

11-14 YEARS SESSION 2: Collective action groups, scatter plots and sample size

Subject: Mathematics/Geography

Age range: 11-14 years

Time: 1 hour

<p>Outline</p> <p>Learners find out about collective action groups, plot their own scatter graphs and learn about the importance of sample size. They will also gain practice identifying outliers and interpreting charts.</p>	
<p>Learning objectives</p> <ul style="list-style-type: none"> • To understand what collective action groups are • To develop data handling and presentation skills • To understand the limitations of sampling data rather than using the whole population 	<p>Learning outcomes</p> <ul style="list-style-type: none"> • Learners will read information from a scatter graph • Learners will produce a scatter graph • Learners will recognise the importance of sample size when analysing data • Learners will recognise the importance of random sampling
<p>Key questions</p> <ul style="list-style-type: none"> • What do we mean by collective action? • What information can be read off a scatter graph? • What effect does only using a small sample have? • How can we reduce any bias in the data we choose? • What effect does belonging to a collective action group have on the levels of honey produced? 	<p>Resources</p> <ul style="list-style-type: none"> • Slideshow 2 • <i>Learner worksheet 2A: Collective Action Groups</i> • <i>Learner worksheet 2B: How to Draw a Scatter Graph</i> • <i>Learner worksheet 2C</i> • <i>Spreadsheet Session 2</i>



Curriculum links

England

Mathematics

Pupils should be taught to:

- describe, interpret and compare observed distributions of a single variable through: appropriate graphical representation involving discrete, continuous and grouped data; appropriate measures of central tendency (mean, mode, median) and spread (range, consideration of outliers)
- construct and interpret appropriate tables, charts, and diagrams, including frequency tables, bar charts, pie charts, and pictograms for categorical data, and vertical line (or bar) charts for ungrouped and grouped numerical data
- describe simple mathematical relationships between two variables (bivariate data) in observational and experimental contexts and illustrate using scatter graphs.

Geography

- Pupils should be taught to extend their locational knowledge and deepen their spatial awareness of the world's countries using maps of the world to focus on Africa
- Pupils should be taught to understand geographical similarities, differences and links between places through the study of human and physical geography of a region within Africa
- Pupils should be taught to understand human geography relating to: population and urbanisation; international development; economic activity in the primary, secondary, tertiary and quaternary sectors; and the use of natural resources
- Pupils should be taught to analyse and draw conclusions from geographical data, using multiple sources of increasingly complex information.

Wales

Mathematics Key Stage 3

Using data skills: collect and record data, present and analyse data, interpret results

- construct and interpret graphs and diagrams (including pie charts) to represent discrete or continuous data
- interpret diagrams and graphs to compare sets of data

Geography Key Stage 3

Understanding places, environments and processes

- describe and explain physical and human features
- explain the causes and effects of physical and human processes and how the processes interrelate

Numeracy Framework: Using data skills

Scotland

Numeracy and mathematics

I can work collaboratively, making use of technology, to source information presented in a range of ways, interpret what it conveys and discuss whether I believe the information to be robust, vague or misleading. **MNU 3-20b**

I can display data in a clear way using a suitable scale, by choosing appropriately from an extended range of tables, charts, diagrams and graphs, making effective use of technology. **MTH2-21a / MTH 3-21a**

Social studies

I can compare the social and economic differences between more and less economically-developed countries and can discuss the possibilities for reducing these differences. **SOC 3-11a**

I can explain why a group I have identified might experience inequality and can suggest ways in which this inequality might be addressed. **SOC 3-16a**



Activity 2.1 (15 min)

Understanding collective action groups

Display the description of one of the collective action groups on slide 3 in Slideshow 2.

Ask learners to discuss and/or write down how being part of the group would help the women farmers. Draw out that training might help women farmers produce more or better-quality goods and/or help them sell their goods to a wider market.

Get some learners to share their ideas with the class.

Either hand out learner worksheet 2A: Collective Action Groups or display the descriptions of the various groups around the room.

If displayed around the room, ask learners to read each description and then decide which group they think would be the most helpful for the women farmers. They should stand next to their chosen description and be ready to explain their choice.

