MEASURING ATTITUDES AND BEHAVIORS TO STUDYING AND LEARNING FOR UNIVERSITY STUDENTS: A RASCH MEASUREMENT MODEL ANALYSIS

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Abstract

A scale of Studying and Learning was created using a model of Motivation (sets of Guttman sub-scales of stem-items based on Striving for Excellence, Desire to Learn and Personal Incentives), integrated with three self-reported aspects (an Ideal Self-view, a Capability Self-view and a Studying and Learning Self-view). The response categories were the number of subjects studied. The stem-item sample was 23, all answered in three aspects, making an effective item sample of 69. The person convenience sample was 372 students in education at an Australian university. The 69 items fitted a Rasch Measurement Model and formed a scale in which the 'difficulties' of the items were ordered from 'easy' to 'hard' and the student measures of Studying and Learning were ordered from 'low' to 'high'. The proportion of observed student variance considered true was 0.944. The response categories were answered consistently and logically and the results supported nearly all the Guttman sub-scales. Students found it 'easy' to form a high view of How they would like to be, much 'harder' to form a high view of What they think they are capable of doing and even 'harder' to perform, at a high level, their Studying and Learning behavior for all stem-items, in accordance with the model.

Background

How university students study and learn is usually studied in a descriptive way or, quantitatively, by separately measuring the main variables considered to be influencing Studying and Learning (see Biggs, 1999, 1987; Dart & Boulton-Lewis,1998; Hansford & Hattie, 1982; Hartley, 1998; Enwistle and Tait, 1994; Fogarty & Taylor, 1997; Marton, Hounsell & Enwistle, 1997; Marton & Saljo, 1976; Ramsden, 1992; Rust, 1998; Watkins & Biggs,1996). Sometimes a model of Studying and Learning is tested by separately measuring the main variables in order to use the scores in a correlation technique such as path analysis or LISREL and to examine the relationships between the variables (see Drew & Watkins, 1998). Variables such as Motivation to Learn, Deep Approach to Studying, Surface Approach to Studying and Strategic Approach to Studying, Perceived Capability, and Ideal Self-Concept and Real Self-Concept have been suggested, from these studies, as having an influence on the learning approaches taken and, subsequently, on learning outcomes.

A typical quantitative example is that provided by Elliot, McGregor and Gable (1999). With a sample of 164 undergraduates from a university in the USA, they measured exam performance and study strategies (as the dependent variables) and mastery goals, performance-approaching goals, performance-avoiding goals, GPA, deep processing, surface processing and disorganization (as independent variables). Mostly, existing Likert type scales were used to measure the variables. A limited amount of analysis was performed on the measures (principal-component factor analysis) and, at best, a rank-ordering scale was obtained with some, but not much, checking for exclusion of items measuring 'noise'. They then used these measures in a multiple regression analysis to test the direct and indirect effects of the independent variables on the dependent variables. They were able to predict anything from about 20% to 50% of the variance in the dependent variables.

There are at least two aspects of these types of studies that are called into question. In the first, the above methods imply that Studying and Learning cannot be thought of as a model involving a unidimensional trait. It suggests that one cannot have a scale of Studying and Learning with measures from 'low' to 'high', calibrated on the same scale as the item 'difficulties' from 'easy' to 'hard'. In the second, no check is made that the items from all the
variables are contributing together in a logical and consistent way to the measurement of Studying and Learning. Correlation methods are somewhat crude and do not solve the problems mentioned above. Items that are measuring 'noise' in Motivation, Self-concept, Capability or Studying and Learning are left in the measures to contaminate the individual measures and distort the correlations. This has been referred to in previous measurement problems (see Andrich, 1989; Waugh, 1999b, 1998).

What is needed is a way of creating a scale in which 'noise' in measures is eliminated or reduced considerably and all the main items of Studying and Learning are calibrated together on the same scale with the student measures of Studying and Learning. This can be done with a Rasch Measurement Model (see Andrich, 1988a, 1988b, 1985, 1982; Rasch, 1960/1980) to be explained later. There is also a need to have the items relating to Motivation, Self-Concept, Self-reported Capability, and Studying and Learning to apply to semester-long subjects at university in up to four or five subjects (in Australia, at least). This will require a different kind of questionnaire from the usual Likert format for self-report data. One way to do this is to use stem-items based on Motivation, with response aspects relating to Ideal Self-views, Self-reported Capability and Self-views of Studying and Learning, and response categories relating to the number of subjects to which these are applicable (explained later).

Aims

The aims of this study are to:

1. Create a questionnaire to measure Studying and Learning based on Motivation, with three student response aspects for an Ideal Self-View, a Capability Self-View and a Studying and Learning Behavior Self-View, relating to the number of subjects to which student self-views are applicable;
2. Create a new scale of Studying and Learning using the computer program RUMM (Andrich, Lyne, Sheridan & Luo, 2000) in which the item 'difficulties' are calibrated on the same scale as the student measures of Studying and Learning;
3. Investigate the psychometric properties of the new scale; and
4. Interpret the meaning of the new scale of Studying and Learning.

Model of the Proposed Studying and Learning Scale

A scale of Studying and Learning was created using a structural model within a model, integrated with a category response model, and a measurement model (Rasch) that was used to calibrate all the item 'difficulties' and the student Studying and Learning measures on the same scale from 'low' to 'high'. The model of Studying and Learning was based on four main, but simple ideas, that when integrated would help explain a complicated situation of Studying and Learning for students. The first involved the creation of a structure based on three main aspects of Motivation (Striving for Excellence, Desire to Learn and Personal Incentives), with each aspect composed of a number of sub-aspects (see Waugh, 1999a). Striving for Excellence was based on the sub-aspects Standards, Goal Setting, Tasks, and Effort (An initial analysis showed that Ability and Values would not fit the model). Desire to Learn was based on the sub-aspects Interest and Learning from Others (An initial analysis showed that Taking Personal Responsibility for Learning would not fit the model). Personal Incentives was based on Intrinsic and Social Rewards together (An initial analysis showed that separate sub-aspects of Extrinsic Rewards, Intrinsic rewards and Social Rewards would not fit the model). The second involved creating stem-items for each sub-aspect in a Guttman pattern. The structure of Motivation (and hence Studying and Learning) was then based on sets of stem-items in Guttman patterns, each aligned from 'easy' to 'hard' in 'difficulty'. The third involved an ordered response set of categories for each of the stem-
items. These are an Idealistic Self-view (expected to be 'easy' on average), a Capability Self-view (expected to be 'harder' on average) and a Studying and Learning Self-view of behavior (expected to be 'harder still' on average). The fourth involved calibrating all the 'difficulties' of the items onto the same scale of Studying and Learning from 'easy' to 'hard' and all the student measures of Studying and Learning on the same scale from 'low' to 'high', using a Rasch Measurement Model.

