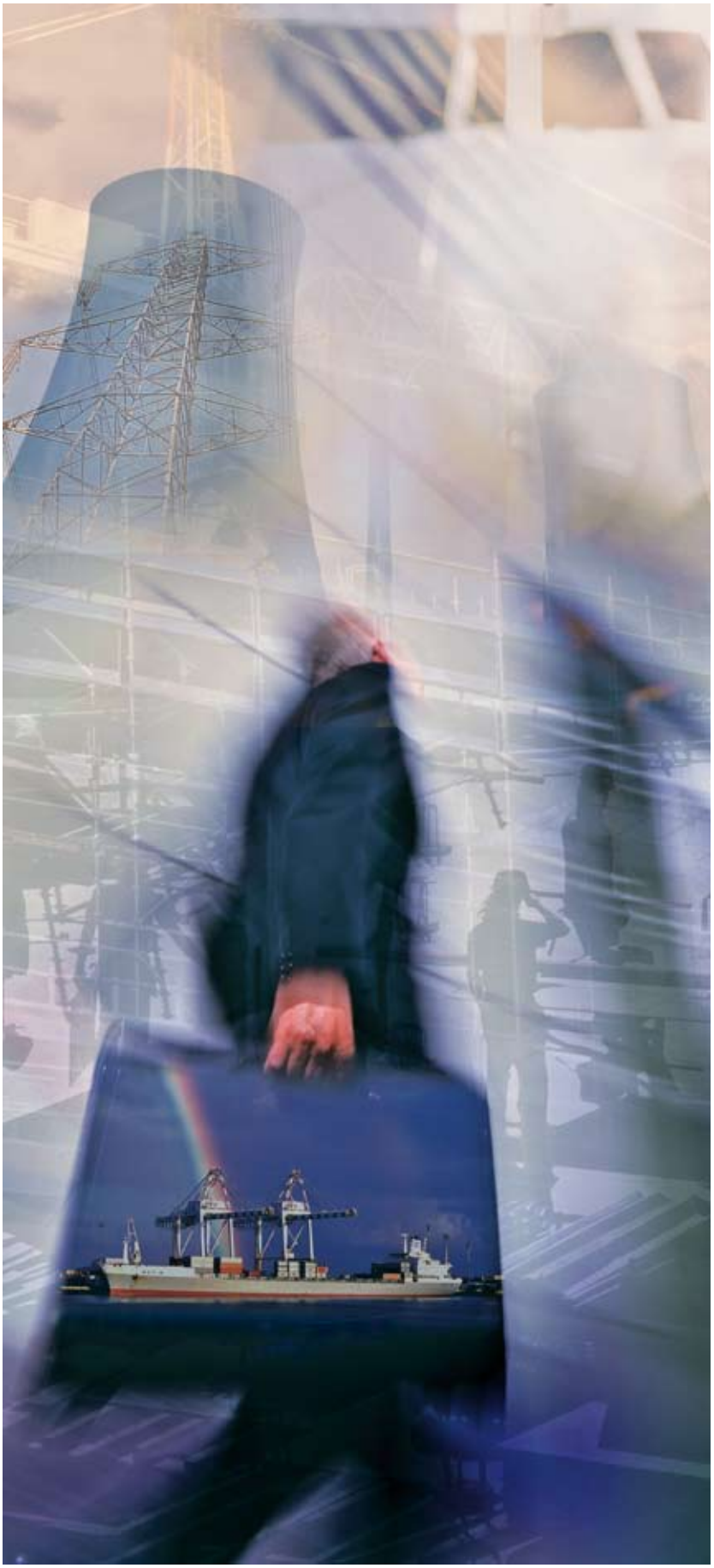

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Development of the "Economic Thinking Ability" Construct and its Applications in Economics Education

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Abstract

In their studies, Eley and Meyer (2004)and Meyer and Cleary (1998) found that there are sources of variation in the affective and process dimensions of learning in mathematics and clinical diagnosis specific to the discipline. Meyer and Shanahan (2002) argue that:

> General purpose models of student learning that are transportable across different discipline contexts cannot, by definition, be sensitive to sources of variation that may be subject-specific (2002, p. 204).

In other words, to explain the differences in learning approaches and outcomes in a particular discipline, there are discipline-specific factors, which cannot be uncovered in general educational research. Meyer and Shanahan (2002) argue for a need to "seek additional sources of variation that are perhaps conceptually unique … within the discourse of particular disciplines" (p. 204). Interestingly, despite their methodological difference, this position as embraced by Meyer and Shanahan is consistent with that of phenomenography. The research agenda of phenomenography is to investigate the qualitatively different ways people perceive and understand a phenomenon of interest (Marton & Pong, 2005). In arguing for empirical, discipline based research into effective teaching and learning, proponents of phenomenography point out that very few research outcomes based on general educational framework can prescribe specific remedies to problems across contexts since "the pedagogical problems of any one discipline are in certain respects unique" (Hounsell, 1997, p. 240).

In this paper, the development of an economics-specific construct (called economic thinking ability) is reported. The construct aims to measure discipline-sited ability of students that have important influence on learning in economics. Using this construct, students' economic thinking abilities were measured twice: at the beginning and at the end of the semester. The developmental changes of students' economic thinking ability over the semester were investigated.

JEL code: A22

1 Background

In their research program, Meyer and Shanahan (2002) looked for the sources of variation of learning outcomes that reflected the discourse in economics and found them in students' prior economics knowledge. They developed a student learning inventory which contained economic-specific items to measure students' prior economics knowledge and investigate how it related to students characteristics and learning outcomes (Meyer & Shanahan, 2001; Shanahan & Meyer, 2001). The economics-specific items of the inventory were constructed from student written statements collected in a survey of first year economics students from two Australian universities. Four categories of prior economics knowledge were identified: economic misconceptions, economic activity, economic reasoning and conception of worth. The economic misconceptions scale taps into students' perceptions about the "aims, objectives and limitations of economics". The economic activity and economic reasoning scales identify students' perceptions of, respectively, what economists do and what economics relationships are about. The last scale aims to separate students into those who view price as reflecting market value and those who view price as reflecting the intrinsic value of the good.

The objective of the present study is to locate aspects of students' cognitive abilities that are unique to, and that might have important impact on learning in, economics. Given this objective, Meyer and Shanahan's economic misconceptions and conception of worth scales (reproduced in Appendix 1) are of direct relevance to this study and will be discussed in more detail. The economic misconceptions scale consists of seven items. Careful item examination reveals that these seven items measure at least two distinct aspects of students' perceptions about economics. The first is about perceptions of what economics as a discipline is (items 1, 2, 3 and 6). For example: Item 2: "Economics is the study of money". The second is about the student's aptitude for economic thinking (items 4 and 5). These two items associate more with the items in the conception of worth scale as they all represent some naïve thinking about economic phenomena. For example: Item 5: "If an employee gets a pay rise at work, and so do all his friends, then they must be better off than before". Item 7 of the economic misconceptions scale describes students' belief about the ability of economics as a discipline (like history, physics) to explain aspects of reality. It states that there is a logical explanation of a particular current economic issue. Hence, it is not about what economics studies, nor is it about students' aptitude for economic thinking. Therefore item 7 reflects a possible third aspect.

Shanahan and Meyer mentioned but did not discuss the issue of dimensionality of the scales (2001, p. 265) and no investigation (for example, factor analysis) was reported to show that the seven items in the economic misconception scale were uni-dimensional[1]. This, however, should not be taken as a criticism of Shanahan and Meyer; their study represents an important departure from the traditional research methodology in economics education. The critical analysis of this scale suggests, however, there is a need for more thorough mapping of their discipline-specific construct of prior economics knowledge.

2 *The Instrument*

Built upon and extending Meyer and Shanahan's breakthrough study in economics education, the "economic thinking ability" construct captures discipline-specific sources of variation in learning economics. The instrument developed to measure this hypothetical construct consists of items that tap into students' misunderstanding in economics in three related aspects: students' ideas of the subject matter that economics as a discipline deals with, their aptitude for economic thinking in microeconomics issues and their aptitude for economic thinking in macroeconomics issues. The construct thus comprises three sub-scales: (1) economic misconception (labelled miscon), (2) naïve microeconomic thinking (NT1), and (3) naïve macroeconomic thinking (NT2). These three aspects are related as students possessing a strong aptitude for economic thinking will have a better understanding of what economics is about. The sources of ideas for constructing items in these three sub-scales and the refinement of the scale are presented below, followed by investigation of the psychometric properties of this construct.

