

BASIC MATHEMATICAL SKILLS OF U.C.C. STUDENTS

(A report on a test administered in October 1985)

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1. INTRODUCTION AND SUMMARY

A recent article [1] in this journal gave evidence of serious deficiencies in the mathematical skills of many students entering Cork R.T.C. in Autumn 1984. We wish to report here similar evidence showing that many students entering Science (and a small number entering Arts) in U.C.C. in Autumn 1984 displayed the same disturbing inability to cope with short basic mathematical problems. We discuss the implications of these results.

2. THE STUDENTS; THE TEST

First year Science students in U.C.C. must take one of the subjects Mathematics (M) or Mathematical Methods (MM). The choice is based on the student's planned career path in later years at U.C.C. On the evidence of Leaving Certificate grades, M students are on average mathematically superior to MM students.

It was decided to administer a test to 1st Science students in Autumn 1985 to determine which mathematical deficiencies (if any) were widespread among them. Such deficiencies would then be tackled by, for example, assigning specific students to small group tutorials. As MM already contained a remedial mathematics component, the test was only given to M students. This group also included some 1st Arts students who were taking computer studies and/or honours mathematics.

The test was given at the end of the second week of classes. It consisted of thirty multiple choice questions, with four possible answers per question, to be completed in one hour.

The students were warned in advance of the test and were provided with copies of a similar test given to the previous year's 1st Science students. The questions were based on material common to both the Higher and Ordinary Level Leaving Certificate course in Mathematics, with the exception of Q.29 which is exclusively Higher Level. Use of calculators or of mathematical tables was not allowed.

We used the following marking scheme. Each correct answer received 1 mark. Each incorrect answer received $-\frac{1}{3}$ mark. No marks were added or subtracted for questions not attempted. Students were advised not to guess answers.

While no pass mark for the test was set in advance, it was felt that, considering the basic nature of the material, a score of at least 20 marks should be expected from any competent student. In the event, 219 students (165 Science, 54 Arts) sat the test and the average score was 16.7 marks. Appendix A lists the test questions and Appendix B the students' success rate for each question (the number of students answering correctly being expressed as a percentage of the number who attempted the question). These results show that logarithms (Q.21, 27) were not understood by the majority of the students (a familiar complaint of third-level lecturers). On the more elementary technique of conversion of units (Q.26) only a dismal 31% of the students answered correctly. The success rates for Q.1, 10, 12, 22 and 23 are also very poor given the basic level of these questions.

3. IMPLICATIONS OF THE RESULTS

The results of this test are similar to those of tests administered to First Science students for the past four years. In discussing the situation with colleagues teaching mathematics at other third-level institutions in Ireland, it is clear that the same weaknesses are prevalent among students nationally. We believe that if similar tests were given to students in

other colleges, the results would be the same. Some colleagues might wish to try.

This is disturbing at two levels. First there is the lack of numerate skills which are required by all adults to cope with everyday living, not to mention studying science at College. Because of the wider use of calculators, micro-computers and computers, the trend is to rely more and more on quantitative presentation of information. The evidence suggests that we can't be confident that all First Science students at U.C.C., let alone the population at large, have mastered the requisite numerate skills.

The second level of concern about the results of these tests is related to studies being undertaken by First Science students at U.C.C. In their other courses (Physics, Chemistry and Biology), it is assumed that they have a basic understanding of topics such as trigonometry, logarithms and exponentials. Furthermore, analysis of laboratory results and the representation of data by graphical methods are also causing difficulties.

Why do students not have the desired basic skills and what can be done about it? While we decry the state of affairs, we must try to determine the causes and rectify them. Recently the Irish Mathematical Society and the Irish Mathematics Teachers' Association agreed to formal links. One area which could be investigated by both immediately, in their publications, is this problem. It is also time for those of us teaching mathematics at third-level institutions to take an interest in and play an active role in designing the mathematics curriculum at first and second levels.

It is not enough to complain about the poor performance of our first year students; we have a responsibility to discuss the issues with mathematics teachers and learn of their difficulties and efforts to cope with a syllabus that many feel is in need of reform.