**Sub-scale Standards under Striving for Excellence**

It was expected that most students would find it 'easy' to say that they would like to Achieve high standards in academic work (item 1) in all their subjects and that there would be some variation around this. It was expected that most students would find it 'harder' to Do their best to reach the academic standards that they set for themselves (item 4) in all their subjects and that there would be some variation around this. It was expected that they would find it 'harder still' to say that they would like to Achieve academically at a level that they believe will satisfy the lecturer (teacher) (item 7) and that there would be some variation around this. It was expected that most students would find it 'even harder' to Evaluate their performance against the academic standards that they set themselves (item 10) in all their subjects and that there would be some variation around this. So it was expected that these four stem-items would form a Guttman pattern of responses, on average, from 'easy' to 'hard', when students reported that this is How they would like to be (their Idealistic Self-view of this stem-item).

It was expected that this Guttman pattern of responses for the Idealistic Self-view for the stem-items for Standards (as explained above) would be repeated for their Capability Self-view (items 2, 5, 8, 11) and, separately, for their Studying and Learning Self-view of behavior (items 3, 6,9, 12). These patterns can be seen in the questionnaire (Appendix A) and in the sample below. That is, for Capability Self-view, the items would be ordered in 'difficulty' from 2 ('easiest') through 5 and 8 to 11 ('hardest') and for Studying and Learning Self-view of behavior from 3 ('easiest') through 6 and 9 to 12 ('hardest').

It was expected that a similar Guttman pattern of responses for any particular stem-item would be present for students Idealistic Self-view, their Capability Self-view and their Studying and Learning Self-view behavior (reported as items 1 to 3, 4 to 6, 7 to 9, and 10 to 12). It was expected that, on average, the Idealistic Self-view would be 'easiest', that the Capability Self-view would be 'harder' and that the Studying and Learning Self-view behavior would be 'harder still'.

This means that students are expected, on average for any sub-aspect, to self-report any particular response aspect (Ideal Self-view or Capability Self-view or Studying and Learning Self-view) in a Guttman pattern from 'easy' to 'hard'. It also means that, for any particular stem-item, students are expected to self-report their responses (Idealistic Self-concept, Capability and Actual Studying and Learning Behavior) in a Guttman pattern from 'easy' to 'hard'. The model of Studying and Learning was designed like this and the questionnaire (Appendix A) was designed to mirror this.

**Expected Guttman Patterns for the other Sub-scales**

The expected Guttman patterns for the other sub-scales follow a similar line to that reported above and are not reported here to avoid repetition and save space. A reader can easily work out the expected patterns of the other sub-scales from Appendix A. In Appendix A, the stem-items are placed in order from 'easy' to 'hard' in each sub-scale (see the logit values too) and the response categories (Idealistic Self-view, Capability Self-view and Studying and Learning Self-view of behavior) are also placed in order from 'easy' to 'hard'.
Method

Studying and Learning

Items from a recent Motivation scale (Waugh, 1999a) were used as stem-items, after non-fitting items were discarded following an initial analysis. Students were requested to respond to each of the stem-items in terms of How I would like to be (an ideal self-view), What I believe I'm capable of doing, and my Actual Studying and Learning Behavior, for the number of subjects studied at university. These were from one (in none or one of my subjects) to 2 (in two or three of my subjects) to 3 (in 4 or more of my subjects). The full questionnaire is given in Appendix A and a sample is given below.

Please rate the 69 items according to the following response format and place a number corresponding to This is how I would like to be, This is what I believe I'm capable of doing, and This is my actual studying and learning behavior, on the appropriate line opposite each statement:

In four or more of my subjects put 3
In two or three of my subjects put 2
In none or one of my subjects put 1

Example Item 1

If you would like to achieve high standards in academic work for four of your subjects, put 3; if you think you are capable of achieving high standards in academic work in three of your subjects, put 2; and, if your studying and learning behavior is like this in one subject put 1.

Item 1. Achieving high standards in academic work. 3 2 1

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Item no. Item wording This is how This is what This is
I would like I believe my to be I'm capable actual (idealistic of doing Studying self-concept) learning behavior

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Sub-Scale: Striving for Excellence (69 items)

Standards

1-3 Achieving high standards in academic work. ------ ------ ------

4-6 Doing my best to reach the academic standards
that I set for myself. ----- ----- ----- 

9. Achieving academically at a level that I believe 
Satisfy the lecturer (teacher). ----- ----- ----- 

10-12 Evaluating my performance against the academic 
standards that I set myself. ----- ----- ----- 

Goal Setting 
13-15 Setting myself realistic but challenging academic 
goals. ----- ----- ----- 

16-18 Renewing my efforts to ensure I achieve my goals, 
when I have difficulties in reaching my goals. ----- ----- ----- 

19-21 Achieving the highest academic goals that I can 
achieve with my ability. ----- ----- ----- 

22-24 Trying different strategies to achieve my 
academic goals, when I have difficulties. ----- ----- ----- 

Tasks 
25-27 Attempting some difficult academic tasks which I 
might be able to do. ----- ----- ----- 

28-30 Achieving in some academic tasks which my peers 
believe are difficult. ----- ----- ----- 

31-33 Achieving in some academic tasks which my lecturers 
(teachers) believe are difficult. ----- ----- ----- 