2.1 Item Construction

The ideas for constructing items in the instrument were obtained from several sources – students' written statements, economics education literature and the author's own experiences teaching economics at university. For collecting written statements, an open-ended questionnaire survey was administered to students in five economics tutorials (four level 1 and one level 3 classes) at a Brisbane university in semester 2, 2003. They were asked to provide written responses to the following question:

> *To you, what is economics? (Think about what economics is about, what economists do, and what you believe economic analysis or economic thinking is.)*

[1] Shanahan and Meyer (2001) provided the Cronbach alphas for the four scales. Although three of the four scales achieved acceptable level of consistency, it is important to note that internal consistency which the Cronbach alpha measures, is not equivalent to uni-dimensionality.

The raw data were examined for common themes. Statements which expressed a common misconception, belief or idea about economics or economic activities were grouped. This method generated the majority of items in the *economic misconception* sub-scale (items 1, 2, 3, 5). The remaining item of the *economic misconception* sub-scale (item 4) was adapted from Shanahan and Meyer (2001).

Items in the two *naïve economic thinking* sub-scales were developed from:

- The literature on irrational behaviour and lay persons' economic beliefs (items 6, 8, 9, 12 & 13) (Brossard, 1996; Morin & Berry, 1996),
- Consensual views expressed by academic economists in surveys conducted in Australia, Britain and the United States (items 7, 10, 11) (Alston, Kearl, & Vaughan, 1992; Anderson & Blandy, 1992; Moorhouse, Morriss, & Whaples, 1999; Ricketts & Shoesmith, 1992), and
- Common misunderstanding of economic phenomena the researcher encountered in his teaching of commencing economics students (items 15, 17 – 22).
- The remaining item (item 14) was from Shanahan and Meyer (2001).

The *economic misconception* sub-scale (five items) measures students' misconceptions of what economics is and what it deals with. A high score would indicate a high level of misconception about the discipline. The *naïve micro- and macroeconomic thinking* sub-scales consist of seven macroeconomic items and ten microeconomics items respectively. For these two sub-scales, a high score (after the scores of the three statements were reversed) would represent a high level of naïve thinking about economic phenomena (or a low level of economic thinking ability).

The items in the two *naïve economic thinking* sub-scales deal with economic phenomena and economic reasoning in the context of everyday life. For example, item 14 of the instrument (Appendix 2) is an item taken from Shanahan and Meyer's (2001) study; this item (reproduced below) describes the effect of a rise in the interest rate.

Do you think that all people in a country benefit when a high rate of interest is paid on savings?

To obtain a complete picture of the situation, the student responding has to go beyond what is given and see the interaction of the demander and supplier of funds. Accepting the statement as true would indicate a naïve view of the phenomenon. This represents a failure to see the two sides involved in the interaction or, in general, the dynamic nature of exchange[2]. In other cases, the naïve thinking is the result of an inability to see the economics of the situation (for example, 'bygones are bygones' or the concept of sunk cost in item 15, Appendix 2), and thus arrive at the wrong conclusion.

The items listed in the survey involve real world situations explained in non-technical language, which can potentially be understood and answered without the use of technical economic skills (such as using the equi-marginal principle to determine profit maximising output and the computation of elasticity or factor productivity). For example, business managers who have never heard of the term elasticity, can, from their careful observation of human behaviour, determine whether an increase or decrease in price would be required to bring about an increase in total revenue. Conversely, while a student may be technically efficient and can solve an elasticity problem, it does not necessarily mean he can apply the concept of elasticity to understand the situation when required.

It is noted that the two *naïve economic thinking* sub-scales (NT1 and NT2) are very similar to Shanahan and Meyer's (2001) conception of worth scale and items 4 and 5 in their economic misconception scale in that they are all about some form of naïve economic thinking in the real life context. The difference is that the two *naïve economic thinking* sub-scales in this instrument deal with a larger number of scenarios than in Shanahan and Meyer's. The method of refining these two sub-scales (NT1 and NT2) is presented next.

2.2 Scale Refinement

Subject The subjects of the study were three groups of economics students (Econ 1, Econ 2 and Intermediate Macro[3]). The students were surveyed twice during the lecture in Week 1 and Week 13 (revision week) of semester 1, 2004. Students respond to each of the 22 items in the economics misunderstanding scale on a five-point Likert scale, with '1' indicating strong

[2] This one-sided conceptualisation of an economic concept or phenomenon was also documented in other studies (Dahlgren, 1997; Pong, 1999). In these studies, many students were found to hold the view that the price of a good is solely determined by its inherent value *or* solely determined by its cost of production.

[3] Both Econ 1 and Econ 2 were introductory level economics units. The two units were designed in such a way that in Econ 1 students were introduced to both micro and macroeconomics, and Econ 2 covered both parts in greater depth. The majority of the Intermediate Macro (over 95%) either had done or were concurrently doing Intermediate Micro at the time of the study.

disagreement and '5' strong agreement with the statement. The numbers of valid responses from the two surveys are 1147 (Week 1) and 647 (Week13).

Method For the purpose of scale refinement, the correlation matrix of the 17 items in the *naïve economic thinking* sub-scales (NT1 and NT2) was examined. The raw scores of three items – 'min-wage', 'deterrent' and 'elasticity' – were reversed to facilitate analysis of the correlation matrix. After the conversion, all 17 items can be interpreted in the same way – a high score would indicate a high level of misunderstanding. So if this group of items measure the same latent construct, their correlations should be positive. A lot of zero or negative correlations of an item with the rest will therefore indicate that the item does not have commonality with other items in the group.

Scrutiny of the correlation matrix (Appendix 3) reveals two such problem items in the NT1 sub-scale – 'min_wage' and 'deterrent'. The two items are reproduced below.

(Min_wage) A minimum wage law increases unemployment among young and unskilled workers.
(Deterrent) Punishment of illegal behaviour has a deterrent effect.

The item 'min_wage' has ten negative correlations with four of them greater than 0.1. The negative correlations suggest it is not tapping into the same dimension as other items. The item 'deterrent' has mostly close to zero or negative correlations with other items, indicating it has also little overlap with other items. In hindsight this item ('deterrent') is problematic because it has a high moral overtone, which means it elicits students' value judgement and therefore it does not necessarily measure students' economic thinking ability. These two items were subsequently deleted.

One more item ('Cost', reproduced below) was deleted from the NT1 sub-scale, but the decision was not based on the correlation matrix.

(Cost) Do you think that if a firm doubles its output from one week to the next, its total cost of producing its output will also double?

Total cost will double only if the average total cost is constant over the range of output being considered. According to the short run production/cost theory, this is not the case. Thus, this statement is false. However, careful examination of the item reveals that when a student gives a correct negative response to this item, it can be due to two different reasons. It can be because he *wrongly* thinks that cost will be less than double (due to perhaps economies of

scale) or because he *correctly* concludes that the cost should be more than double due to diminishing returns. Given that the two self-contradictory ways of reasoning can give rise to the same negative response, this item was deleted from the sub-scale. With the three items deleted, the number of items in the revised *naïve microeconomic thinking* sub-scale (NT1) sub-scale was reduced from ten to seven. The numbers of items in the *economics misconception* sub-scale (five items) and *naïve macroeconomic thinking sub-scale* (seven items) were unchanged.

The new construct is a measure of the level of economic misunderstanding (labelled EconMisU) the student possesses. A low EconMisU score indicates a high level of economic thinking ability. Therefore the construct is called *economic thinking ability* in this paper.

2.3 Exploratory Factor Analysis

Method Instead of using the 19 raw scores, simple composite sub-scale scores were computed. The use of scale-based composites (also known as parcels) as indicator variables is recommended in factor analysis literature since it will increase scale reliability (MacCallum & Austin, 2000; Vitacco, Neumann, & Jackson, 2005). The *economic thinking ability* construct thus has three indicator variables: miscon, NT1 and NT2. The Week 1 data on the three indicators (n = 1147) was subjected to Exploratory Factor Analysis for testing of its psychometric properties. The Principal Component method of extraction was used (Graetz, 2003). Since the indicators measure one latent construct, a one-factor solution was imposed, although the eigen value > 1 rule suggested two.

