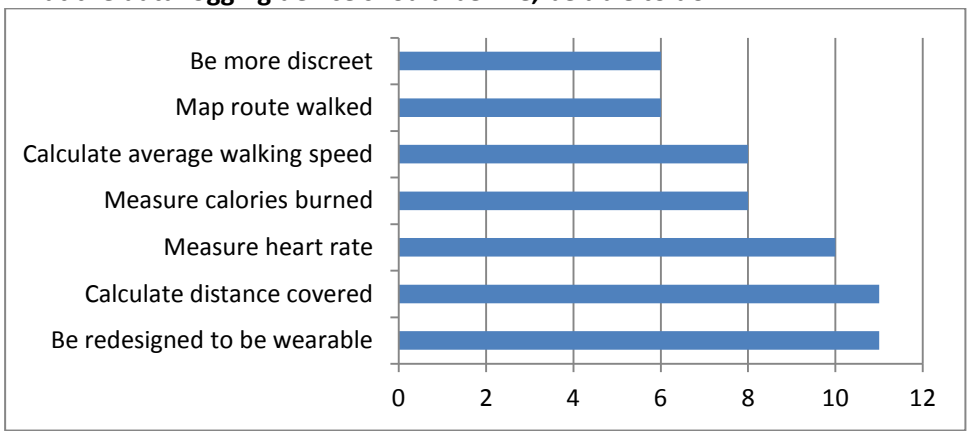
- Seven believed they would continue to monitor their activity levels.
- Seven were unsure whether they would continue to monitor their activity levels.
- Two believed they would not continue to monitor their activity levels.

## G.2 Data logging devices

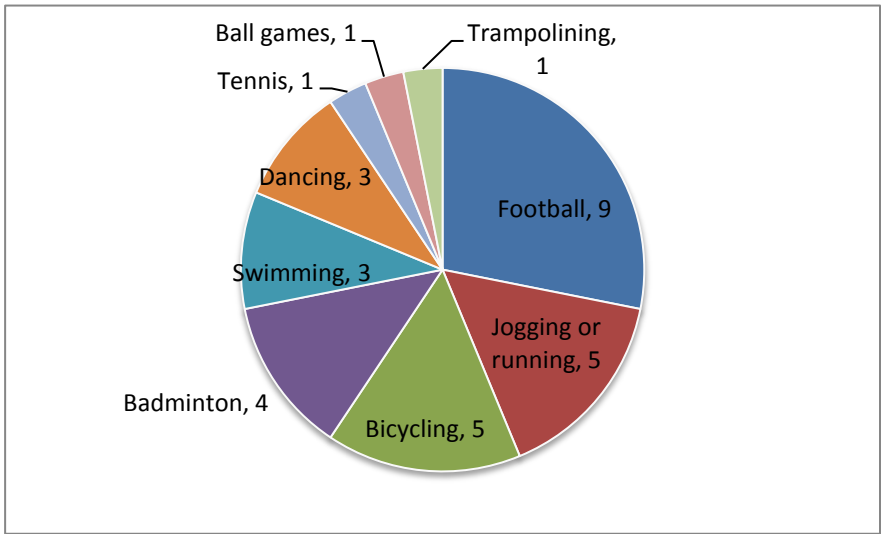
**How the data logging device should be worn**
From 17 respondents the feedback was:

- Keep in a pocket (10 respondents)
- Wear on a clip (six respondents)
- Keep in a bag (one respondent)
- Although only four were bothered about other people being able to see the device.

**What the data logging device should be like, be able to do**



**Other activities that should be recorded by data logging devices**




## G.3 Reflection on social support and competition (for website participants)

Data in this section are from the 12 participants in Groups A and B.

**Reaction to option to share daily steps achievement (with reasons)**

| | | Reason: | | |
|---|---|---|---|---|
| | **Share?** | **Keep low number private v. share high number** | **Not bothered if others see** | **Proud of the steps done, want others to see** |
| **Ag1** | depends | y | | |
| **Ag2** | depends | y | | |
| **Ag3** | depends | y | | |
| **Ab1** | depends | y | y | |
| **Ab2** | depends | y | | |
| **Ab3** | No | y | | |
| **Bg1** | Yes | | y | |
| **Bg2** | Depends | | y | |
| **Bb1** | Yes | | y | |
| **Bb2** | Depends | y | | |
| **Bb3** | Yes | | | y |
| **Bb4** | Depends | | y | |

### Interest in others' performance and impact on individual performance

| | How interested in others' steps counts 5 (very much) to 1 (not at all) | Impact of others' performance on individual's activity level |
|---|---|---|
| **Ab2** | 5 | positive |
| **Bb2** | 4 | positive |
| **Ag1** | 4 | negative |
| **Ab3** | 4 | negative |
| **Ag3** | 3 | positive |
| **Ab1** | 3 | positive |
| **Bg1** | 3 | neutral |
| **Ag2** | 2 | neutral |
| **Bb3** | 2 | neutral |
| **Bg2** | 1 | neutral |
| **Bb1** | 1 | neutral |
| **Bb4** | 1 | neutral |

### Impact of website's daily and weekly rewards announcements on activity

| | Reward announcements encouraged more activity 5 (very much) to 1 (not at all) | Reasons: | | |
|---|---|---|---|---|
| | | Personal achievement | motivate me | didn't care |
| **Ab1** | 5 | | y | |
| **Ab2** | 4 | y | | |
| **Bb2** | 4 | | | y |
| **Ag2** | 3 | | y | |
| **Ag3** | 3 | | y | |
| **Bb1** | 3 | | | |
| **Bg1** | 3 | | | y |
| **Ab3** | 2 | | | y |
| **Ag1** | 1 | | | y |
| **Bg2** | 1 | | | y |
| **Bb3** | 1 | y | | |
| **Bb4** | 1 | | | y |

### Extent to which site provided a sense of competition

| | 5 (very much) to 1 (not at all) | Reason |
|---|---|---|
| **Ab1** | 5 | want to get more points* |
| **Ab2** | 5 | the points and we could win the voucher* |
| **Ag2** | 4 | it made me want to do more steps |
| **Bb2** | 4 | get more points |
| **Ag1** | 3 | competing points |
| **Ag3** | 3 | sometimes, depends on my mood |
| **Ab3** | 3 | sometimes it did, sometimes not |
| **Bb3** | 3 | I just do what I normally do |
| **Bg1** | 2 | I'm not competitive |
| **Bg2** | 1 | I'm not competitive |
| **Bb1** | 1 | Poor PC access |
| **Bb4** | 1 | It has no mention of intentional competition |

*in each group the participant with most points at the end of the project won a gift voucher, this was introduced to stimulate competition.