The responses to the categories were checked to ensure that discrimination was satisfactory 
and that student responses were logical and consistent in relation to the measurement of 
the Studying and Learning scale. Discrimination is satisfactory when the thresholds are 
ordered in correspondence with the ordering of the response categories. In Rasch 
measurement, threshold values are calculated so that there are odds of 1:1 of students 
answering in adjacent response categories. If thresholds are disordered, items are discarded 
because it means that the response categories are not answered logically or consistently. In 
the present study, all the thresholds were properly ordered.
Measurement Model

The Extended Logistic Model of Rasch (Andrich, 1988a; Rasch, 1960/1980) was used with the computer program Rasch Unidimensional Measurement Models (RUMM) (Andrich, Lyne, Sheridan & Luo, 2000) to analyze the data and create a scale of Studying and Learning. Items fitting the model were calibrated from 'easy' to 'hard' and student measures were aligned from 'low' to 'high' on the same scale. The Rasch method produces scale-free student measures and sample-free item 'difficulties' (sometimes called locations by Rasch experts) (Andrich, 1988b; Wright & Masters, 1982). This means that the differences between pairs of student measures and pairs of item 'difficulties' are expected to be sample independent - one of the requirements of measurement.

The Rasch model requires that data must fit the measurement model and not the other way round (see Andrich, 1989). This follows from the requirements needed to create a proper scale. There are three main requirements and they are not assumptions of the model (see Andrich, 1989). One is that of scale additivity. Equal differences between two sets of item locations ('difficulties') on the scale must equal differences between the two corresponding sets of measures on the scale. (In a Maths test where item scores are added to give a percentage, the difference between 40% and 50% doesn't equal the same amount of Maths understanding as between 70% and 80%; that is, there is no additivity and simply adding marks on a scale of items doesn't mean one has a proper scale). A second is that it should be possible to omit some items without affecting an individual's measure on the scale. A third is that the created scale should not be affected by the opinions of students whose answers are used to construct it. That is, a proper scale is invariant across groups for which it is used. This means that, for the Rasch model, all the items contributing to the scale must have the same discrimination parameter.

The RUMM program (2000) calculates standard errors of measurement for the student measures of Studying and Learning and for the item 'difficulties', as well as a Student Separability Index. The equations for these are given in Wright and Masters (1982). The Index shows the proportion of observed variance considered true.

The zero point on the scale does not represent zero Studying and Learning. It is an artificial point representing the mean of the item 'difficulties', calibrated to be zero. It is possible to calibrate a true zero point, if it can be shown that an item represents zero Studying and Learning. There is no true zero point of Studying and Learning in the present study.

The RUMM program (2000) parameterizes an ordered threshold structure, corresponding with the ordered response categories of the items. If there are three category responses, there are two thresholds; one between each of the two adjacent categories. They are related to the change in the odds of successfully responding to adjacent item categories. Thresholds fall between item categories when the data fit the model (see Andrich & van Schoubroeck, 1989; Andrich, 1988a).

The RUMM program substitutes the parameter estimates back into the model and examines the difference between the expected values predicted from the model and the observed values using two tests of fit: one is the item-trait interaction and the second is the item-student interaction. The item-trait test-of-fit (a chi-square) examines the consistency of the item parameters across the student measures for each item and data are combined across all items to give an overall test-of-fit (see Andrich and van Schoubroeck, 1989, pp479-480 for the equations). This shows the collective agreement for all items across students of differing Studying and Learning measures. The item-student test-of-fit examines both the response patterns for students across items and for items across students. It examines the residual between the expected estimate and the actual values for each student-item.
summed over all items for each student and summed over all students for each item (see Styles and Andrich, 1993, p914 or Andrich and van Schoubroeck, 1989, p482 for the equations). The fit statistics approximate a distribution with a mean near zero and a standard deviation near one, when the data fit the measurement model. Negative values indicate a response pattern that fits the model too closely (probably because response dependencies are present, see Andrich, 1985) and positive values indicate a poor fit to the model (probably because other measures - 'noise' - are present).

There are at least three reasons why items may not fit the measurement model. One, the thresholds may be disordered indicating that the response categories are not answered consistently and logically. An example would be where a student with a high measure answers a low category for an easy item and a higher category for a harder item. Two, the residuals may be too large indicating that there is too big a difference between the actual and expected values according to the measurement model. Items with residuals greater than 2.25 SD were discarded. Three, students may not be able to agree on the 'difficulty' of an item on the scale. This may indicate, for example, that half the good students answer an item positively and the other half answer negatively. In the present study, 22 stem-items were discarded during the preliminary analyses leaving 23 stem-items (69 items) fitting the measurement model.

**Administration and Samples**

The questionnaire was pretested with four students and discussed with them before being used in the study. Some changes were made to the wording, as considered appropriate. The student-sample consisted of 372 students at an Australian University studying in Education and is basically a convenience sample. The item-sample consisted of 23 stem-items from a model of Motivation to Learn, each measured in three aspects, making a total of 69 items. Permission was obtained from the University Ethics Committee and from the lecturers of university classes to administer the questionnaire during classes. The questionnaire was explained to the students who generally took 15-20 minutes to complete it.

*(Place Table 1 about here)*

**Results**

The results are set out in two Appendices, two Figures and one Table. Appendix A shows the item 'difficulties', in logits. Appendix B shows the item 'difficulties', the standard error, the residual and fit to the model for each item. Figure 1 shows a graph of the item 'difficulties' on the same scale as the student measures of Studying and Learning. Figure 2 shows a graph of the item threshold values on the same scale as the student measures of Studying and Learning. Table 1 provides a summary of the psychometric characteristics of the Studying and Learning scale.

*(Place Figure 1 about here)*

**Psychometric characteristics of the Studying and Learning Scale**

For each item of the Studying and Learning Scale, the threshold values between the response categories are ordered from 'low' to 'high' (see Figure 2). As the response categories increase, students need correspondingly higher Studying and Learning measures in order to answer them positively. Similarly, as the 'difficulty' of the item along the scale increases, students need higher Studying and Learning measures to answer the items positively (see Figure 1). This means that the students have answered the response
categories consistently and logically for each item along the scale. These are requirements for measurement.

The Index of Student Separability for the 69 item scale with three response categories is 0.944. This means that the proportion of observed variance considered true is 94%.

