Course Manual Statistics I: SSC2061-17/18

I. Course Information

II. Course Material: the Weekly program

Our main activities: the Explorations:

	Explorations in First Tutorial Group session	Explorations in Second Tutorial Group session	Exploration as individual end of the week activity
Week 1	P3 & 1.1	1.2 & 1.3	1.4 & 1.5
Week 2	2.1 & 2.2	2.3 & 3.1	3.2
Week 3	3.3 & 3.4A	3.5B & 4.1	4.2
Week 4	5.1 & 5.2	6.1 & 6.2	5.3 & 6.3
Week 5	7.1 & 7.2	8.1 & 9.1	7.3 & 8.2
Week 6	10.1 & 10.2	10.3 & 10.4	9.2 & 10.5

On average, we plan to do 6 Explorations in each of the 6 weeks. Last year, when we had one regular TG session per week, and one computer lab per week, we split every exploration in a first part not requiring computer simulation, to be done in the TG session, and the second part requiring simulations to be done in the computer lab. Students were required to upload reports of all their simulations.
This split between computer simulations and non-computer dependent parts of the explorations was however not really a must: most of you bring laptops into the tutorial sessions (strongly encouraged), TG rooms have a laptop. Therefore, we make another allocation:

- Two explorations in the 1st TG session
- Two explorations in the 2nd TG session
- One or two explorations as individual work, to be sent in at the end of the week through Studentportal.

Introduction to Statistics I

The course is completely redesigned according to the principles of 'randomization-based statistics education'. That principle departs from the classical statistics curriculum of first covering descriptive statistics, next discuss probability theory and models of random variables, continue with sampling theory, to deal with inferential statistics only in the very end of the course. Randomization-based courses make a drastical change, and start with inferential statistics from the very beginning.

This approach is very new: there are in fact no proven textbooks in the market organized by this principle. We will make use of the preliminary edition of Introduction to Statistical Investigations by Tintle et al. There may be a print edition available. In the StudentPortal, we may post the pdf's of the preliminary edition, in case there are not yet printed versions available. The preliminary edition covers a huge number of about 1400 pages, due to primitive type setting. So better not start printing the pdf's. If the hardcopy of the preliminary edition is available, you are strongly recommended to buy it. It is relatively cheap (€58), much better than having a collection of prints. If no hardcopy is available, you can do no better than using the pdf version, but best use them in digital format.

This new randomization-based statistics education is made possible by the availability of computing power. Doing simulations is within the range of most of higher education, be it not always easy to organize. This new textbook has been beta-tested in a couple of US universities, nearly always within liberal arts programs. In the US context, class sessions will often take place in computer labs, with small groups of students, having relatively many lab hours each week. In our context, we will use the regular TG sessions.

Given the experimental character of this course, and the circumstance that our context is rather different from the (US) contexts in which the materials are already tried out, we need to be adaptive. So although this course manual provides a rather detailed description of weekly activities, we will certainly need to adapt that scheme. So please consult The StudentPortal frequently for potential updates of the weekly program.

1.1 Goals Statistics I

In the course Statistics I, you will perform your own (first) research using quantitative techniques. In doing so, you will get familiarized with quantitative research methods in two ways. First of all, you will develop the abilities to read, understand and criticize scientific articles in the domain you study or work, as a passive use of your knowledge of quantitative techniques. On top of that, you will gain experience in actively performing such a quantitative analysis yourself, making use of familiar tools

After completing this course, the student should be able to:

1. Critically read and analyze a basic statistical study.
2. Perform one-tailed and two-tailed hypothesis tests.
3. Perform a linear regression analysis.
4. Solve basic probability problems.
5. Construct a confidence interval and explain its meaning.
6. Compute and explain the meaning of measures of center and spread in context of the problem.
7. Use a statistical package on a graphics calculator or a computer to carry out statistical procedures.

