EQI INSTRUMENT: ARV CARD, CHECKLIST AND RUBRICS

APPENDIX C

ARV CARD

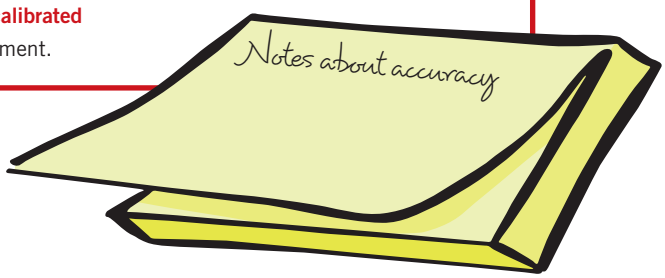
to ensure the accuracy, reliability and validity of an inquiry

Accuracy

...is influenced by the performance of **measurements** and observations.

Measurements of an inquiry are **accurate** enough when....

- ☐ ...the measurements / observations are done with **several, independent observers,** who speak in advance about the inquiry method.
- ☐ ...the measurements / observations are done in an **objective way.**
- ☐ ...the measurements / observations are done in a **systematic way.**
- ☐ ...the measuring instruments have an **adequate measuring range** (between the **minimum and maximum expected measuring rates**).
- ☐ ...the measuring instruments are **precise enough** for the inquiry.
- ☐ ...the measuring instruments are **calibrated** or **set to zero** before each measurement.



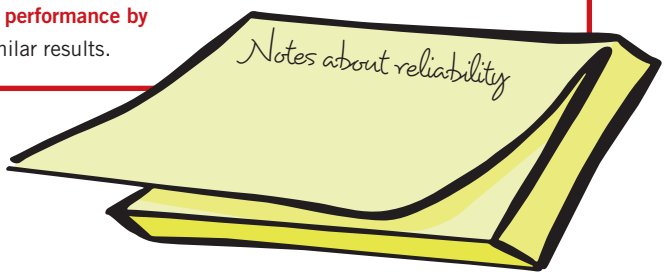
The EQI instrument is initially written in Dutch and translated into English for publication purposes.

Reliability

....is influenced by the **repeatability** and **reproducibility** of the **results** of an inquiry.

Results of an inquiry are **reliable** enough when....

- ☐ ...the **influence of other variables** is minimal
- ☐ ...a **control experiment** is performed to determine any influence of other variables.
- ☐ ...the results are comparable when the **measurements or observations** are **repeated.**
- ☐ ...the **test sample** is **large enough.**
- ☐ ...the test sample is **sufficiently varied** to be a faithful reflection of the research population.
- ☐ ...**another inquiry method** or **performance by another researcher** yields similar results.

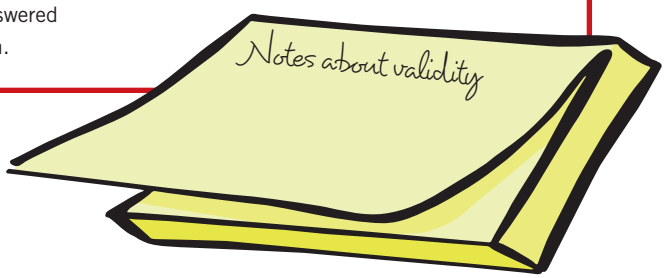


Validity

...increases when **different parts** of an inquiry are coherent.

An inquiry has good **validity** when....

- ☐ ...the **same independent** and the **same dependent variable** is used in each part of an inquiry
- ☐ ...the **inquiry question** is **univocal** and **defined.**
- ☐ ...the **hypothesis can be tested.**
- ☐ ...the **inquiry method serves** to answer the inquiry question and/or to test the hypothesis.
- ☐ ...the researcher has **sufficient appropriate results** to draw a conclusion.
- ☐ ...the **conclusion is based on** the results of the performed inquiry.
- ☐ ...the **inquiry question** is answered **completely** in the conclusion.



CHECKLIST

HAVE I DONE EVERYTHING?

USE THE CHECKLIST TO SEE WHETHER ALL ACTIONS HAVE BEEN CARRIED OUT

The checklist on the following pages has been prepared to check what actions you should think of when preparing and performing an inquiry. By using the checklist, you can see whether you have carried out all relevant actions regarding your inquiry.