If using the worksheet, learners could discuss each group in pairs and/or write down why they think each one would help the women farmers and which they think would be the most helpful. Ask learners to create an impact or consequence chain for one or more of the groups – writing down what all the positive impacts of belonging to that group could be. Slide 6 in Slideshow 2 supports this activity.

Have learners share their ideas with the class.

There are no right or wrong answers here, the idea is to encourage learners to think about and discuss the merits of the different types of group. In fact, Oxfam found that it was a combination of different types of groups that had the biggest impact, as each group gave women different types of skills and benefits, such as improving their writing or numerical skills, speaking in front of a group and knowing how to process, package and sell honey.

If you can, draw out the differences between groups and the impact on the outcomes for the women involved in terms of their productivity and their access to suitable markets for their product.

Activity 2.2 (10 min)

Interpreting scatter graphs

Display slide 7 in Slideshow 2 to explain the term wealth in the context of this session. It is important that learners understand that the wealthier women in this study are not wealthy by UK standards but wealthier than the other women surveyed for this project.

Display scatter graphs comparing the amount of honey produced and wealth by women in collective groups and those not in collective groups in Ethiopia on slides 8-10 in Slideshow 2 and the first worksheet in Spreadsheet Session 2.

Ask learners to interpret the graphs, what do they think they show?

Learners should identify as much information as possible from the graphs without being led by the teacher. You could remind them of the importance of the axis labels, general shape of the data and the highest/lowest values in one variable. You could separate this task out, asking learners to first analyse the WCA group members graph then analyse the non-WCA members graph and finally make comparisons between the two, using the overlaid graph.

You can then support learners' analysis of the graph by asking them the following questions:

- What is the name of this type of graph?
- What patterns can you spot in this graph?

- What does it look like is happening in this graph?
- Do women with a higher wealth index tend to produce more or less honey?
How can you tell this?
- Why might women with higher wealth also produce more honey?
- What does this type of graph generally show us?

Draw out that the graphs show that being a member of a WCA group improved honey production and that wealthier women tended to produce more honey.

Point out what the graphs do not tell us, such as whether being wealthier is the cause of the women producing more honey.

Activity 2.3 (10 min)

Comparison with a sample graph

Explain that these graphs show a large amount of data – all of the data collected in Ethiopia (approximately 900 women). Ask learners what they think it might be like to create a graph on paper with this amount of data. It would be very time consuming and there would be a high risk of error. Therefore sometimes we work with a smaller sample of data. Real researchers also sometimes work with smaller sample sizes (although the whole data set would usually be much larger than 900). In these cases, researchers need to be very careful about how they select data from the main set. Point out that learners will be finding out more about sample size in a later session.

Show learners the reduced scatter diagrams (using only data for women aged 30 or younger) that don't show the same pattern, on slides 12 and 13 in Slideshow 2, and then discuss the following questions:

- What patterns can you spot in this graph?
- What does it look like is happening in this graph?
- Do your answers match those provided in the graph of the full data set? Why or why not?
- How could we try and avoid this misrepresentation?
Note: Although the graph might be misrepresentative of the whole group, it is not misrepresentative of the sample in question. It tells you information about women under thirty.
- Are there any points which don't fit the general pattern (outliers or anomalies)?

Through discussion – slide 14 in Slideshow 2 can support this, draw out the following points:

- This sample is unrepresentative of the whole data set because it only shows women under the age of 30. Learners need to recognise that to avoid smaller samples being unrepresentative of the whole set, researchers may take a *random sample*.
- Even with a random sample there is a risk that the sample is not representative of the whole data set. To avoid this problem, researchers analyse multiple samples, use larger samples or use technology to work with the full data set. As many of these ideas as possible should be elicited from the learners.

Finish by discussing any outlier and anomalies in the reduced scatter diagram:

- Why does this value stick out?
- What should we do with it? Ignore it? Include it?

Activity 2.4 (20 min – this could take a lot longer, if this is the first time your learners have plotted a scatter graph)

Plotting scatter graphs

Have learners work in pairs to plot their own scatter graphs using one of the eight random samples of 60 data points taken from the full dataset for Ethiopia. They should create one graph for 30 collective action group members and one for 30 non-group members. This data is available in learner worksheet 2B: Ethiopia Honey Data – Production vs. Wealth Index and worksheets 3-8 in Spreadsheet Session 2. You do not need to use all of the data sheets, if you feel this will be too much to manage. However, using more than one sample is useful for generating discussion about how learners' graphs look different and then to highlight the importance of using the correct sampling techniques.