1.2 Structure Statistics I

We use a nontraditional approach to teaching introductory statistics. While we end up with basically the same outcomes as that of a traditional course, our path getting there is a bit different. A traditional course consists of four sections: definitions and vocabulary of statistical terms, descriptive statistics,

probability/sampling distributions, and inferential statistics. With more and more statistics being taught in the high school curriculum, most of you already have a grasp of descriptive statistics. We will quickly include the descriptive topics that are needed for inference throughout the course, but will not devote the amount of time on these topics as is traditionally done. The second part of a traditional course (probability and sampling distributions) is typically included to help students understand the theory behind inferential statistics. We, however, believe that introducing students to inferential statistics is better done using simulations called permutation tests or randomization to learn the statistical inference process. Introducing inference this way is more intuitive (and thus more understandable) and allows us to spend much more time on it. Therefore, you should, gain a better understanding of the inferential process as we will thoroughly cover the entire statistical investigative method throughout the entire semester. We will still cover the theory based methods that are traditionally taught including tests and confidence intervals for a single mean and proportion, matched pairs, comparing two means, comparing two proportions, proportions (chi-squared), correlation and regression.
In the following we provide a suggestion on how to structure your weekly learning activities in order to help you benefit as much as possible from this course. However, since learning styles and background knowledge differ greatly between individuals, this schedule should only be considered as an indication.

1.3.1 Literature

We strongly recommend that you turn to the weekly literature before the first session of the week. In the weekly program, we indicate the sections from the text you best read in order to start up the weekly learning cycle.

1.3.2 The tutorial group sessions

We discuss two explorations in each of the two weekly TG sessions. We leave one or two explorations for individual work, that, like last year, has to be send in.

1.3.3 The plenary session

This session is a mixture of a traditional overview lecture and a response lecture where your problems discovered when studying will be addressed.

1.3.5 Learning tools

Textbook: Introduction to Statistical Investigations, Preliminary Edition, by Nathan Tintle, Beth L. Chance, George W. Cobb, Allan J. Rossman, Soma Roy, Todd Swanson, Jill VanderStoep. The text will be available in digital format. The text we use is more a workbook, than a textbook, but it is in itself sufficient to master all topics. Those we like a more extensive read, may choose to do so with Stats, Data and Models, a text we will also use in Statistics II.

1.3.6 The Student Project

The aim of the student project is to provide students with a more authentic experience in applying their learning to real problems. A typical project requires students to think of a problem, outline their plans for collecting data to solve the problem, then complete the project, write up the results and present them to the tutor and/or the tutorial group.
To find data for your student project, we will use questionnaires.
To summarize, the student project consists of the following parts:

- Four required questionnaires: weeks 1-4.
- The Report of your Student Project, due in week 7.

The project accounts for 22 of the credit points; to achieve credits, one should fulfil all required parts (Excel assignments, questionnaires) and hand in the project report. The assessment is based upon the quality of the report, and the statistical analyses described in the report.

1.3.7 The Weekly Learning Cycle

Participating in tutorial groups for some time, you are experienced in problem-based learning (pbl) and its techniques, like the '7-jump'. In this course, you will encounter another experience with pbl, be it in a somewhat different interpretation. In terms of the 7-jump, steps 1-4, the so-called pre-discussion steps, do take place, but not in the tutorial group, but in your own dormitory or library when reading the text. Doing so allows much more time in the tutorial groups to spend on the post-discussion steps. Why make these changes? It is our experience that a pre-discussion is especially efficient if students possess different, but equal amounts of prior knowledge. You need some symmetry: all students have some insights that are worthwhile to share. If that symmetry is absent, pre-discussion degenerates into traditional teaching: the students with a more advanced background will act as lecturers, the students with a less-advanced background as pupil. And lecturing is not we are striving at.

1.4 Position in Curriculum

Statistics I is a course belonging to Social Sciences. It requires a basic mathematical prior knowledge, e.g., the Mathematics A1 program of the Dutch secondary school system, or a minor in mathematics ('Grundkurs)' in foreign high school systems. It does not require prior knowledge in statistics. The course prepares for other, methods oriented courses in your Bachelor.

1.5 Grading policies Statistics I

To determine your Statistics I grade, a portfolio of different assessment instruments with different weights will be used, as described in the table:

Assessment instruments	Weight in grading
Final exam	50 points
6 individual explorations	30 points
Student project	20 points

Your final score is the total number of points achieved, divided by 10.

1.5.1 Final exam

The final written exam can include both essay and multiple choice types of questions. More information on the final exam will be made available during the course in The StudentPortal.

