Taking steps for maths


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Fitness trackers can provide primary students with exciting opportunities to calculate, measure time and distance, graph, make sense of data, and improve their activity levels. This article suggests ways to use fitness trackers in the classroom.

Introduction

In recent years, fitness trackers have become extremely popular, especially as technology provides instant feedback in a fast-paced world. These devices are usually worn on the wrist and different fitness trackers provide and record different types of information, such as: steps walked, distance walked, time, date, sleep patterns, calories burnt, heart rate, weight, food plan, and fluid intake. The fitness trackers can be synchronised with a phone through a downloadable app, which varies depending upon the device.

Due to the increasing popularity of fitness trackers, Lisa, a classroom teacher, wondered how these devices could be utilised in the classroom. She realised that there were opportunities to use the trackers in activities that could incorporate mathematical ideas, such as: measurement, computation, place value, time, data gathering, statistical variation, and graphing. Lisa also wanted to take advantage of cross-curricula opportunities, especially incorporating Health and Physical Education (HPE). She recognised that fitness trackers could be used to help students "investigate, represent and interpret situations in their personal … lives" (ACARA, 2018a) and build understanding of a range of concepts within mathematics—especially from the statistics strand—as well as health and well-being, thus allowing students to "recognise connections between the areas of mathematics and other disciplines" (ACARA, 2018a).

For twelve months, Lisa had been using her own personal fitness tracker, which cost only $25, and which was able to record time, date, steps walked, distance walked, and the calories burnt (see Figure 1). She realised that this affordable price made it feasible to purchase a number of fitness trackers, which could be utilised by a class and across the whole school.

Figure 1. Fitness tracker on the wrist of one of the students.

Fitness trackers in the classroom — overview

Lisa was teaching a Year 4/5 class in a regional town outside Hobart. There were 24 students with a diverse range of learning abilities. The school purchased four of the $25 fitness trackers and Lisa also had a spare one (in addition to the one she wore herself), so there were five trackers available for use by the students at any given time. Lisa developed a sequence of activities to be conducted over a four-week period which would allow students to use the trackers and record and interpret the data they generated in a variety of ways.

She decided she wanted each student to use the device one day a week over a four-week period. Each day five students wore one of the fitness trackers. She had a class list on the wall where students counted down the list to determine on which day they would be wearing the device. Once the students received the device for the day, they ticked off their name in the appropriate

day. Lisa wanted the students to wear the fitness trackers on different days over the four-week period with the intention of gathering data about their steps to identify any differences with their step counts and how this might be affected by their daily activities.

First week—step counting with the trackers

For the first week, Lisa created a recording sheet to record the students' individual data. The fitness trackers reset to zero at midnight, but on her way to work they would jiggle in her bag and would have data already recorded on them. She wanted the students to record their own information and, to do this, students would record the 'start steps' on their individual recording sheets, which was the number of steps already recorded on the tracker (after jiggling) when they received it. This was necessary to allow them to work out their personal step count at the end of the day.

They also had to estimate how many steps they thought they might take throughout the school day. This was an interesting task as many students did not know what a fitness tracker was or how effectively it could be used, and they had no idea about how many steps they might take during the school day. Some students estimated as low as 50 steps. To gauge an initial understanding of how many steps they might walk in one day, Lisa asked the students to count the number of steps they took in walking from the classroom to the toilet block. The students then adjusted their estimated number of steps, although some made only marginal changes.

At the end of the school day students recorded their 'end steps' and wrote an expression to determine how many steps they took. Some students had difficulty in writing their expressions as they wrote the 'start steps' and subtracted the 'end steps' which resulted in a negative number of steps. With an explanation of how to write the expression, students then used calculators and/or a written algorithm to determine how many steps they took throughout the school day. Some students did not know how to use a calculator, and this created another teaching opportunity, with Lisa modelling different computation strategies (NCTM, 2000, p. 156). The use of calculators enabled students to use subtraction with four- and five-digit numbers effectively (see ACMNA073 in the Australian Curriculum).