**The kinds of challenges or rewards that would encourage participants to do more steps**
Under this heading the participants identified

- Money (5 participants).
- Prizes (3 participants).
- Staged monetary rewards.
- Extra points.

## G.4 Reflection on social support and competition (for console game participants)

Data in this section are from 11 participants in Groups A and C.

**Impact of having a "Walk With Me" friend**

| | Effect friend had on participant's daily step count 5 (very high) to 1 (not at all) | Increase in friend's activity over the project 5 (very high) to 1 (not at all) | Frequency of sharing data with friend |
|---|---|---|---|
| **Ab1** | 3 | 4 | every day |
| **Ab3** | 2 | 3 | once or twice a week |
| **Ag3** | 1 | 3 | less than once a week |
| **Ag1** | 1 | 1 | less than once a week |
| **Ag2** | 1 | 1 | none* |
| **Ab2** | 1 | 1 | every day |
| **Cb1** | 4 | 4 | every day |
| **Cb4** | 3 | 4 | every day |
| **Cb3** | 3 | 1 | once or twice a week |
| **Cb2** | 2 | 1 | less than once a week |
| **Cb6** | 1 | 4 | every day |

*Ag2's friend lost the activity meter

**Console game's mini-games**
Five "mini-games" are provided in the "Walk With Me" game.

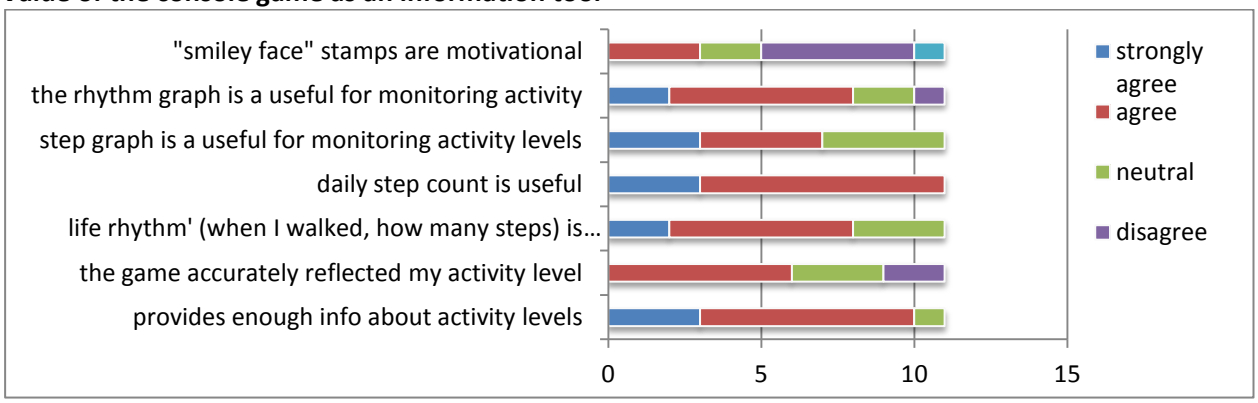
Best game: Walk the World

- 11 participants chose this (no other games were nominated).
- The supporting comments all referred to the motivation it provided since it rewarded participants with images and information about places as they achieved certain targets.
- In addition one participant commented "I wanted to beat my friend".

Worst games: *Ranking* and *Illuminate*

- Five participants nominated *Ranking*
- Three participants nominated *Illuminate*
- Both were seen as "boring".

**Value of the console game as an information tool**




Participants were asked if they would value comparing their step/life rhythm graphs with their Walk With Me friend's:

- seven said yes
- in addition, six of these thought it would motivate/provide competition.
- four said no
- one thought however that it might motivate
- one believed he'd be in the losing position.

# Appendix H: Elgg website usage data

| | Web points | No. of wire posts | No. of photos | No. of blogs | No. of comments | No. of pages | No. of messages left on other's message board |
|---|---|---|---|---|---|---|---|
| **Ag1** | 1604 | 13 | 44 | 8 | 30 | 1 | 18 |
| **Ag2** | 401 | 6 | 5 | 2 | 9 | 0 | 5 |
| **Ag3** | 340 | 16 | 10 | 1 | 3 | 1 | 12 |
| **Ab2** | **2068** | 2 | 4 | 28 | 18 | 0 | 14 |
| **Ab3** | 42 | 1 | 0 | 1 | 0 | 0 | 0 |
| **Bg1** | 22 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Bg2** | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Bb1** | 50 | 0 | 0 | 1 | 0 | 0 | 0 |
| **Bb2** | **1299** | 9 | 134 | 5 | 3 | 0 | 4 |
| **Bb3** | 431 | 2 | 5 | 7 | 3 | 0 | 1 |
| **Bb4** | 372 | 1 | 0 | 0 | 0 | 0 | 0 |

# Appendix I: Barriers to Usage

## I.1 Summary of Issues Identified

### Problems with recording full number of daily steps accurately

| | No. of participants | Group A | Group B | Group C |
|---|---|---|---|---|
| Forgot to wear it | 5 | 2 | 3 | |
| Can't wear during activity (nowhere to keep it) | 4 | 2 | 1 | 1 |
| Pedometer/activity meter didn't record data accurately although worn | 4 | 3 | | 1 |
| Loss of pedometer/activity meter | 2 | 1 | | 1 |
| Not allowed to wear – school/organised activities | 2 | | 1 | 1 |

### Barriers to activity

| | No. of participants | Group A | Group B | Group C |
|---|---|---|---|---|
| **Illness** | 9 | 4 | 2 | 3 |
| **Problems of weather (snow/rain)** | 7 | 3 | 1 | 3 |
| **Holiday** | 4 | 3 | | 1 |
| **Homework** | 3 | 2 | | 1 |
| **Long distance car journey** | 1 | | | 1 |

### Choose not to be active

| | No. of participants | Group A | Group B | Group C |
|---|---|---|---|---|
| "Lazy day" | 3 | 2 | | 1 |

