

Chapter 6

Are personal and contextual variables good indicators of prior knowledge? Ex post facto research 2

1 Introduction

This chapter presents the methodological approach and the results of a second investigation form which the research agenda is to look for indicators of prior knowledge, to explore further the value of the variable 'student type' as an indicator and to search for reasons for the differences found in the former investigation. This, given the fact that the first ex post facto-research revealed that the E & M course is not truly multifunctional and helped to support the hypothesis that students with an economics-background are better fitted to pass tests for the E & M course.

These indicators are expected to correlate to a high degree with the test results of students. 'Personal and contextual variables' are presented as an operationalization of these 'indicators'. This type of indicator is easy to define and information about them is easy to collect. It is expected that they can be considered as good indices of the prior knowledge of individual students. These indicators can also help to define specific sub-populations within the experimental group, which, for example, possess restricted or elaborated prior knowledge. The former sub-population in particular deserves special attention in educational settings. Law students (LS) and economics students (ES) are considered to have different prior knowledge levels. But next to this possible indicator 'student type', we found 77 other possible indicators. (for an overview, see Dochy, Bouwens, Wagemans and Niestadt, 1991)

2 Research design

2.1 Hypotheses

The first ex post facto research project indicated that the type of student (ES or LS) might be a relevant indicator of prior knowledge. As a consequence, it seems that the particular course is not fully multifunctional: students aiming at different degrees (i.e. different student types) seem not to obtain comparable results. The hypothetical relationship between student type and prior knowledge, with reference to the common prior knowledge theories, is further elaborated in the main part of the hypotheses in the present research. Briefly, the hypotheses to be tested are:

1. ES (economics students) obtain higher test scores than LS (law students).

2. ES obtain better scores for open-ended or multiple-choice questions than LS.
3. ES obtain better test scores than LS for test-items measuring the mastery of procedural knowledge.
4. ES obtain higher scores than LS for items with a high difficulty index.
5. Personal and contextual variables are relevant indicators of prior knowledge.

2.2 Research population

The sample consists of 100 law students and 100 economics students. Law students (LS) and economics students (ES) are defined as students taking at least 2 courses that fit into the compulsory programme of the diplomas Dutch Law or Economics and subscribing for at least one summative test.

The following background information of the sample helps to describe this population in more detail¹: 24.5% are female (21%); 47.2% of the students are 30 years old or younger (41%); 52.8% are 31 or older (59%). Examination of the initial education of the students reveals that 28.3% of the experimental group have a higher vocational education background (35%). Only 7.7% have a university degree (10%). Statistical tests (χ^2) reveal that there are no significant differences between this sample and the total Open University student population. The sample can be considered as a representative subset of the population.

2.3 Research instruments

Research data were gathered in two ways: a questionnaire helped to describe personal and contextual variables in relation to each subject and a test helped to measure the mastery level of subject-oriented knowledge.

2.3.1 The questionnaire

The administrative information, available in the BASIS-system of the Open University, is insufficient to document relevant personal and contextual variables of the research sample. In order to supplement the information from the BASIS-system, a questionnaire was developed consisting of multiple-choice and open-ended questions. The questions asked for information about the individual's general background, including occupation, educational level, etc. and were based on the personal and contextual variables as described by van Galien-Roodhardt (1987).

After a first try-out, a final version of the questionnaire was developed. When discussing the research results, no separate analysis of the questionnaire

¹ The values given between brackets are those for the OU student population.

answers will be presented. Since the answers help to define personal and contextual variables in the individual students, this information will rather be used to determine the independent variables in our statistical analysis of the test results of the individual students.

2.3.2 The subject-oriented knowledge test

Description of the test

As mentioned above, the test scores are used as a basis for obtaining information about the mastery level of the subject-oriented knowledge. The knowledge test consists of two open-ended questions (consisting of two or more sub-items) and 30 multiple-choice questions (4 alternatives). Besides the subdivision between open-ended and multiple-choice questions, one can also group the questions into two knowledge categories: declarative and procedural questions (see chapter 3).

Declarative questions measure the mastery level of declarative knowledge, i.e. appreciation, recognition and reproduction of information. Procedural questions measure the ability of the students to apply the procedural knowledge, i.e. production of information and applications (De Corte, et al., 1976).

In processing the test results for this ex post facto investigation, the dual subdivision between open-ended versus multiple-choice questions and declarative versus procedural questions has been taken into account. It is also to be repeated that not all the students in the experimental group took the subject-oriented knowledge test at the same time (between November 1985 and October 1988). This implies that parallel versions of the test were available.