Lisa placed an A3-sized whole-class recording sheet in a table format on the wall. Students could record their daily steps alongside their name, so that the whole class could see, on a daily basis, the number of steps that had been taken (see Figure 2). As the week progressed, students would check the whole-class recording sheet and aim to beat the previous highest recorded step count, creating competitiveness amongst many students in the class. They would calculate what they would have to walk by adding their 'start steps' to the previously recorded highest number of steps to determine what needed to be showing on the tracker at the end of the day. So, for example, if Ben received a fitness tracker with 455 steps already logged, and he knew that Breanna had the current record of 4024 steps, he could calculate that he needed to get his fitness tracker count up to at least 4480 (=455 + 4024 + 1) by the end of the day to become the new record holder. Individual students would write down the number of steps they needed to take to have the highest number of steps. This allowed students to focus on four- and five-digit numbers and they could use calculators to determine what total needed to be on the tracker to get their predetermined goal. On the days the more competitive

Monday 30/10/17	Tuesday 31/10/17	Wednesday 1/11/17	Thursday 2/11/17	Friday 3/11/17	Total steps for the week
Sam 2,209	Kobey 4895	Ronas 4598	Lucy 5611	Luke 4632	
Jake 21 30	Abbey 3624	connor 8549	BJ 4434	Alex 8004	
Selly 3019	Ben 7136	Shaynia 4,519	Leah 9009	Josh 10248	
madison 2,261	Mitchell 4248	Cooper 5055	Lachlan 7858		
Breanna 4,024	Estyn 4449	Ashlee 4625	Mia 53405		
Ms Monks 4379	Ms Monks 3457	Ms Monks 5863	Ms Monks 4947	Ms Monks 4768	
18022 Total steps	27799 Total steps	33209 Total steps	37704 Total steps	27656 Total steps	144390 Total steps

Figure 2. The class record of students' daily step counts for the first week.

students wore the fitness trackers, they would ask to run errands to get more steps, and during breaks in their work they would ask to walk up and down the corridor or would ask to run laps of the school oval. This made the students more active and competitive.

The students recorded what activities they were doing during the day such as: table work, daily physical education (a short PE session everyday), PE (a longer session run only on one day of the week), music, library, and what they were doing during recess and lunch time. They also had to decide if having the fitness trackers encouraged them to be more active or not. In the first week, the focus was on understanding that the fitness trackers could count steps, and on discussing some of the reasons why students' total step counts varied (for example because the students were doing different activities or not wearing the trackers for as long as others).