1.5.2 Student project

In week 7, besides taking the final exam, you have to hand in your student project report. This report will contain at least 5 pages written text (and more pages statistical output). The project is rewarded a maximum of 20 points.

The project is composed off an applied analysis of your own data, and a statistical comparison of these data with data on other students. To allow you (and other students) to perform such an analysis, we need data. So a required part of the project is to take four questionnaires: one in every week. More information will be distributed in The StudentPortal.

1.5.3 Explorations

Each week, you will do an individual 'exploration' outside the tutorial session, and hand in a report of that exploration. That report will be graded, and you will receive (and provide) peer-feedback on those reports. Each weekly exploration counts for 5 points, of which 4 points for your report, and 1 point for the quality of your peer feedback.

1.5.4 Attendance & participation requirement

For all group sessions (in total: 12), the compulsory attendance requirement is 85%; that is 10 meetings (so you can miss at most 2).

1.5.5 Resit

The grade in the first sit is determined by your performance in the full portfolio consisting of final written exam, student project, and six weekly exploration reports, with weights as described above. In case you do not achieve a passing grade, two different options are available:

- Take a resit of written exam, student project, or weekly explorations, or a combination of the above, with the resit score substituting the first sit score for the specific component of the portfolio (such as redoing the student project, and getting a new score for the student project only), or
- Take a resit of the final written exam only, with the written exam score determining the full resit grade.

1.6 Schedule

In Statistics I, two different activities have been scheduled: plenary sessions, and group sessions.

1.6.1 Plenary sessions

Plenary sessions will take place on Friday. This is a lecture, with opportunity to discuss any problems/questions you encounter when studying the text.

1.6.2 Group sessions

Group sessions are regular TG sessions: Monday or Tuesday, and Thursday of Friday.

1.7 Literature Statistics I

The prescribed literature is:

- **Introduction to Statistical Investigations, Preliminary Edition**
- **Nathan Tintle, Beth L. Chance, George W. Cobb, Allan J. Rossman, Soma Roy, Todd Swanson, Jill VanderStoep**
- **ISBN: 978-1-118-95667-0**
- **1368 pages**
- **October 2014, ©2015**

1.8 Planning Group Statistics I

The planning group consists of:
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II. Course Material: weekly program

II.1: Program week 1

Topics: Introduction to Statistical Investigations, Preliminaries & Chapter 1, sections 1.1, 1.2, and 1.3.

❶ **First TG session.** Please prepare this session by reading both the Preliminaries and Chapter 1: Significance: How strong is the evidence? We will do Exploration P3 (skipping steps 3, 4, 5, 10, and 11) and Exploration 1.1 (skipping step 13) in the TG session, so you do not need to do them whilst reading the materials. Supplement with the discussion of some exercises, to the extent time allows.

❷ **The plenary session.** The lecture will cover Preliminaries and Chapter 1: Significance: How strong is the evidence?

❸ **Second TG session**. We will do Exploration 1.2 and Exploration 1.3 in the TG session.

❹ **Individual Exploration.** Do Exploration 1.4 and Exploration 1.5 yourself, and hand them in through The StudentPortal. Deadline: Monday week 2, 18.00. Explorations done individually will be assessed both by the tutors, and two peer students .

❺ **Student Project.** Sunday 12PM, the first questionnaire is due (required component of the Student Project). See THE STUDENTPORTAL. By filling questionnaires in the first four weeks, you will collect data for the project. Those questionnaires are available on the internet. In week 5, you will receive the data out of these questionnaires that need to be analyzed. Since you need to analyze your own data, it is important to fill the questionnaires in a serious and 'honest' way: if you provide data that isn't fully correct, you will find yourself into troubles doing the project.

II.2: Program week 2

Topics: Introduction to Statistical Investigations, Chapter 2 all 3 sections, and Chapter 3, sections 3.1 and 3.2.

❶ **First TG session.** Please prepare this session by reading the several sections of Chapters 2, and 3. We will do Exploration 2.1 and Exploration 2.2 in the TG class session, so you do not need to do them whilst reading the materials. Supplement with the discussion of some exercises, to the extent time allows.