Psychometric qualities of the subject-oriented knowledge test

In ex post facto research designs, the researcher generally has no impact on the construction of the instruments used. As a consequence, it is necessary to check the quality of the test, i.e. difficulty level, reliability and validity.

Difficulty level

The difficulty level of test items is not always taken into account when designing tests for Open University courses. When it has been taken into account, different procedures have been adopted for assessing it in the past. We will document the difficulty level of the test items in more detail when discussing the research results in relation to hypothesis 4.

Reliability

In calculating the mean α -coefficient of the 10 parallel test versions, distinction has been made between open-ended (OQ) and multiple-choice questions (MQ).

Table 1: Mean α -coefficients for the subject-oriented knowledge test

	α
OQ	.41
MO	.81
Total test score	.64

The reliability-coefficient of the multiple-choice questions is acceptable ($\alpha > .8$). The open-ended questions are less reliable. This can be explained in different ways. It is possible that the open-ended questions are too heterogeneous. Secondly, marking by the individual evaluators is not done in the same objective way. Thirdly, the question content differs from what the students consider to be important. Fourthly, it is possible that in the starting phase of this course, little was known about the empirical quality of these newly developed questions. The sample of these test-items was never analyzed before and might reflect a variety of attempts to design open-ended questions. Nevertheless, overall experience reveals that it is always difficult to produce a range of reliable open-ended test-items. In general, we can state that the overall reliability of the different parallel test versions of the test is acceptable in relation to test length.

Validity

To define the content validity of the test, test construction specialists and domain experts were interviewed by an independent and unbiased interviewer. During the interview, the construction of the test, the relevance of the items and the balance of the sample of test items were discussed. As Carmines and Zeller (1979, p.22) indicate, determining content validity is satisfactory if 'the universe of the context is accepted as entirely adequate to define the quality to be measured.' The results indicate that the items are considered to be very relevant and the sample of items reflects in an equilibrated way the different learning units of the course. Reijnders (1990) reports that the relation between tests and learning goals is generally not recognized by students, especially students at the beginning of their studies. Our investigation cannot confirm this, although it is clearly possible that this phenomenon is a cause of drop-out.

Summarizing these findings, the psychometric quality of the subject-oriented knowledge test is acceptable, although there are problems concerning the reliability of the open-ended questions. The latter fact will be taken into account when analyzing and interpreting the research results.

The questionnaire was sent to the students of the sample group, from which 114 students responded. Next, the questionnaire data were related to the final test results for the 'Economics and Money' course. The results from 106 subjects were finally made use of. (The test score data for eight subjects were insufficient for our purposes (too many missing values)). The following table presents the frequency distribution of the remaining sample, taking into account the date they passed the summative test. Statistical analysis (t-test) reveals that there are no significant differences between the mean scores of the students in the initial and final cohorts.

Table 2: Frequency distribution of LS and ES in relation to the date they passed the final test

Group	Frequency		
	ES	LS	ES+LS
1	7	13	20
2	5	5	10
3	3	4	7
4	2	5	7
5	2	6	8
6	5	2	7
7	5	5	10
8	10	2	12
9	2	9	11
10	6	8	14
Total	47	59	106

3 Research results and discussion

3.1 Introduction

In analyzing the research findings, the test scores were reviewed in relation to personal and contextual variables as possible indicators. As indicated earlier, one of the more important variables in the actual investigation is the 'student type' of the students involved (ES or LS).

3.2 ES obtain better test scores than LS

The results of the analysis clearly indicate that the test-scores of ES & LS does not differ ($F=1.90$, $p_r=.172$). This seems in contrast with the findings of ex post facto research project 1 (chapter 5). However, multiple classification analysis (MCA)² of the above results reveals a very consistent trend:

Table 3: MCA table of total test scores in relation to student type (ES or LS)

ES	LS
1.92	-1.53

Although not significant, there is a tendency that economics students (ES) obtain a positive mean deviation from the mean of the total sample; the contrary is true for law students (LS). Before drawing a conclusion in relation to the above hypothesis about the interrelation between student type and test scores, it is helpful further to analyze the total test scores by looking at specific sub-scores.

3.3

Scores of ES and LS for open-ended and multiple-choice questions

Analysis of variance in the test scores of LS and ES reveals that there are no significant differences. The analysis has been carried out for the open-ended items (OE), multiple-choice items (MC) and the total test (OE + MC).

² Multiple Classification Analysis (MCA) shows the mean difference between the mean scores of a specific subpopulation and the mean of the total experimental population. MCA helps in this way to show "trends" in the scores of the subgroups; even if these differences are not statistically significant (Norusis, 1986; part B, p.174).