The final 69 items of the Studying and Learning Scale have a good fit to the measurement model, indicating that there is a strong agreement between all 372 students as to the different 'difficulties' of the items on the scale (see Table 1). The item-trait tests-of-fit indicate that the values of the item 'difficulties' along the scale are strongly consistent across the range of student Studying and Learning scores (p<0.0009), see Table 1. The item-student tests-of-fit (see Table 1) indicate that there is good consistency of student and item response patterns. This is strong evidence for the construct validity of the scale.

The 'difficulties' of the items are well targeted against the students and cover the range of student Studying and Learning measures. The student Studying and Learning measures range from -2.0 to +5.8 logits. The item 'difficulties' range from -2.2 to +2.6 logits (see Figure 1). So the measures from +2.6 to +5.8 logits are not covered by the items. However, most of these student measures are covered by the values of the thresholds that range from -3.8 to +4.0 logits (see Figure 2). Since there are only 10 students with Studying and Learning measures above +4 logit (see Figure 2), the students are well targeted by the scale.

These data on reliability, fit to the measurement model, construct validity and targeting of items against measures indicate that an excellent scale of Studying and Learning has been constructed. The errors are small in relation to the separation of measures on the scale (see Appendix B), the student Separability Index (internal reliability) is excellent and the power of the tests-of-fit are excellent.

(Place Figure 2 about here)

Discussion of the Meaning of the Studying and Learning Scale

The scale for measuring Studying and Learning was conceptualized from a model of Motivation, involving an Ideal Self-view, a Capability Self-view and a Study and Learning Self-view of behavior. There are four stem-items for Standards, four for Goal Setting, three for Tasks, and three for Effort, under Striving for Excellence, all created as sets of Guttman patterns. There are three stem-items for Interest in Academic Work and three for Learning from Others, under Desire to Learn, both created as sets of Guttman patterns. There are three stem-items for Personal Incentives, created as a Guttman pattern. Each of the 23 stem-items was answered as an Ideal Self-view ('easiest'), a Capability Self-view, and a Studying and Learning Behavior Self-view with the expectation that the three self-views will be ordered from 'low' to 'high', for each stem-item. All the items are calibrated on the same scale together so that their 'difficulties' in relation to one another can be seen (see Appendix A) and so that the relationships between the aspects can be tested and explained. The results support this model in relation to the Ideal Self-view and the Capability Self-view, but only partially in relation to the Studying and Learning Self-view of behavior.

Equal differences on the scale between the measures of Studying and Learning represent equal differences in item 'difficulty'. However, there is no true zero point of item 'difficulty' or Studying and Learning and the scale is thus at the interval level. The 69 items of the scale are ordered from 'easy' to 'hard' (see Figures 1 and 2). Nearly all the students answered the 'easy' items positively for all their subjects (for example, items 1, 13, 34, 25, 43, 52). As the item 'difficulty' becomes progressively higher on the scale, the students need a
corresponding higher Studying and Learning measure to answer them positively for all subjects. The 'hardest' items are only answered positively for all subjects by students who have high Studying and Learning measures (for example, items 3, 24, 42, 51, 57, 66). Students with low measures of Studying and Learning cannot answer these 'difficult' items positively for all their subjects.

**Standards (under Striving for Excellence)**

The wording for the four stem-items under Standards was created as a Guttman pattern. Achieving high standards in academic work was conceptualized as the 'easiest'. Doing my best to reach the academic standards that I set for myself was conceptualized as 'a little harder'. Achieving academically at a level that I believe will satisfy the lecturer was conceptualized as 'harder still'. Evaluating my performance against the academic standards that I set myself was conceptualized as 'harder again'. The results (see Appendix A) show that the item 'difficulties' are in exactly this order as conceptualized for an Ideal Self-view of Academic Standards.

For a Capability Self-view, it was conceptualized that the four item 'difficulties' would be in the same order amongst themselves as for the Ideal Self-view, but all shifted in 'difficulty' along the scale to a corresponding 'harder' position than those for the Ideal Self-view. The results (see Appendix A) are in exactly this order, as conceptualized for a Capability Self-view.

For the self-reported Studying and Learning behavior, it was conceptualized that the four item 'difficulties' would be in the same order amongst themselves as for the Ideal Self-view, but shifted along the scale to a 'harder' position from those of the Capability Self-view. The results (see Appendix A) are not in the conceptualized order for self-reported Studying and Learning behavior. That is, the Guttman pattern is not in the same order for self-reported Studying and Learning behavior as for the Ideal Self-view and the Capability Self-view. The 'hardest' item is Achieving academically at a level that I believe will satisfy the lecturer, whereas this is the 'easiest' item for both the Ideal Self-view and the Capability Self-view. The 'easiest item is Achieving academically at a level that I believe will satisfy the lecturer, whereas this is the third 'hardest' item for both the Ideal Self-view and the Capability Self-view.

For each of the four stem-items, the Ideal Self-view is the 'easiest', the Capability Self-view is 'harder' and the Studying and Learning behavior is the 'hardest', as conceptualized in the model (see Appendix A). For example (items 1-3), students found it 'very easy' to report that they would Ideally like to Achieve high standards in their academic work, 'much harder' to report that they are Capable of Achieving high standards in their academic work, and 'very much harder' to report that their Studying and Learning behavior involves Achieving high standards in academic work. Similarly for items 4-6, students found it 'very easy' to report that they would Ideally like to Do their best to reach the academic standards that they set for themselves, 'much harder' to report that they are Capable of Doing their best to reach the academic standards that they set for themselves, and 'very much harder' to report that their Studying and Learning behavior involves Doing their best to reach the academic standards that they set for themselves.

**Goal Setting (under Striving for Excellence)**

The wording for the four stem-items under Goal Setting was created as a Guttman pattern. Setting myself realistic but challenging academic goals was conceptualized as the 'easiest'. Renewing my efforts to ensure I achieve my goals, when I am having difficulties, was conceptualized as 'a little harder'. Achieving the highest academic goals that I can achieve with my ability was conceptualized as 'harder still'. Trying different strategies to
achieve my academic goals, when I have difficulties, was conceptualized as 'harder again'. The results (see Appendix A) show that the item 'difficulties' are in exactly this order as conceptualized for an Ideal Self-view of Goal Setting.

