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Learning Preferences Reported by Engineering Students*

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A learning styles questionnaire (LSQ) was designed to check engineering students' learning preferences in such aspects as favoured learning sequence, relative emphasis on studying problems or theory, problem-solving methods and the value of mathematical connections. These learning preferences were then related to Myers–Briggs Type Indicator personality type, particularly to the sensing/intuition dimension. This paper presents comparative response data for both first-year and senior-year engineering students.

INTRODUCTION

THE MYERS–Briggs Type Indicator (MBTI) [1] is a self-report, forced-choice personality instrument well used in engineering education [2], which identifies basic individual preferences regarding perception and judgment, and expresses them on four separate bipolar scales: extraversion/intraversion (E/I), sensing/intuition (S/N), thinking/feeling (T/F) and judgment/perception (J/P). Each person uses all eight functions and attitudes but usually favours four of them. These four preferences, the MBTI type, model an individual's consciousness and influence his or her attitudes and behaviours including learning styles and study habits.

This study reports student responses to a learning styles questionnaire (LSQ) which was designed to probe student learning preferences in engineering courses with particular reference to possible differences that might relate to the S/N perception dimension of the MBTI. Any results that do connect learning preferences to MBTI type will help to make the MBTI a more useful framework for student academic counselling.

Engineering students are uniformly represented on the S/N scale of MBTI: about 50% S and 50% N. McCaulley [3] has suggested that S type students would benefit from step-by-step instruction containing practical examples and attention to detail, whereas N types would benefit from exposure first to theoretical principles followed by examples and applications.

A previous experiment in problem-solving [4], though limited by its small scale, suggested that all engineering students, irrespective of their S/N type or of the nature of the immediate teaching treatment, seemed to address the solving of algorithmic problems in the same way: by attempting a formula-centred solution with no reference to concept or the underlying physics.

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Another study [5] recorded student protocols as they read texts selected to be S style or N style. The results showed that these mechanical engineering students read the book first for problems and examples and only as a last resort read for theoretical textual explanations. The students were more active reading the text than they were in lectures, and controlled the learning—both the rate and the sequencing. The S students read the topic more carefully for details and tried to picture the problem, whereas N students tended to skim the material and were more concerned to hook the topic into the overall context of the subject.

This study presents students' responses to a learning style questionnaire analysed in relation to MBTI type. In particular, to what extent are the learning preferences of engineering students congruent with their S/N type? Do S students prefer detailed, specific, inductive presentations and N students a broader more abstract, conceptual, deductive approach? Do S students prefer to spend study time on problems and N students prefer to study concepts? Do S students tend to categorize problems more than N students and do N students enjoy algebraic examples, mathematical connections and novel problems more than S students? Finally, as Rodman [6] suggests, do all students irrespective of type respond more in accordance with those learning behaviours that make them successful in engineering courses rather than with their natural preferences?

METHOD

The MBTI and LSQ shown in the Appendix were administered in the same first-year class of 266 students. These students have not yet selected their particular engineering discipline.

The LSQ was also administered in several third- and fourth-year classes to a total number of 188 senior-level students. About half this group, 95

Table 1. Number of students

	Number of students	
	Year 1	Year 3/4
Total number in study	266	188
Number completing MBTI	266	95
Number completing LSQ	266	188
Number in mechanical engineering		105
Number in electrical engineering		62

students, were of known MBTI type. Within this group of senior students there were 105 mechanical engineering students and 62 electrical engineering students. These student numbers are summarized in Table 1.

The student responses were analysed in two ways. A direct chi-square analysis of the LSQ data compared average first-year responses with average senior-year responses for significant differences between these two groups. Similarly, senior electrical student responses and senior mechanical student responses were compared for significant differences. Secondly, for those students of known MBTI type it was possible to sort out students agreeing with Q3 (for example) and compare their type table distribution with all students responding to Q3. Such a selection ratio type table (SRTT) analysis was run separately for first-year responses and senior-year responses of each of the LSQ questions.

In the following results sections the responses to the LSQ questions have been grouped into four areas by topic and the main results derive from the SRTT analyses. Also included are the results from those cases where the chi-square analyses of the average responses gave significant results.

LEARNING SEQUENCE

Questions 1 and 2 on the LSQ with confirmation from Q6 were meant to elicit student preferences for inductive or deductive sequencing, and thus to check the suggestion that S types might prefer inductive and N types a deductive presentation.

