# Dragging school bags around

## Purpose:

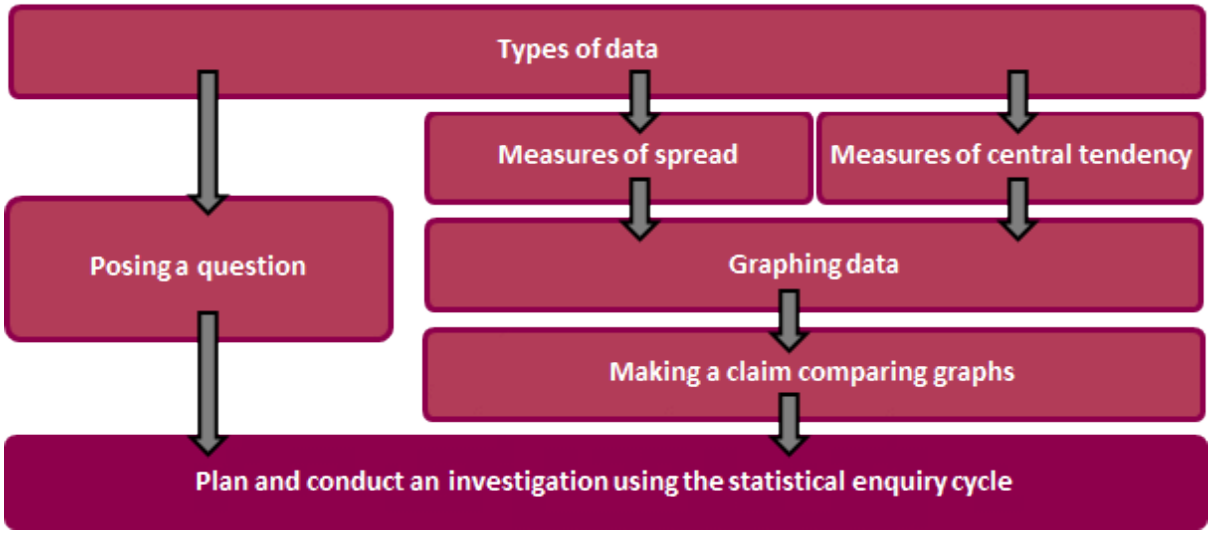
The purpose of this multi-level task is to engage students in an investigation following the statistical enquiry cycle.

## Achievement Objectives:

S5-1: Plan and conduct surveys and experiments using the statistical enquiry cycle: determining appropriate variables and measures; considering sources of variation; gathering and cleaning data; using multiple displays, and re-categorising data to find patterns, variations, relationships, and trends in multivariate data sets; comparing sample distributions visually, using measures of centre, spread, and proportion; presenting a report of findings.

## Description of mathematics:

The background knowledge presumed for this task is outlined in the diagram below:




This task may be 'scaffolded' with either a focus on following the procedures given, or it may be given as an opportunity for students to design their own simulation. The approach should be chosen in sympathy with their skills and depth of understanding.

## Activity:

Task: After a successful 'walk and wheels' week, students suggested they would be more likely to walk or ride to school if they didn't have to carry so much in their school bags.

A PE teacher countered that argument by suggesting that if they did walk or ride, they might get fitter and stronger and so not notice the weight of their bags so much.

Does bag weight affect how students travel to school? Use the data in the sample of year 9 and 10 students from CensusAtSchool, to investigate these ideas.

## The procedural approach

The student is able to carry out a statistical investigation, using the statistical enquiry cycle, following the given processes and guidelines for how to make the call.

Prompts from the teacher could be:

1. Pose a question for investigation. You should consider the travel methods in two distinct groups.
2. Sort the raw data given. You will need to eliminate incomplete data and highlight the two travel groups differently. Enter the bag weight data for each travel group into a graphical calculator (or on a spreadsheet) to calculate the sample statistics that you will analyse.
3. Look for the key features of raw data and the statistics that you have calculated.
4. Construct box plots and dot plots to compare the two travel groups. Follow the guidelines for how to make the call to see if a claim can be made.
5. Write a conclusion for your investigation.

Ideally, the students should check with their teacher at each stage of the investigation, before proceeding to the next stage.