For a Capability Self-view, it was conceptualized that the four item 'difficulties' would be in the same order amongst themselves as for the Ideal Self-view, but all shifted in 'difficulty' along the scale to a corresponding 'harder' position than those for the Ideal Self-view. The results (see Appendix A) are in exactly this order, as conceptualized for a Capability Self-view, except for Achieving the highest academic goals that I can with my ability, which is the 'easiest' item. That is, the Guttman pattern is not quite in the same order for Capability Self-view as for Ideal Self-view.

For the self-reported Studying and Learning behavior, it was conceptualized that the four item 'difficulties' would be in the same order amongst themselves as for the Ideal Self-view, but shifted along the scale to a 'harder' position from those of the Capability Self-view. The results (see Appendix A) are in the conceptualized order for self-reported Studying and Learning behavior, except for Achieving the highest academic goals that I can with my ability, which is the second 'easiest' item. That is, the Guttman pattern is not quite in the same order for self-reported Studying and Learning behavior as for the Ideal Self-view and the Capability Self-view.

For each of the four stem-items, the Ideal Self-view is the 'easiest', the Capability Self-view is 'harder' and the Studying and Learning behavior is the 'hardest', as conceptualized in the model (see Appendix A). For example (items 13-15), students found it 'very easy' to report that they would Ideally like to Set realistic but challenging academic goals, 'much harder' to report that they are Capable of Achieving of Setting realistic but challenging academic goals, and 'very much harder' to report that their Studying and Learning behavior involves Setting realistic but challenging academic goals. Similarly for items 22-24, students found it 'very easy' to report that they would Ideally like to Try different strategies to achieve their academic goals when they have difficulties, 'much harder' to report that they are Capable of Trying different strategies to achieve their academic goals when they have difficulties, and 'very much harder' to report that their Studying and Learning behavior involves Trying different strategies to achieve their academic goals when they have difficulties.

Tasks (under Striving for Excellence)

The wording for the three stem-items under Tasks was created as a Guttman pattern. Attempting some difficult academic tasks which I might be able to do was conceptualized as the 'easiest'. Achieving in some academic tasks which my peers believe are difficult was conceptualized as 'a little harder'. Achieving in some academic tasks which my lecturers believe are difficult was conceptualized as 'harder still'. The results (see Appendix A) show that the item 'difficulties' are in exactly this order as conceptualized for an Ideal Self-view of Tasks.

For a Capability Self-view, it was conceptualized that the four item 'difficulties' would be in the same order amongst themselves as for the Ideal Self-view, but all shifted in 'difficulty' along the scale to a corresponding 'harder' position than those for the Ideal Self-view. The results (see Appendix A) are in exactly this order, as conceptualized for a Capability Self-view of Tasks.

For the self-reported Studying and Learning behavior, it was conceptualized that the three item 'difficulties' would be in the same order amongst themselves as for the Ideal Self-view, but shifted along the scale to a 'harder' position from those of the Capability Self-view. The results (see Appendix A) are in exactly this order as conceptualized for self-
reported Studying and Learning behavior. That is, the Guttman pattern for tasks is in the same order for self-reported Studying and Learning behavior as for the Ideal Self-view and the Capability Self-view.

For each of the three stem-items, the Ideal Self-view is the 'easiest', the Capability Self-view is 'harder' and the Studying and Learning behavior is the 'hardest', as conceptualized in the model (see Appendix A). For example (items 25-27), students found it 'very easy' to report that they would Ideally like to Attempt some difficult academic tasks that they might be able to do, 'much harder' to report that they are Capable of Attempting some difficult academic tasks that they might be able to do, and 'very much harder' to report that their Studying and Learning behavior involves Attempting some difficult academic tasks that they might be able to do. Similarly for items 31-33, students found it 'very easy' to report that they would Ideally like to Achieve in some academic tasks that their lecturers believe are difficult, 'much harder' to report that they are Capable of Achieving in some academic tasks that their lecturers believe are difficult, and 'very much harder' to report that their Studying and Learning behavior involves Achieving in some academic tasks that their lecturers believe are difficult.

Effort (under Striving for Excellence)

The wording for the three stem-items under Effort was created as a Guttman pattern. Making a strong effort to find the right answers when they are given an academic task or assignment was conceptualized as the 'easiest'. Making a strong effort to achieve as high as they can in academic work was conceptualized as 'a little harder'. Making strong demands on themselves to achieve in academic work was conceptualized as 'harder still'. The results (see Appendix A) show that the item 'difficulties' are in exactly this order as conceptualized for an Ideal Self-view of Effort.

For a Capability Self-view, it was conceptualized that the four item 'difficulties' would be in the same order amongst themselves as for the Ideal Self-view, but all shifted in 'difficulty' along the scale to a corresponding 'harder' position than those for the Ideal Self-view. The results (see Appendix A) are in exactly this order, as conceptualized for a Capability Self-view of Effort.

For the self-reported Studying and Learning behavior, it was conceptualized that the three item 'difficulties' would be in the same order amongst themselves as for the Ideal Self-view, but shifted along the scale to a 'harder' position from those of the Capability Self-view. The results (see Appendix A) are in exactly this order as conceptualized for self-reported Studying and Learning behavior. That is, the Guttman pattern for effort is in the same order for self-reported Studying and Learning behavior as for the Ideal Self-view and the Capability Self-view.

For each of the three stem-items, the Ideal Self-view is the 'easiest', the Capability Self-view is 'harder' and the Studying and Learning behavior is the 'hardest', as conceptualized in the model (see Appendix A). For example (items 34-36), students found it 'very easy' to report that they would Ideally like to Make a strong effort to find the right answers when they are given an academic task or assignment, 'much harder' to report that they are Capable of Making a strong effort to find the right answers when they are given an academic task or assignment, and 'very much harder' to report that their Studying and Learning behavior involves Making a strong effort to find the right answers when they are given an academic task or assignment. Similarly for items 40-42, students found it 'very easy' to report that they would Ideally like to Make strong demands on themselves to achieve in academic work, 'much harder' to report that they are Capable of Making strong demands on themselves to achieve in academic work, and 'very much harder' to report that their Studying and
Learning behavior involves making strong demands on themselves to achieve in academic work.