Table 4: Analysis of variance in the test scores and student type (ES or LS)

	OE	MC	OE + MC
F	1.69	.87	1.90
P _F	.198	.353	.172

The results of the table suggest that the prior knowledge of ES & LS does not differ. Multiple classification analysis (MCA) of the above results reveals again a consistent trend:

Table 5: MCA table of the test scores in relation to the student type (ES or LS)

	OE	MC	OE + MC
ES	1.29	.63	1.92
LS	-1.03	-.50	-1.53

With the necessary caution, we see from this table that economics students seem to obtain a positive mean deviation from the mean of the total sample; law students obtain a negative mean deviation from the mean.

3.4 Test scores for test-items measuring the mastery of declarative and procedural knowledge

Table 6 gives the results of an analysis of variance in the test results of ES and LS in relation to this type of questions. A distinction has been made between declarative and procedural questions. We feel it should be repeated that 10 parallel versions of the test have been used; therefore the analysis is repeated for each version of the test. Moreover the analysis is only executed for the multiple-choice questions. Table 6 presents the F and p_F values and includes data from a further multiple classification analysis (MCA) of the results.

Table 6: Analysis of variance of test results for declarative and procedural questions with student type (ES or LS) and MCA data

	Declarative questions				Procedural questions			
	F	P _F	MCA		F	P _F	MCA	
			ES	LS			ES	LS
1	1.296	.270	-.79	.42	.484	.495	-.36	.20
2	.535	.485	1.60	-1.60	.074	.792	.10	-.10
3	.357	.576	-.57	.43	.065	.809	-.10	.07
4	.016	.906	-.43	.17	1.190	.325	-.71	.29
5	.713	.431	3.00	-1.00	.196	.674	.38	-.13
6	.079	.790	-.34	.86	1.531	.271	-.43	1.07
7	1.235	.299	2.60	-2.60	6.145	.038	1.30	-1.30
8	.275	.612	-.27	1.33	.009	.927	.02	-.08
9	.580	.466	-3.36	.75	4.091	.074	-.68	.15
10	.210	.655	-.57	.43	.274	.610	.38	-.29

There are no significant differences between ES and LS in relation to their scores for declarative or procedural questions. The MCA-data do not reveal a consistent trend in the results. As a consequence, the hypothesis about the relationship between these two variables (student type x type of questions) is to be rejected.

3.5 Scores for items with a high difficulty index

There are no significant differences between LS and ES in relation to high or low difficulty indexes of the multiple-choice questions (Figure 1). Only a trend can be observed: LS get higher scores for items with a low p-value. This trend is not observed when comparing items with a high difficulty index.

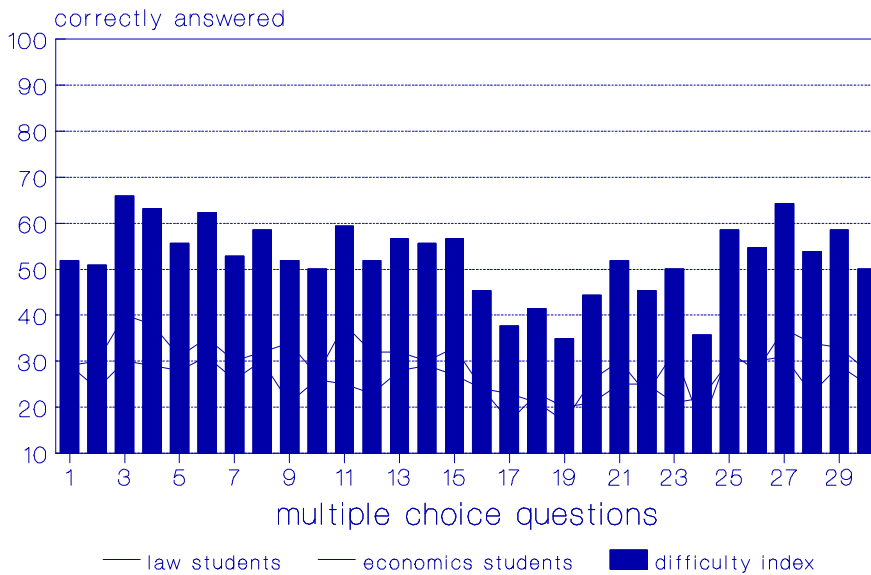


Figure 1: Differences between LS and ES in relation to high or low difficulty indexes of the multiple-choice questions

3.6 Contextual and personal variables as relevant indicators of prior knowledge

The answers on the questionnaire helped to derive 77 other personal and contextual variables (see Dochy, Bouwens, Wagemans and Niestadt, 1991) as potential indicators of prior knowledge. These variables were related to different categories: personal variables, motives, study time, former education, certifications, attended sorts of educational institutions, nature of profession, position in society, payment of professional work and working time. In analysing the test results, the difference between open-ended and multiple-choice questions was taken into account and the students were also grouped in accordance to their test scores in a high group (33%), a medium group (33%) and a low group (33%).