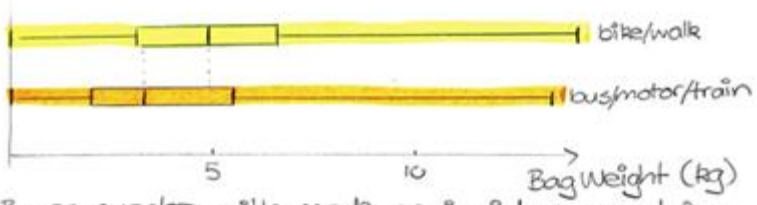
Question: Do students who travel to school by bike or walking carry lighter schoolbags than those who get a ride? I'm using year 9 and 10 students from CensusAtSchool.

Highlighting and calculations on the sheet.

Features of the data:

- More people get a ride than bike/walk.
- $\bar{x}$, Q1, med, Q3 and max are all slightly higher for bike/walk.

Box Plot:

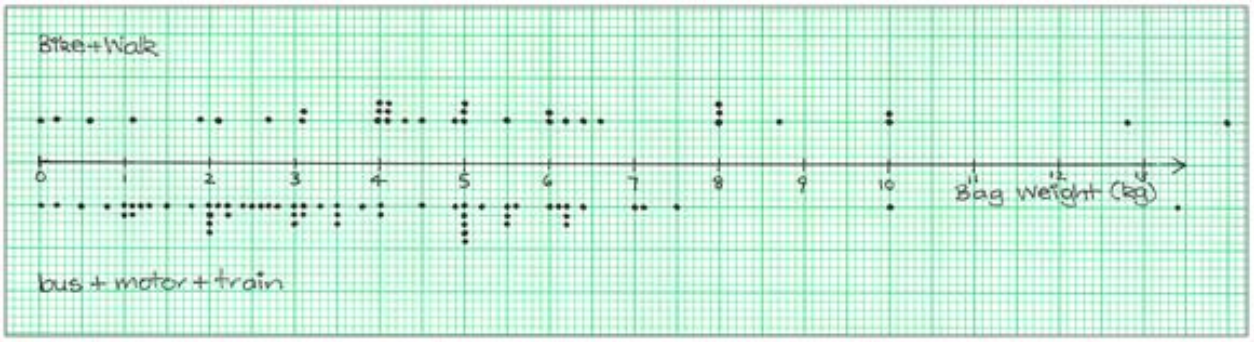



Boxes overlap with medians inside: no claim

Overall Visible Spread: $6.6 - 2 = 4.4$

Distance between medians: $4.9 - 3.3 = 1.6$

$$\frac{DBM}{OVS} = \frac{1.6}{4.4} = 0.36 > 0.2 \quad (n=100)$$




From the dotplot, I can see that many more students bus/motor/train and of those that get to school that way, they mostly have a bag weight around 1-6 kg, compared with those who bike/walk who mostly have bag weights around 4-6.5 kg.

So I can make a claim that the students who bike/walk tend to have heavier bags.

Conclusion

I can make a claim (but not a strong one) that students who bike or walk to school tend to have slightly heavier bags.