**Interest (under Desire to Learn)**

The wording for the three stem-items under Interest was created as a Guttman pattern. **Showing interest in a number of academic topics** was conceptualized as the 'easiest'. **Displaying curiosity about the world and 'how it works'** was conceptualized as 'a little harder'. **Thinking about solving problems with which others have difficulty because I'm interested** was conceptualized as 'harder still'. The results (see Appendix A) show that the item 'difficulties' are in exactly this order as conceptualized for an Ideal Self-view of Interest.

For a Capability Self-view, it was conceptualized that the four item 'difficulties' would be in the same order amongst themselves as for the Ideal Self-view, but all shifted in 'difficulty' along the scale to a corresponding 'harder' position than those for the Ideal Self-view. The results (see Appendix A) are in exactly this order, as conceptualized for a Capability Self-view of Interest.

For the self-reported **Studying and Learning** behavior, it was conceptualized that the three item 'difficulties' would be in the same order amongst themselves as for the Ideal Self-view, but shifted along the scale to a 'harder' position from those of the Capability Self-view. The results (see Appendix A) are in exactly this order as conceptualized for self-reported Studying and Learning behavior. That is, the Guttman pattern for Interest is in the same order for self-reported Studying and Learning behavior as for the Ideal Self-view and the Capability Self-view.

For each of the three stem-items, the Ideal Self-view is the 'easiest', the Capability Self-view is 'harder' and the Studying and Learning behavior is the 'hardest', as conceptualized in the model (see Appendix A). For example (items 43-45), students found it 'very easy' to report that they would **Ideally like to Show interest in a number of academic topics**, 'much harder' to report that they are **Capable of Showing interest in a number of academic topics**, and 'very much harder' to report that their **Studying and Learning behavior involves Showing interest in a number of academic topics**. Similarly for items 49-51, students found it 'very easy' to report that they would **Ideally like to Think about solving problems with which others have difficulty because they are interested**, 'much harder' to report that they are **Capable of Thinking about solving problems with which others have difficulty because they are interested**, and 'very much harder' to report that their **Studying and Learning behavior involves Thinking about solving problems with which others have difficulty because they are interested**.

**Learning from Others (under Desire to Learn)**

The wording for the three stem-items under Learning from Others was created as a Guttman pattern. **Paying attention during most of my lectures in order to learn as much as I can** was conceptualized as the 'easiest'. **Participating in class discussions to improve my understanding in academic matters** was conceptualized as 'a little harder'. **Learning from others with more knowledge than I have** was conceptualized as 'harder still'. The results (see Appendix A) show that the item 'difficulties' are in exactly this order as conceptualized for an Ideal Self-view of Learning from Others.

For a Capability Self-view, it was conceptualized that the three item 'difficulties' would be in the same order amongst themselves as for the Ideal Self-view, but all shifted in 'difficulty' along the scale to a corresponding 'harder' position than those for the Ideal Self-view. The results (see Appendix A) are in exactly this order, as conceptualized for a Capability Self-
view of Learning from Others, although within the error of measurement there is no difference between items 56 and 59.

For the self-reported Studying and Learning behavior, it was conceptualized that the three item 'difficulties' would be in the same order amongst themselves as for the Ideal Self-view, but shifted along the scale to a 'harder' position from those of the Capability Self-view. The results (see Appendix A) are not in the order as conceptualized for self-reported Studying and Learning behavior. That is, the Guttman pattern is not in the same order for self-reported Studying and Learning behavior as for the Ideal Self-view and the Capability Self-view. The 'easiest' behavior item is Learning from others with more knowledge than I have, whereas this is the 'hardest' item for both the Ideal Self-view and the Capability Self-view.

For each of the three stem-items, the Ideal Self-view is the 'easiest', the Capability Self-view is 'harder' and the Studying and Learning behavior is the 'hardest', as conceptualized in the model (see Appendix A). For example (items 52-54), students found it 'very easy' to report that they would Ideally like to Pay attention during most of their lectures in order to learn as much as they can, 'much harder' to report that they are Capable of Paying attention during most of their lectures in order to learn as much as they can, and 'very much harder' to report that their Studying and Learning behavior involves Paying attention during most of their lectures in order to learn as much as they can. Similarly for items 58-60, students found it 'very easy' to report that they would Ideally like to Learn from others with more knowledge than they have, 'much harder' to report that they are Capable of Paying attention during most of their lectures in order to learn as much as they can, and 'very much harder' to report that their Studying and Learning behavior involves Paying attention during most of their lectures in order to learn as much as they can.

Personal Incentives

The wording for the three stem-items under Personal Incentives was created as a Guttman pattern. Involving myself in the intellectual challenge of academic work was conceptualized as the 'easiest'. Involving myself in the curiosity of academic work was conceptualized as 'a little harder'. Liking the social relationships while involved in academic work was conceptualized as 'harder still'. The results (see Appendix A) show that the item 'difficulties' are in exactly this order as conceptualized for an Ideal Self-view for Personal Incentives.

For a Capability Self-view, it was conceptualized that the three item 'difficulties' would be in the same order amongst themselves as for the Ideal Self-view, but all shifted in 'difficulty' along the scale to a corresponding 'harder' position than those for the Ideal Self-view. The results (see Appendix A) are in exactly this order, as conceptualized for a Capability Self-view for Personal Incentives.

For the self-reported Studying and Learning behavior, it was conceptualized that the three item 'difficulties' would be in the same order amongst themselves as for the Ideal Self-view, but shifted along the scale to a 'harder' position from those of the Capability Self-view. The results (see Appendix A) are not in the order as conceptualized for self-reported Studying and Learning behavior. That is, the Guttman pattern is not in the same order for self-reported Studying and Learning behavior as for the Ideal Self-view and the Capability Self-view. The 'easiest' behavior item for Personal Incentives is Liking the social relationships while involved in academic work, whereas this is the 'hardest' item for both the Ideal Self-view and the Capability Self-view.