Learners will probably need support with choosing scales for their graphs. Learner worksheet 2C: How to Draw a Scatter Graph, will help them with this and with plotting their graphs. The second page of the worksheet has a pre-drawn axis, which could be used with all learners or just those who need more support.

Once they have completed their graphs, ask learners to write a paragraph about their two scatter diagrams answering the following questions:

- What do you notice about your graphs?
- Do you see any outliers?
- Is there any missing data? How might this affect the results?
- What does this graph show about honey production by women who are members of collective action groups? And those not in groups?

Ask learners to compare their graphs with other pairs in the class who used a different random sample. Are all the graphs similar? Can learners think of a reason for any differences?

Show learners the graph of the full data set for honey production vs. wealth in Ethiopia on slides 8 and 9 in Slideshow 2 and worksheet 1 in Spreadsheet Session 2.

Discuss the following questions:

- Do your graphs tell a different story than the ones from the full dataset?
- What are the differences between your graphs and those displayed?
- What do the differences tell us? Which graphs do you think are the most accurate – yours or the ones from the full dataset? Why?
- How representative of the full dataset do you think your sample is?
- What might be the problem with using a small sample to test theories?

Plenary (5 min)

Ask learners to write down or share with a partner two things they have learnt about sampling in this session. Draw out that both how we choose a sample and sample size can influence the results and conclusions of a study.

Finally ask learners to think of two things they have learnt about women's collective action groups or honey production in Ethiopia.

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Collective Action Groups

Farming co-operative

Members share their land and/or equipment and all work together to make or grow their products. By sharing and working together they can be more efficient and produce more. This means they have more to sell and can earn more money. This group has both men and women. It is a *formal* group, meaning it has rules that members must follow and sometimes members contribute membership fees.

Women's credit association

The group loans women small amounts of money to help them pay for things like seeds, fertilizer or equipment. This group only has women members. It is *informal*, meaning that women do not need to register their details or pay to be a member.

Rural savings association

This group provides a place for members to save their money, so they can eventually afford to buy things like equipment or pay for transport to sell their products. This is important as in many rural areas there are no banks. This group has both men and women. It is *informal*, meaning the group does not have to follow any legal guidelines.

Farmer extension group

This group has "master" farmers who have particularly good knowledge and expertise. They support and train other members of the group by passing on their knowledge of farming techniques. This group has both men and women. Extension services can be informal or formal, for example some may be set up through the government's ministry of agriculture.

Marketing co-operative

This group provides services for members to help them *market* their products. This means finding people to buy them for a good price. It is a *formal* group, meaning it can sign contracts with the people buying its products. By signing a contract both the producer and the buyer must stick to the sale price they agreed. This group normally has many more men than women.

Women's labour-sharing group

This is an informal group made up of women who know each other and agree to trade days of work. For example, the group may work together to harvest crops on a different family's land each day, or to work together to process or dry crops. The groups are often organised by verbal agreement and there is no fee paid by the women. Often these arrangements last over many years.

Women's training group (displayed in slideshow)

This group provides training for women to help them develop their knowledge and farming skills. This includes training on how to grow and make their products and how to get a good price for their products. The group provides training about many different crops and products. This group only has women members. This group is *informal*.

Ethiopia Honey Data

Random Sample 1

Units Produced = how much honey is produced, measured in kilograms.

Wealth Index = a measure of how wealthy the women are which includes how many farming animals they own and what their house is like, amongst other things.

These women DO NOT belong to a WCA group		These women DO belong to a WCA group	
Units Produced	Wealth Index	Units Produced	Wealth Index
9	36	39	35
9	53	1	32
40	50	15	40
20	41	5	23
40	49	10	34
5	39	15	34
165	63	18	28
50	36	55	55
10	17	10	39
13	26	80	44
2	11	24	30
22	38		
15	36	52	71
6	28	40	18
7	18	35	37
8	33	100	44
25	30	30	31
3	34	21	37
29	28	76	82
3	41	10	9
23	57	15	27
14	43	54	30
5	19	26	45
32	33	22	25
5	33	30	14
5	27	30	23
80	47	160	29
15	36		81
5	26	15	24
9	28	6	30

Ethiopia Honey Data

Random Sample 2

Units Produced = how much honey is produced, measured in kilograms.