The first column contains descriptions about actions in your inquiry. Tick the box after each description (in each row) that is applicable to your inquiry plan.

PREPARATION of inquiry	**Fully described in inquiry plan**	**Partly described in inquiry plan**	**Not described in inquiry plan**	**Inapplicable to this inquiry plan**
VALIDITY **Does the inquiry plan contain…**				
…the same independent and dependent variables in all parts?	☐	☐	☐	☐
…a theoretical framework?	☐	☐	☐	☐
…a univocal and defined inquiry question?	☐	☐	☐	☐
…a hypothesis that can be tested?	☐	☐	☐	☐
…a method with which the inquiry question can be answered?	☐	☐	☐	☐
…a method with which the hypothesis can be tested?	☐	☐	☐	☐
RELIABILITY				
Do you state other variables that could influence the measurements and observations and should be controlled?	☐	☐	☐	☐
Do you explain how the influence of other variables will be reduced?	☐	☐	☐	☐
Do you describe a control experiment to determine any influence of control variables?	☐	☐	☐	☐
Do you state how many times you will repeat the measurements?	☐	☐	☐	☐
Do you describe how you will sample the population?	☐	☐	☐	☐
Do you describe another inquiry method with which you will try to get comparable results?	☐	☐	☐	☐
ACCURACY				
Have you planned to do the observations and measurements with several, independent observers, with whom you will speak in advance about the inquiry method?	☐	☐	☐	☐
Have you explained how you will do the observations and measurement in an objective way?	☐	☐	☐	☐
Have you explained how you will do the observations and measurement in a systematic way?	☐	☐	☐	☐
Do the measuring instruments have an adequate measuring range (between minimum and maximum expected measuring rates)?	☐	☐	☐	☐
Are the measuring instruments accurate enough?	☐	☐	☐	☐
		Do you have ticks in the column above? Change your inquiry plan!	**Do you have ticks in the column above?** Change your inquiry plan!	

The first column contains descriptions about actions in your inquiry. Tick the box after each description (in each row) that is applicable to your inquiry.

PERFORMANCE of inquiry	**Yes**	**Partly**	**No**	**Inapplicable to this inquiry**
VALIDITY				
Have you investigated the independent variable(s)?	☐	☐	☐	☐
Have you measured the dependent variable(s) with appropriate measuring instruments?	☐	☐	☐	☐
Have you observed the dependent variable(s) from the inquiry question?	☐	☐	☐	☐
Do you have sufficient measuring rates / observation results to draw a conclusion?	☐	☐	☐	☐
RELIABILITY				
Have you reduced the influence of other variables as much as possible?	☐	☐	☐	☐
Have you repeated the measurements a couple of times?	☐	☐	☐	☐
Was your test sample large enough and sufficiently varied?	☐	☐	☐	☐
Have you conducted a control experiment?	☐	☐	☐	☐
Have you only measured the influence of the independent variable(s) on the dependent variable(s)? This can be determined by comparing the results from the control experiment with the results of your 'real' experiment	☐	☐	☐	☐
Did another inquiry method or a performance by another researcher yield similar results?	☐	☐	☐	☐
ACCURACY				
Have you done all observations and measurements with several, independent observers?	☐	☐	☐	☐
Have you done and noted down all observations and measurements in an objective way?	☐	☐	☐	☐
Have you done and noted down all observations and measurements in a systematic way?	☐	☐	☐	☐
Did the measuring instruments have an adequate measuring range (between the minimum and maximum expected measuring rates)?	☐	☐	☐	☐
Did you calibrate or set to zero the measuring instruments before each measurement you performed?	☐	☐	☐	☐
		Do you have ticks in the column above? Perform (relevant parts of) your inquiry again.	**Do you have ticks in the column above?** Perform (relevant parts of) your inquiry again.	

RUBRICS

WHAT LEVEL HAVE I ACHIEVED?

EVALUATE THE QUALITY OF YOUR INQUIRY WITH THESE RUBRICS

The following pages describe the quality of an inquiry. The descriptions are hierarchically compiled in rubrics. With these rubrics you can decide what the quality of your inquiry is.

The different levels of quality are stated in a blue frame.