❷ **The plenary session.** The lecture will cover Chapters 2 and 3.

❸ **Second TG session**. We will do Exploration 2.3 and Exploration 3.1 in the TG session.

❹ **Individual Exploration.** Do Exploration 3.2 yourself, and hand them in through The StudentPortal. Deadline: Monday week 3, 18.00. Explorations done individually will be assessed both by the tutors, and two peer students .

❺ **Student Project.** Sunday 12PM, the 2nd questionnaire is due (required component of the Student Project).

II.3: Program week 3

Topics: Introduction to Statistical Investigations, Chapter 3, sections 3.3 - 3.5, and Chapter 4, both sections.

❶ **First TG session.** Please prepare this session by reading both the several sections of Chapters 3 and 4, starting from 3.3. We will do Exploration 3.3 and Exploration 3.4A in the TG class session, so you do not need to do them whilst reading the materials. Supplement with the discussion of some exercises, to the extent time allows.

❷ **The plenary session.** The lecture will cover Chapters 3 and 4.

❸ **Second TG session**. We will do Exploration 3.5B and Exploration 4.1 in the TG session.

❹ **Individual Exploration.** Do Exploration 4.2 yourself, and hand them in through The StudentPortal. Deadline: Monday week 4, 18.00. Explorations done individually will be assessed both by the tutors, and two peer students .

❺ **Student Project.** Sunday 12PM, the 3rd questionnaire is due (required component of the Student Project). And the second Excel Assignment (if not already finished in the group session). See the StudentPortal.

II.4: Program week 4

Topics: Introduction to Statistical Investigations, Chapter 5 and Chapter 6, all sections.

❶ **First TG session.** Please prepare this session by reading both the several sections of Chapters 5 and 6. We will do Exploration 5.1 and Exploration 5.2 (skip step 14) in the TG class session, so you do not need to do them whilst reading the materials. Supplement with the discussion of some exercises, to the extent time allows.

❷ **The plenary session.** The lecture will cover Chapters 5 and 6.

❸ **Second TG session**. We will do Exploration 6.1 and Exploration 6.2 in the TG session.

❹ **Individual Exploration.** Do Exploration 5.6 and Exploration 6.3 yourself, and hand them in through the StudentPortal. Deadline: Monday week 5, 18.00. Explorations done individually will be assessed both by the tutors, and two peer students .

❺ **Student Project.** Sunday 12PM, the 4th questionnaire is due (required component of the Student Project). And the second Excel Assignment (if not already finished in the group session). See the StudentPortal.

II.5: Program week 5

Topics: Introduction to Statistical Investigations, Chapter 7, Chapter 8 and Chapter 9, section 9.1.

❶ **First TG session.** Please prepare this session by reading both the several sections of Chapters 7 and 8, and 9.1. We will do Exploration 7.1 and Exploration 7.2 in the TG class session, so you do not need to do them whilst reading the materials. Supplement with the discussion of some exercises, to the extent time allows.

❷ **The plenary session.** The lecture will cover Chapters 7 and 8.

❸ **Second TG session**. We will do Exploration 8.1 and Exploration 9.1 in the TG session.

❹ **Individual Exploration.** Do Exploration 7.3 and Exploration 8.2 yourself, and hand them in through the StudentPortal. Deadline: Monday week 2, 18.00. Explorations done individually will be assessed both by the tutors, and two peer students.

II.6: Program week 6

Topics: Introduction to Statistical Investigations, Chapter 9, section 9.2 and Chapter 10, all sections.

❶ **First TG session.** Please prepare this session by reading both the several sections of Chapters 9 and 10. We will do Exploration 10.1 and Exploration 10.2 in the TG class session, so you do not need to do them whilst reading the materials. Supplement with the discussion of some exercises, to the extent time allows.

❷ **The plenary session.** The lecture will cover Chapters 9 and 10.

❸ **Second TG session**. We will do Exploration 10.3 and Exploration 10.4 in the TG session.

❹ **Individual Exploration.** Do Exploration 9.2 and Exploration 10.5 yourself, and hand them in through the StudentPortal. Deadline: Monday week 7, 18.00. Explorations done individually will be assessed both by the tutors, and two peer students.