# Appendix J: Design Ideas for eHealth Technologies

## J.1 Feedback on "Walk with Me" game and mini-games

| Concept | Sub-theme | Verbatim comments |
|---|---|---|
| INTEGRATION | | It would be better to integrated it with other site that you would normally use, |
| COERSION (EXTERNAL MOTIVATION) | | somebody else to present a challenge every day, someone told me to do it, and I will do it. |
| GAME PLAY | Variety of games | I liked how the game gave you something to do (play) other than only check your steps |
| | | I like the game, it has good games on it, and very detailed. |
| | | The game is good, but may be have different kinds of game, like football games or physical games |
| | motivation to exercise | I like it, it is a good game, because it keeps your fitness up and keeps your on your toes. It encouraged me to do more steps. It is a fun game, |
| | | My dad walked more while he was using the activity meter. |
| DATA SHARING | Social impact | My walk with me friend made me feel bad, she walked more steps than me most of the time, because she walked back home, and I had to take bus home |
| | Technical limitation | it's easy to share steps with my dad, as he came in and just gave me the meter straightaway. But it will be more difficult to share information with my friends |
| | | It is difficult to check my friend's data. Sometimes I don't have time to check what my friend has done. Like the last 2 weeks, I can't check as it has been snowing and I didn't go out. It will be better to have something you can check the steps without having to get the activity meter of your friends. |
| | Collaboration | I like the walk the space one, it connects to the Internet and you walk with other people together to walk into the space, there are 88000 people in my group. |
| DATA VISIBILITY | | I didn't like that you can't see your steps when you are out without your DS |
| | | I didn't like how long it takes you to check your data. |
| VARIETY OF REWARDS | | I did not like the repetition of the game. It used an animal a day to present your steps level, it was interesting for the first a few days, but them, it wasn't anymore. I kept get the same one every day, the morning horse. (Because his activity level is very consistent, Daniel gets different ones as he didn't have consistent activity levels). |
| | | The walk with me game is good, as I can play games on it. I like the around the world game. |
| | | I like the walk the world game |

## J.2 Feedback on "Walk with Me" activity meter and Omron pedometer

| Concept | Verbatim comments |
|---|---|
| WEAR-ABILITY | when I was playing football or different sports, I ended up having it in my gloves, so a clip, clip around your belt or watch will be useful. |
| | It will be good if I could use if when I am doing sports, as sometimes, I don't have pocket. I did notice the game provided a clip, but I couldn't figure out how to put it on |
| | It is good, because it's being small, you could just put it in your pocket, without worrying it falling out |
| LACK OF ACCURACY | It could more accurate. |
| | When I was running, the information didn't seem to be recorded. |
| DATA VISIBILITY | It's better than the big pedometer thing, because it gives you more surprises. Because it doesn't have the numbers on if you think you haven't done many, but you actually did more, it's a boost. It makes me want to do more and more, I prefer this more than the ones you can see the numbers |
| | I like the same of the activity meter, or like the size of my mobile phone, touch screen with steps and times on it. So I can know easily how many steps I did |
| | I think the mobile phone size is too big, need smaller size. I like the size that we have now, but I want to be able to see how many steps I did all the time instead of having to get my DS every night to check. I want to be able to check on the go. |
| LACK OF INTEGRATION | For it's being small, I kept on losing it, and I was searching for it all over the place, |
| | Something to help you to find it will be useful if you lost it, like your phone, you can ring it if you lost it. |
| | *Feedback from the boy who dropped out was that he did so because that he kept losing/mislaying his activity meter and he forgot to use it many times* |

## J.3 Response to research team's ideas

### Link steps to existing games

| Concept | Sub-theme | Verbatim comments |
|---|---|---|
| CHEATING | Positive | I play many games and love puzzle and action games as with this it is like a cheat box because we got help for doing lots of steps. |
| | Negative | It is good that it can help with levels, good fun, however, it is cheating, and may defeat he point of the game. |
| | | Help you with levels, but it feel like cheating as it makes the game a lot easier. Defeats the points of completing a level. |
| | | Moreover, the fact that it is a video game encourages sitting around. But it is cheating. |
| GAME GENRES | Collaboration | It is a good idea, but we prefer the ones that we could compare with our friends, we more prefer the social games, like the farmville one |
| | Game content | I would like it linked to a car game. |
| | | It's a good idea, because it gets weapon and action, we prefer this one. |
| | | I like shooting things, so this one will be good for me, and my friends actually. This is more of my comfort zone. |
| | | Everyone loves video games so this would be a good way of looking at your physical activity. But girls didn't really like war and action games, so need to make it more unisex. |
| | | I like the fact that it is an add on to a popular game. I will like the idea of the game as I like action games. |
| POINTS AS REWARD | | You can get points to get better things. |
| | | It will be nice to compete others on games to get more points. |
| | | This is a very good idea, because it will upgrade you in something you are interested in. It couldn't be better. |
| | | It is good, for example, it could go on to your PSS online and you could buy maps for COD and themes for your PSS upgrades. Or you could collect points to buy guns for Black ops! |

### Link steps to virtual pet (move locus of control)

| Concept | Sub-theme | Verbatim comments |
|---|---|---|
| COMPETITION | | It is good, it makes I do better and you want to do better than everybody else in the game, but it is not for me |
| | | The guilt trip you into more exercise, the dogs are cute, and wouldn't want your dog to die compare with your friends. |
| | | I like it that I could compete with friends, and dogs are cute. |
| TARGET AUDIENCE | | It is a cute way of looking at your activity. It will attract female people, girls. It is only for girls and not for boys. So maybe to make it more manly but still include a girl aspect. |
| | | It would be good for young people, but the older you get, the mature you get, you will be less interested in this. |
| | | It's like Nintendo dog. It will not attract me and my friends, but it will be for younger ages, say under 8 |
| BOREDOM | | I might get bored |
| | | May get bored of it after a while. |
| | | May get bored eventually |
| VALUE OF THE PET | Positive | It encourages you to do well as you don't want to hurt your dog. |
| | | The dog will be happier if you walk more. Fun! It is for everyone, I live with dog and I love dog. (2 people) |
| | | It's a good idea. I do more exercise because I want to make my dog happy, not sad. (But I prefer the game one) |
| | | It is fun to play with dogs, such as Nintendo dogs or real dogs. They have same emotion and buy things with steps. |
| | | I like that it is like a realistic pet. It encourages you to do more exercises and walking as the fate and happiness of your dog is in your hands, it's fun! This one is my favourite! |
| | Negative (avoid negative consequences) | Sometimes may forget about the game. |
| | | if I am too busy, my dog might die. Maybe use a different animal. |
| | | if you have no time to sign in your dog may die. Maybe use a different animal. |
| | | It would be better if the dogs were hamsters. |