| gender | age | travel | timetravel | bagweight | year |
|---|---|---|---|---|---|
| male | 13 | bike | 13 | 8 | 9 |
| male | 13 | bike | 40 | 4.1 | 9 |
| male | 14 | bike | 23 | 3.1 | 9 |
| male | 14 | bike | 10 | 4 | 10 |
| male | 15 | bike | 15 | 1.9 | 10 |
| male | 14 | bus | 45 | 2.2 | 9 |
| male | 14 | bus | 28 | 10 | 9 |
| male | 13 | bus | 18 | 6.4 | 9 |
| male | 13 | bus | 25 | 3.1 | 9 |
| male | 14 | bus | 20 | 6 | 9 |
| female | 14 | bus | 40 | 0.2 | 9 |
| female | 13 | bus | 45 | 5 | 9 |
| male | 13 | bus | 40 | 5.5 | 9 |
| male | 13 | bus | 5 | 3.5 | 9 |
| female | 13 | bus | 45 | 3.5 | 9 |
| male | 13 | bus | 45 | 4.5 | 9 |
| female | 13 | bus | 20 | 2 | 9 |
| female | 13 | bus | 25 | 3.5 | 9 |
| male | 14 | bus | 30 | 7.5 | 9 |
| male | 13 | bus | 10 | 3.1 | 9 |
| female | 13 | bus | 23 | 4.9 | 9 |
| male | 13 | bus | 20 | 3 | 9 |
| female | 13 | bus | 40 | 7 | 9 |
| male | 14 | bus | 50 | 1 | 10 |
| female | 14 | bus | 18 | 1.3 | 10 |
| female | 14 | bus | 40 | 1.1 | 10 |
| female | 14 | bus | 35 | 5 | 10 |
| ~~female~~ | ~~14~~ | ~~bus~~ | ~~25~~ | | ~~10~~ |
| female | 14 | bus | 25 | 3.3 | 10 |
| female | 14 | bus | 10 | 5 | 10 |
| male | 14 | bus | 20 | 13.4 | 10 |
| ~~female~~ | ~~15~~ | ~~bus~~ | ~~25~~ | | ~~10~~ |
| female | 14 | bus | 25 | 5 | 10 |
| female | 14 | bus | 15 | 2.8 | 10 |
| female | 14 | bus | 90 | 7.1 | 10 |
| female | 14 | bus | 65 | 3 | 10 |
| female | 14 | bus | 40 | 1.1 | 10 |
| female | 15 | bus | | 6.2 | 10 |
| female | 13 | motor | 15 | 6.2 | 9 |
| male | 14 | motor | 7 | 4 | 9 |
| female | 13 | motor | 5 | 5.5 | 9 |
| male | 13 | motor | 5 | 6.1 | 9 |
| male | 13 | motor | 9 | 2.2 | 9 |
| male | 14 | motor | 10 | 5.6 | 9 |
| male | 13 | motor | 25 | 6.2 | 9 |
| male | 14 | motor | 15 | 1.5 | 9 |
| female | 13 | motor | | 5 | 9 |
| ~~female~~ | ~~13~~ | ~~motor~~ | ~~5~~ | | ~~9~~ |
| female | 14 | motor | 10 | 0.8 | 10 |

bike + walk

$n = 35$
$\bar{x} = 5.3$
min = 0
Q1 = 3.1
med = 4.9
Q3 = 6.6
max = 14

bus + motor + train

$n = 59$
$\bar{x} = 3.8$
min = 0
Q1 = 2
med = 3.3
Q3 = 5.5
max = 13.4

| | | | | |
|---|---|---|---|---|
| female | 14 motor | 15 | 5.5 | 10 |
| female | 14 motor | 10 | 2 | 10 |
| female | 15 motor | 7 | 1.8 | 10 |
| female | 14 motor | 15 | 5.2 | 10 |
| male | 14 motor | 4 | 1 | 10 |
| female | 14 motor | 15 | 2.7 | 10 |
| female | 14 motor | 10 | 3 | 10 |
| female | 15 motor | 25 | 2 | 10 |
| male | 15 motor | 10 | 2 | 10 |
| female | 14 motor | 5 | 0 | 10 |
| male | 14 motor | 30 | 2.5 | 10 |
| male | 14 motor | 3 | 2.4 | 10 |
| female | 15 motor | 6 | 3.8 | 10 |
| female | 14 motor | 10 | 4 | 10 |
| male | 14 motor | 17 | 1.2 | 10 |
| female | 14 motor | 10 | 0.5 | 10 |
| ~~female~~ | ~~12 other~~ | ~~20~~ | ~~3~~ | ~~9~~ |
| female | 13 train | 25 | 2.1 | 9 |
| male | 14 train | 20 | 1.6 | 10 |
| female | 13 walk | 10 | 4.3 | 9 |
| female | 13 walk | 15 | 14 | 9 |
| female | 13 walk | | 6.6 | 9 |
| female | 13 walk | 8 | 5 | 9 |
| female | 13 walk | 20 | 5 | 9 |
| female | 13 walk | 10 | 6.2 | 9 |
| male | 13 walk | | 10 | 9 |
| female | 14 walk | 2 | 0.6 | 9 |
| female | 13 walk | 5 | 0.2 | 9 |
| male | 13 walk | 15 | 5 | 9 |
| male | 13 walk | 25 | 8 | 9 |
| male | 13 walk | 3 | 8.7 | 9 |
| ~~male~~ | ~~13 walk~~ | ~~30~~ | | ~~9~~ |
| female | 13 walk | 15 | 12.8 | 9 |
| male | 13 walk | 45 | 4.1 | 9 |
| female | 14 walk | 15 | 4.9 | 9 |
| female | 13 walk | 12 | 4.1 | 9 |
| female | 14 walk | 8 | 2.7 | 10 |
| male | 14 walk | 12 | 6.4 | 10 |
| male | 14 walk | 25 | 1.1 | 10 |
| male | 15 walk | 9 | 5.5 | 10 |
| female | 15 walk | 20 | 6 | 10 |
| female | 14 walk | 15 | 8 | 10 |
| female | 14 walk | 40 | 6 | 10 |
| male | 14 walk | 30 | 10 | 10 |
| female | 14 walk | 5 | 2.1 | 10 |
| male | 14 walk | 17 | 0 | 10 |
| male | 14 walk | 20 | 4 | 10 |
| female | 14 walk | 50 | 4 | 10 |
| female | 14 walk | 2 | 3.1 | 10 |
| | 14 walk | 5 | 4.5 | 10 |