The expected level of quality of your inquiry is stated in a red frame.

Mark the level of quality of your inquiry (your opinion) with a circle around the appropriate number.

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This booklet contains rubrics about:

12 This rubric was not used in the studies as described in Chapter 4-6. In the successive inquiry units, the theoretical framework was given to the students. Therefore it was not necessary and possible to evaluate the validity of an own written theoretical framework.

What level have you achieved? Circle this level ↓	THE THEORETICAL FRAMEWORK…	Benchmark samples
1	is based on information from everyday life.	*I saw an interview with a cyclist on the impact of sports on his heart rate in a sports programme on the television.*
2	is based on one scientific study.	*In the science section of the newspaper I read that the physiologist Harry Brown studied the correlation between sports and heart rate in 2008.*
3	is based on various scientific studies.	*Brown (2008) stated the correlation between sports and heart rate. He also studied that… Owen (2004) studied this correlation and her conclusions were…*
4	is based on information from various scientific studies which has been incorporated into a coherent text. The central inquiry topic has clearly emerged.	*When the conclusions of Brown (2008) are compared to those of Owen (2004), it can be seen that the first study proved that sports reduced the heart rate. The second study proved that there is no correlation between sports and the change of heart rate.*
5	is based on information from various scientific studies which has been incorporated into a coherent text. The inquiry topic is considered from different inquiry perspectives.	*From the study of Contador (2005), we inferred that the measuring instruments from the study of Jansen (2008) and Owen (2004) probably did not lead to comparable results.*

What level have you achieved? Circle this level ↓	THE INQUIRY QUESTION...	Benchmark samples
1	indicates the (global) topic of your inquiry	*Can changes in heart rate be measured?*
2	indicates one variable you want to examine during the investigation.	*What happens to the heart rate when people do something?*
3	indicates a couple of variables you want to examine during the investigation.	*What happens to the heart rate of people when they hold a handstand for some time?*
4	describes what correlation you want to explore between the independent and dependent variable.	*To what extent can a correlation be found between the length of time people hold a handstand and the changes in their heart rates?*
5	describes what correlation you want to explore between the independent and dependent variable. It corresponds to the information from previous research as mentioned in the theoretical framework.	*The theoretical framework contains information about studies on changes in the body when someone stands upside down, about studies on heart rate and about studies on factors that influence the heart rate. It is followed up by the inquiry question: 'To what extent can a correlation be found between the length of time people hold a handstand and the changes in their heart rates?'*

What level have you achieved? Circle this level ↓	**THE HYPOTHESIS...**	**Benchmark samples**
1	contains a general outcome of the inquiry.	*Something happens to your heart rate.*
2	mentions an outcome of one variable that you will measure or observe during the inquiry.	*Your heart rate changes when you hold a handstand*
3	mentions outcomes of a couple of variables that you will measure or observe during the inquiry.	*Your heart rate increases when holding a handstand, and after a while it changes again.*
4	describes the correlation you expect to explore between the independent and dependent variable.	*The longer someone holds a handstand, the higher his or her heart rate will be.*
5	is fully in line with the information you have mentioned in the theoretical framework.	The hypothesis is based on the theoretical framework: *Thijssen (2009) describes what happens in the body when you do a handstand, Hamadi et al. (2001) describe what heart rate frequency is and Johnson (1999) did relevant research on the change in heart rate frequency. Based on these previous studies, we propose that: "The longer someone holds a handstand, the higher his or her heart rate will be".*

What level have you achieved? Circle this level ↓	THE INQUIRY METHOD...	Benchmark samples
1	indicates in general terms what research you will perform.	*We will inquire how the body reacts when someone holds a handstand.*
2	contains one variable / aspect that you measure or pay attention to in the inquiry.	*We measure the heart rate by….. [description of one aspect of the inquiry method].*
3	contains a couple of variables / aspects that you measure or pay attention to in the inquiry.	*First, we will measure the heart rate of a test subject by ….. [experimental method]. Then we will measure the heart rate of a test subject when he holds a handstand by ….. [experimental method].*
4	contains an explanation of how different variables / aspects of the inquiry will be combined.	*First, we will measure the heart rate of several test subjects by ….. [experimental method]. Then we will measure the heart rate of a test subject when he holds a handstand by ….. [experimental method]. After finishing the measurements we will calculate for each test subject how his heart rate changed during the experiment.*
5	is suitable to answer the inquiry question fully and / or to test the hypothesis.	*First, we will measure the heart rate of several test subjects by ….. [experimental method]. Then we will measure the heart rate of the test subject when he holds a handstand by ….. [experimental method]. After finishing the measurements we will calculate for each test subject how his heart rate changed during the experiment. We will draw a table to show for each test subject whether his heart rate increased or decreased during the experiment.*