For each of the three stem-items, the Ideal Self-view is the 'easiest', the Capability Self-view is 'harder' and the Studying and Learning behavior is the 'hardest', as conceptualized in the model (see Appendix A). For example (items 61-63), students found it 'very easy' to report
that they would ideally like to involve themselves in the intellectual challenge of academic work, 'much harder' to report that they are capable of involving themselves in the intellectual challenge of academic work, and 'very much harder' to report that their studying and learning behavior involves themselves in the intellectual challenge of academic work. Similarly for items 67-69, students found it 'very easy' to report that they would ideally like the social relationships while involved in academic work, 'much harder' to report that they are capable of liking the social relationships while involved in academic work, and 'very much harder' to report that their studying and learning behavior involves liking the social relationships while involved in academic work.

Summary and Conclusion

A new questionnaire utilizing stem-items was developed on the basis of a model of studying and learning involving three main aspects of motivation (striving for excellence, desire to learn and personal incentives). The stem-items were created in Guttman patterns for each of the sub-aspects of the scale. Students answered the questionnaire in three response-aspects (how I would like to be, what I am capable of doing, and my actual studying and learning behavior). The computer program RUMM (Andrich, Lyne, Sheridan & Luo, 2000), based on a Rasch measurement model (Andrich, 1988a; Rasch, 1960/1980), proved very useful in analyzing the data to create a proper scale of studying and learning and in testing that the items fitted the measurement model. The scale had excellent psychometric properties. Student measures of studying and learning were calibrated on the same scale as the item 'difficulties'. This test has supported, almost, but not quite completely, the model of studying and learning and the Guttman patterns for the sub-aspects. Students found it 'easy' to have high ideal self-views for all the stem-items of studying and learning, 'harder' to say that they have high capability self-views, and 'even harder' to say that they have high studying and learning self-view behaviors.
References


Appendix A

THIS QUESTIONNAIRE IS ANONYMOUS. PLEASE DON'T PUT YOUR NAME OR ANY IDENTIFICATION ON IT.

PLEASE READ THE CONSENT AND COVER PAGE.

QUESTIONNAIRE: LEARNING AND STUDYING

Please rate the 69 items according to the following response format and place a number corresponding to This is how I would like to be, This is what I believe I'm capable of doing, and This is my actual studying and learning behavior, on the appropriate line opposite each statement:

In four or more of my subjects put 3
In two or three of my subjects put 2
In none or one of my subjects put 1

Example Item 1

If you would like to achieve high standards in academic work for four of your subjects, put 3; if you think you are capable of achieving high standards in academic work in three of your subjects, put 2; and if your studying and learning behavior is like this in one subject, put 1.

Item 1. Achieving high standards in academic work. 3 2 1

-----------------------------------------------------------------------------------------------

Item no. Item wording This is how This is what This is
I would like I believe my actual
to be I'm capable studying
(idealistic of doing and
self-concept) learning behavior

Sub-Scale: Striving for Excellence (14 stem-items, 42 items)
Standards (4 stem-items, 16 items)
1-3 Achieving high standards in academic work. -2.194 -0.751 +1.661
4-6 Doing my best to reach the academic standards that I set for myself. -1.614 -0.632 +1.189

7-9 Achieving academically at a level that I believe will satisfy the lecturer (teacher). -0.953 -0.280 +1.101

10-12 Evaluating my performance against the academic standards that I set myself. -0.821 +0.165 +1.186

**Goal Setting (4 stem-items, 16 items)**

13-15 Setting myself realistic but challenging academic goals. -1.713 -0.325 +1.135

16-18 Renewing my efforts to ensure I achieve my goal, when I have difficulties in reaching my goals. -1.481 -0.145 +1.616

19-21 Achieving the highest academic goals that I can achieve with my ability. -1.239 -0.870 +1.479

22-24 Trying different strategies to achieve my academic goals, when I have difficulties. -1.001 +0.215 +1.962

**Tasks (3 stem-items, 9 items)**

25-27 Attempting some difficult academic tasks which I might be able to do. -0.922 +0.272 +1.597

28-30 Achieving in some academic tasks which my peers believe are difficult. -0.754 +0.511 +1.915

31-33 Achieving in some academic tasks which my lecturers (teachers) believe are difficult. -0.230 +1.153 +2.415

**Effort (3 stem-items, 9 items)**

34-36 Making a strong effort to find the right answers when I am given an academic task or assignment. -1.885 -0.988 +0.706

37-39 Making a strong effort to achieve, as high as
I can, in academic work. -1.598 -0.787 +0.995

40-42 Making strong demands on myself to achieve in academic work. -0.782 -0.052 +1.293

| In four or more of my subjects put 3 |
| In two or three of my subjects put 2 |
| In none or one of my subjects put 1 |

-----------------------------------------------------------------------------------------------

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<th>This is what</th>
<th>This is</th>
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<td></td>
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<td>self-concept)</td>
<td>learning behavior</td>
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**Sub-Scale: Desire to learn (6 stem-items, 18 items)**

**Interest (3 stem-items, 9 items)**

43-45 Showing interest in a number of academic topics. -1.489 -0.394 +0.864

46-48 Displaying curiosity about the world and how 'it works'. -1.072 -0.035 +1.098

49-51 Thinking about solving problems, with which others have difficulty, because I'm interested. -1.040 +0.197 +1.359

**Learning from others (3 stem-items, 9 items)**

52-54 Paying attention during most of my lectures (classes) in order to learn as much as I can. -1.719 -0.774 +0.792

55-57 Participating in class discussions to improve
my understanding in academic matters. -1.542 -0.272 +1.322

58-60 Learning from others with more knowledge than I have. -1.163 -0.270 +0.722

Sub-Scale: Personal Incentives (3 stem-items, 9 items)

63. Involving myself in the intellectual challenge of academic work. -0.699 +0.325 +1.333

64-66 Involving myself in the curiosity of academic work. -0.572 +0.255 +1.471

67-69 Liking the social relationships while involved in academic work. -0.426 +0.054 +0.823

Notes

1. The 'difficulties' of the items are in logits.

2. The Ideal Self-view, the Capability Self-view and the Studying and Learning Self-view item 'difficulties', for any one particular stem-item, increase in correspondence with the model from 'easy' to 'harder' to 'harder still'.