### Link steps to social games

| Concept | Sub-theme | Verbatim comments |
|---|---|---|
| SOCIAL COLLABORATION | Social focus | You could make it more like Habbo hotel so you can talk to friends while looking at activity. |
| | | You get more things and get onto facebook games, which will help people with their farms and games. But it will not work for someone who does not play those types of games. |
| | | It is good as it is a social game, so friends can work together to help build up their levels. |
| | | We prefer the social games, as we like to be able to share with friends. |
| | Personal focus | I prefer the game one as I am not really bothered about what my friends are doing, as long as I am doing well |
| SOCIAL GAME CONTENT | | It's a good idea, but not for me. It's like the pet one, not really my comfort zone. I played the farm game before, and I just don't find it's that interesting. But I played the restaurant city, building hotels and things, that one was good. |
| | | I wouldn't go on the game much, as the farmville game isn't appealing. |
| | | We prefer the game one as we like action games. But if the social game is to build an army or something, we will like that one |
| | | Need to choose something better than farmville though. |
| NEGATIVE CONSEQUENCES | | It is good to pass time, compete with friends, and you have goals to compete. However, the plants die if no time to harvest. If you go away, your farm will die. |
| | | It's a good way of wanting to do exercise so you can get money to help your game. But my experience of games like farmville is bad as you are expected to be on all the time, otherwise, your plant will die. |
| REWARDS | | I like it as you get to buy things with points, and you can get to go on facebook. |
| | | It is good, people can link the steps to their farm, or other games. |
| PLATFORM | | However, I don't use facebook, and sometimes annoying as many people talk about how good it is |
| | | Bring it out for gaming consoles would be better. (2 people, say the same thing). |
| | | I would not really use it much, I think it would be better if it was a Nintendo game. I don't really use games like this. I think the idea is good, I just don't like the game. |

## J.4 Participants' ideas

### Data-logging Device Design

| Concept | Sub-theme | Verbatim comments |
|---|---|---|
| FUNCTIONALITY | Operational information | The pedometer should have a touch screen like the ipad which can count your steps, calories, the amount of time walking plus it can be used like a calculator, notes pages, internet access, but it would only be a small size so you can fit it into your pocket. |
| | | Something to help you find it, if you lost the pedometer, like your phone, you can ring it if you lost it |
| | | A water-proof watch that measures your pulse rate and beeps if you have reached a target |
| | Persuasive design | it lights up so when you do a lot of steps, you get green, but when you didn't do that much, it goes red |
| | | When you have reached certain target (eg. 10000 steps), it should light green like the "walk with me meter does. You can attached it to any pairs of shoes |
| | | A pedometer built into a pair of shoe and the logo changes colour as you walk, it can be any kind of colour you want. |
| | | Super cool shoes which glows a different colour for every 1000 steps, you will look so cool. |
| WEAR-ABILITY | Used for purposeful exercise | A hat keeps your head warm, counts your steps and plays the music you download when you do exercise |
| | | Integrated it into a bottle, bottle as a device to connect the steps. You can drink from it and know your steps. |
| | Ubiquity & Invisibility | I like the shoe thing, place a pedometer in your shoe, so that I could use it when I am doing sports |
| | | Have it on your watch. |
| | | Put it your glasses so you have it on all the time. It tells you on the side of how many steps you did |
| | | It should be like a button, it looks cool |
| | | A bracelet like pedometer, it looks fashionable, counts the calories you burn, how far you walked, and waterproof |
| | | The pedometer is attached to shoes, so it gets an accurate result. It should be small so it is out of view. |
| | | A bag with a pedometer in it |
| | | it could be a belt and the pedometer could be the buckle because you won't forget it or else your trousers will fall down |
| | | My mum likes the idea of it being inside jewellery, eg, rings etc |
| | Positionable Meter | It is clip-able to fit around a belt or a watch |
| | | I like to have one that could be put around your ankle, as the current one, I couldn't use it to count steps when I am doing exercise, if there isn't a pocket that I could put it in |
| | | I like the ones that you can clip them anywhere you want |
| | | I like the one that you can clip your pedometer to anywhere you want |
| | | Maybe have a little pocket bag, because I play snooker, I walk around the table, I don't normally have my coat on, so it will be useful to use a bag for one, a pocket bag |

| Concept | Sub-theme | Verbatim comments |
|---|---|---|
| RECORDING A VARIETY OF ACTIVITIES (NOT JUST STEPS) | | Connect it to your BMX, put it on your handle bars for your bicycle, it picked up how many times you paddle, and how long it takes |
| | | A water proof pedometer, so you could wear it when you are swimming. |
| | | Record football, eg, how many times you ticked, and how far or how tall it goes |
| | | A belt with a pedometer and different sport settings that can be changed |
| INTEGRATION WITH OTHER TECHNOLOGIES | Connectivity | It also has a USB adaptor so that person can put his/her points into their computer xbox or ps3 |
| | | It connects to your Wii fit |
| | | The pedometer should be connected to the Wii fit, so you can view for walking amounts and your physical activity on the actual Wii fit, this would give an accurate level of fitness |
| | | It could connect it to the Wii as well |
| | | I like the idea of linking it to facebook, as people will be encouraged to do it more often when they go on facebook every night |
| | Integration into existing technology | I like it to built into a phone as well, or Ipod, as I won't lose it. |
| | | I prefer it to be integrated to my Ipod or phone, it is much easier to remember to carry it, as I carry my phone every day |
| | | A pedometer and timer built in the phone. |
| | | You can have it on something you use every day, such as ipod and key rings |
| | | If it is built in a phone, you can text it, if you lost it, and it will start a song, so that you can find it easily |
| | | A pedometer in headphones so joggers can count their steps with the movement of their head |
| | | Connect to the Ipod |
| | | an iphone app would be good :) i have my phone with me contstantly and therefore i would never forget it :D it would be also alot easier to acess :D |
| | | It could be actually in your phone because i almost always remember that : ) |
| | | Build it into an iPod or PS3, or Xbox |