The overall correlation matrix of the personal and contextual variables with the test scores reveals few significant correlations, with the exception of some obvious correlations between, for example, previous educational level and test scores.

Age

Age (students \leq 30), as a particular personal variable, does not reveal significant differences in the final test scores (OE, MC or OE+MC).

Previous educational level

Students educated to previously university level (WO) seemed to belong to a very considerable extent to the high group when grouping the students in relation of their final test scores.

Remarkable is the significant, negative correlation (-.98**) between high test results and students previously educated to secondary level (VO) with mathematics as a main topic. Also it should be noted that amongst students in this experimental sub-group, the majority did not take mathematics as a main subject. This is remarkable since 'mathematics' is a prior knowledge requirement for the 'Economics and Money' course.

Job and job level

There is a slight significant correlation between test scores for the multiple-choice questions and a certain 'job level'. 81 % of the students with a lower job level (12% of the experimental group) obtain high scores for this type of question. Students working in the sector 'Trade and Traffic' (9.4% of the sample) obtain mean scores lower than the mean of the total experimental group.

Students with low test scores: interaction with other indicators

When focusing the analysis on students with low final test scores (N=39), there are no significant correlations with test scores for the open-ended questions (this sub-group of the experimental group does not comprise students with a previous university degree).

Analysis of the scores for the multiple-choice questions does reveal interesting information: 71.4% of the male students have a mean score higher than the mean for the entire group; 72.7% of the female students obtain test scores lower than the mean.

4 Conclusions

The results of this investigation can be summarized as follows:

- The expected differences between economics students and law students cannot be confirmed, but, nevertheless, there is a tendency that economics students perform better than law students.
- The difficulty level of the test-items does not reveal significant differences between ES and LS students.
- The hypothesis that personal and contextual variables could be valuable as indicators of prior knowledge is to be rejected. This agrees with findings of earlier research (see Powell, Conway and Ross, 1990). Past research has - yet - not been able to detect relevant and valid 'indicators'. 'Interestingly, the level of previous educational experience (formal qualifications), although measured in the study, did not enter the model as a significant predictive factor' (Powell, et al., 1990). Although Powell et al. suggest that 'subjective ratings' might be better indicators of prior knowledge, this research direction does not show a hopeful perspective (see chapter 4) and is not helpful for educational purposes. Subjective perceptions are difficult to influence and to change. Moreover it is difficult to relate them to the acquisition of knowledge to be learned or the knowledge already mastered. In other words, they are of little help in facilitating the educational process or in making it more flexible. At best we could say that previous university education is a possible indicator, but a very weak one since the population consists only of 10 % of such students.
- The slight significant correlation between test results and specific personal and contextual variables (e.g. preliminary educational level) are of little use as indicators of prior knowledge since they cannot be manipulated.

The overall conclusion of this investigation is that research in the field of prior knowledge will have to be reoriented. In our view, an in-depth analysis and assessment of the virtual prior knowledge state of students is a more promising track. Therefore, the development of prior knowledge state tests will probably be of great value.

"Show me which level of prior knowledge you have reached and I will tell you how to reach study success efficiently".

Chapter 6

Are personal and contextual variables good indicators of prior knowledge? Ex post facto research project 2

		99	
1	<i>Introduction</i>	99	
2	<i>Research design</i>	99	
2.1	<i>Hypotheses</i>	99	
2.2	<i>Research population</i>	100	100
2.3	<i>Research instruments</i>	100	
2.3.1	<i>The questionnaire</i>	100	
2.3.2	<i>The subject-oriented knowledge test</i>	101	
2.4	<i>Research procedure</i>	103	
3	<i>Research results and discussion</i>	104	
3.1	<i>Introduction</i>	104	
3.2	<i>ES obtain better test scores than LS</i>	104	
3.3	<i>Scores of ES and LS for open-ended and multiple-choice questions</i>	104	
3.4	<i>Test scores for test-items measuring the mastery of declarative and procedural knowledge</i>		105
3.5	<i>Scores for items with a high difficulty index</i>	106	
3.6	<i>Contextual and personal variables as relevant indicators of prior knowledge</i>	107	
4	<i>Conclusions</i>	108	