❺ **Student Project.** Sunday 12PM, the 4th questionnaire is due (required component of the Student Project). And the second Excel Assignment (if not already finished in the group session). See the StudentPortal.

II.7: Program week 7

❶ **Written exam ……...**

❷ **Hand in Student project report**.

Student project information

Problem assignment for student project: comparing positively and negatively phrased items
In the first problem assignment for your student project, we will focus on individual data. Both in week 1, and in week 3, you have filled the questionnaire AILI (for more information on AILI and the concept it measures, metacognition, see the data folder). In fact, you have filled two different versions of AILI, AILI-A and AILI-B. AILI-A consists of 45 items, of which 23 positively phrased, and 22 negatively phrased. AILI-B consists again of 45 items, and relates to AILI-A in that the phrasing of each statement is reversed (so it contains 22 positively phrased, and 22 negatively phrased items).
Designers of questionnaires are always careful in phrasing the statements as neutral as possible: answers being dependent on the particular way in which questions are stated, is the night mare of every designer. One issue that deserves special interest is the potential difference between positively and negatively formulated statements, especially in the AILI, where the designers found it unavoidable to use many (double) negations. The designers asked us to investigate if any statistical dependency of answers on phrasing can be found, and that is exactly what we promised to do, in your student projects.
In the AILI data file, for every student three columns of data can be found. The first refers to the answers of AILI-A, the second to the answers of AILI-B, and the third to the difference of answers to corresponding questions in AILI-A and AILI-B, where the difference is determined such that the answer to the positively formulated questions is always first, and the to the negatively formulated question last. If phrasing has no impact, the differences are expected to be zero.
Before focussing on the inference, please start with an extensive descriptive analysis of one of AILI-A or AILI-B, in combination with the set of differences. Use several techniques, such as box plots, histograms, and analyse both the complete set, as the separate scales (K, R, and O).
The next issue is the hypothesis test. Please formulate null and alternative hypotheses. Next calculate confidence intervals and perform the hypothesis test. Do so for both the set of all items, and separately for the sets of items belonging to the K, R, and O scales. Interpret the outcomes of all tests and confidence intervals.
Although each student is bound to do the analysis with her/his personal data, there is ample opportunity to cooperate in the preparation and interpretation phases. That is certainly the most important phase: once you have decided what to calculate with what data because of what hypothesis, the calculus itself takes no more than one hour. The outcome of this part of the project will be a project report that takes

4-5 pages, of which 1 page text (clarification, explanation, discussion), and the other pages screen shots from the computer applications. Make it attractive to read (so text and figures integrated); text should contain about 1000 words.
The file contains AILI data of all students. In fact, there are three columns of AILI data:

- scores on the first AILI test, AILI-A
- scores on the second AILI test, AILI-B
- the differences of these two scores, such that we always subtract the score of the negatively phrased items from the score of the positively phrased item (so A-B for half of the items, and B-A for the other half).

Information on the data file to be used in the student project
AILI: Awareness of Independent Learning Inventory description
General information about the AILI
The AILI is an instrument aiming to measure "Metacognition". Metacognition enables us to be successful learners, and has been associated with intelligence. Metacognition refers to higher order thinking which involves active control over the cognitive processes engaged in learning. Activities such as planning how to approach a given learning task, monitoring comprehension, and evaluating progress toward the completion of a task are metacognitive in nature. Because metacognition plays a critical role in successful learning, it is important to study metacognitive activity and development to determine how students can be taught to better apply their cognitive resources through metacognitive control.
"Metacognition" is often simply defined as "thinking about thinking." In actuality, defining metacognition is not that simple. The term "metacognition" is most often associated with John Flavell. According to Flavell, metacognition consists of both metacognitive knowledge and metacognitive experiences or regulation. Metacognitive knowledge refers to acquired knowledge about cognitive processes, knowledge that can be used to control cognitive processes. Flavell further divides metacognitive knowledge into three categories: knowledge of person variables, task variables and strategy variables.
The AILI, one of the very first instruments measuring metacognition, has been designed for people from whom it can be expected that they possess substantial metacognitive qualities that are based on ample learning experiences. We use the term "independent learning" to designate a type of learning and studying that is accompanied and directed by metacognition. The inventory can be used for students from all stages of higher education, regardless of their specific studies. The instrument will provide an answer to the following three questions:

1 To what extent do students, according to themselves, have declarative knowledge about learning and studying?
2 To what extent do students, according to themselves, have the skills to systematically regulate their own learning and studying?
3 To what extent do students, according to themselves, have a sensitive and inquisitive attitude towards information that is important for further development of their metacognitive knowledge and regulatory skills?