## Data

| Concept | Sub-theme | Verbatim comments |
|---|---|---|
| SHARING | Competition | Maybe walk around the world, compete with the people all over the world, to see what kind of people in different countries do more steps, to see who is the fittest country, does most of the steps |
| | | You should be able to compete with people around the world for fun |
| | Social Support | Link it to game like HABBO hotels (more than 3 mentioned this) |
| | | The pedometer should be programmed to facebook, so that you can chat with your friends, and count your steps |
| | | Develop the social idea and use visual people to socialise and keep track of your physical activity. |
| VISIBILITY | | I would like it connected to Internet, it came out with all the list of friends and their steps |
| | | All my friends like fiddling around touch screen, so something has touch screen on will be better |
| | | You should be able to see straightaway how many steps you did, so you will do more steps. |

## Persuasion to exercise

| Concept | Sub-theme | Verbatim comments |
|---|---|---|
| LOCUS OF CONTROL | | Link to a virtual person, if you didn't walk enough, the person will die. |
| MOTIVATION | Negative consequence ("stick") | Do steps to unlock your xbox or laptop, eg. every 10000 steps you get an hour for it. (I will not like this idea though). |
| | | the pedometer could play your ipod music but only when you do activity |
| | | Music will stop playing if you stop the exercise. |
| | Positive consequence (carrot) | Connect pedometer to the computer. If you do enough steps, you could get on your faviourate game, eg. football manager, Sims2. |
| | | A text sent to your phone saying a sports and a length of time, if the people does it, there will be phone credit topped up on the phone |
| | | Game that is powered by travel, eg. do exercise and get the chance to use the xbox game |
| | | Similar to Nintendo Mario Party, it is like a board game, but in your ds. Transfer the walking results to the game, and it would convert your actual steps into playing steps so your character would walk around the board and every time you finish moving, you will be given a challenge. Eg. Skip for 10 minutes, or kicks bum. |
| KINETIC DESIGN | | Every 10000 steps you do, it could power your tv for an hour as well as actual electricity. It saves money, save environment and keep healthy |
| | | It charges the phone battery. The more steps, the more battery you have for your phone. But the phone also has a small battery so if you haven't done enough steps, it still works |

## Games

| Concept | Sub-theme | Verbatim comments |
|---|---|---|
| CONTENT | | Different games, like football games, physical games |
| | | It should be something to do with football, Sunderland football club. |
| | | Built your own world, you could have friends as your neighbours, you have from a small flat to bungalow and to mansion etc. |
| | | Try different game, instead of farm steps, you could have football steps or fantasy thing, buy places, you start with a small stadium, do more steps and upgrade your places. Boys could build their own football team, and girls are into fashion, so maybe clothes shop |

## Individuality

| Concept | Sub-theme | Verbatim comments |
|---|---|---|
| FOCUSED ON "ME" | | A robot dog that walks along side of you when you are walking. If you not doing much walking, it talks to you and motivate you to do more. It has different types of dogs, and you can upload your favorite songs to it, and it will blast them out in speakers. It gives you fitness tips depending on how much exercise you do and your fitness level |
| | | You should be able to design what your pedometer looks like, so you will have your very own personal pedometer. It has to be colourful. |
| | | It should have a camera on, you give your friends, so that you can see where they are, what they are doing. Little camera and sensor, when you press button on your DS or computer, you can see yours steps, activities and your friends too if you two have special camera codes. So if I play football, a clip on my trousers, I will be run around and my friend could tune in and watch me, like where I put my pedometer and view my acts, like if I scored, he could see it. |
| | | it could have a little camera in to show you the highlights of your active day, like showing you play football |
| | | An "invisibubble", a giant transparent see-through hamster ball, with a pedometer to record how many steps you did and how much calories you burned, it is waterproof, with a hidden camera, so that you can upload the video to youtube, so people can watch and laugh |

## Rewards for doing exercise

| Concept | Sub-theme | Verbatim comments |
|---|---|---|
| WITHIN GAME REWARDS | | Link your points to facebook game, eg, farm, get points |
| | | I would like to have the step counts connect to the step counts. Trading steps for the points of face book games |
| | | Should be able to connect to online games, so you go on Internet and connect it with your step counts. It gives you points, could be an online world, like a Mii character or something. You can built your own world, every active walking, eg. each 10 minutes you do active walking, you get £1, to buy some clothes. More steps you get more points. For example, 10000, you will get 10 points, so you can extend your house or something. |
| | | Connect to a football game for Xbox, PS3, your players can get better Staminer ???? or unlock accessories for your own player. |
| | | A Tamagotchi like pedometer, with a virtual you on it. More steps you do, you get a bigger gift for you little virtual you, eg. clothes etc. If you don't do many steps you get a tiny/joke gift, but if you do very well you get a bigger prize. It would display your step count, amount of calories lost, basic things from a pedometer, but making it fun by making it a game. You could have different designs for the back of the tamagotchi thing, and it should be waterproof (Mel, Charlotte loves this idea) |
| REAL WORLD REWARDS | Discount | can give them discount on different things. (e.g call of duty maps or music) |
| | "Freebies" | Maybe a game, if it's like Call the Duty, everyone would do more steps, just in order to get the game. So get fit and get a free game (eg. black ops, fifa II) |
| | | Get a free sports equipment if you walked lots of steps, eg. boxcises things, football things |
| | | If you get enough points, if you support Newcastle, you can get things like, walk around the Newcastle football thing, you could get points to look around preview video inside the ManU ground |
| | | link exercise to points for game, free download, or Call for duty black ops. |
| | | Connect points on iphone/ipad, get free applications |
| | Financial rewards | If you have done 10000 steps plus, you will get £1. |
| | | Get a voucher for shops if you walk lots of steps. |
| | | It can be built into your iPod, you can get money off application and songs |

# Appendix K: Background literature review.

**Introduction**

For many years technology has been seen to be a major contributing factor to the decline in physical activity among both adults and children (Nigg, 2003). However, advances in ubiquitous and mobile technology, interactive gaming and social networking now mean that these offer new possibilities for encouraging and supporting individuals in the adoption of a healthier life style. The purpose of this paper is to review the literature on how digital technology can be used to motivate individuals to partake in more physical exercise, and identify the aspects of this research that could effectively contribute to the research design of the Children's health project.