Wealth Index = a measure of how wealthy the women are which includes how many farming animals they own and what their house is like, amongst other things.

These women DO NOT belong to a WCA group		These women DO belong to a WCA group	
Units Produced	Wealth Index	Units Produced	Wealth Index
50	27	27	57
60	44	70	35
30	38	63	40.
20	52	70	25
15	46	20	42
50	54	32	61
15	55		
5	41	13	39
60	24	39	35
6	36		15
25	38	10	34
20	38	15	24
7	42	35	26
40	31	45	55
10	42	35	51
8	34	40	52
4	34	51	34
3	39		
6	21		
70	45	90	54
6	25	33	22
5	40	100	34
6	29	26	45
40	32	8	42
13	46	8	48
8	51	31	36
30	35	40	29
5	29	4	12
5	39	18	44
15	16	12	66

Ethiopia Honey Data

Random Sample 3

Units Produced = how much honey is produced, measured in kilograms.

Wealth Index = a measure of how wealthy the women are which includes how many farming animals they own and what their house is like, amongst other things.

These women DO NOT belong to a WCA group		These women DO belong to a WCA group	
Units Produced	Wealth Index	Units Produced	Wealth Index
40	40	50	18
25	11	28	60
3	40	8	48
10	38	4	12
30	38	8	54
5	43	8	31
40	33	45	45
24	25	4	56
50	30	110	43
		10	27
10	42	35	35
5	19	40	29
3	27	75	47
30	33	95	65
58	64		
9	36	3	39
40	21		
15	45	60	32
2	37	310	61
30	21	22	25
75	29	70	35
15	51		
30	22	90	49
30	35	60	59
11	33	15	38
14	49	16	25
30	35	27	57
30	29	180	
2	49	14	55
34	44	40	45

Ethiopia Honey Data

Random Sample 4

Units Produced = how much honey is produced, measured in kilograms.

Wealth Index = a measure of how wealthy the women are which includes how many farming animals they own and what their house is like, amongst other things.

These women DO NOT belong to a WCA group		These women DO belong to a WCA group	
Units Produced	Wealth Index	Units Produced	Wealth Index
24	46	8	37
200	67	35	29
20	41	3	46
30	21	75	47
45	21	35	58
20	34	30	39
30	25	10	27
	33	35	40
12	31	27	30
25	17	20	42
130	49	50	42
15	59	80	37
10	38	45	45
9	36	30	14
15	29	38	17
12	49	12	49
7	26	42	49
	29	63	40
20	39	35	26
25	44	14	55
2	41	22	25
3	34		
		23	56
6	15	55	35
65	53	7	25
30	24	80	80
7	23	50	17
25	42	23	31
5	41	1	32
2	37	42	27

Ethiopia Honey Data

Random Sample 5

Units Produced = how much honey is produced, measured in kilograms.

Wealth Index = a measure of how wealthy the women are which includes how many farming animals they own and what their house is like, amongst other things.

These women DO NOT belong to a WCA group		These women DO belong to a WCA group	
Units Produced	Wealth Index	Units Produced	Wealth Index
10	25		
10	51	50	17
80	46	18	19
30	67	31	16
18	32	15	15
40	32	60	59
		18	37
20	36	160	32
20	47	13	39
6	18	25	29
60	30	85	30
10	42	20	50
6	36	50	20
18	27	20	14
8	17	30	25
10	51	30	32
10	30		32
12	26	35	58
25	35	15	36
8	23	55	55
	31	34	48
	34	42	54
15	22	25	35
16	42	18	32
10	46	55	41
15	49	3	39
20	39	95	45
3	28	150	55
6	40	35	29
10	28	30	43

Ethiopia Honey Data

Random Sample 6

Units Produced = how much honey is produced, measured in kilograms.

Wealth Index = a measure of how wealthy the women are which includes how many farming animals they own and what their house is like, amongst other things.

