

Tackling challenging topics

Collecting and interpreting data

Session 1: Data collection and questionnaires

Introduction

Knowledge about the collection and interpretation of data is needed to support mathematical understanding in a range of vocational settings. Teachers*, can modify the examples in these sessions to suit their particular vocational area by introducing relevant data sets or charts.

We use 'teaching and learning' and 'teacher' as generic terms to include:

- teaching, training and learning
- teachers, tutors, trainers, lecturers and instructors in the further education (FE) system.

This is the first of a set of four sessions with a common theme. You can use each session individually or link them. Each session has a number of stages and activities, which can also be used separately or linked. Learners would benefit if these smaller units were delivered consecutively, with the teacher ensuring that the overall session coverage is achieved.

Learning objectives and outcomes

Taking part in this session will help learners to:

- understand terminology associated with data collection
- assess the quality of questions used in a questionnaire
- design effective questionnaires
- recognise bias in data collection methods
- work co-operatively to build on prior knowledge and to explore and resolve misconceptions
- discuss mathematical problems, improving their ability to describe situations and concepts using appropriate mathematical language
- collaborate in solving problems, learn from each other and clarify their own understanding by engaging in activities that encourage discussion with their peers.

Resources required

For each small group of learners you will need:

- **Sheet 1: Discussing Mathematics**
- **Card set A: Words**
- **Sheet 2: Questionnaire** (five pages)
- **Card set B: Sampling** (two pages)
- sticky spots or stars
- felt tip pens.

Optional:

- **large sheets of paper (A2 would be ideal).**

Starting points

Most learners will have some prior knowledge of data collection. If they are not familiar with the vocabulary, it may be useful to have dictionaries or access to the internet so that they can research definitions.

Planning learning in multiple environments

During discussion, draw on learners' own experience of collecting data. This may have been at school or college, in work experience, or in their current vocational course. Try, wherever possible, to relate the collection and interpretation of data to the wider vocational context by using vocationally relevant examples.

Time needed for this session

Between 1 and 1.5 hours, depending on the number of definitions the groups tackle in Stage 1 and the number of examples they provide.

Suggested approach

Stage 1: Using specialist language in data handling

Working in groups

Arrange learners in groups of two or three and prepare them to work co-operatively. If learners are unfamiliar with this way of working, the handout **Sheet 1: Discussing Mathematics** may be helpful.

Explain the purpose of the activity and the learning objectives.

Photocopy **Card set A: Words** and give one card to each group of learners. Ask them to come up with a definition or explanation of their word or phrase and some examples. If there are more groups of learners than cards, two groups can have the same word. If there are more cards than groups, each group can have more than one word. If learners have no idea of the meaning of their word, suggest that they start by using a dictionary definition (or a definition from the internet) and then try to adapt the definition to a statistical context.

Ask each group to share their findings with the rest of the class and encourage other groups to come up with additional examples.

Ask learners to think of scenarios where they might need to collect data in their chosen vocational area. Discuss how this information might be collected and recorded.

Stage 2: Designing questionnaires

Working in groups

Give out **Sheet 2: Questionnaire** (five pages) to each pair or small group of learners. The questions have been written by Joshua who is conducting a survey on the use of mobile phones. There are six copies of the questionnaire. The two on page one have been filled in already. On pages four and five, there is information about four more people. Learners have to complete the questionnaires on pages two and three for these people. While they are doing this, they should consider whether the questions are appropriate or need rewriting. To help them to decide, suggest that they discuss the following.

- Are the questions clear?
- Are they ambiguous?
- Are they leading?
- If they are open, is this appropriate?

Class discussion

In class discussion, share comments about the questions. Also, ask learners questions about the questionnaires that have been filled in. For example:

“How often does Angela use her mobile phone?”
 “How often does Tim use his?”

This should highlight the need to be more careful when using open questions because there is no indication of time in Angela’s response. She could mean ‘per day’, ‘per week’ or even ‘per month’.

Where there are problems, ask learners to suggest new improved questions for discussion.