Result The Kaiser-Meyer-Olkin (KMO) index has a value of 0.622. KMO is a measure of commonality of the data. Data with higher commonality are more suitable for factor analysis. According to Graetz (2003), a KMO index greater than 0.6 indicates sufficient commonality for factor analysis.

Scale analysis (SPSS Version 12) shows the scale has an alpha value (Cronbach alpha) of 0.531. Based on the conservative standard of 0.7, this figure is low. But given the small number of items (n = 3) for this scale, the scale reliability was attenuated (Stringer & Irwing, 1998). Moreover, according to Schmitt (1996), "there is no sacred level of acceptable or unacceptable level of alpha" (p. 351). When the items can be argued as covering a clear, uni-dimensional domain, alpha as low as 0.49 is acceptable for its use in making distinctions in learning behaviours and outcomes (Cortina, 1993). As discussed earlier, the three sub-scales

all measure aspects of students' misunderstanding about economics. Therefore taking into account the small number of items and the theoretical basis for development of the scale, the relatively small alpha value was acceptable. The factor loadings of the scale are present in Table 1 (below).

Table 1 Factor loadings – EconMisU_1 scale

	Loading
Miscon_1	.731
NT1_1	.717
NT2_1	.719

Note: The extension '1' indicates the variables were measured in the first survey in Week 1.

Before reviewing the factor loadings, the question concerning the significance of factor loading will be discussed. While there may be disciplinary differences, in educational psychology it is argued that given the complexity of cognitive functioning in learning, if the latent construct can account for 10% of the variance of an item, then it is regarded as possessing sufficient explanatory power (Harlow, 2005; Thompson & Dinnel, 2003). This value of 10% is equivalent to a factor loading of roughly 0.3. So, factor loadings of magnitude of 0.3 or above are normally regarded as possessing practical significance (Meyers, Gamst, & Guarino, 2006) in educational psychological research. In this investigation, the loadings are high with all being above 0.7, and the construct accounts for 52.2% of the total variance of the indicator variables.

The results of factor analysis and scale analysis show that the instrument possesses desirable psychometric properties for further model testing. The next step is to validate the construct with an independent sample.

2.4 Confirmatory Factor Analysis

Method Confirmatory Factor Analysis (CFA) of a measurement model is conducted usually when the model has been fully developed and the factor structure validated in previous studies. The use of CFA is a hypothesis-testing process. That is, based on a postulated model, the researcher tests for its validity given the sample data (Byrne, 2001). Using AMOS 6.0, CFA was conducted on the model (Figure 1) on Week 13 data (n = 647).

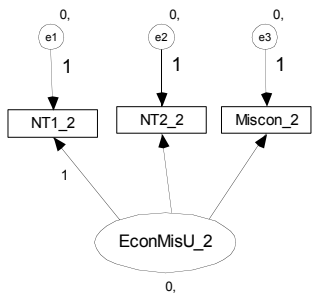


Figure 1 The EconMisU_2 model

Result Before reviewing the path coefficients, it is noted that since the construct of economic misunderstanding is a one-factor model with three indicators, the model is just identified and will fit the data perfectly. Therefore AMOS did not generate any goodness of fit statistics for evaluation of model fit. Note also the suffixes of the indictor variables and latent construct. The suffix 2 in Figure 1 shows that the construct and its indicator variables were measured in the *second* survey.

Table 2 Factor loadings – EconMisU_2 scale

	Regression weight
Econmis_2←EconMisU	0.510*
NT1_2←EconMisU	0.706
NT2_2←EconMisU	0.615*

* p = 0.000

Table 2 shows that the path coefficients are all greater than 0.5, which are large by conventional standard in educational research (Harlow, 2005), which gave further support for the validity of the model.

3 Application

After establishing the construct of economic thinking ability, students' development of this discipline-specific ability was investigated. The research questions of interest in this investigation are:

(1) At the start of semester, do students in different units (offered at different stages of progression through the degree) possess different levels of economic thinking ability? If so, do they reflect the amount of economic training previously received? If there are between-unit differences, will these differences persist at the end of the semester?

(2) By end of semester, will students acquire an ability of thinking like an economist which is greater than at the start of the semester?

(3) Related to the above questions, particularly for (a), will different economic units have similar or different impacts on the development of students' ability in economic thinking?

With regard to the first two research questions, some predictions can be made. If the economic training at university can help develop students' economic thinking ability, it is predicted that students in higher level economic units will exhibit more economic thinking ability which will translate into a lower EconMisU score in Week 1 (EconMisU_1) in higher level units. But it is uncertain if these differences will be maintained after one semester. Also, after one semester students' economic thinking ability in Week 13 on average should increase (that is, their EconMisU_2 score should fall) for each of the three units. However, there is no theoretical basis to predict whether or not the improvement in students' economic thinking ability would be the same across the three units. The results of these investigations will be presented below.

3.1 Between-group Differences on EconMisU_1 and EconMisU_2

Method To investigate research question (1), two SEM techniques[4] can be used to test for between-group differences: (i) structural regression on the latent dependent variable (EconMisU), with 'unit' as the independent variable, and (ii) multi-group comparisons of latent mean structures. Method (i) assumes homogeneity of variance and covariances of the factors and homogeneity of measurement intercepts, whereas method (ii) explicitly tests these assumptions. Therefore the multi-group method is a more rigorous technique to test between-group differences on the latent mean (Arbuckle, 2006). The two methods are expected to produce similar results if the assumptions of equivalent factor variance and covariances, and equivalent measurement intercepts are met. Since the multi-group method is to confirm the validity of the results obtained by structural regression method, the results obtained from multi-group comparison for the latent mean structures for Econ 1 and Econ 2 will be reported in Appendix 4.

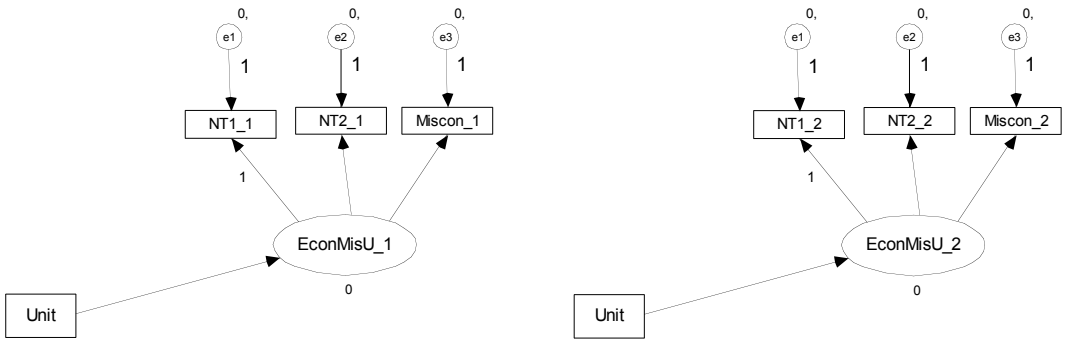
It is noted that using the structural regression method, instead of comparing the economic thinking ability of students in the three economics units in a single model, separate

[4] It is noted that an alternative method, one way 3 × 3 MANOVA (3 units by 3 sub-scales) could be conducted with similar effects. For two reasons, this method was not pursued. First, in order to investigate developmental changes the comparisons of interest are between adjacent economics units, that is, between Econ 1 and Econ 2, and between Econ 2 and Intermediate Macro. The comparison between Econ 1 and Intermediate Macro in the one way 3 × 3 MANOVA would be redundant. Second, in SEM, the coefficient of the path from Unit to the dependent variable (EconMisU_1) provides a measure of the mean difference in students' economic thinking ability between units, whereas one way MANOVA indicates only whether or there is significant group difference but does not quantify the difference.

comparisons were made between adjacent units, that is, between Econ 1 and Econ 2, and then between Econ 2 and Intermediate Macro. This is necessary since the effect of the independent variable, 'Unit' on students' economic thinking ability is likely to be non-linear and may not even be ordinal in terms of their effects on EconMisU_1 and EconMisU_2. Therefore, it is invalid to include all three units in a single analysis.