These women DO NOT belong to a WCA group		These women DO belong to a WCA group	
Units Produced	Wealth Index	Units Produced	Wealth Index
20	34	50	12
25	32	43	38
10	31	21	66
5	40	63	40
120	60	40	38
8	49	21	37
25	27	30	55
4	26	30	25
50	60	10	47
7	42	24	30
30	25		
60	57	10	34
90	37	15	27
25	38	60	32
40	33	20	14
80	51		
3	44	15	34
21	28	23	56
	60		
8	34	35	51
4	47		
40	32		
80	47	12	36
17	29	18	28
5	33	21	29
30	67	10	65
24	25		31
3	22	47	42
13	40	20	23
5	29	31	36

Ethiopia Honey Data

Random Sample 7

Units Produced = how much honey is produced, measured in kilograms.

Wealth Index = a measure of how wealthy the women are which includes how many farming animals they own and what their house is like, amongst other things.

These women DO NOT belong to a WCA group		These women DO belong to a WCA group	
Units Produced	Wealth Index	Units Produced	Wealth Index
	34		
5	19	6	23
3	43	70	20
15	51	16	15
3	31	35	75
3	27		31
5	30	30	34
3	28		
7	38	70	26
15	55	10	50
4	34	9	31
	29	20	49
12		55	41
10	38	45	37
14	35		
20	32	15	31
30	22	135	50
15	44	10	8
12	34	20	30
50	29	30	55
165	63	500	89
3	39	50	76
37	37	5	39
23	40	55	35
15	30		
60	67	90	49
3	41	15	24
22	19	50	36
50	35	35	51
4	47		

Ethiopia Honey Data

Random Sample 8

Units Produced = how much honey is produced, measured in kilograms.

Wealth Index = a measure of how wealthy the women are which includes how many farming animals they own and what their house is like, amongst other things.

These women DO NOT belong to a WCA group		These women DO belong to a WCA group	
Units Produced	Wealth Index	Units Produced	Wealth Index
10	29	15	29
25	46	135	50
6	27	40	29
165	63	40	45
20	43	80	44
67	45	15	37
40	33	45	37
4	38		46
30	22	28	60
3	39	20	14
16	39	76	82
4	44	8	37
12	51		
10		30	39
	34	15	29
8	33	150	55
4	21	22	25
50	30	16	25
	29	36	38
40	50	42	22
40	26	37	28
24	25	25	31
34	44	12	36
4	28	31	16
4	26	40	26
15	41	60	49
20	75	20	50
10	42	55	41
8	32	20	49
13	28		

How to draw a scatter graph

1. **Always use a pencil and a ruler.** You will make mistakes and it is easier to rub these out rather than start again from the beginning!
2. **Work out the scale for your graph.** This requires a bit of thought – what is the biggest number you will be plotting on your graph? You need to count how many squares are available and then work out the best way to divide these equally, so you will be able to plot the biggest number. Use the larger squares on the graph paper to help you work this out. Your x and y axis do not need to have the same scale.
3. **Draw the axis.** Now draw your x and y axis and write on the numbers at equal intervals. The x axis is the horizontal axis – this will be a straight line along the bottom of your page. The y axis is the vertical axis – this will be a straight line from the top to the bottom of the page, on the left-hand side. Make sure you draw these lines over one of the thicker lines on the graph paper, so you are using the larger squares. Generally the independent variable goes on the x axis (the thing that you are changing or measuring) the dependent variable goes on the y axis (this is the thing you are trying to measure or predict).
4. **Label both axis.** Make sure you include units of measurement – in brackets, if needed.
5. **Give your graph a title.** What data are you comparing in your graph? E.g. A graph to show...
6. **Plot points.** Take your time over this, you need to be accurate. You can use a ruler to help you plot correctly. Draw a small cross for each point.
7. **Correlation.** There is a correlation between the two sets of data when they are connected in some way. If when one increases so the does the other, there is a positive correlation. If one set of data increases while the other decreases, there is a negative correlation. If there is no connection between the data, and all the points are spaced out across the graph, there is no correlation.
8. **Line of best fit.** A 'line of best fit' is a straight line (drawn with a ruler) that goes through the middle of all the points plotted on your graph. This is an estimate, but try to get half of the points on either side of it. The 'line of best fit' does not have to go through the origin. If there is no correlation, you cannot draw a "line of best fit".

A graph to show _____.