Table 2 shows the main student responses to Q1, Q2 and Q6 of the LSQ. Over 70% of students preferred the sequence of concept followed by example, both in lecture and textbook presentation. Their remaining responses were split almost equally between the three remaining choices. All students were less positive about the preferred presentation sequence for the written textbook, probably because the reader can dictate his or her own reading sequence if necessary.

The upper-year students were a little more positive about the deductive sequence in lectures than the first-year students and the chi-square analysis confirmed the difference at the 0.02 level. The only significant type differences were that N first-year students were overrepresented in the group preferring 'thorough concept presentation followed by brief example' and also in 'grasping overall concept first' (Q6). The result that the first-year students are responding 'to type' on these questions, whereas the upper-year students are not, might reflect the fact that most engineering courses are 'concept followed by several examples' pattern and upper-year students, irrespective of type, have learnt to recognize this as a familiar, successful presentation sequence.

EMPHASIS ON PROBLEMS

Problems and worked examples feature significantly in most engineering courses and all students recognize them as a necessary way to learn the course material and an even more necessary route to passing the course examinations. Do S students,

Table 2. Analyses of responses to Q1, Q2 and Q6 of the LSQ

	% Students agreeing (type overrepresented)	
	Year 1	Year 3/4
1. In a *lecture presentation* of a new topic		
(A) I like a thorough presentation of the overall concept (the big picture, the underlying theory) followed by a brief example.	19.2% (N*)	11.6%
(B) I like *equal emphasis* on concept and example, but I like to have the *concept first*.	51.1%	66.3%
2. Topic *from a textbook*		
(A) I like a thorough presentation of the overall concept (the big picture, the underlying theory) followed by a brief example.	9.8%	8.4%
(B) I like *equal emphasis* on concept and example, but I like to have the concept first.	56.0%	62.8%
6. I like to grasp the overall concept and global ideas first.	74.9% (N*)	78.9%

* $P < 0.05$.

though, with inclination towards details, facts and drill-and-practise procedures appreciate problems even more?

The results shown in Table 3 confirm that most students like numerical examples and working on problems but that S students, both first-year and upper-year, like them significantly more.

The first-year students emphasize working problems when studying alone even more than the upper-year students and the chi-square analysis confirmed this difference at the 0.01 level. In explanation of this difference it should be noted that most first-year courses are almost exclusively problems and also that upper-year students, after three or four years at university, should have developed a healthy respect for the value of understanding the concepts and theories!

PROBLEM-SOLVING STRATEGIES

Three of the questions in the LSQ referred to the students' preference for categorizing the problems or making use of a checklist strategy. The analyses of the student responses to these questions is shown in Table 4.

The senior students appreciated a checklist strategy more than the first-year students and a chi-square analysis showed this difference to be significant at the 0.02 level. Once again the students might be thinking of different problem types: the first-year closed problems are more straightforward and might not benefit from a checklist strategy in the same way that a more open-ended design procedure might. The first-year students preferring a checklist strategy were significantly more IJ, which may be explained by the I needing the security and the J the organization afforded by the checklist. There is no obvious reason why the E senior students have a greater preference for the checklist.

Most students, both first year and seniors, agreed it was useful to categorize a test problem into a problem type. The S students with their preference for drill-and-practise problem solving and the SJ students with their preference for system and order feature significantly in this first-year group. The upper students were significantly overrepresented in various combinations of S, T and J, representing preferences for practise, logical analysis, and order respectively, which are all attributes needed to categorize problems into types.

The preference for categorizing a test problem as 'exactly similar' appealed to the first year but not so much to the seniors. This difference in response produced a chi-square significance level of 0.001. Perhaps the senior students realize that test problems are almost never the same as a previously solved problem. The S students with their better application to problem solving practise are over-represented in the first-year students trying to match a test problem with an exactly similar one. The F students are also significantly featured in this group, for no obvious reason: could it be that they hope, albeit illogically, for exactly similar test problems?

Table 3. Analyses of responses to Q3 and Q8 of the LSQ

	% Students agreeing (type overrepresented)	
	Year 1	Year 3/4
3. I like lots of numerical examples.	79.6% (S*)	75.8% (S*)
8. When I work alone, I prefer to concentrate on working problems rather than study theories and concepts.	74.7% (S**)	58.9% (S**)

* $P < 0.05$; ** $P < 0.01$.

Table 4. Analyses of responses to Q4, Q9 and Q10 of the LSQ

	% Students agreeing (type overrepresented)	
	Year 1	Year 3/4
4. I like to see a check list strategy for solving each problem type.	58.3% (IJ**)	72.0% (E*)
9. When I am presented with a test problem I try to categorize it into *a type* for which I know the routine solution.	70.8% (S*SJ*)	66.3% (T*SJ*ST*TJ**EJ**)
10. When I am presented with a test problem I try to recognize it as an exactly similar problem that I have previously solved.	61.5% (F**S*)	36.8%

*$P < 0.05$; **$P < 0.01$.