Comment

Learners may come up with all sorts of comments but they should include:

- The categories in Question 1 overlap, so there are two possible answers for those on the boundary.
- Question 2 is too personal – you should never ask for people’s earnings. Offering ranges, as in Question 1, is more acceptable.
- Question 5 is a vague open question – there will be confusion over time periods and between texts and calls.
- Question 6 does not have enough possibilities, so most respondents will go for the middle one.

If learners need more practice, they can design and discuss a questionnaire on a topic that is appropriate to their vocational context.

Stage 3: Choosing a sample

Working in groups

Give learners the scenario that two learners are planning a survey among their fellow learners to find out what sort of things people have for breakfast and whether they eat breakfast in the canteen. They are feeling ambitious and want to ask 100 learners. They are discussing where they should find their sample of 100 learners. They come up with the following possibilities.

Give **Card set B: Sampling** (two pages) and some sticky spots or stars, or felt tip pens in two different colours, for example, red and green, to each pair of learners. Ask them to rate each sampling method on a one, two or three star rating scale (three is the best). The ratings should be for:

- ease of collection
- lack of bias
- other issues - any other negative or positive aspect that learners come up with.

Learners place their stickers and share and discuss the results as a whole group. Learners should explain the reasons why they rated a particular method as they did. While they are explaining, other learners can add or remove stickers if they are swayed by the arguments.

Alternatively, learners could devise their own scoring system and use that instead of the star rating.

Comment

Some sampling methods are much easier to carry out than others, for example, emailing is easy to do, whereas going into 20 different classrooms is much more time-consuming.

A possible example of bias is that, by collecting data only at 08.30 at the entrance, learners who arrive later, and so potentially have had more time for breakfast, are excluded from the survey, as are those who have arrived early enough to have time to visit the canteen before their first session of the day. These are important exclusions that relate to the subject of the survey, so the results could be biased. Similarly, only asking people in the canteen could bias the results as they are likely to be there because they are eating breakfast.

Other issues could include:

- honesty of response – anonymous responses may be more truthful than having to give a response in front of fellow learners
- the possibility of people being asked twice
- how realistic the method is – data protection might prevent some methods from being carried out even though they may be effective.

Some learners might consider gender to be an important variable. Others might think that mode of transport or distance from college are relevant.

As a result of the discussions ask each pair of learners to come up with their number one choice of the best way to select a sample in this situation and ask them to identify the advantages and disadvantages of their chosen method. This could be done on a poster; all the posters could be pinned up for the rest of the learners to see.

Comment

There is no right or wrong answer as to which sampling methods are best. Some are better than others but some are a matter of opinion, for example, some might think that gender is important in this research, so male and female respondents should be represented. Others might disagree, so representative numbers of males and females is not important. What is important is that learners can justify their decisions, that they realise that bias can distort results, that different projects will have different issues, and that what is appropriate for one piece of research is not appropriate for another.

Stage 4: Reviewing the learning

Group discussion

Have a group discussion about open and closed questions. What are the advantages and disadvantages of each?

Comment

Learners may come up with comments such as:

- Responses to closed questions are easier to analyse as they usually involve tick boxes or set responses.
- Open questions are often difficult to analyse as the answers can be very diverse and sometimes ambiguous (as was the case in the mobile phone question 5). If questions are asked face to face, any ambiguities can be clarified by further questioning and people are less likely to give an ambiguous response.

However, when there are lots of possible responses, open questions can be better, for example, "What did you eat for breakfast?" This is open but is the best way to find out as the list of possibilities is so long.

Sheet 1: Discussing Mathematics

Discussing Mathematics

Why discuss Mathematics?

Many people think that there isn't much to discuss in Mathematics. After all, answers are just right or wrong, aren't they?

There is more to learning Mathematics than getting answers. You need discussion in order to learn:

- what words and symbols mean
- how ideas link across topics
- why particular methods work
- why something is wrong
- how you can solve problems more effectively.