Second week—preliminary data analysis and working with decimals

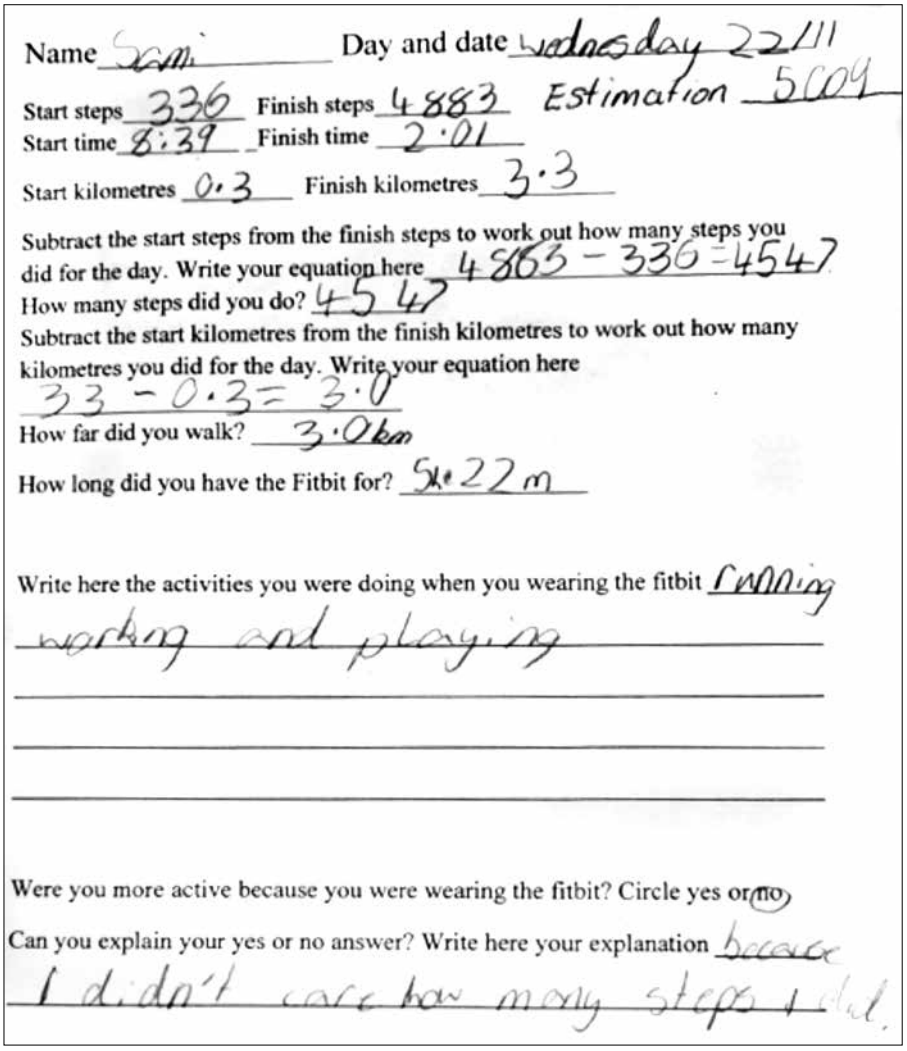
At the beginning of the second week, students were given an A4 recording sheet, similar to the A3 class recording sheet, together with questions about the data (Figure 3). These questions asked students to calculate the number of steps that had been taken by the students who wore fitness trackers for each day of the week, the total for the week, which student had the highest step count, which day had the greatest step count, and discuss why they thought there was variation across the days. Students had to analyse the data by reading the table in Figure 2, add the step counts, and give reasons for the differences. This was followed by a class discussion about the results, where answers and reasons were checked and discussed. This session also gave students (particularly the ones who used the fitness trackers at the beginning of the week) more of an insight into what everyone else in the class was doing, sparking more competition in the weeks to follow. Students also queried how some students who they thought were less active recorded more steps than some of the more active students, and a class debate erupted about students 'cheating' by simply waving their arms around to record steps instead of being physically active. Whilst there was analysing and debating being created ad hoc during this lesson, students were clearly paying attention and were engaged in their learning.

Students also questioned why one student who had purposefully run during recess and lunch had fewer steps recorded than a student who had walked during these times. This ended up being discussed with the Principal, who said it was might be due to the fitness trackers not being sensitive enough to pick up all the individual student's steps or being more sensitive to some types of movement and not others. In addition, Lisa later realised that while walking and running might result in different length steps, it may not necessarily be the case that running steps happen more quickly than walking ones, and so a runner might not produce more steps in the same time as a walker. Finally, it was also noted that the measured distance (in contrast to step count) that the tracker reports is affected by what the tracker 'thinks' the step length is and, of course, this varies for different people and so this means the trackers have to be calibrated for individuals.

It became apparent to Lisa that students did not have a full understanding of the size and relationships among units of 'length'. During their daily mental computation activities it was evident that students lacked understanding of decimals and place value. During Week 2, groups of students continued to record their use of the fitness trackers daily but at the same time Lisa had a focus on measurement and place value.

Throughout the week students learned about place value and the importance of decimal places and the sizes of tenths and hundredths. They did this using 'Linear Arithmetic Blocks' (LAB or 'decipipe') materials, which represent decimal quantities using lengths of PVC pipe. These materials enabled the students to visualise and understand that a tenth is bigger than a hundredth, and to start to visualise the relative sizes of decimal quantities. Lisa was able to use the materials to address specific misconceptions, such as "the greater the number of decimal places the larger the number" (see Steinle, Stacey, & Chambers, 2006). Students completed various activities with the LAB, trying to identify which decimal numbers were bigger, working both individually and in small groups. After a few days of completing different tasks with place value, students were given a set of cards with different decimal numbers on them, and in mixed ability/mixed grade groups, had to put the cards in order from smallest to largest. There were some healthy discussions within the groups and rationalising about which number was biggest and why, sometimes referring to the LAB materials for checking. Once their understanding was consolidated, the groups raced each other to determine who could get their decimal cards in the correct order first, with each member of the group contributing equally, as they worked together in teams. The hands-on materials allowed students to build a better understanding of decimals, with improved outcomes on comparison and ordering tasks.