What level have you achieved? Circle this level ↓	**DRAWING A SAMPLE** *If you are dealing with too large a population to inquire, then ...*	**Benchmark samples**
1	you test a few subjects from your daily environment.	*I will perform the inquiry on my two brothers.*
2	you choose a few subjects from the population and you focus on one variable you want to investigate.	*I will perform the inquiry with one test subject who regularly does a handstand during gymnastics and one test subject who has never done a handstand before.*
3	you draw a sample from the study population in which all variables occur that are important for answering the inquiry question.	*I will perform the inquiry with ten test subjects who regularly do a handstand during gymnastics and ten test subjects who have never done a handstand before. Each group contains an equal number of men and women of different ages.*
4	you calculate how big the sample should be to get results which are as reliable as possible.	*We have calculated [student gives the calculation] that we have to perform the experiment with at least 56 of the 93 students from Grade 9.*
5	you make sure that the sample is representative of the whole population.	*The computer will select at random the 56 students who will be invited to participate in the experiment. The percentage of boys and girls in the sample will be comparable to the ratio of boys and girls in Grade 9.*

What level have you achieved? Circle this level ↓	AVERAGE AND DEVIATION OF MEASUREMENTS
1	You display all measurement rates from the experiment.
2	You have calculated the average of the measurement rates from comparable measurements.
3	You have calculated the deviation around each of the averaged measurement values.
4	You have indicated possible outliers in the data set of the experiment and stated whether these outliers should be removed from the results. This indication is based on the deviation and the accuracy of the measurements.
5	You have used the information about the deviations around the averaged measurement rates to decide on the reliability of the results from the experiment.

What level have you achieved? Circle this level ↓	THE ANSWER TO THE INQUIRY QUESTION [CONCLUSION] ...	Benchmark samples
1	is formulated in general terms.	*We noted that something happened to the heart rate.*
2	contains one variable that was stated in the inquiry question.	*The heart rate of the test subjects increased during the experiment.*
3	contains the variables that were stated in the inquiry question.	*The heart rate of the test subjects increased during the experiment. Also, the time span for holding a handstand increased during the experiment.*
4	indicates to what extent there is a correlation between the measured values of the independent and dependent variables from the inquiry.	*The longer the test subjects held a handstand, the more their heart rate increased.*
5	indicates to what extent the found correlation matches with previous inquiries as described in the theoretical framework.	*We found this correlation: The longer the test subjects held a handstand, the more their heart rate increased. In the theoretical framework, we stated that the heart rate will increase when someone stands upside down. We found the same correlation during our experiment.*

What level have you achieved? Circle this level ↓	THE EVIDENCE IN THE CONCLUSION...	Benchmark samples
1	is mainly based on general knowledge about the topic of the inquiry.	*The heartbeat of humans goes up when someone is doing exercises.*
2	contains one result that supports the answer to the inquiry question.	*The table shows that the heart rate of one of the five test subjects increased.*
3	contains a couple of results that support the answer to the inquiry question.	*The table shows that the heart rate of test subjects 1, 2, 3 and 5 increased.*
4	shows how the answer to the inquiry question is supported by all results from the experiment.	*The table shows that the average heart rate of four out of five test subjects increased as they were holding a handstand over a longer time span.*
5	connects your answer to the inquiry question to previous inquiries as described in the theoretical framework to show how generally applicable your answer to the inquiry question is.	*The table shows that the average heart rate of four out of five test subjects increased as they were holding a handstand over a longer time span. This conclusion tallies with the conclusion in the inquiry of Brown (2008) (see: theoretical framework).*