Teachers often say that they understand Mathematics better when they start teaching it. In the same way, you will find that, as you begin to explain your ideas, you will understand them better.

As you begin to understand Mathematics, you will remember it more easily and, when you do forget something, you will be able to work it out for yourself.

Some Don'ts

- **Don't rush**
It is more important to get a better understanding than to finish the activity.
- **Don't be a passenger**
Don't let someone in your group 'take over'.

Stick to these basic rules and you will find that:

- you begin to enjoy Mathematics more
- you learn more from others
- your difficulties are the same as those experienced by others
- you can help others too!

Some Dos

- **Talk one at a time**
Give everyone a chance to speak. Take it in turns to put forward ideas, explanations and comments. Let people finish.
- **Share ideas and listen to each other**
If you don't understand what someone has said, keep asking "why?" until you do understand. Ask them to give an example, draw a diagram, or write down their explanation.
- **Make sure people listen to you**
If you have just said something and are not sure if people have understood you, ask them to repeat what you have just said in their own words.
- **Follow on**
Try to say something that follows on from what the last person said.
- **Challenge**
If you disagree with what people say, challenge them to explain. Then put your point of view.
- **Respect each other's opinions**
Don't laugh at other people's contributions (unless they're meant to be funny!).
- **Enjoy mistakes**
Don't worry about making mistakes. If you don't make mistakes, you cannot learn anything! It is sometimes interesting to make deliberate mistakes to see if your partner is listening!
- **Share responsibility**
If the teacher asks your group to report back, make sure anyone in your group can do so.
- **Try to agree in the end**

Card set A: Words

Sample	Bias
Open question	Leading question
Closed question	Population
Unbiased	Survey
Census	Pilot survey

Sheet 2: Questionnaire (page 1 of 5)

Angela

1. What age are you?

0 – 10	10 – 20	20 – 30	30 – 40 ✓	over 40
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2. How much do you earn? Nothing
3. Do you have a mobile phone? Yes / ~~No~~
4. Is it Pay As You Go? Yes / ~~No~~
5. How often do you use it? Once or twice
6. Regarding value for money do you think your phone is:

Very good value	Just OK ✓	Very expensive
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7. Do you agree that mobile phone masts should not be put near schools because of the health risks? Yes / No **X**

Tim

1. What age are you?

0 – 10	10 – 20 ✓	20 – 30	30 – 40	over 40
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2. How much do you earn? About £500
3. Do you have a mobile phone? Yes / ~~No~~
4. Is it Pay As You Go? Yes / ~~No~~
5. How often do you use it? About three times a week for calls and about 12 times a day for texts.
6. Regarding value for money do you think your phone is:

Very good value	Just OK ✓	Very expensive
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7. Do you agree that mobile phone masts should not be put near schools because of the health risks? Yes / No **X**

Sheet 2: Questionnaire (page 2 of 5)

Peter

1. What age are you?

0 – 10	10 – 20	20 – 30	30 – 40	over 40
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2. How much do you earn?

3. Do you have a mobile phone? Yes / No

4. Is it Pay As You Go? Yes / No

5. How often do you use it?

6. Regarding value for money do you think your phone is:

Very good value	Just OK	Very expensive
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7. Do you agree that mobile phone masts should not be put near schools because of the health risks? Yes / No

Amir

1. What age are you?

0 – 10	10 – 20	20 – 30	30 – 40	over 40
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2. How much do you earn?

3. Do you have a mobile phone? Yes / No

4. Is it Pay As You Go? Yes / No

5. How often do you use it?

6. Regarding value for money do you think your phone is:

Very good value	Just OK	Very expensive
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7. Do you agree that mobile phone masts should not be put near schools because of the health risks? Yes / No

Sheet 2: Questionnaire (page 3 of 5)