## The conceptual approach

The student is able to carry out a statistical investigation, using the statistical enquiry cycle, cleaning data as appropriate and drawing a conclusion based on the key features of the data.

Students may show an ability to link the mathematical statements, within the data, to the context. Such students are likely to distinguish between significant differences in data sets and suggest practical reasons, within the context, for those differences. These students should be encouraged to follow the conceptual approach, independently noting the key features of the data to draw an appropriate conclusion.

Prompts from the teacher could be:

1. Pose a question for investigation. You should consider the travel methods in two distinct groups.
2. Sort the raw data given. You will need to eliminate incomplete data and highlight the two travel groups differently. Enter the bag weight data for each travel group into a graphical calculator (or on a spreadsheet) to calculate the sample statistics that you will analyse.
3. Look for the key features of raw data and the statistics that you have calculated.
4. Construct box plots and dot plots to compare the two travel groups. Follow the guidelines for how to make the call to see if a claim can be made.
5. Write a conclusion for your investigation.

Variables to consider are implicit in this statement

Sources of data acknowledged

Question for investigation:

I wonder if school bags are heavier or lighter depending on how you get to school...
using census at school, Year 9 and 10 students
$n \approx 100$.

Cleaning Data

I removed students from the sample where –
values were missing
travel was 'other'
bag weight was less than 0.5 kg

T: Tell me why you have eliminated the bags less than 0.5kg.

S: It's just too light to have been measured properly. A pencil case or a lunch would weigh that much.

Assumptions / Grouping

I assumed that people weren't walking for a long time to get to a bus stop, so I made two catagories

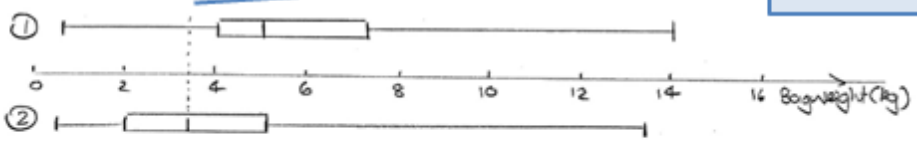
① Getting yourself to school
Bike/Walk

② Being taken to school
Bus/train/motor

Statistics:

| | n | $\bar{x}$ | min | LQ | med | UQ | max |
|---|---|---|---|---|---|---|---|
| ① | 33 | 5.6 | 0.6 | 4 | 5 | 7.3 | 14 |
| ② | 52 | 3.7 | 0.5 | 2 | 3.4 | 5.1 | 13.4 |