APPENDIX A

- No. 1 $\sqrt{x^2 + 25}$ is equal to
A) $5x$ B) $x + 5$ C) $\sqrt{x-5(x+5)}$ D) none of these
- No. 2 $\sqrt{x} - x\sqrt{x}$ is equal to
A) $\sqrt{x}(1 - x)$ B) $-x$ C) $\frac{x^{\frac{1}{2}}}{x^{\frac{1}{2}}}$ D) $\frac{1}{2}(x - x^2)$
- No. 3 $\cos^2\sqrt{1+x}$ is equal to
A) $\sqrt{1+x} \cos\sqrt{1+x}$ B) $(\cos\sqrt{1+x})(\cos\sqrt{1+x})$ C) $\cos(1+x)$ D) $2\cos\sqrt{1+x}$
- No. 4 $(\sqrt{x})^3$ is equal to
A) $x^{\frac{1}{3}}$ B) $x^{\frac{7}{2}}$ C) $(x^3)^{\frac{1}{2}}$ D) $x^{\frac{3}{2}}$
- No. 5 $\log x + \log x^2$ is equal to
A) $2\log^2 x$ B) $\log 2x^2$ C) $3\log x$ D) $\log 3x$
- No. 6 Which of the following is a solution to the equation $x^2 - 0.04 = 0$?
A) .02 B) .002 C) -.2 D) none of these
- No. 7 If $x = 10^k$ and $y = 10^{-m}$, then $\log_{10} xy$ is
A) mk B) $\frac{k}{m}$ C) 10^{k-m} D) $k-m$
- No. 8 $\frac{.0032 \times 5.71}{4 \times .04}$ is equal to
A) .1042 B) 1.142 C) .1142 D) none of these
- No. 9 Which of the following is a solution of the equation $x^3 - (x-2)(3-x) - 8 = 0$?
A) 2 B) 0 C) -2 D) none of these
- No. 10 The solution of $\frac{3x^2}{x^2 - 4} = 0$ is
A) $x = \pm\sqrt{3}$ B) $x = 0$ C) $x = \pm 2$ D) $x = \pm 2$ or 0

No. 11 The area of an equilateral triangle of side 3 cm is

- A) $\sqrt{3} \text{ cm}^2$ B) 4.5 cm^2 C) $9\sqrt{3} \text{ cm}^2$ D) $\frac{9\sqrt{3}}{4} \text{ cm}^2$

No. 12 Only one of the following is true. Which is it?

- A) $\pi = 3.14$ B) $\frac{9}{12} < \frac{4}{5} < \frac{5}{6}$ C) $\tan 45^\circ = \frac{\sqrt{3}}{2}$ D) $\frac{7}{12} < \frac{8}{15} < \frac{2}{5}$

No. 13 $\frac{0.00125 \times 10^{-5}}{10^{-8}}$ is equal to

- A) 125 B) 12.5 C) 1.25 D) 0.125

No. 14 If $v = u + at$, express a in terms of u , v and t .

- A) $\frac{v-u}{t}$ B) $\frac{v}{u} - t$ C) $\frac{uv}{t}$ D) $\frac{v-u}{t}$

No. 15 Given that $s = \frac{p^3 - q^3}{r^2}$ find s when $p = -1$, $q = 3$ and $r = 8$

- A) $-\frac{7}{16}$ B) $-\frac{7}{64}$ C) $-\frac{13}{32}$ D) $-\frac{1}{8}$

No. 16 Solve the following equation to find the value of x :