However, before discussing how technology can be used to promote activity, it is worth considering the type of exercise that technology might support. Broadly speaking exercise can be divided into two types: opportunistic and structured. Structured exercise refers to activities that are undertaken with the purpose of raising the heart rate over an extended period of time. This type of exercise may include, but is not limited to: swimming, running, or the use of home exercise equipment. A wide range of technologies have been developed to support this type of exercise, ranging from motivational displays to limit boredom on fixed exercise bikes (Mokka et al, 2003), through to computer and console games, for example shadow boxer (Hoysniemi et al, 2004) and football (Mueller et al, 2003). Possibly the most extensively studied game of this type is the "Dance Dance Revolution" game which was first released in 1998. Players stand on a platform or subsequently a dance mat, and work through a series of steps and jumps sequences of computer-generated patterned lights on a dance mat. The game has been studied in single group and comparison group format on a range of measures relating to its potential to increase fitness (Baranowski, Buday, Thompson and Badanowski, 2008). While such games have been shown to lead to an increase in energy expenditure, and increased social contact in the case of Mueller et al's (2003) work, users must engage with the technology purposefully, much as they might by going to a dance class or going to a gymnasium.

Opportunistic exercise however refers to engaging in activity, as and, when the opportunity arises in one's everyday activities. For example, walking to school rather than taking the bus, using the stairs rather than the lift or escalator. Engaging in structured exercise may be a daunting prospect for the physically unfit or overweight person; therefore many healthy lifestyle initiatives focus on having people increase the level of opportunistic exercise first, in order to build fitness, before progressing to a more intense structured activity. Given that this type of activity happens during people's daily lives, as they go about their everyday activities, most attempts to increase physical activity through technology have leveraged ubiquity; the most often used technologies being the mobile phone e.g. (Nokia 5500 and many Sony Ericsson phones) and personal digital assistants (PDAs). These have the benefit of being portable and providing additional services, so that users receive added value in use; they are not simply being used as pedometers. In the case of mobile phones they also allow the user to make calls, send and receive messages. Researchers have also investigated how technology can be used to change the way we do our everyday tasks in order to incorporate exercise while we work. For example, Meyers et al (2006) studied the possibility of increasing daily physical activity by making computer-based tasks users already perform in their working lives more physically demanding. Specifically they investigated the use of Step Interfaces, in which users would issue

commands through a dance mat, for example by making a single step, holding a step or making a dual step or jump. Two applications were developed: Step-mail which was used to manage email communication and Step-photo for managing a digital image collection. Ten people participated in an evaluation of the interfaces. The evaluation focused on understanding the level of enjoyment and exertion as measured through users self perception and heart rate. The interfaces led to a 13% increasing in resting heart rate for the mail application and a 19% increase for the mail application. Participants were positive about their experience with the interface and indicated that it was easy to learn and use. However, the interfaces had limited functionality, to fully map a step input system to all of the actions one might perform with an email system could render that system less useful than its desk based counterpart.

Advances in technology also mean that mobile devices are also able to run applications that can serve as persuasive agents; providing incentives to encourage greater physical exercise. Such persuasive technology replaces face-to-face contact, and is intended to nudge into making behavioural change. Persuasion is often delivered in an abstract form through non-literal representations of the user's behaviour. For example, Jafarinaimi et al (2005) developed the breakaway device, which is intended to persuade users to change their behaviour by taking breaks during long periods of P.C. usage. Rather than use a literal reminder to get up and move away from the computer, the Breakaway device is a small statue that sits near the computer monitor, if the user takes regular breaks, the statue sits upright, if she fails to take breaks the statue begins to slouch giving a visual reminder of the need to breakaway.

In the context of life style choices, persuasion may also be delivered through social mechanisms where a user's data is shared with a group of peers. This can take the form of social support and inspiration, which is meant to be at the heart of many traditional and successful weight loss clubs (e.g. Weight Watchers and Slimming World). It may nurture competition on an individual level or a sense of team spirit; or it may leverage an individual's desire to simply create a good impression.

The following discussion describes how such ubiquitous and persuasive technologies have been used to increase daily activity levels in adult and child users. The final section of this report draws together our analysis of this literature into a set of specific design considerations for the project website and the selection of the game software to be used during the project.

**Ubiquity, Persuasion and Opportunistic Exercise.**

Not all attempts to increase activity have used non-literal persuasion, many have simply sought to provide users with a means to both record their activity levels and to provide advice on behaviour change. For example King et al (2008) investigated the impact of a hand held computer or Personal Digital Assistant (PDA) on increasing the levels of healthy but underactive middle aged adults over a 8 week period. 37 people were assigned to one of two conditions: the first received a PDA that was programmed to check their physical activity levels twice per day, and provide individualised feedback, and a set of paper-based physical activity guidelines. The device was programmed to ask a series of 36 questions twice per day. These related to amount and type of physical activity undertaken and motivational factors. The second group who served as a control only received the paper-based materials. Pedometers were also used to gather data on the number of steps taken by participants; this data was entered into the PDAs as a simplified scale rather than the actual achieved figure. Those participants who received the PDA reported significantly greater mean estimated caloric expenditure levels per week than the

control group. However, because the data was taken, in the main, from self report and self entered figures it is difficult to know the real extent to which behaviours had actually changed.

Consolvo, Everitt, Smith and Landay (2006) investigated the design requirements for technologies that encourage users to engage in physical activity using a purpose built application called Houston that enabled users to enter data on the daily number of steps they had taken from a standard pedometer and to make fitness based diary entries. Over a 3 week period participants, who were all adult females and known to one another, used the software to record their own daily activities. In addition to the recording activity and making journal entries, the Houston application also included social competition as a mechanism to motive an increase in activity. One group of participants were given a personal version of the software which allowed them to track their progress toward their individual step rate goals and record diary entries, another group were given a shared version of the software which allowed them to share their data with other participants, view other people's data and progress toward their step goals and to send brief messages of encouragement to one another. The results suggest that the sharing group were more likely to meet their personal set goals than the group who used the software on an individual basis. Out of the 13 people who participated, 7 individuals increased their daily step count from baseline recordings, and when participants did not reach their daily goal it tended to be by a large quantity of steps rather than by a small number; suggesting that on those occasions, extraneous factors may have been at work, e.g. illness, bad weather. In terms of barriers to the technology being used effectively, participants identified that the pedometers were not always convenient to wear, and did not always take accurate readings. For example they could not take account of the intensity of the walk. Moreover, the focus on steps meant that if participants engaged in a structured exercise that was not based on walking, e.g. swimming or cycling, their overall activity for the day would be recorded as low. The ability to enter information about activity levels appears to be of value to participants, particularly those who would share their data with others. It is important to note however that the study was based on a small group of adult females who had all expressed an interest in increasing their physical activity, prevent weight gain and in some cases reduce weight.