Students were curious about the features of the fitness trackers, and, apart from the steps, they knew that the trackers also recorded the number of kilometres walked. Whilst students had explored measurement in previous years, they found it difficult to visualise the length of a kilometre. Some students also had difficulty visualising the length of a metre while they walked. After developing a better grasp of place value, some students were able to start to make sense of, and discuss what, for example, the number 1.6 in 1.6 km meant in


Name Sam Day and date Wednesday 22/11

Start steps 336 Finish steps 4883 Estimation 5004
Start time 8:39 Finish time 2:01

Start kilometres 0.3 Finish kilometres 3.3

Subtract the start steps from the finish steps to work out how many steps you did for the day. Write your equation here 4883 - 336 = 4547
How many steps did you do? 4547
Subtract the start kilometres from the finish kilometres to work out how many kilometres you did for the day. Write your equation here
3.3 - 0.3 = 3.0
How far did you walk? 3.0km

How long did you have the Fitbit for? 5h 22m

Write here the activities you were doing when you wearing the fitbit running working and playing

Were you more active because you were wearing the fitbit? Circle yes or (no)

Can you explain your yes or no answer? Write here your explanation because I didn't care how many steps I did.

Figure 3. Worksheet for week 2 and week 3 data gathering, including steps, time and distance.

comparison to 1.2 km, even though they were yet to visualise what 1.6 km looked like.

Because the fitness trackers could also give time and distance information, Lisa included this on the record sheets after the first week, allowing students to record and calculate not just their steps, but also how long they wore the trackers and what distance they travelled. This, together with the work on decimals that they had done, allowed them to develop an understanding of the magnitude of some lengths (see Figure 3), and also provided opportunities to do computation with time as they worked out the duration between the times they started and finished wearing the trackers.

Third week—beginning to graph the data

After two weeks, when each of the students had obtained two days' worth of personal step counts, Lisa introduced them to recording their data in graphical form. She wanted students to become more proactive in their use of the fitness trackers and hoped that by recording their own individual data they could compare how their progress was going over the weeks. She decided that a simple representation using a column graph would be easy for students. She carefully designed the elements of the graph so that the columns were wide enough for the students to visually identify the difference between one week and the next, and the scale was appropriate for the values the students were obtaining.

Lisa modelled how to draw the columns to show how many steps had been recorded on each of the two days so far. One of the key things that she had to explain was how to estimate the position for values like 5894 between 5500 and 6000, by discussing that 5894 is close to 5900 and that 5900 is closer to 6000 than to 5500. She chose fictional data values for her own two columns, so that students could not copy her values when they came to draw their own individual column graphs. She also discussed labelling the axes and recording the day for each column. Students were given pre-scaled A4 grids to do their own graphs, with spaces for five separate days of data (see Figure 4, which is cropped to show only part of the graph). Because the grid was meant to be simple for students to use, with a focus on being able to locate the correct values, it did not have gaps between the columns as should be the case for conventional column graphs (Figure 7 shows a proper column graph).

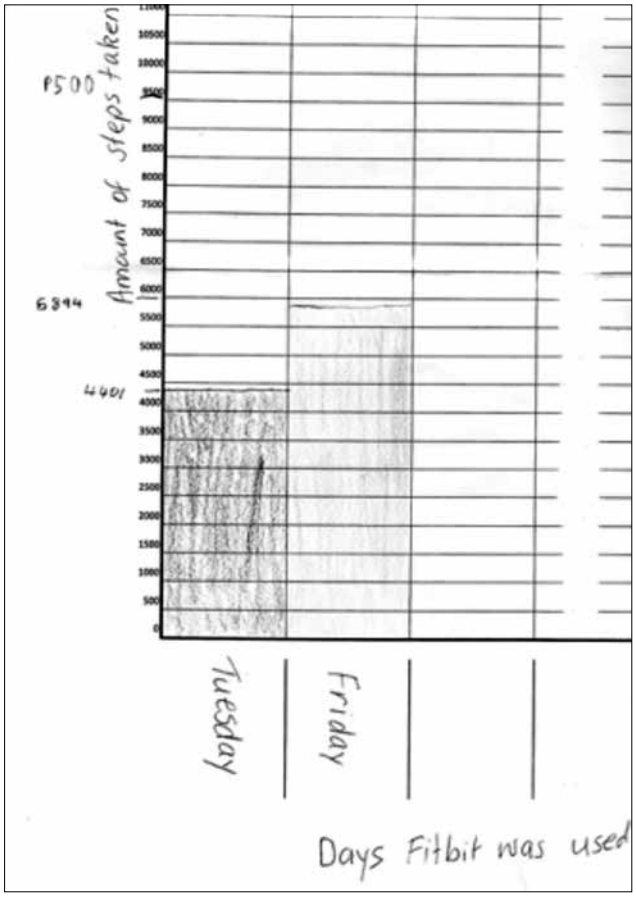


Figure 4. Model graph to show students how to graph their individual daily step counts.