In these investigations, the independent variable 'Unit' takes on two values (0 for Economics 1 and 1 for Economics 2 in the first investigation, and 0 for Econ 2 and 1 for Intermediate Macro in the second). With a latent dependent variable that has three indicators, the test conducted in each of these two investigations is equivalent to a 2×3 Multivariate Analysis of Variance (MANOVA) in large samples.

Data In order to track the changes of students' economic thinking ability over one semester, only students who are present and identifiable in both Week 1 and Week 13 surveys are included in the sample. The sample (n = 488), labelled Week 1_13, consists of 356 Econ 1, 78 Econ 2 and 54 Intermediate Macro students. However, given that less than 50% of students in the Week 1 cohort are included in the Week 1_13 sample, one would question the representativeness of the much reduced Week 1_13 sample. To address this issue, the Week 1 data is split into two groups: those who are identified in both surveys (n = 488) and those who are not (n = 626). The demographic characteristics, pre-course aptitude for economic thinking, and initial learning styles (in terms of the four sub-scale scores) of these two groups of students were compared. The result (not presented in this paper) shows that there are no significant differences between the two groups on demographics, pre-course economic thinking abilities and learning styles at the level of 0.05. There is thus no evidence to suggest that the Week 1_13 sample is a non-representative sample of the original Week 1 cohort.



(a) Pre-course economic thinking ability **(b) Post-course economic thinking ability**

Figure 2 Between-unit comparisons of students' economic thinking ability

3.1.1 Parameter estimates (pre-course economic thinking ability)

Econ 1 vs Econ 2 Referring to Table 3, the standardised path coefficient from Unit to EconMisU_1 [Figure 2 (a)] has a value of -0.227 which is significant at the level of 0.000. This represents a small to medium effect size[5]. The negative sign indicates Econ 2 students have a smaller EcoMisU_1 score than Econ 1 students in Week 1. For interpretation purpose, the unstandardised regression weight is easier to use. Given Econ 1 = 0 and Econ 2 = 1, the unstandardised path coefficient of -0.201 means that Econ 2 students on average have *less* economic misunderstanding than Econ 1 students by 0.201 point on a five-point scale.

Table 3 Effects of Unit on EconMisU_1 and EconMisU_2

		Econ 1 vs Econ 2			Econ 2 vs Inter macro		
		Unstd est	Std est	p	Unstd est	Std est	p
Week 1	*EconMisU_1 <--- Unit*	-0.201	-0.227	.000	-0.237	-0.270	.011
Week 13	*EconMisU_2 <--- Unit*	0.019	0.022	.718	-0.335	-0.359	.000

Unstd est = Unstandardised estimate; std est = standardised est

Econ 2 vs Intermediate Macro Now consider Econ 2 and Intermediate Macro students. The standardised path coefficient from Unit to EconMisU_1 [Figure 2 (a)] has a close to medium effect size of -0.270. The unstandardised value of -0.237, significant at the level of 0.05 (p = 0.011) indicates that at the start of the semester Intermediate Macro students have on average a lower level of economic misunderstanding than Econ 2 by 0.237 point on a five-point scale.

3.1.2 Parameter estimates (post-course economic thinking ability)

Econ 1 vs Econ 2 Referring to Table 3, at the end of semester, using the same dataset (Week 1_13 data) as in the Week 1 analysis, it was found that there is no significant difference in the EconMisU_2 score between Econ 1 and Econ 2. The coefficient for the path from Unit to EcoMisU_2 [Figure 2 (b)] is close to zero (std est = 0.022; p = 0.718). The positive sign of the estimate means students in Econ 2 actually have a slightly higher level of economic misunderstanding than students in Econ 1 by the end of semester.

Econ 2 vs Intermediate Macro Considering Econ 2 and Intermediate Macro, in Week 13 the standardised path coefficient: Unit→EconMisU_2 increases numerically to -0.359,

[5] Kline (2005) provides a guide for interpretation of the magnitudes of the path coefficients in social sciences. Standardised path coefficients numerically around 0.1 indicate a small effect, values around 0.3 a medium effect and values around 0.5 or above a large effect.

which is highly significant at the level of 0.000. The unstandardised estimate of -0.335 suggests that the gap between the two groups has increased slightly by end of the semester.

3.2 Changes in Economic Thinking Abilities

The investigation presented in the last section only compares students in adjacent units on their economic thinking abilities in Week 1 and then in Week 13. The results does not show whether or not students' had improved on their economic thinking ability after one semester of formal economics training. The investigation reported in this section aims to investigate this question.

Method In order to determine if students had improved in their economic thinking ability over one semester, composite pre-course and post-course Economic MisUnderstanding scores (labelled EconMisU_1 and EconMisU_2 respectively) were computed. This methodology is valid as the scale has sufficient internal consistency. The composites scores can be obtained by using the factor score weightings generated by AMOS or by taking the simple mean scores. In his empirical studies, Grice (2001) found that the method of using factor score weightings is no better in producing consistent ranking of subjects than a simple average composite. So in this investigation, the latter method was used. A paired t-test was subsequently conducted to compare students' pre-course and post-course economic thinking ability scores. The result is presented in Table 4 below.

Result Considering all three units as a single group, it is evident that there is a significant decrease in students' level of economic misunderstanding. In other words, their economic thinking ability improved over the semester. The difference of 0.270 on a five - point scale is highly significant ($t = 16.202$, $p = 0.000$).

Since the whole group contains mostly Econ 1 students (72%), the change in the composite score is dominated by the effect of the Econ 1 sample. It is therefore necessary to consider the change in the composite economic thinking ability score for each of the three economics units. Separate paired t-tests were conducted for each unit. Results from the t-tests (Table 4) reveal that the improvement, though significant in each case at the conventional 0.05 level, is far from uniform for the three units. The improvement in Econ 1 of -0.321 point is (numerically) much greater than the improvements in the other units (-0.104 and -0.174 for Econ 2 and Intermediate Macro respectively). This observation will be further explored in the discussion section.

Table 4 Changes in students' economic thinking ability

		Mean	n	Std dev	t (p-value)
All units	EconMisU_1	2.758	488	0.405	16.202
	EconMisU_2	2.488	488	0.019	(0.000)
Econ 1	EconMisU_1	2.825	356	0.388	16.829
	EconMisU_2	2.504	356	0.393	(0.000)
Econ 2	EconMisU_1	2.649	78	0.363	2.736
	EconMisU_2	2.545	78	0.465	(0.008)
Inter Macro	EconMisU_1	2.478	54	0.421	3.351
	EconMisU_2	2.304	54	0.473	(0.001)

Further Analysis Having examined the overall improvement in students' economic thinking ability, we can further investigate students' improvement in each of the three aspects of the economic thinking ability construct. To achieve this, pairwise t-tests were conducted on each of the three sub-scales. The results are presented in Table 5 below.

Table 5 Changes in students' miscon, NT1 and NT2 sub-scale scores

		Econ 1 (n=356)			Econ 2 (n=78)			Inter Macro (n=54)		
		mean	std. dev.	t (p value)	mean	std. dev.	t (p value)	mean	std. dev.	t (p value)
Pair 1	miscon_1	2.4811	.63127	12.85 (0.000)	2.2615	.55203	1.82 (0.073)	2.1603	.72232	1.78 (0.081)
	miscon_2	2.0343	.61112		2.1487	.65381		2.0013	.75241	
Pair 2	NT1_1	2.8149	.40573	5.17 (0.000)	2.7275	.49316	1.64 (0.106)	2.5514	.50374	0.79 (0.435)
	NT1_2	2.6968	.43242		2.6447	.54080		2.4967	.50823	
Pair 3	NT2_1	3.1783	.55310	13.34 (0.000)	2.9590	.52405	1.95 (0.055)	2.7234	.55119	4.88 (0.000)
	NT2_2	2.7811	.54384		2.8407	.53451		2.4127	.52703	

On all three sub-scales there are significant decreases in scores for Econ 1. But for Econ 2, the reductions are non-significant for miscon and NT1 sub-scale whereas the improvement in NT2 approaches significance at the level of 0.05 ($p = 0.055$). Lastly for Intermediate Macro, there is a large and (statistically) significant improvement is in macroeconomic thinking ability (NT2), but not for the other two sub-scales.