One of the first attempts to use non-literal persuasion to increase activity was the Fish n Steps application developed by Lin, Mamykina, Lindtner, Delajoux and Strub (2006) combined the use of a pedometer with an application that encouraged increased activity through the care of a virtual pet whose development was linked to activity levels. Specifically, the user's daily activity as recorded by the pedometer was used to dictate the growth of a virtual fish tank. The interface was evaluated with 19 adult participants who were divided into two groups. Participants in the first group each had an individual fish in a tank; the more steps they took towards their daily step goals, the larger and happier the fish would become. The application also leveraged social competition in that the second test group also had individual fish, but fish tanks were shared between four participants, who could see their own fish and that of the other three people. Initially baseline data was collected about the participants' attitudes towards physical exercise using the Transtheoretic Model (TTM). The model classifies individuals into stages according to their expressed levels of commitment towards physical exercise. This ranges from pre-contemplative: people who do not recognise there is a need to change and have no intention of making a change, to those who are engaged in behaviour change or those who have successfully modified their behaviour. Thereafter the evaluation commenced and lasted for a period of 6 weeks. The results suggest that the game only influenced the behaviour of individuals who were already at the preparation stage of the TTM. While the game had the

impact of making those at the lower end of the TTM spectrum aware of the need for action, the game did not lead to a change in overt behaviour. Moreover, there was no difference in performance between the two study conditions; people with the shared tanks did not increase their daily step count significantly more that those in the single fish condition. A small number of participants demonstrate some signs of attachment towards the fish, expressing feelings of happiness when the fish grew. However this had the potential to backfire on the success of the game, as one person reported that when the fish looked unhappy she would avoid logging on; presumably so as not to witness a further decline in its condition.

More recently Consolvo et al (2008) developed a persuasive device called UbiFit Garden. This application uses on-body sensing devices to record real time activity data which is linked to a mobile phone display. There is also an interactive application that includes information about the users' activities and holds journal information entered by them. The mobile phone uses a glance-able display based on a non-literal representation of the user's physical activity. The display uses the metaphor of a garden, flowers grow and bloom with activity and butterflies appear to signify goal attainment. The system works only on positive reinforcement. If users do not reach their goals or engage in activity the garden does not bloom; there are no negative consequences such as cloudy skies or weeds. The authors conducted a three week evaluation of the application with 12 people aged 25-35. All participants were mobile phone users who wanted to increase their physical activity. Participants were interviewed about their attitudes and behaviours towards physical activity, and were set a weekly activity goal of their own choosing. In follow-up sessions participants were interviewed about their experiences and were given the opportunity to revise their weekly goals. The results showed that UbiFit Garden could detect a range of physical activities, that participants responded well to the glanceable display, and were motivated by the growth of the garden and the incentives of the butterflies for goal achievement. Participants were also given the opportunity to edit their data, this facility compensated for sensing errors, demonstrating that people wanted their data to be accurate.

Fujiki, Kazkos, Puri, Buddharaju and Pavlidis (2008) examined the impact of a novel ubiquitous gaming paradigm on teenagers' exercise levels. Participants used a wearable accelerometer that controlled the animation of an avatar that represented the individual in a virtual race with other players over the mobile phone network. The game runs in the background and gathers movement data throughout the day. Winning or losing the game is directly related to the amount of physical activity the individual does. Game winners are given hints that help them complete a series of mental games in the suit such as Sudoku. Over a short (few days) trial, the results indicated that a "good percentage" of participants increased their physical activity levels. However, participants indicated that the game needed to provide more encouragement and technical issues with regard to battery charging and system size affected the user experience.

The majority of these studies have been carried using adult participants who are interested in making positive lifestyle changes. It is unclear at present however, whether the non-literal approach adopted by applications such as Fish n Steps or UbiFit Garden are more powerful than journal based approaches such as Houston. For example, Maitland, Chalmers and Siek (2009) suggest that in respect of promoting health related behaviour change, what is needed is attempts facilitate change rather than to motivate change through persuasion. Maitland et al investigated attitudes towards making positive dietary changes from the primary caregivers of 17 low income families. They found that participants were well aware of the dietary limitations and were motivated to change but lacked the resources to be able to do so.

Moreover, it is unclear as to whether the approaches used above would prove more or less successful with children. Children and teenagers may draw motivation from different sources; what appeals to younger children may not appeal to teenagers. Motivational factors for girls maybe very different than those for boys. There are a small number of studies of how ubiquitous and persuasive technology can be used to motivate teenagers to undertake more physical activity; these are discussed below.

Toscos et al (2006) developed a mobile phone application to motivate teenage girls to exercise. The software aims to leverage social networking between peers. Girls were of particular interest in that there is evidence to suggest that they are more likely to become physically less active in adolescence than boys. The authors employed a user-centred design process which included interviews with the target user group for the application called Chick Clique. The software allows up to four friends to join a group in which the groups walking activities are tracked. Daily step totals are manually entered each day into the phone application by each participant. Automated text messages are sent to each member indicating group performance, fitness level achieved and the step value associated with each member. The text messages also offer praise for meeting goals and a food tips tool provides information on healthy food choices. A small evaluative study lasting four days was conducted using two groups of teenagers. Both groups were given a partially implemented version of the Chick Clique application to use. At the end of the study the girls were given a standard pedometer to use for comparison. The results showed that the most powerful method in behaviour change was group performance. The participants rated the use of a pedometer alone as being able to increase exercise more than the Chick Clique application however in terms of actual performance the girls using Chick Clique recorded more steps. Unfortunately however, our ability to draw any firm conclusions from this study are limited for a number of reasons: first the short time duration, second the two groups of girls were different in age profile, the average age of one group was 16 while the other group was 13;finally, one group was on a school holiday while the other wasn't.

Arteaga, Kudeki, Woodworth and Kurniawan (2010) developed a mobile system operating on the iphone platform that was intended to motivate teenagers to undertake physical exercise through the use of an agent who would provide encouragement and the use of a series of small games that were linked to the user's personality traits as measured by the Big Five Inventory. Artegea et al based their design on the fruits of a small-scale (28 respondents) survey they conducted to understand teenagers' views on physical activities and the use of mobiles phones as motivational devices, and focus group discussions with individuals from the target age group (12-17 years). The prototype system presents users with a brief personality test and then on the basis of the user's responses the system displays a set of games that are relevant to the user's personality traits. Unfortunately the authors do not describe the individual games nor how they relate to different personality traits. The agent serves to introduce activities and to provide motivational phrases. The system was evaluated over a four weekends by five participants who were asked to use the device for an hour each day. Participants were interviewed about their experiences in relation to the usability of the system and its impact on their motivation to exercise. The participants liked the agent and enjoyed receiving the motivational phrases, but wanted the game instructions to be more clear and easier to understand. The authors conclude that individuals with certain personality traits are more likely to be receptive to the idea of motivational technology, and that games that allow for socialisation and or competition are more likely to be successful. However, these suggestions

arose from the focus group discussion with the teenagers rather than from the evaluation of the system.