When students had completed their own graphs, there was class and individual discussion about what caused the variation from day to day. Some of the reasons included: having the trackers on for different durations (for example, if their specialist music or library sessions were at the end of the day, the students had to return the trackers early); doing extra exercise during lunchtime; and having active or less active lessons during one day compared to another. Students could also compare their own graphs with those of other students and discuss the differences they observed.

Fourth week—basketball court explorations and whole class data

Once the students were familiar with what the trackers recorded—particularly distance and number of steps—Lisa created a worksheet for an activity on the basketball court. Students had to estimate the number of steps it would take to walk from one end of the basketball court to the other, as well as the distance, and then actually complete the appropriate measurements, both manually —by counting their own steps and measuring with a trundle wheel—and by using the data from the fitness trackers. This would allow students to compare data that they measured manually with what the fitness trackers recorded. Some students had initial difficulty due to not having a deep understanding of what a metre looked like,

Figure 5. Students measuring the length of the basketball court and counting their paces.

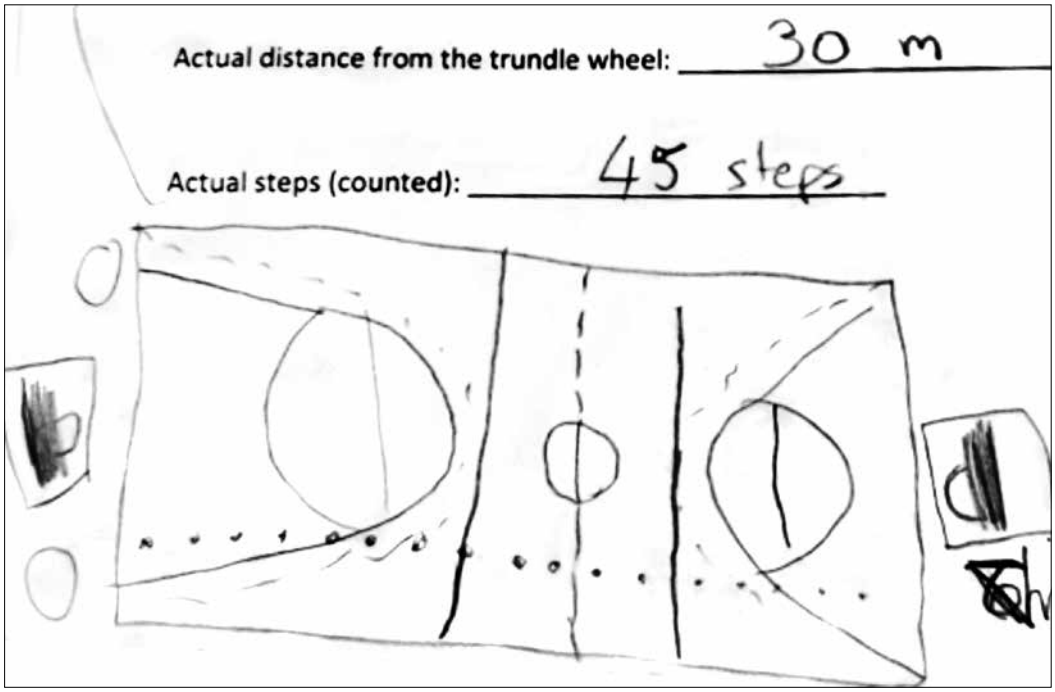


Figure 6. Student-drawn map of the basketball court, with data recorded by a partner.

but the use of the trundle wheels gave them additional experience with this (see Figure 5).