3.3 Interaction of Unit and Treatment Effect

The investigation reported in Section 4.2 establishes that, in general formal economic training has a positive impact on students' economic thinking ability. The third research question concerns the interaction of Unit with the treatment effect (that is, the effect of formal economic training on students' economic thinking ability). The research question asked is: Does formal economics training in each of the three economics units have the same or different impacts on improvement of students' economic thinking ability?

Method To address this research question, the most appropriate statistical method to use is analysis of covariance (ANCOVA) using the EconMisU_2 composite score as the dependent variable and the EconMisU_1 composite score as a covariate (Harlow, 2005). However, for the test to be valid, the assumption of homogeneity of slopes is required. This involves evaluation of the interaction between the covariate and the factor (in this case, Unit) in the prediction of the dependent variable (EconMisU_2); a significant interaction between EconMisU_1 and Unit would suggest that the results from ANCOVA are not meaningful. The SPSS output shows the interaction is significant, with the value of $F(2, 482) = 3.884$ and $p = 0.021$. Therefore, ANCOVA cannot proceed. An alternative is to compute the difference between EconMisU_2 and EconMisU_1 composite scores for each student and take the average difference in each economics unit as a measure of the improvement of economic thinking ability of students in that unit. A one-way ANOVA can then be conducted to compare their improvements in the three units. The independent variable, Unit, contains three levels representing the three economics units. The dependent variable was the difference in the composite scores (diff_EconMisU = EconMisU_2 – EconMisU_1), with a negative difference indicating an improvement of economic thinking ability.

Result The ANOVA was significant, with $F(2, 485) = 13.728$, $p = 0.000$. Follow-up tests were conducted to compare the mean improvements in economic thinking ability of the three groups of students. Since the Levene test of homogeneity of variances is non-significant ($p = 0.656$), the Bonferroni method of post hoc multiple comparisons was chosen.

Table 6 Bonferroni Multiple Comparisons (DV: diff_EconMisU)

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	p value
Econ 1	Econ 2	-.2160	.04487	.000
	Inter Macro	-.1459	.05242	.017
Econ 2	Econ 1	.2160	.04487	.000
	Inter Macro	.0701	.06354	.811
Inter Macro	Econ 1	.1459	.05242	.017
	Econ 2	-.0701	.06354	.811

The result shows (Table 6) that there is significant difference between Econ 1 and Econ 2 (mean difference = -0.216; $p = 0.000$) and between Econ 1 and Intermediate Macro (mean difference = -0.146; $p = 0.017$) but there is no significant difference between Econ 2 and Intermediate Macro (mean difference = -0.070; $p = 0.811$). It can thus be concluded that the

average improvement in economic thinking ability of Econ 1 (-0.321) was greater than Econ 2 (-0.104) and Intermediate Macro (-0.174) but there is no significant difference in the improvement between Econ 2 and Intermediate Macro.

Further Analysis So far, the investigations have been focused on the overall measure of economic thinking ability (EconMisU). Analysis of covariance (ANCOVA) can also be conducted at the sub-scale level to compare the improvements of the three units on the three sub-scales – miscon, NT1 and NT2. As mentioned, for ANCOVA to produce meaningful results, the assumption of homogeneity of slopes must hold. Tests of homogeneity of slopes were conducted on each of the three subscales.

Miscon sub-scale

For the miscon sub-scale, the interaction between Unit and miscon sub-scale was significant, $F(2, 482) = 3.592$, $p = 0.028$. Therefore, ANCOVA cannot be conducted for this sub-scale. Instead of ANCOVA, analysis of variance (ANOVA) was conducted on this sub-scale with the difference in the pre-course and post-course sub-scale scores (diff_miscon = miscon_2 – miscon_1) as the dependent variable. The ANOVA result, $F(2, 482) = 11.742$, $p = 0.000$, shows a significant group effect. Follow up Bonferroni tests adjusted for multiple comparisons were conducted to evaluate pairwise differences of the group means. The results are presented in Table 7, which show that the reduction in the miscon sub-scale score for Econ 1 was greater than Econ 2 and Intermediate Macro, significant at the level of 0.01 whereas there is no significant difference between Econ 2 and Intermediate Macro.

Table 7 Bonferroni Multiple Comparisons (DV: diff_miscon)

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	p-value
Econ 1	Econ 2	-.33402	.08006	.000
	Inter Macro	-.28783	.09352	.007
Econ 2	Econ 1	.33402	.08006	.000
	Inter Macro	.04618	.11337	1.000
Inter Macro	Econ 1	.28783	.09352	.007
	Econ 2	-.04618	.11337	1.000

NT1 and NT2

For NT1 and NT2, the tests of homogeneity of slopes were both non-significant ($F = 1.697$, $p = 0.184$ and $F = 0.527$, $p = 0.591$ respectively) and thus ANCOVA can be conducted for both NT1 and NT2. The results of the ANCOVA are presented in Tables 8 (a) and (b).

Table 8 (a) Tests of Between-Subjects Effects (DV: NT1_2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	28.401(*)	3	9.467	60.204	.000	.272
Intercept	15.837	1	15.837	100.715	.000	.172
NT1_1	26.481	1	26.481	168.402	.000	.258
Group	.151	2	.075	.479	.619	.002
Error	76.108	484	.157			
Total	3573.808	488				
Corrected Total	104.509	487				

* R Squared = .272 (Adjusted R Squared = .267)

Table 3.8 (b) Tests of Between-Subjects Effects (DV: NT2_2)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	41.605(*)	3	13.868	62.590	.000	.280
Intercept	24.258	1	24.258	109.478	.000	.184
NT2_1	34.476	1	34.476	155.594	.000	.243
Group	3.263	2	1.632	7.364	.001	.030
Error	107.242	484	.222			
Total	3838.950	488				
Corrected Total	148.847	487				

* R Squared = .280 (Adjusted R Squared = .275)

Of all the output presented in the tables, the most important to the present investigation is the 'Group' source which evaluates the null hypothesis of equal adjusted population means. For students' Week 13 microeconomic thinking score (NT1_2), the result in Table 8(a) shows that there is no significant difference in the adjusted means between the three economics units, $F(2, 482) = 0.479$, $p = 0.619$. This means after adjusting for students' level of microeconomic thinking ability score in Week 1 (NT1_1), there is no significant relationship between economics units and students' (adjusted) Week 13 microeconomic thinking ability score (NT1_2). In other words, the null hypothesis of equal improvements in the three units cannot be rejected.

Regarding students' Week 13 macroeconomic thinking ability score (NT2_2), Table 8 (b) shows that there is a significant group difference, $F(2, 482) = 7.364$, $p = 0.001$. The partial eta squared (η^2) of 0.030 is of small effect size. Follow up pairwise tests of the adjusted mean differences of the three economics units using Bonferroni method were conducted.

Table 9 Bonferroni Multiple Comparisons (DV: NT2_2)

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	p value
Econ 1	Econ 2	-.166	.059	.016
	Inter Macro	.147	.071	.116
Econ 2	Econ 1	.166	.059	.016
	Inter Macro	.313	.084	.001
Inter Macro	Econ 1	-.147	.071	.116
	Econ 2	-.313	.084	.001

The results (Table 9) show that the Econ 1 and Intermediate Macro have a lower adjusted NT2_2 score than Econ 2, significant at the 0.05 level. A lower adjusted mean score in NT2_2 implies greater improvement in macroeconomic thinking ability. Thus, it can be concluded that the improvements in macroeconomic thinking ability for Econ 1 and Intermediate Macro are greater than Econ 2.

3.5 Discussions

The developmental changes as measured by the decrease in the average EconMisU scores from Week 1 to Week 13 for the three units are depicted in Figure 3.