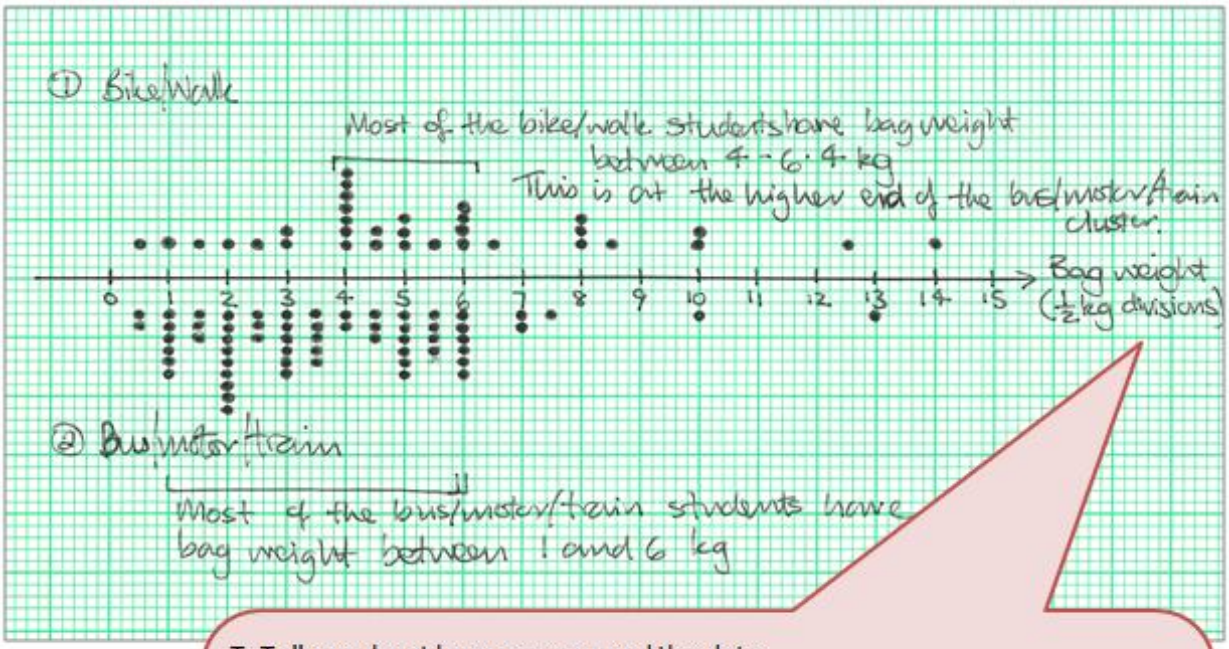
Dotted line shows key observation for conclusion




The students who get themselves to school tend to carry heavier bags. I can make this claim because the median of one group lies outside the middle 50% of the other.

T: So there is only one reason for your conclusion?

S: No, but this is the main one. Every statistic - mean, median, quartiles and stuff are all bigger for the walk / bike group.




T: Tell me about how you grouped the data.

S: I thought that a bag weigh to the nearest tenth of a kilogram is too accurate to allow for changes during the day, such as eating your lunch, so the nearest half a kilogram is more reasonable. Also if it's grouped, I can see the clumps more clearly.

T: I noticed that on your graph you marked an interval 1-6, but called it 1-6.4.

S: Yeah, that's because the groups are from 1-1.4 up to 6-6.4 in that section.

This result surprised me, but I guess these students need to carry a raincoat and maybe they are a bit fitter or tougher so don't mind carrying more stuff.

| gender | age | travel | timetravel | bagweight | year |
|---|---|---|---|---|---|
| male | 13 | bike | 13 | 8 | 9 |
| male | 13 | bike | 40 | 4.1 | 9 |
| male | 14 | bike | 23 | 3.1 | 9 |
| male | 14 | bike | 10 | 4 | 10 |
| male | 15 | bike | 15 | 1.9 | 10 |
| male | 14 | bus | 45 | 2.2 | 9 |
| male | 14 | bus | 28 | 10 | 9 |
| male | 13 | bus | 18 | 6.4 | 9 |
| male | 13 | bus | 25 | 3.1 | 9 |
| male | 14 | bus | 20 | 6 | 9 |
| ~~female~~ | ~~14~~ | ~~bus~~ | ~~40~~ | ~~0.2~~ | ~~9~~ |
| female | 13 | bus | 45 | 5 | 9 |
| male | 13 | bus | 40 | 5.5 | 9 |
| male | 13 | bus | 5 | 3.5 | 9 |
| female | 13 | bus | 45 | 3.5 | 9 |
| male | 13 | bus | 45 | 4.5 | 9 |
| female | 13 | bus | 20 | 2 | 9 |
| female | 13 | bus | 25 | 3.5 | 9 |
| male | 14 | bus | 30 | 7.5 | 9 |
| male | 13 | bus | 10 | 3.1 | 9 |
| female | 13 | bus | 23 | 4.9 | 9 |
| male | 13 | bus | 20 | 3 | 9 |
| female | 13 | bus | 40 | 7 | 9 |
| male | 14 | bus | 50 | 1 | 10 |
| female | 14 | bus | 18 | 1.3 | 10 |
| female | 14 | bus | 40 | 1.1 | 10 |
| female | 14 | bus | 35 | 5 | 10 |
| ~~female~~ | ~~14~~ | ~~bus~~ | ~~25~~ | | ~~10~~ |
| female | 14 | bus | 25 | 3.3 | 10 |
| female | 14 | bus | 10 | 5 | 10 |
| male | 14 | bus | 20 | 13.4 | 10 |
| ~~female~~ | ~~15~~ | ~~bus~~ | ~~25~~ | | ~~10~~ |
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| female | 14 | bus | 15 | 2.8 | 10 |
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| female | 13 | motor | 15 | 6.2 | 9 |
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| male | 13 | motor | 9 | 2.2 | 9 |
| male | 14 | motor | 10 | 5.6 | 9 |
| male | 13 | motor | 25 | 6.2 | 9 |
| male | 14 | motor | 15 | 1.5 | 9 |
| female | 13 | motor | | 5 | 9 |
| ~~female~~ | ~~13~~ | ~~motor~~ | ~~5~~ | | ~~9~~ |
| female | 14 | motor | 10 | 0.8 | 10 |

