### July 2012. This material is shared by Pip Arnold. It is part of her thesis which she is currently writing. The copyright for this material rests with Pip. Feel free to share but please acknowledge the source. Queries can be directed to Pip at parnold@cognition.co.nz

Material covered include; [criteria for what makes a good investigative question](#_Criteria_for_what), [comparison question categories](#_Comparison_question_categories), [population categories](#_Population_categories) and [SOLO grading criteria for comparison questions at level 5](#_Table_1._SOLO).

### Criteria for what makes a good investigative question

The criteria and considerations for teaching are:

|  |  |
| --- | --- |
| Criteria | Considerations for teaching and curriculum development |
| 1. The variable(s) of interest is/are clear and available
 | * The variable being described for a summary situation is clear.
* The variable being compared in a comparison situation is clear.
* The variables being looked at for a relationship are clear.
* The variable(s) has been correctly identified from the actual survey question that was asked; see the example given in section 6.4.4 about students rating their ability in maths.
* The variable(s) is/are available. For example, students pose a question around favourite place to live when the variable given is the region that students live in. The variable *favourite place to live* was not available, only the variable *where students live* was.
 |
| 1. The population of interest is clear
 | * Watch student use of the words “a” or “the” in front of the population or group they are using. For example students write about “a boy”, “the boys” or they can simply have boys. The difference between these three is that “a boy” indicates an individual, “the boys” suggests the boys in the sample, whereas “boys” most likely indicates that it is about the population. In addition students sometimes refer to “these boys” also meaning the sample rather than the population.
* The use of language is often the downfall of students who inadvertently refer to the sample rather than the population, but students can also pose their question directly about the sample rather than the population, missing the point about posing questions about the population. An example of this is: “I wonder if the boys sampled in the 2007 NZ CensusAtSchool have a longer arm span than the girls sampled?” (2008 student, post-test)
* Students must identify both population groups. Students can identify one of the population groups and then revert to an abbreviated form for the second group, and as a result not clearly identify the second population group, for example, referring to the first group as year 10 NZ boys and then girls for the second group.
* Watch the use of age groups as a possible population group that is represented by the data when the data is from a single year level. The issue here is that it might be a biased sample as only the oldest, or the youngest of a particular age group would be represented in a single year group. For example, in year 10 most students are 14 years of age, there are also 13 year olds and 15 year olds. The 13 year olds tend to be students in their second half of their 14th year and the 15 year olds tend to be students in the first half of their 16th year.
 |
| 1. The intent is clear
 | * From the question it needs to be clear if it is a summary, comparison or relationship question. The intent of the question is critical as it indicates the relevant analysis that will be undertaken for the variable(s).
 |
| 1. The question can be answered with the data
 | * The problematic situation first arose around this criterion (see Chapter 5). The question is not able to be answered due to too small a sample size for at least one of the groups being compared.
* Specific, so that it is answerable from data – questions that are too vague and general are harder to answer. ([Graham, 2006](#_ENREF_1))
 |
| 1. The question is one that is worth investigating, that it is interesting
 | * The information obtained by answering the question will be useful to someone.
* Personally interesting to you – not only will this bring greater motivation, but also your common-sense knowledge about the context should help to ensure that the investigation proceeds along sensible lines ([Graham, 2006](#_ENREF_1)).
* If neither of these points are relevant then one would need to ask the question, why we are investigating this situation.
 |
| 1. The question that allows for analysis to be made of the whole group
 | * In this case the question is referring to the aggregate picture rather than an individual case. For example, questions that ask about who is the tallest, who has the longest armspan are not suitable, as are those that ask whether the median height for boys is bigger than the median height for girls.
 |

The investigative question considers all of the criteria given and can be grouped into two main aspects: (1) the quality of the question posed (encompassing criteria 1, 3, 4, 5 and 6) and (2) the population (criteria 2). These two aspects are considered separately and for the different types of questions, summary and comparison.