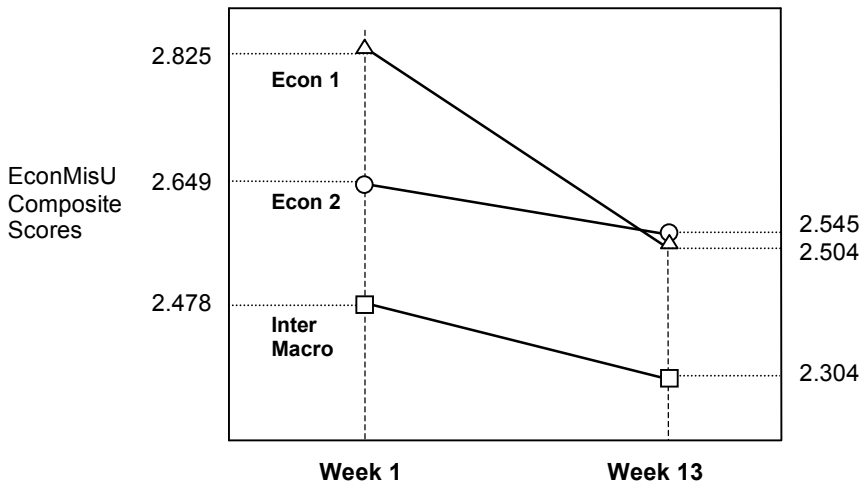


Figure 3 Changes in students' economic thinking ability for each unit

The graph is based on the EconMisU composite scores obtained in Section 4.2. It shows that in Week 1, Econ 1 students on average have more economic misunderstanding (EconMisU_1) than Econ 2 students. But by end of the semester, the Week 1 gap of 0.176 was reduced practically to zero – the students in the two units have the same average level of economic thinking ability. Between Econ 2 and Intermediate Macro, there is also a similar size gap of 0.171 in their economic thinking ability in favour of Intermediate Macro students in Week 1.

The gap appears to grow marginally bigger to 0.241 in Week 13. However, as shown in the further analysis conducted in Section 4.3, the marginally bigger improvement of Intermediate Macro is due solely to its bigger improvement in macroeconomic thinking ability (NT2_2) compared to Econ 2.

From the above results it is evident that formal economic training has a larger effect on Econ 1 than Econ 2 and Intermediate Macro. These observations can be interpreted and explained in several possible ways. The first explanation is that development of economic thinking ability is non-linear. Once a student's economic thinking ability has reached a certain level, its further development will slow down. In other words, it will take a longer time (more exposure to economics) to further enhance this ability. According to this argument, the nature and quality of the economics course do not matter much. It is similar to the stage theory of cognitive development of children (Biggs & Telfer, 1987). It is argued in the theory that the different stages of cognitive development are to a great extent age dependent. Consider the transition from the concrete-symbolic mode to the formal mode of thought. Children begin to handle concepts that are *directly* linked to concrete experience from around the age of 5 (concrete-symbolic mode). And they typically will not advance to the next stage (formal mode) – being able to manipulate reality with concepts and symbols which are not confined by immediate concrete experience – until they start high school around the age of 12.

A second more likely explanation for the relative lack of improvement in economic thinking ability in Econ 2 and to a smaller extent Intermediate Macro concerns the teaching effectiveness of these units. If a unit is poorly taught, then students are less likely to appreciate the economic analysis and are more likely to rote-learn the material. As a result, it is possible that these students fail to acquire more understanding about the nature of economics and to apply economic concepts to novel situations. Since the present study was not designed to investigate teaching methods, comparisons of teaching effectiveness between units cannot be conducted to test this hypothesis.

Consider now the changes in the sub-scale scores, NT1 and NT2. There are improvements at or approaching the 0.05 significance level in macroeconomic thinking ability (NT2) for students in all three units; however, this improvement is notably absent in microeconomic thinking ability (NT1) for Econ 2 and Intermediate Macro. Notice also that while the improvement in NT1 for Econ 1 is significant, the improvement in NT1 is much smaller than that of NT2. One might argue that the lack of improvement of Intermediate Macro students in

microeconomic thinking ability could be because they did not do Intermediate Micro in the same semester. This explanation can be discarded as the majority (over 95%) of these students did Intermediate Micro and Intermediate Macro in the same semester.

Curricular design provides a possible explanation for the disparity of improvements in students' micro and macroeconomic thinking abilities. In his detailed examination of the content of popular introductory micro and macroeconomics texts used in Europe in the last 30 years, Gartner (2000) found that there have been a lot of innovations in the structure and content in macroeconomics texts, but such innovations were notably absent in microeconomics texts. The same neoclassical framework covering the same topics in more or less the same sequence was observed in these introductory microeconomic texts. The relevance of this observation could be argued as capable of explanation in two opposite ways. One can argue that there has been a lack of progress in the pedagogical structure of microeconomics. One can also say the micro part in economics was already well developed with an optimal conceptual framework, and thus no further development was necessary. Gartner (2000) challenged this complacency and called for economics educators to re-think the current approach of organising and teaching introductory economics in general and microeconomics in particular.

4 Conclusion

The discipline-specific construct of economic thinking ability was developed to capture students' understanding of what economics is about, and their thinking ability in micro and macroeconomics issues. It was found to possess desirable psychometric properties for future modelling purposes.

This paper has compared students' pre and post-course economic thinking ability in different economics units over one semester. At the beginning of the course, it was found that Intermediate Macro students on average have a lower level of EconMisU_1 than Econ 2 which in turn have a lower EconMisU_1 than Econ 1. However, the improvement for Econ 1 students was so much bigger than Econ 2 that by the end of one semester of formal economic training the Week 1 gap in economic thinking ability was completely closed.

Detailed examination of the three components of the economic thinking ability construct revealed that for Econ 1 students, the improvement in microeconomic thinking ability (NT1)

score is much less than the other two subscale scores. For Intermediate Macro students, there is a big improvement in macroeconomic thinking ability (NT2) but no significant improvement in NT1. A similar but less pronounced differential improvement in micro versus macroeconomic thinking ability for Econ 2 was also observed. Possible explanations of these observed differences in students' development of micro and macroeconomic thinking abilities were proposed and discussed: non-linear development of economic thinking ability, teaching effectiveness and curricular design. In this study no conclusive evidence was collected to refute or confirm any of these explanations. In order to more fully understand students' development of students' economic thinking ability over one (or more) semester, further research involving the content, teaching approach and assessment of the economics unit is recommended.

5 Further Applications

The discipline-specific construct of economic thinking ability has applications in three related areas in economics education. First, as a pre-course factor, the student's economic thinking ability is expected to impact on their appreciation and understanding of the content and methods in economics, and hence their learning in economics. The following research questions focus on the approaches and outcomes of learning in economics.

- Will students with stronger economic thinking ability also have greater academic achievement?
- Will students with stronger economic thinking ability be more likely to utilise more deep and less surface approaches to learning in economics?
- Is the effect of economic thinking ability on academic achievement in economics, if it exists, a direct effect or predominantly mediated by learning approaches?

Second, if the student's economic thinking ability influences learning in economics, it is important to investigate the factors associated with this pre-course measure. Such factors include students' demographics and general academic aptitude. Research questions of interest include:

- Are there gender and age differences in students' pre-course economic thinking ability?
- Is there is any difference in this ability between economics and non-economics majors?

- Is economic thinking ability capturing cognitive ability different from general academic aptitude?

It is anticipated that the answer to the last research question will be positive if the construct of economic thinking ability captures cognitive ability unique to economics.

The third research agenda involves using the construct of economic thinking ability as a measure of learning outcome. One would expect if the economics course teaches and assesses students' ability of thinking like an economist, a student with high academic achievement in economics would score well in the economic thinking ability instrument. By investigating students' economic thinking ability and their academic achievement in economics at the end of a course, this hypothesis can be tested and the following research questions formulated:

- Is there a strong association between students' post-course economic thinking ability and their academic achievement in economics?
- Are the factors (including learning approaches) that influence these two measures of learning outcomes the same or different?

The construction of this economics-specific construct reported in this paper will not only open avenues for future research in economics education, but provide economics educators with information about the role of this discipline-specific ability in learning economics, and the nature of the cognitive ability being required in traditional assessments in economics courses. This information will be valuable in developing teaching and assessment strategies in promoting quality learning outcomes in economics education.

Appendix 1 Meyer and Shanahan's (2001) Misconceptions and Conceptions of Worth Scales

Misconceptions:

1. Economics is responsible for the effect of policy decision on the economy.
2. Economics is the study of money.
3. Economics is an exact science.
4. All the people in a country benefit when a high rate of interest is paid on savings.
5. If an employee gets a pay rise at work, and so do all his friends, then they must be better off than before.
6. Economics analyses problems that have little effect on how people live.
7. There is generally no logical explanation for things like the currency crisis in Asia.