The instrument consists of 45 statements, 15 for each of the above questions. The statements about this kind of knowledge are presented to the students in positive and negative expressions.

The components of metacognition measured in the AILI
In designing the AILI three main categories have been distinguished within metacognition: metacognitive knowledge (K), metacognitive skills (R), and metacognitive attitude (O). Within the three main categories three components; one from the preparatory stage, one from the executive stage, and one from the concluding stage of a learning episode.

K: Metacognitive Knowledge
- K1: in the person category
- K2: about strategies
- K3: about study tasks

R: Metacognitive skill:
- R1: orientation on one's own functioning in a learning episode
- R2: monitoring one's execution of a learning episode
- R3: evaluation of one's own functioning in a learning episode

O: Metacognitive attitude:
- O1: sensitivity to metacognitive experiences (internal feedback during learning)
- O2: sensitivity to external feedback on one's cognitive functioning
- O3: curiosity with respect to one's own cognitive functioning and development

K1. **Knowledge about students**
This component of metacognitive knowledge could be knowledge students have acquired by means of a transfer of knowledge, for example in study skills classes, but it could also be empirical knowledge (beliefs students have developed themselves).

K2. **Knowledge about study strategies**
This knowledge about strategies could be knowledge students have acquired for example in study skills classes, but it could also be empirical knowledge (knowledge gained from experience).

K3. **Knowledge about study tasks**
Task knowledge enables people to distinguish task qualities that have implications for the cognitive and metacognitive approach to the task.

R1. **Orientation**
This component of metacognitive regulation is a higher level skill that plays a part in the preparatory stage of learning and problem solving processes. In the AILI the focus is on the habitually performed regulation that occurs in advance.

R2. **Monitoring**
This component of metacognitive regulation is a higher level skill that plays a part in the executive stage of learning and problem solving processes. In the AILI the focus is on the habitually performed monitoring.

R3. **Evaluation**
This component of metacognitive regulation is a higher level skill that plays a part in the concluding stage of learning and problem solving processes. In the AILI the focus is on the habitual conclusion of the process.

O1. **Sensitivity to internal feedback in the shape of metacognitive experiences.**
Metacognitive experiences usually have both a cognitive and an affective component. Examples of these experiences are: the pleasant, slightly surprised feeling you experience when it looks like you are going to complete a difficult task successfully after all and the unpleasant, slightly confusing experience that at a certain point you are not quite sure whether or not you truly understand a particular text. Researchers suppose that metacognitive experiences function as internal feedback. Possible consequences: the feedback can result in the setting of new goals, it can result in a change in the metacognitive knowledge base (through addition, deletion or revision), and it can lead to the activation of strategies (that are aimed at achieving cognitive and metacognitive goals). The AILI presents students with statements in which metacognitive experiences are verbalised.

O2. **Sensitivity to external feedback on a metacognitive level**
Represents the view that it is important that students are able to profit from external feedback that goes beyond practical. Monitoring and redirection processes are of vital importance to cognitive functioning. These processes are based on internal feedback. However, in addition to these processes, students test

their own standards of comprehension against those of others, for instance against those of teachers. To bring about this testing, students should interpret the teacher's feedback at a metacognitive level and they should not translate it directly into a practical measure. Suppose the teacher tells a student 'You should process the subject matter on a deeper level', or perhaps a little more subtly: 'I don't know exactly how to explain this to you, but I'm under the impression that your definition of comprehension is different from my own. It seems to me that in your view understanding a text more or less equals being able to recount it, whereas I would like you to distance yourself a little more from the text and to think about it for yourself whether you truly understand the information'. In a case like this, working harder by doing 'more of the same thing' (spending more time on a task while still using the same approach) is not the right solution. In some way or another, the student will have to attempt to find a different organisation of the comprehension-monitoring process and different settings of the comprehension monitor. In the AILI the focus is on the sensitivity to this kind of feedback.