$$\frac{x-1}{x-3} + 3 = 5. \quad \text{The solution is}$$

- A) 5 B) -1 C) $\frac{17}{4}$ D) none of these

No. 17 $2^n + 2^n$ is equal to

- A) 2^{n+1} B) 2^{2n} C) 4^n D) none of these

No. 18 $\sqrt{0.00016}$ is equal to

- A) 0.0126 approx. B) 0.04 C) 0.00126 approx. D) 0.004

No. 19 Simplify $\left(\frac{t^{-3}(t^{-2})}{t}\right)^2$

- A) t^{18} B) t^{-2} C) t^{-4} D) t^6

No. 20 The area of a circle of diameter d is

- A) πd^2 B) $2\pi d$ C) $\pi d^2/2$ D) $\pi d^2/4$

No. 21 $\frac{\log 20}{\log 5}$ equals

- A) $\log 4$ B) $\log 15$ C) 4 D) none of these

No. 22 2π radians = 360° , so 60° is closest to

- A) 0.5 radians B) 1 radian C) 1.5 radians D) 2 radians

No. 23 The value of 4×10^3 divided by 8×10^7 is

- A) 5×10^{-5} B) 5×10^{-3} C) 2×10^4 D) 2×10^{-4}

No. 24 $\frac{\sin \frac{\pi}{2}}{2}$ is equal to

- A) $\sin \frac{\pi}{4}$ B) $\sin \pi$ C) 0 D) $\frac{1}{2}$

No. 25 In the triangle , $\cos A$ is equal to

- A) $3/4$ B) $2/4$ C) $2/3$ D) none of these

No. 26 Express 0.01 m^3 in cm^3

- A) 1 cm^3 B) 10^3 cm^3 C) 10^4 cm^3 D) none of these

No. 27 Given that $\log_{10} 5 = 0.699$ (approx.), $\log_{10} 0.005$ is approximately

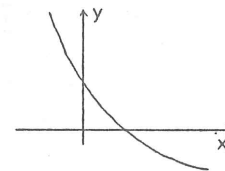
- A) -3.699 B) -3.301 C) -2.301 D) 0.00699

No. 28 $\sin^2 x - \cos^2 x$ is equal to

- A) -1 B) $2\sin^2 x - 1$ C) $\sin x - \cos x$ D) $1 + 2\cos^2 x$

No. 29 For the graph

- A) $\frac{dy}{dx} > 0$ and $\frac{d^2y}{dx^2} > 0$ B) $\frac{dy}{dx} > 0$ and $\frac{d^2y}{dx^2} < 0$
C) $\frac{dy}{dx} < 0$ and $\frac{d^2y}{dx^2} > 0$ D) $\frac{dy}{dx} < 0$ and $\frac{d^2y}{dx^2} < 0$



No. 30 If $x^2 < 4$, then

- A) $x < \pm 2$ B) $x < 2$ C) $x > 0$ D) none of these

APPENDIX B

	Number Choosing Each Answer				Number of Correct Answers	Total Number of Students Attempting Question	% Success Rate (See Text)
	A	B	C	D			
QUESTION 1	0	26	33	144	144	209	69
QUESTION 2	189	9	1	3	189	202	94
QUESTION 3	2	159	6	13	159	180	88
QUESTION 4	10	16	163	6	163	195	84
QUESTION 5	18	9	123	4	128	159	81
QUESTION 6	10	0	153	47	153	210	73
QUESTION 7	1	12	23	129	129	168	77
QUESTION 8	5	17	143	38	145	205	71
QUESTION 9	185	1	0	22	185	208	89
QUESTION 10	5	136	25	30	136	196	69
QUESTION 11	0	45	17	93	93	155	60
QUESTION 12	47	149	1	5	149	208	72
QUESTION 13	1	6	151	6	194	207	94
QUESTION 14	0	0	1	207	207	208	100
QUESTION 15	202	2	5	1	202	210	96
QUESTION 16	196	1	3	10	196	210	93
QUESTION 17	101	46	14	46	101	207	49
QUESTION 18	136	7	12	40	136	196	69
QUESTION 19	168	10	3	2	159	188	89
QUESTION 20	7	1	33	159	159	205	78
QUESTION 21	19	62	10	75	75	166	45
QUESTION 22	59	111	11	5	111	186	60
QUESTION 23	133	19	3	41	133	201	66
QUESTION 24	22	11	13	141	141	193	73
QUESTION 25	8	64	4	116	116	192	60
QUESTION 26	83	21	57	25	57	186	31
QUESTION 27	62	5	62	25	62	154	40
QUESTION 28	16	123	3	14	123	159	77
QUESTION 29	17	19	39	30	39	105	37
QUESTION 30	86	58	0	60	58	204	28

REFERENCE

1. Report on the Basic Mathematical Skills Test of First Year Students in Cork R.T.C. in 1984. *I.M.S. Newsletter* 14 (1985) 33-43.

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