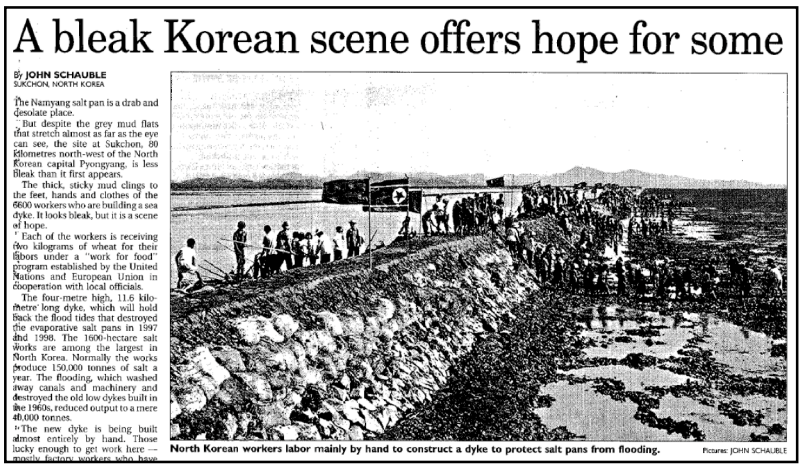
Conceptions of Worth:

1. The worth of human life can be expressed in dollar terms.
2. The worth of something is the price you pay for it.
3. The price of something can be unrelated to what it is actually worth.
4. What you pay for something is what it is worth.
5. The cost of manufacturing a loaf of bread determines its worth.

Appendix 2 The Instrument – Economic Thinking Ability

The 22 items for measuring students' economic thinking ability are presented below. Item 4 and 14 (marked with an asterisk) are adapted from Meyer and Shanahan's (2001) study.

Economic Misconception		**Label**
1.	Economics is about how to make money.	make$
2.	Economic theories apply only to market economies like Australia and the USA.	mktecon
3.	Economics is mainly a study of financial markets (e.g. stock/share market and foreign exchange market).	finmkt
4.	Economics is the study of money. *	study$
5.	Economics and economists tend to serve and perpetuate the interest of the well off in society.	welloff
Naïve Economic Thinking		
6.	A high Australian dollar is generally good for our economy.	aus$_1
7.	Import tariffs and quotas usually increase the welfare of the general public.	tariff
8.	In the long term, new technology creates unemployment by replacing workers with machines.	tech_u
9.	Competition from foreign countries would be ultimately bad for the economy.	competitn
10.	A minimum wage law increases unemployment among young and unskilled workers.	min_wage
11.	Punishment of illegal behaviour has a deterrent effect.	deterrent
12.	The government can improve the economic well being of the country by maintaining a strong dollar.	aus$_2
13.	During school holidays, owners of accommodation (such as motels and caravan parks) charge holiday makers considerably higher prices than off-peak season. Do you think that these holiday makers are being exploited?	d_s_1
14.	Do you think that all people in a country benefit when a high rate of interest is paid on savings? *	int_rate
15.	Tom had purchased a 12 month gym club subscription for $800. It's the policy of the gym club that once purchased, there was no refund or transfer of the subscription. At first, Tom went frequently, but his visits became less frequent after the first few weeks. Tom said to himself: "After all it cost me $800, I should be using the gym facilities more often." Do you think that Tom's reasoning is correct?	sunkcost
16.	In the earlier 1990s, an influx of migrants into Vancouver led to a rise in prices of houses in that city. Owning a house had become more difficult for many families there. Would you think that this rise in the house prices was bad for society as a whole?	welfare
17.	In Australia, a few years ago, the federal government introduced the First Home Owners' Scheme, which grants $7000 for those purchasing (or building) their first house. Peter and Mary, newly married, are planning to own their dream home. Do you think that the grant will save them $7000?	d_s_2
18.	Australia has rich deposits of coal and iron ore. A large amount of coal and iron ore mined in Australia is exported to Japan, where it is refined and turned into steel. Then the steel produced in Japan is exported back to Australia for its construction industry. Do you think that it would be good for Australians if the coal and iron ore is turned into steel in Australia?	comp_adv
19.	Do you think that the reason that doctors (i.e. physicians) are typically paid more than accountant is that medical students have to study at university for more years?	d_s_3
20.	Suppose in Country A, people as a whole spend a similar amount on medical operations and on chicken meat. *Leaving moral and ethical considerations aside*, if its government wishes to raise tax revenue, do you think that it will be more successful if the tax is on medical operations than on chicken meat?	elasticity
21.	Do you think that if a firm doubles its output from one week to the next, its total cost of producing its output will also double?	cost
22.	North Korea is one of the poorest countries in Asia, with huge unemployment and incomes a fraction of those in Australia. The picture below shows North Koreans working mainly by hand to construct a dam wall to protect salt pans from flooding. Do you think that since there is no machinery used, this is not the best method of constructing this dam wall in North Korea?	efficiency



A bleak Korean scene offers hope for some

By JOHN SCHAUBLE
SUKCHON, NORTH KOREA

The Namyang salt pan is a drab and desolate place.

But despite the grey mud flats that stretch almost as far as the eye can see, the site at Sukchon, 80 kilometres north-west of the North Korean capital Pyongyang, is less bleak than it first appears.

The thick, sticky mud clings to the feet, hands and clothes of the 6600 workers who are building a sea dyke. It looks bleak, but it is a scene of hope.

Each of the workers is receiving two kilograms of wheat for their labors under a "work for food" program established by the United Nations and European Union in cooperation with local officials.

The four-metre high, 11.6 kilometre long dyke, which will hold back the flood tides that destroyed the evaporative salt pans in 1997 and 1998. The 1600-hectare salt works are among the largest in North Korea. Normally the works produce 150,000 tonnes of salt a year. The flooding, which washed away canals and machinery and destroyed the old low dykes built in the 1960s, reduced output to a mere 40,000 tonnes.

The new dyke is being built almost entirely by hand. Those lucky enough to get work here — mostly factory workers who have

North Korean workers labor mainly by hand to construct a dyke to protect salt pans from flooding. Pictures: JOHN SCHAUBLE