3. The item 'difficulties' for any one particular response aspect (such as the Ideal Self-view), for any one particular aspect of Studying and Learning (such as Tasks), increase in correspondence with the model from 'easy' to 'harder' to 'harder still' (except for three stem-items in the Studying and Learning Self-view).

Table 1. Summary of psychometric statistics for the Studying and Learning scale

(Response categories=3, No. of items=69, No. of students=372)
Mean 0.000 -0.198 1.633 -0.684
SD 1.132 +1.225 1.144 +2.081

-------------------------------------------------------------------------

Item-Trait Interaction
Total Item Chi Sq 501.3
Total Degree Freedom 345
Total ChiSq Probability <0.0009

-------------------------------------------------------------------------

Proportion of observed variance considered true for the scale is 0.944 (94%)

-------------------------------------------------------------------------------------------------------------------------
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Notes

1. The item-student interaction indicates the degree to which students answer items of different difficulty in a logical and consistent manner. When the data fit the model, the fit statistic has a mean near zero and a SD near 1. A negative fit statistic indicates that the data fit the model very closely. A positive fit statistic indicates that some ‘noise’ is present.

2. The item-trait interaction indicates the consistency of the item difficulties across the different student scores of Studying and Learning on the scale. When the data fit the model, the fit statistic (a chi-square) has a probability less than 0.05 (in this case <0.001).

3. The reliability of the scale (proportion of observed variance considered true) should be close to 1 when the data fit the model (in this case 0.944).

4. The power of the tests-of-fit is excellent.
### Appendix B: Item location, standard error, residual and fit to the model

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**Notes**

1. Location (item 'difficulty') is measured in logits (log odds of answering positively).
2. SE is the standard error in logits.
3. Residual is the difference between the actual item location and the expected item location, according to the model. The closer to zero the residual, the better the fit to the model and residuals outside the range +2.25 to -2.25 indicate the item does not fit the model.
4. Probab is the probability of fit to the model (a chi-square).

![Person-Item Location Distribution](image)

**Figure 1.** Studying and Learning scale with student scores (n=372) and item 'difficulties' (L=69) calibrated on the same scale.

**Notes**

1. The scale is in logits
2. Student measures (top of scale) go from -2 to +5.8 logits.
3. Item 'difficulties' (bottom of the scale) go from -2.2 to +2.6 logits.
4. The scale probably needs a few more 'difficult' items in the range 3 to 6 logits, although to a large extent the student scores in this range are covered by the more 'difficult' threshold values (see Figure 2).
6.0 logits |
| X |
| X |
| X |
5.0 |
| XX |
| X |
4.0 X | I0033.2
XX | I0003.2
XXXXX | I0030.2
XX | I0024.2 I0018.2
X | I0129.2 I0021.2
3.0 XXXXX | I0006.2 I0027.2
XXXXXX | I0012.2 I0009.2 I0066.2
XXXXXXXX | I0032.2 I0042.2
XXXXXXXX | I0045.2 I0039.2 I0051.2
XXXXXXXXXXX | I0054.2 I0015.2 I0057.2 I0048.2
2.0 XXXXX | I0026.2 I0002.2 I0029.2 I0036.2
XXXXXXXXXXXX | I0069.2 I0017.2 I0060.2
XXXXXXXXXXXXXXXX | I0023.2 I0062.2 I0011.2
XXXXXXXXXXXXXXXX | I0047.2 I0008.2 I0050.2 I0065.2
XXXXXXXXXXXXXXXX | I0068.2 I0014.2 I0056.2 I0041.2 I0005.2 I0020.2
I0044.2

1.0 XXXXXXXXXXXXXXXX | I0035.2 I0059.2 I0053.2
XXXXXXXXXXXXX | I0038.2
XXXXXXXXXXXXXX | I0033.1
XXXXXXXXXXXXXX | I0024.1
XXXXXXXXX | I0057.1

0.0 XXXX | I0030.1 I0051.1 I0027.1
XX | I0048.1 I0025.2 I0042.1 I0012.1 I0015.1 I0031.2
I0066.1

XXX | I0032.1 I0010.2 I0028.2 I0018.1 I0021.1 I0069.1
XX | I0022.2 I0043.2 I0039.1 I0063.1 I0040.2 I0060.1
I0064.2 I0061.2 I0067.1 I0031.1 I0067.2

X | I0045.1 I0007.2 I0036.1 I0016.2 I0009.1 I0064.1
I0003.1 I0046.2 I0049.2 I0006.1 I0054.1

-1.0 X | I0034.2 I0058.2 I0061.1 I0013.2
X | I0028.1 I0029.1 I0007.1 I0055.2 I0062.1 I0052.2
I0050.1 I0068.1 I0065.1 I0037.2 I0040.1 I0019.2

X | I0058.1 I0010.1 I0023.1 I0004.2 I0041.1
X | I0059.1 I0001.2 I0047.1 I0046.1 I0026.1 I0019.1
I0011.1 I0049.1 I0022.1

| I0056.1 I0025.1

-2.0 X | I0004.1 I0055.1 I0014.1
| I0044.1 I0017.1 I0037.1 I0008.1
| I0052.1 I0016.1
| I0038.1 I0013.1 I0043.1
| I0034.1 I0053.1 I0005.1
Figure 2. Studying and Learning scale with student measures (n=372) and item thresholds (n=138) calibrated on the same scale.

Notes

1. The scale is in logits and each X represents 2 students.
2. Student scores (left of scale) go from -2 to +5.6 logits.
3. Item threshold locations (right of the scale) go from -3.8 to +4.0 logits.
4. The range of threshold values are well-targeted at the students; that is, the range of item 'difficulties' covers the range of student Studying and Learning scores, except that a couple of very 'difficult' items in the range 5 to 6 logits are needed.
5. The scale has 69 items and 2 threshold values per item.