1

2

| | | | | | |
|---|---|---|---|---|---|
| female | 14 motor | 15 | 5.5 | 10 | |
| female | 14 motor | 10 | 2 | 10 | |
| female | 15 motor | 7 | 1.8 | 10 | |
| female | 14 motor | 15 | 5.2 | 10 | |
| male | 14 motor | 4 | 1 | 10 | |
| female | 14 motor | 15 | 2.7 | 10 | |
| female | 14 motor | 10 | 3 | 10 | |
| female | 15 motor | 25 | 2 | 10 | |
| male | 15 motor | 10 | 2 | 10 | |
| ~~female~~ | ~~14 motor~~ | ~~5~~ | ~~0~~ | ~~10~~ | |
| male | 14 motor | 30 | 2.5 | 10 | |
| male | 14 motor | 3 | 2.4 | 10 | |
| female | 15 motor | 6 | 3.8 | 10 | |
| female | 14 motor | 10 | 4 | 10 | |
| male | 14 motor | 17 | 1.2 | 10 | |
| female | 14 motor | 10 | 0.5 | 10 | |
| ~~female~~ | ~~12 other~~ | ~~20~~ | ~~3~~ | ~~9~~ | 2 |
| female | 13 train | 25 | 2.1 | 9 | |
| male | 14 train | 20 | 1.6 | 10 | |
| female | 13 walk | 10 | 4.3 | 9 | |
| female | 13 walk | 15 | 14 | 9 | |
| female | 13 walk | | 6.6 | 9 | |
| female | 13 walk | 8 | 5 | 9 | |
| female | 13 walk | 20 | 5 | 9 | |
| female | 13 walk | 10 | 6.2 | 9 | |
| male | 13 walk | | 10 | 9 | |
| female | 14 walk | 2 | 0.6 | 9 | |
| ~~female~~ | ~~13 walk~~ | ~~5~~ | ~~0.2~~ | ~~9~~ | |
| male | 13 walk | 15 | 5 | 9 | |
| male | 13 walk | 25 | 8 | 9 | |
| male | 13 walk | 3 | 8.7 | 9 | |
| ~~male~~ | ~~13 walk~~ | ~~30~~ | | ~~9~~ | 1 |
| female | 13 walk | 15 | 12.8 | 9 | |
| male | 13 walk | 45 | 4.1 | 9 | |
| female | 14 walk | 15 | 4.9 | 9 | |
| female | 13 walk | 12 | 4.1 | 9 | |
| female | 14 walk | 8 | 2.7 | 10 | |
| male | 14 walk | 12 | 6.4 | 10 | |
| male | 14 walk | 25 | 1.1 | 10 | |
| male | 15 walk | 9 | 5.5 | 10 | |
| female | 15 walk | 20 | 6 | 10 | |
| female | 14 walk | 15 | 8 | 10 | |
| female | 14 walk | 40 | 6 | 10 | |
| male | 14 walk | 30 | 10 | 10 | |
| female | 14 walk | 5 | 2.1 | 10 | |
| ~~male~~ | ~~14 walk~~ | ~~17~~ | ~~0~~ | ~~10~~ | |
| male | 14 walk | 20 | 4 | 10 | |
| female | 14 walk | 50 | 4 | 10 | |
| female | 14 walk | 2 | 3.1 | 10 | |
| | 14 walk | 5 | 4.5 | 10 | |