Appendix 3 Correlations of the 17 Items in Naïve Economic Thinking Sub-scales

		aus$_1	tariff	tech_u	competitn	aus$_2	d_s_1	int_rate	sunkcost	welfare	d_s_2	comp_adv	d_s_3	cost	efficiency	mi_wage	deterrent	elasticity
aus$_1	Pearson Correlation	1	.213(**)	.149(**)	.187(**)	.461(**)	.020	.142(**)	.151(**)	.012	.108(**)	.144(**)	.016	.140(**)	.025	.030	-.005	.025
	Sig. (2-tailed)		.000	.000	.000	.000	.490	.000	.000	.690	.000	.000	.577	.000	.404	.307	.871	.393
tariff	Pearson Correlation	.213(**)	1	.162(**)	.197(**)	.207(**)	.035	.154(**)	.050	.030	.085(**)	.111(**)	.052	.111(**)	.016	.115(**)	-.017	.082(**)
	Sig. (2-tailed)	.000		.000	.000	.000	.235	.000	.089	.304	.004	.000	.080	.000	.596	.000	.575	.005
tech_u	Pearson Correlation	.149(**)	.162(**)	1	.268(**)	.157(**)	.164(**)	.201(**)	.070(*)	.165(**)	.080(**)	.033	.023	.143(**)	.070(*)	-.111(**)	.039	.056
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.017	.000	.007	.262	.442	.000	.018	.000	.185	.058
competitn	Pearson Correlation	.187(**)	.197(**)	.268(**)	1	.113(**)	.152(**)	.154(**)	.010	.163(**)	.123(**)	.157(**)	.050	.174(**)	.066(*)	-.106(**)	-.008	.024
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.747	.000	.000	.000	.091	.000	.026	.000	.796	.421
aus$_2	Pearson Correlation	.461(**)	.207(**)	.157(**)	.113(**)	1	.081(**)	.176(**)	.136(**)	.053	.116(**)	.098(**)	.038	.165(**)	.053	-.020	-.062(*)	-.008
	Sig. (2-tailed)	.000	.000	.000	.000		.006	.000	.000	.074	.000	.001	.200	.000	.072	.495	.035	.777
d_s_1	Pearson Correlation	.020	.035	.164(**)	.152(**)	.081(**)	1	.189(**)	.025	.176(**)	.120(**)	.118(**)	.048	.136(**)	.110(**)	-.034	.043	.018
	Sig. (2-tailed)	.490	.235	.000	.000	.006		.000	.405	.000	.000	.000	.102	.000	.000	.247	.146	.550
int_rate	Pearson Correlation	.142(**)	.154(**)	.201(**)	.154(**)	.176(**)	.189(**)	1	.090(**)	.108(**)	.106(**)	.079(**)	.021	.160(**)	.098(**)	-.042	.026	-.015
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.002	.000	.000	.008	.483	.000	.001	.160	.377	.603
sunkcost	Pearson Correlation	.151(**)	.050	.070(*)	.010	.136(**)	.025	.090(**)	1	.017	.111(**)	.046	-.016	.032	-.045	.025	-.066(*)	-.005
	Sig. (2-tailed)	.000	.089	.017	.747	.000	.405	.002		.573	.000	.122	.591	.285	.125	.392	.025	.873
welfare	Pearson Correlation	.012	.030	.165(**)	.163(**)	.053	.176(**)	.108(**)	.017	1	.042	.030	.113(**)	.132(**)	.127(**)	-.109(**)	.055	-.008
	Sig. (2-tailed)	.690	.304	.000	.000	.074	.000	.000	.573		.152	.305	.000	.000	.000	.000	.061	.782
d_s_2	Pearson Correlation	.108(**)	.085(**)	.080(**)	.123(**)	.116(**)	.120(**)	.106(**)	.111(**)	.042	1	.000	.076(*)	.173(**)	.063(*)	-.037	-.059(*)	-.024
	Sig. (2-tailed)	.000	.004	.007	.000	.000	.000	.000	.000	.152		.988	.010	.000	.033	.215	.047	.410
comp_adv	Pearson Correlation	.144(**)	.111(**)	.033	.157(**)	.098(**)	.118(**)	.079(**)	.046	.030	.000	1	.014	.092(**)	.024	.048	-.025	.013
	Sig. (2-tailed)	.000	.000	.262	.000	.001	.000	.008	.122	.305	.988		.634	.002	.413	.107	.404	.661
d_s_3	Pearson Correlation	.016	.052	.023	.050	.038	.048	.021	-.016	.113(**)	.076(*)	.014	1	.172(**)	.128(**)	-.101(**)	-.046	.035
	Sig. (2-tailed)	.577	.080	.442	.091	.200	.102	.483	.591	.000	.010	.634		.000	.000	.001	.120	.232
cost	Pearson Correlation	.140(**)	.111(**)	.143(**)	.174(**)	.165(**)	.136(**)	.160(**)	.032	.132(**)	.173(**)	.092(**)	.172(**)	1	.192(**)	-.022	.055	-.022
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.285	.000	.000	.002	.000		.000	.457	.061	.461
efficiency	Pearson Correlation	.025	.016	.070(*)	.066(*)	.053	.110(**)	.098(**)	-.045	.127(**)	.063(*)	.024	.128(**)	.192(**)	1	-.069(*)	.034	-.053
	Sig. (2-tailed)	.404	.596	.018	.026	.072	.000	.001	.125	.000	.033	.413	.000	.000		.019	.245	.074
mi_wage	Pearson Correlation	.030	.115(**)	-.111(**)	-.106(**)	-.020	-.034	-.042	.025	-.109(**)	-.037	.048	-.101(**)	-.022	-.069(*)	1	.056	.124(**)
	Sig. (2-tailed)	.307	.000	.000	.000	.495	.247	.160	.392	.000	.215	.107	.001	.457	.019		.059	.000
deterrent	Pearson Correlation	-.005	-.017	.039	-.008	-.062(*)	.043	.026	-.066(*)	.055	-.059(*)	-.025	-.046	.055	.034	.056	1	.067(*)
	Sig. (2-tailed)	.871	.575	.185	.796	.035	.146	.377	.025	.061	.047	.404	.120	.061	.245	.059		.023
elasticity	Pearson Correlation	.025	.082(**)	.056	.024	-.008	.018	-.015	-.005	-.008	-.024	.013	.035	-.022	-.053	.124(**)	.067(*)	1
	Sig. (2-tailed)	.393	.005	.058	.421	.777	.550	.603	.873	.782	.410	.661	.232	.461	.074	.000	.023	

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Table 3.1 Correlation matrix of naïve economic thinking items

Appendix 4 Tests for Multi-group Invariance – Economic Thinking Ability

This appendix reports on three tests of multi-group invariance conducted to test that the construct of economic thinking ability has equivalent factor loadings and factor variances for (a) both genders, (c) the three economics units and (c) economics majors and non-majors.

Gender Invariance

Multi-group factor analysis was conducted to test for gender invariance on Week 1 data (n=1147). Since it is a just identified measurement model, the Chi-square of the baseline (unconstrained) model is zero. Table 4.1 (italics) shows the increase in Chi-square for the model that assumes equal measurement weights (or factor loadings). The Chi-square value of 1.545 for two degrees of freedom is non-significant (p = 0.462). So we cannot reject the null hypothesis their factor loadings are equal. There is no significant evidence that male and female students have different parameter values.

Model	df	χ^2	p
Measurement weights	*2*	*1.545*	*.462*
Structural covariances	3	4.803	.187
Measurement residuals	6	14.246	.027

Table 4.1 Chi-square statistics, assuming unconstrained model to be correct

The next step is to constrain the structural variances and covariances to be the same. Table 4.2 (italics) presents the increase in Chi-square statistic when structural covariances are assumed equal. Given the model of equal factor loadings is accepted, the increase in Chi-square of 3.258 for one degree of freedom has a p-value of 0.071. So, the null hypothesis of equivalent structural variances and covariances also cannot be rejected at 0.05.

Model	df	χ^2	p
Structural covariances	*1*	*3.258*	*.071*
Measurement residuals	4	12.701	.013

Table 4.2 Chi-square statistics, assuming equivalent measurement weights

***Remark*:** The test of invariant residuals does reject the null hypothesis of equal error variances and covariances at the level of 0.05 (p=0.024). However, this requirement is unnecessary stringent and is only required when testing for the invariant reliability of an instrument for multi-groups (Byrne 2001, p.202).

Unit Invariance

For the same rationale, similar tests for invariance across the three units were conducted on the Week 1 data. Since the procedure and analysis is the same as the invariance test for gender, the results will be reported in brief. Refer to the AMOS output in italics in Table 4.3 the increase in Chi-square of 4.214 with a df of 4 is non-significant at 0.05 (p = 0.378). This shows that the null hypothesis of equivalent measurement weights cannot be rejected.

Model	df	χ^2	p
Measurement weights	*4*	*4.214*	*.378*
Structural covariances	6	6.172	.404
Measurement residuals	12	25.770	.012

Table 4.3 Chi-square statistics, assuming unconstrained model to be correct

Now given factor loadings invariance, Table 4.4 presents the increase in Chi-square and the associated p-value when the factor variances and covariances are further constrained to be equal. The null hypothesis of equal factor variances again cannot be rejected at any conventional level (p = 0.376).

Model	df	χ^2	p
Structural covariances	*2*	*1.959*	*.376*
Measurement residuals	8	21.557	.006

Table 4.4 Chi-square statistics, assuming equivalent measurement weights

Economics/Non-economics Major Invariance

Refer to the AMOS output in Table 4.5, the increase in Chi-square of 4.989 with a df of 2 is non-significant at 0.05 (p = 0.083). Thus, the null hypothesis of equivalent measurement weights cannot be rejected at the conventional level of 0.05.

Model	df	χ^2	p
Measurement weights	*2*	*4.989*	*.083*
Structural covariances	3	5.796	.122
Measurement residuals	6	14.076	.029

Table 4.5 Chi-square statistics, assuming unconstrained model to be correct

In the next step, Table 4.6 shows that the increase in Chi-square of 0.806 associated with a df of 1 is non-significant at 0.05 (p = 0.369). The null hypothesis of equal factor variances again cannot be rejected at any conventional level.

Model	df	χ^2	p
Structural covariances	*1*	*.806*	*.369*
Measurement residuals	4	9.087	.059

Table 4.6 Chi-square statistics, assuming equivalent measurement weights

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