O3. **Inquisitive attitude towards one's own functioning**

The view that it can be important whether or nor students adopt an inquisitive attitude is based on the importance of reflection, as well as ?elaboration?: activities people with an adequate metacognitive attitude undertake to conclude learning or problem solving processes. These 'elaboration' activities include drawing conclusions, recapitulating, and generating self-explanations. If the cognitive process has taken place methodically and if the different steps have been kept track of accurately 'if, in other words, the problem solving has been of a high quality' the gains of these 'elaboration' activities are that students not only acquire knowledge about the problems they just solved or the learning tasks they just performed, but also create favourable conditions for learning how to solve this kind of problems in general. Some authors refer to the 'high road' to transfer in this context. In the AILI we present statements to students in which there is mention of an inquisitive attitude towards the development or results of previous cognitive processes. By an inquisitive attitude we mean that students ask why-questions and look for answers within their own view of or approach to the task or, put differently, within their own subjective working concept instead of looking for answers in external factors. The statements are presented to the students in positive and negative expressions such as the following:

The content domain covered by the AILI

Metacognition can be related to many different kinds of cognitive functioning, including learning, problem solving, memorising (meta-memory) and to many different aspects of cognitive functioning, including the direction of cognitive processes, emotional control, and motivation. In the AILI a selection has been made from this broad domain. All of the items refer to students in higher education. We have selected five topics that could be important points of interests for students when they are reflecting on their studying experiences and approaches.

Topics 1, 2, and 3 are 'learning goal', 'emotional interest', and 'collaborative learning'. These topics refer to the relationship between the cognitive processes of independent learning and three other human functions: conation (attempting and striving), affect (feeling), and focus on others (the social aspects). These topics have been included in the AILI because students in higher education have to give direction to the studying and learning processes and in doing this they have to take into account their goals, their interests in particular subjects and tasks, and the social aspects of learning. Topics 4 and 5 are 'deep understanding' and 'orderliness/systematic approach'. These topics revolve around the necessity of gaining comprehension and insight (besides memorising and retaining information) and the necessity of an orderly and systematic approach, so that the abundance of information does not inhibit the learning process. In the AILI each topic has been represented by nine items.

T1.**Learning Goal**

This refers to metacognition about the relationship between learning and conation (attempting/striving). The items are related to knowledge (for example about the importance of setting learning goals for

oneself), to regulation (habitual regulatory strategies employed to make sure one's own learning goals are addressed within a specific study), and to attitude (for example in the shape of an inquisitive attitude towards the subjectively experienced value of the gains of study activities).

T2. **Emotional Interest**

This refers to metacognition about the relationship between learning and affect (feeling). The items are related to knowledge (for example about strategies employed to create an emotional interest in the study), to regulation (habitual ways to bring the subject matter 'to life'), and to attitude (for example in the shape of sensitivity to internal signs about the absence of emotional interest).

T3.**Collaborative learning**

This refers to metacognition about the relationship between learning and the social aspects. The items are related to knowledge (for example about the kinds of tasks that provide ample opportunities for learning from other students), to regulation (habitual regulation of the processes of learning from others or in collaboration with others), and to attitude (for example in the shape of taking an interest in the question why collaboration sometimes is and sometimes is not experienced as being of value to the learning process).

T4.**Deep understanding**

This refers to metacognition that is related to the gaining of insight by means of personal efforts and activities that are aimed at deepening comprehension. The items are related to knowledge (for example about the efforts necessary to acquire understanding and insight), to regulation (habitual regulation of the striving for understanding and insight), and to attitude (for example in the shape of sensitivity to external signals pointing to a lack of depth of the process of understanding).

T5.**Orderliness/Systematic approach**

This refers to metacognition that is related to the organisation and structure students themselves create in order to make possible learning in a complex learning environment. The items are related to knowledge (for example about strategies that stimulate working in a systematic way), to regulation (habitual regulation for the purpose of stimulating orderliness), and to attitude (for example in the shape of sensitivity to internal signals pointing to the circumstance that one's own systematic approach is not attuned to the task).