Daniel

1. What age are you?

0 – 10 10 – 20 20 – 30 30 – 40 over 40

2. How much do you earn?

3. Do you have a mobile phone? Yes / No

4. Is it Pay As You Go? Yes / No

5. How often do you use it?

6. Regarding value for money do you think your phone is:

Very good value Just OK Very expensive

7. Do you agree that mobile phone masts should not be put near schools because of the health risks? Yes / No

Kelly

1. What age are you?

0 – 10 10 – 20 20 – 30 30 – 40 over 40

2. How much do you earn?

3. Do you have a mobile phone? Yes / No

4. Is it Pay As You Go? Yes / No

5. How often do you use it?

6. Regarding value for money do you think your phone is:

Very good value Just OK Very expensive

7. Do you agree that mobile phone masts should not be put near schools because of the health risks? Yes / No

Sheet 2: Questionnaire (page 4 of 5)

Peter

Peter is aged 30 and earns about £25,000 a year. He has a mobile phone that he uses when he is on holiday. It is Pay As You Go and he thinks it is OK for value. He is a dad with two small children so he thinks masts should not be built near schools although he is not sure whether the risk is scientifically proven.

Amir

Amir is aged 27. He has a mobile phone and earns £21,000 a year. He uses Pay As You Go.

He sometimes uses his mobile at weekends but not much during the week. He uses it a lot when he is away on holiday. He thinks it is normally good value but a bit expensive when he is abroad.

He has no really strong opinion about masts but will answer “yes” to the question because it sounds as though it could be dangerous and he is a teacher.

Daniel

Daniel is aged 58 and does not have a mobile phone.

He has no really strong opinion about masts but will answer “yes” to the question because it sounds as though it could be dangerous and he is a grandad. He is retired but does some part-time work and earns an average of £120 a week.

Sheet 2: Questionnaire (page 5 of 5)

Kelly

Kelly is aged 43 and has a mobile phone. She uses Pay As You Go.

She uses her mobile regularly in the evenings but never during the day at work. She makes about 14 calls per week and sends about 20 texts per week.

She believes masts should be built away from children. She earns £35,000 a year.

Card set B: Sampling (page 1 of 2)

<p>Stand at the main entrance at 08.30 on Monday and ask the first 100 learners who come through the door.</p>	<p>Ease</p>	<p>Bias</p>	<p>Other</p>
<p>Ask all the other learners in your group and in nearby rooms during one of your sessions.</p>	<p>Ease</p>	<p>Bias</p>	<p>Other</p>
<p>Stand at the entrance at 08.30 each day for a week and ask the first 20 learners you see each day.</p>	<p>Ease</p>	<p>Bias</p>	<p>Other</p>
<p>Give every learner in the college a number. Choose 100 numbers at random from a hat and ask those learners to answer the questionnaire.</p>	<p>Ease</p>	<p>Bias</p>	<p>Other</p>
<p>Go into 20 classrooms of different subjects during the morning and ask five learners in each classroom.</p>	<p>Ease</p>	<p>Bias</p>	<p>Other</p>
<p>Go round during the day asking learners to complete the questionnaire, but first ask learners where they live to make sure that different distances are represented.</p>	<p>Ease</p>	<p>Bias</p>	<p>Other</p>

Card set B: Sampling (page 2 of 2)

<p>Email a questionnaire to every learner in the college.</p>	<p>Ease</p>	<p>Bias</p>	<p>Other</p>
<p>Go to the canteen at lunchtime and ask 50 male and 50 female learners.</p>	<p>Ease</p>	<p>Bias</p>	<p>Other</p>
<p>Stand at the entrance at five different times during the day and ask 10 female and 10 male learners each time.</p>	<p>Ease</p>	<p>Bias</p>	<p>Other</p>
<p>Wander around college at break time and ask the first 50 female and the first 50 male learners you meet.</p>	<p>Ease</p>	<p>Bias</p>	<p>Other</p>
<p>Go around during the day asking learners to complete the questionnaire, but ask them which course they are doing to make sure that every type of course is represented.</p>	<p>Ease</p>	<p>Bias</p>	<p>Other</p>
<p>Go to the canteen at 08.30 each day and ask 20 learners.</p>	<p>Ease</p>	<p>Bias</p>	<p>Other</p>