### Comparison question categories

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Question category** | **Student question example** | **Commentary** |
| Comparison investigative questions (level 4-6) | F. A question that compares a summary statistic. | I wonder if the typical right foot length for year 11 boys is greater than the typical right foot length for year 11 girls from the 2007 NZ Census at School database. (2008 student, post-test) | This question is comparing “the typical” which is interpreted as a summary statistic, for example, the median or the mode. |
| I wonder if the average hair length of 16 year old girls is greater than the average hair length of 16 year old boys. (2008 student, pre-test) | This question is comparing the average, which could be median, mean or mode. |
| G. A question that assumes the idea of tendency. This includes questions that ask how much bigger or if there is a difference. | I wonder if secondary girl students have bigger wrist circumference than secondary boy students. (2009 student, post-test) | This question uses the phrase “have bigger” but unlike the example in category D they haven’t indicated that they are thinking all girls bigger than all boys, so this style of question has been categorised as assuming tendency. |
| I wonder if boys have longer popliteal lengths than girls. (2009 student, post-test) | A second example showing a different variable, commentary as above relevant for this question also. |
| H. A question that includes the idea of tendency, for example, on average, generally, tends | I wonder if boys in year 10 tend to be **taller** than girls in Year 10. (2009 student, post-test) | This question structure has one population tending to be bigger/smaller/longer of the **variable** than the other population. |
| I wonder if on average right handers have longer **hair** than left handers. (2008 student, pre-test) | This is a similar structure to the first, but instead of using tend, they have used on average. |
| I wonder if Yr 9-13 NZ boys have typically higher **pulse rates** compared to Yr 9-13 NZ girls. (2011 student, post-test) | This is a similar structure to the first also, but this time they have used typically to express the idea of tendency. |
| I wonder if the **popliteal length** of Yr9-13NZ girls tend to be longer than Yr 9-13 NZ boys **popliteal length** (2011 student, post-test) | This question structure has the **variable** (of one of the groups) tending to be bigger/smaller than the **variable** (of the other group). A different structure to the previous three. |
| Comparison investigative question level 7 | I. A question that reflects the level of analysis that students working at curriculum level 7 have, that is, the question reflects that analysis includes finding an informal confidence interval for the median.  | Proposed question: I wonder if the median height of NZ year 11 boys is greater than the median height of NZ year 11 girls? | At level 7 students can now find an estimate for the population median for each group, then find an informal confidence interval for the population median and use this to make a call. The question needs to reflect these new tools that students have. |
| Comparison investigative question level 8 | J. A question that reflects the level of analysis that students working at curriculum level 8 have, that is, the question reflects that analysis can now determine if there is a difference between medians or mean and quantify this in terms of a confidence interval. | Proposed question:I wonder what the difference in median heights is between NZ year 11 boys and NZ year 11 girls?  | At level 8 students have more tools in their toolkit and can use bootstrapping to find a confidence interval for the difference in medians (or means). The question needs to reflect this further sophistication in analysis. |

### Population categories

The final six population categories that students use are:

1. Referring to the sample.
2. Broad population, not specifying students.
3. Broad student population, for example, boys, girls, students.
4. Broad New Zealand student population, for example, New Zealand boys, New Zealand students.
5. Any relevant student population that can be generalised about from the actual New Zealand student population used, for example, year 11 students, teenagers, secondary school girls.
6. Actual New Zealand student population, for example, New Zealand Year 10 students, New Zealand Year 11 students, New Zealand secondary school girls.

In the teaching and learning the focus should be on using the **category six type populations**, but in assessment situations **category five would be an acceptable population** as well, but not category four as there needs to be some recognition of the limiting factor of the specific age or year level group selected in the sample. The fact that they are New Zealand students is not enough by itself.

**These population categories would need to be aligned when using other populations. These ones are specifically related to using CensusAtSchool databases, or other NZ student populations.**

### Table 1. SOLO criteria for grading comparison investigative questions at level 5 in the NZC\*

|  |  |  |
| --- | --- | --- |
| SOLO taxonomy level | Grade allocated | Description of evidence |
|  | 0 | Questions that are not comparison questions, nonsense or not related questions. |
| Pre-structural | 1 | Questions that are partially related to the data, but not answerable by the given data. |
| Uni-structural | 2 | Questions that hint at comparison or have all of one group bigger/smaller than the other, any population. |
| Multi-structural | 3 | Questions that compare categorical data, any population.Relational or extended abstract categories (F, G and H) with population categories 1-4. |
| Relational | 4 | Questions that compare summary statistics or assume the idea of tendency, including the idea of difference. Population is “acceptable”.Category F and G questions, population categories 5 and 6. |
| Extended abstract | 5 | Questions that include the idea of tendency. Population is “acceptable”.Category H questions, population categories 5 and 6. |

\*For NCEA level 1 I would be expecting **at least relational or extended abstract as a minimum standard**. You need to note that this table was used for research purposes to grade student posed investigative questions at curriculum level 5**. It is not designed to grade NCEA level 1, 2 or 3 responses.**

Graham, A. (2006). *Developing thinking in statistics*. London: Paul Chapman Publishing.