Both of these studies propose innovative strategies to motivate teenagers to exercise; however the limitations in the evaluative studies do not permit us to draw firm conclusions about the success or the longevity of that success. On a more positive note however, both studies have used a user-centred approach, working with the target user groups through small questionnaires and focus groups to try and understand what specific interventions might work well for that group. However, there remain a lot of unanswered questions about the form and function of such devices. There are opportunities for research into requirements elicitation for both these types of technology and that particular age group of users, and the types of methods that would be useful (e.g. technology probes, focus troupes).

**Research Design Considerations**

From our analysis of the literature we have identified four related areas of impact for the design of the children health project: portability and accuracy; social support; goal setting; incentives and rewards.

**Portability and Accuracy**

The findings of Consolvo et al (2006, 2008) and Fujiki et al (2010) suggest that the portability and wear-ability of any device to monitor activity was a key concern for users and would likely determine if the product would be used. Many standard pedometers do not attach to all clothing options (e.g dresses) and some are unattractive and cumbersome. A key factor for the Tosco et al's (2006) Chick Clique study was to find a pedometer than would be stylish for teenage girls to wear. In order therefore to improve the success of the ehealth project it is necessary to find an application that utilises a discrete activity meter that can easily be attached to clothing, or be carried in a pocket or bag.

Concerns have been expressed by participants across all of the studies mentioned about the accuracy of the devices used to record daily activities. For example, participants in Consolvo's (2006) study felt cheated when activity they had engaged in was not able to be recorded by the pedometer, for example swimming and bike rides. They wanted to be able to add in data about these non-recorded activities, and commented that this was particularly important if the information was to be shared with others.

**Social Support**

A number of the studies above sought to use information sharing between people as a means to provide social support and encouragement between people (for example Consolvo et al's Houston application) or as a means of creating completion (for example Lin et al's Fish n Steps application).

The impact of social support was unclear; Consolvo et al (2006) found that people were more likely to reach their daily step goals in the information sharing group than those who did not share. Conversely Lin et al (220) found no impact of social sharing with the Fish n Steps application. The problem in comparing these studies is difficult for two main reasons. First, the interface used was very different; one was a journal based interface and the other a virtual pet. It may be that the format in which the information is shared interacts with the success. Second, the more successful use of social support focused on data, what individuals actually achieved and the use of encouragement, through messages, between participants. The other application

used positive reinforcement through the growth of the fish, but it also used negative reinforcement with the emotional appearance of the fish being subject to change and the loss of tank decorations and water discolouration.

Maitland and Chalmers (2008) suggest that the evidence gathered on the impact of social support on health related interventions is inconclusive; suggesting that the notion of social support itself is unclear in much published research. They identify two forms of social support: the first comes from online interactions between people who normally would not meet. The second and more powerful type comes from the family and friends of the individuals concerned. Maitland and Chalmers conducted 14 in depth interviews with women who were either engaged in trying to lose weight and become healthier, or had already successfully lost weight, in order to derive guidelines about the use of social support within applications aimed at improving health and fitness. Their results suggest that applications should allow for selective, partial and incremental disclosure of monitored behaviour, and that when people compare their performance with others, this should be done relatively rather than in absolute figures, taking account differences in gender, weight and height. While these recommendations were derived in the main from an analysis of experiences in sharing information about weight loss, they are still relevant to the sharing of data about physical activity. For example, some of the participants in Consolvo et al's (2006) Houston project indicated that they would have liked each person to have the same step goal to make comparison easier and therefore allowing them to compete with one another. Ahtinen et al (2009) echoed the positive influence of social support in their study of the design of wellness applications in India.

**Goal Setting**

Consolvo et al (2008) note that there are a number of alternative ways to set activity goals for participants; these range from assigned goals, participant-determined goals, negotiated goals and goals based on national recommendations or one-size-fits all, e.g. 10,000 steps per day. Although the one-size-fits-all approach is possibly the most effective in terms of allowing people to compare themselves to one another, most studies have calculated goals based on a baseline measurement of the participants' daily activity over a short time period plus with a 20-30% improvement as the target goal. It is important not to set the goal too high as participants may feel it is impossible to achieve. For example, those individuals in Consolvo's (2006) study whose base line level of activity was already high were given goals that they felt were unreasonable. Moreover as Lin et al (2006) comment, if the goal is too high, it will either delay or deny the participants exposure to the incentives offered by the software, in their case the growth of the virtual pet.

Consolvo et al (2009) explored their participants' preferences for goal setting. Specifically they looked at goal source (that is who should set the goal) and goal timeframes (how long the individual should have to achieve that goal). The result suggests that self set goals were popular, although the authors propose that these should be set with reference to national recommendations. Participants also like the idea of group set goals and goals set with the advice of a fitness expert. However, it is important to note that the participants' only direct experience was of self set goals, they were only asked their opinions on the other goal sources. The authors suggest that having participants declare their goal publicly might be effective in terms of increasing goal commitment. In terms of timeframes weekly goals were popular but participants wanted to be able to declare their own week start and end dates, they also wanted the record of past achievements to remain.

**Incentives and Rewards**

The studies surveyed used a variety of reward types ranging from blooming flowers and butterflies, to simply encouraging statements. All concluded that participants like to receive their rewards and take pleasure in reviewing them. Positive reinforcement appeared to be more successful than negative. Within Lin et al's (2006) Fish n Steps study, if the participant failed to engage in exercise the expression of the fish changed to one of sadness and over time the tank water would become murky. This negative reinforcement backfired and discouraged use for some participants as they began to avoid logging on to the system to avoid seeing the unhappy fish. While these participants expressed feelings of guilt, they were not motivated to act.

Clearly, within the bounds of a small project such as ours, we would be unable to develop a non-literal display or virtual pet interface; however, these findings suggest that reinforcement is important and that the form of encouragement and positive reinforcement needs to be investigated.

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