MATHEMATICAL RELATIONSHIPS AND NOVEL PROBLEMS

Table 5 shows the student responses to questions about their preferences for mathematical similarity and working novel problems.

Only 40% of the students preferred algebraic to numerical worked examples, whereas almost twice that many appreciated seeing mathematical relationships between one area and another. These questions did not produce any significant difference by type but the chi-square analyses of Q7 showed that first-year students preferred 'mathematical similarities' to the seniors (0.001), and also, within the senior group, the electrical were significantly (0.01) more positive than the mechanical. It is disappointing that the senior students are less interested to see mathematical similarities between areas than the first year. Could that be a reflection on the way concepts and derivations are compartmentalized (except in electrical) within engineering course presentations?

There were about 40% of students who enjoyed solving problems of a type new to them. These students were significantly N and P. The intuitive students would be better at making the leap from the known problem to the new one and more confident of making the connection. The perceptive students are more curious about a wide range of subjects including, in this case, new problems, and would be more prepared to try something novel. The senior students as a group were more J (0.01) than the first year, and the chi-square comparison, which showed first-year students to be significantly (0.01) more interested in new problems, might be reflecting the need the seniors have for order and predictability. The chi-square comparison of the electrical students with the mechanical on this question showed the mechanicals to be much surer (0.05) that they did not want new problems!

CONCLUSION

The learning style questionnaire used in this study is an imperfect instrument but with experience several of its questions may be refined and focused more sharply. Nevertheless, even in its present form the LSQ has provided interesting comparisons of the detailed learning style preferences between first-year and senior-year engineering students. Also the LSQ responses have enabled specific learning preferences to be better connected with MBTI type, which increases the usefulness of the indicator for the academic counselling of engineering students.

Table 5. Analyses of responses to Q5, Q7 and Q11 of the LSQ

	% Students agreeing (type overrepresented)	
	Year 1	Year 3/4
5. I prefer algebraic rather than numerical worked examples because mathematical relationships are more obvious.	39.9%	43.1%
7. I like to see mathematical similarities between one area or another.	80.8%	67.3%
12. I enjoy tackling problems of a type that I have never seen before.	41.5% (N***P**)	36.8% (N**IN*)

*$P < 0.05$; **$P < 0.01$. ***$P < 0.001$.

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APPENDIX

TEACHING/LEARNING PREFERENCE QUESTIONNAIRE

This questionnaire refers to your teaching/learning preferenes only and does not relate to any particular course or instructor.

Part A

Select from the following responses to answer questions 1 and 2.

A. I like a thorough presentation of the overall concept (the big picture, the underlying theory) followed by a brief example.

B. I like equal emphasis on concept and example, but I like to have the concept first.

C. I like equal emphasis on concept and example, but I don't care which sequence in which they are presented.

D. I like equal emphasis on concept and example, but I like to have the example first.

E. I like lots of examples and applications first and then a brief statement of the concept.

F. Write your own.

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1. In a lecture presentation of a new topic in an engineering course, which of the above responses best describes your preferred style?

   circle one: A B C D E F

2. If you are learning a new engineering topic from a textbook, which of the above responses best describes your preferred style?

   circle one: A B C D E F (Please turn over)

Part B

Please respond to the following statements as to whether you agree or disagree by circling the number that best characterizes your preference

(1) strongly agree
(2) agree
(3) Neutral
(4) disagree
(5) strongly disagree

	Agree 1	2	3	4	Disagree 5
3. I like lots of numerical examples.	1	2	3	4	5
4. I like to see a check list strategy for solving each problem type.	1	2	3	4	5
5. I prefer algebraic rather than numerical worked examples because mathematical relationships are more obvious.	1	2	3	4	5
6. I like to grasp the overall concept and global ideas first.	1	2	3	4	5
7. I like to see mathematical similarities between one area and another.	1	2	3	4	5
8. When I work alone, I prefer to concentrate on working problems rather than study theories and concepts.	1	2	3	4	5
9. When I am presented with a test problem I try to categorize it into a type for which I know the routine solution.	1	2	3	4	5
10. When I am presented with a test problem I try to recognize it as an exactly similar problem that I have previously solved.	1	2	3	4	5
11. I enjoy tackling problems of a type that I have never seen before	1	2	3	4	5

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