The recording sheet that Lisa prepared allowed students to record starting and finishing steps from the tracker, and had a place to calculate the resulting number of steps. She also provided a place to record the counted number of steps that pairs of students determined while one of the pair wore the tracker. Students also used trundle wheels to measure the actual length of the basketball court. Students were able to discuss differences in the number of steps that different students took (due to different pace lengths), and also think about reasons why the tracker recorded a different number of steps in comparison to what they counted (there was usually a discrepancy, as suggested earlier, influenced by how sensitive the trackers were to movement and what kind of movements the trackers regarded as being 'steps').

It was interesting to notice that the fitness trackers did not measure the change of distance very well, as they recorded the distance in kilometres to an accuracy of only one decimal place. This meant that students needed to walk more than 100 metres for the recorded distance to change and be noticeable on the fitness tracker, and this was more than the length of the basketball court. A future activity could involve walking a much longer distance—perhaps a couple of laps of the football oval—and comparing the tracker's distance with the measured distance.

One student, who was still developing writing skills, asked to draw the basketball court. The student drew the basketball in great detail, counting the dots that are painted on the ground for class line-ups at the end of recess (see Figure 6). Although it was not drawn to scale, the student was able to draw the basketball court from a bird's eye point view. Lisa allowed him to use his existing knowledge and experiences (van de Walle, Karp, Bay-Williams, 2010, p. 23) to further consolidate some important mathematical ideas about spatial representations. The student was then partnered with someone who could write for them and the student did the measuring using the trundle wheel while the other student wrote down what was counted.

Towards the end of the fourth week Lisa used a spreadsheet to produce a whole-class graph, showing all the students' data grouped for each student (see Figure 7, which shows the data for the first three weeks). This allowed students to see their own data in comparison to other students'. Again, there was good discussion about why some students' values were higher than others, why data were missing (e.g., one student was absent for a whole week, and so missed a turn using the trackers), why individual students' data varied, and what the total number of steps might be.

Concluding comments

The fitness tracker activities gave students the opportunity to collect personal real-world data, allowing them to undertake data representation in the form of graphs, and engage in statistical reasoning and data interpretation as they explained variation in the graphs. They also conducted measurement activities relevant to their environment, built understanding of metric units and the role of decimals, and practiced mental, pen-and-paper and calculator-supported computation. In addition to the activities described in this article, the following are some additional ideas that could be utilised in a classroom that has access to fitness trackers:

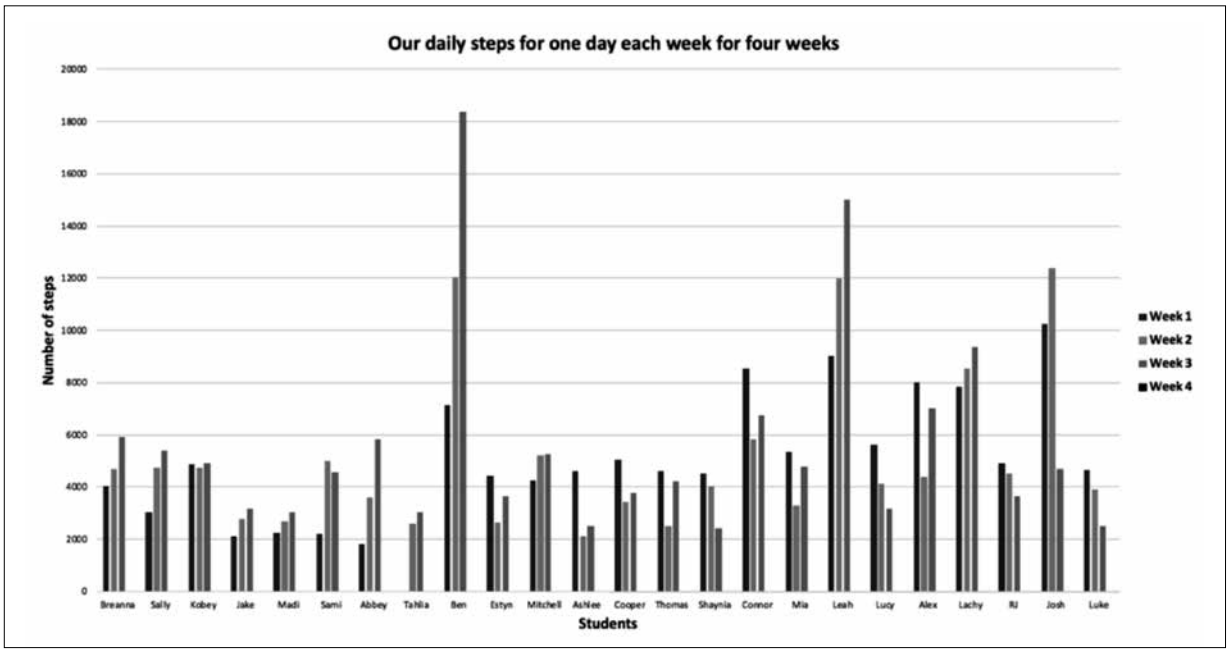


Figure 7. Class graph produced in Excel, showing students' data for the first three weeks, prior the inclusion of Week 4's data.

- To check the calibration and accuracy of the information recorded, students could wear two fitness trackers on the same wrist and record the 'starting information' and the 'end information', making sure they initially identify which one is fitness tracker 'one' and fitness tracker 'two'. Students could then compare and contrast the differences, if any, between the data recorded from both fitness trackers.
- Students could have a classroom debate about whether they think fitness trackers make them more active because they are wearing one, or whether the trackers did not help with fitness motivation, and why.
- Depending on the number of the fitness trackers, one class could challenge another class to a competition to determine which class can achieve the most steps in a week.
- Students could prepare text or posters, or present a slide show presentation demonstrating what they did, including photos, data and graphs explaining their personal journey using the fitness trackers.
- Students could walk a long distance and see how the distance recorded on the tracker compared with that measured using a trundle wheel.
- For appropriately-aged classes, each student could calculate his or her own average number of steps for the days that the tracker was worn, and this could be compared with the class average. Daily averages could also be calculated for the group of students who had trackers on one particular day, to allow comparison across different days (e.g., the day on which the students have specialist PE lessons might result in a higher average than the other days of the week).

There are also some practical issues that may need to be considered when conducting such activities:

- Some students who were not sporty or competitive did not participate as enthusiastically as some of the others. They said they wore the fitness trackers because it was just something the teacher said they had to do.
- The more competitive students—mostly boys—strived to get the most steps, sometimes getting a bit carried away in their endeavours.
- A few students took up the opportunity to purchase their own fitness trackers as a result of these activities, while other students had more expensive versions of the trackers. Students with their own alternative-brand trackers still wore the class ones and compared the data recorded on the class fitness trackers with their own.
- At first, some students wanted the fitness tracker on their 'writing hand' wrist but then they found it difficult to do any written work due to it feeling uncomfortable, and so they asked to swap wrists.
- The particular fitness trackers used in Lisa's classroom were time-consuming to put onto students' wrists, as they had awkward clasp mechanisms, and occasionally they would come undone. In addition, some students' wrists were small and so the students had to wear the fitness tracker half way up their forearm which would have affected their data.

The students enjoyed using the fitness trackers, especially because the trackers provided real information about their physical activity, and because the trackers were authentic devices that they had seen adults using. The students came to understand how the trackers recorded data about their activities, and they also learned

how graphs can help show data in a way that allows differences to be noticed and explained. They were engaged with, and interested in, the activities, because the data were about them and because the mathematical content was accessible. Furthermore, they had the tools, such as calculators and spread sheets, to deal with computational and representational challenges. Sullivan (2011) points out that making connections (such as between decimal numeration and metric measurement, and across curriculum areas), fostering engagement, and differentiating challenges (as when one student drew a plan view because written work was difficult) are key principles for effective mathematics teaching.

Significantly, the trackers gave the students an opportunity to work with important mathematical ideas. The concepts incorporated in the classroom activities addressed many of the numeracy general capabilities (ACARA, 2018b), such as using measurement, interpreting statistical information, estimating and calculating with whole numbers, and using decimals and rates. They were also able to reason with and about data, using personal contexts to justify and explain characteristics of the data they obtained, including identifying the variation that occurs in the results and why it arises. According to Watson (2005), variation is a key idea that students can and need to understand before they understand expectation and measures of central tendency like the mean. Students were also able to use their results and their experiences with the trackers as a basis for discussing whether or not the trackers offer health benefits. This allowed them to see the role that mathematics can play in other curriculum areas and, indeed, in their everyday lives, making the use of the trackers a worthwhile activity.

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