What level have you achieved? Circle this level ↓	EVALUATION OF ACCURACY	Benchmark samples
1	You indicate that you have done the measurements or observations accurately.	*We have continually measured as accurately as possible.*
2	You mention one (correct) aspect that may have influenced the accuracy of the measurements or observations.	*We did not control before each measurement whether the heart rate sensor was calibrated.*
3	You mention a couple of (correct) aspects that may have influenced the accuracy of the measurements or observations.	*We did not control before each measurement whether the heart rate sensor was calibrated. Two persons read the values from the measuring instruments.*
4	You explain to what extent the described aspects have influenced the accuracy of the measurements or observations.	*Our measured values are perhaps too high or too low because we did not control before each measurement whether the heart rate sensor was calibrated.*
5	You explain to what extent the (in)accuracy of the measurements or observations affect the inferred conclusion of the inquiry.	*We did not calibrate the heart rate sensor before each measurement, so our conclusion may not be based on the measured values.*

What level have you achieved? Circle this level ↓	EVALUATION OF RELIABILITY	Benchmark samples
1	You indicate whether someone can rely on the results of the inquiry.	*We have measured as fairly as possible.*
2	You mention one (correct) aspect that can have influenced the reliability of the results of the inquiry.	*Due to lack of time, we could not repeat all the measurements.*
3	You mention a couple of (correct) aspects that can have influenced the reliability of the results of the inquiry.	*Due to lack of time, we could not repeat all the measurements. Some of the test subjects played football shortly before we had to measure their heart rate at rest.*
4	You explain to what extent the described aspects have influenced the reliability of the results of the inquiry.	*Due to the absence of repeated measurements, we do not know what the average is of the changes in the heart rate of some test subjects. In addition, we do not know the heart rates of all test subjects at rest, because we did some measurements shortly after they had played football.*
5	You explain to what extent the (un)reliability of the results has affected the conclusion of the inquiry.	*We do not have an average heart rate of all test subjects, so actually it was not possible to compare these results. However, to answer the inquiry question we made a comparison that is partly based on these unreliable results.*

What level have you achieved? Circle this level ↓	**EVALUATION OF VALIDITY**	**Benchmark samples**
1	You indicate whether the inquiry is valid.	*Our inquiry is valid.*
2	You mention one (correct) aspect that may have influenced the validity of the inquiry.	*We have measured what we wanted to measure: the heart rate of our test subjects.*
3	You mention a couple of (correct) aspects that may have influenced the validity of the inquiry.	*We have measured what we wanted to measure: the heart rate of our test subjects. In addition, we have measured the length of time of each handstand.*
4	You explain to what extent the described aspects have influenced the validity of the inquiry.	*We have measured what we wanted to measure: the heart rate of our test subjects. In addition, we have measured the length of time of each handstand. Therefore, we have measured both the independent and dependent variables as described in the inquiry question.*
5	You explain to what extent the (in)validity of the inquiry has affected the conclusion of the inquiry.	*By measuring another variable while performing the experiment, our conclusion does not fit the initial inquiry question.*

What level have you achieved? Circle this level ↓	SUGGESTIONS FOR FUTURE INQUIRIES	Benchmark samples
1	You indicate general suggestions for future inquiries on the same subject.	*want to gain more knowledge on I the functioning of the heart, because I want to become a cardiologist.*
2	You mention one suggestion for a future inquiry that fits the same topic.	*In future inquiries, we would like to measure the heart rate of more test subjects.*
3	You mention a couple of suggestions for future inquiries that fit the same topic.	*In future inquiries, we would like to measure the heart rate of more test subjects. We also want to investigate whether there is a difference between measured values in the morning and at night.*
4	You describe how suggestions for future inquiries contribute to the improvement and/or deepening of the conclusion of this inquiry.	*To enlarge the reliability of the results of this inquiry, we want to measure the heart rate of more test subjects. By comparing measurements from different times of the day, we want to figure out whether the time of measurements influences the results.*
5	You explain how suggestions for future inquiries contribute to expanding the theory from previous inquiries as described in the theoretical framework.	*In this inquiry, we had too few test subjects to verify whether the results from the study of Brown (2008) are applicable to the results of test subjects that do a handstand. Therefore, we want to measure the heart rate of more test subjects in a future inquiry.*