BASIC MATHEMATICAL SKILLS OF U.C.C. STUDENTS

(A report on a test administered in October 1985)

Donal Hurley and Martin Stynes

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 0.29 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 -½ 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 (185 Science, 34 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 (0.21, 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 (0.26) only a dismal 31% of the students answered correctly. The success rates for 0.1, 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, microcomputers 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) \( x \sqrt{X(1-x)} \) C) \( \frac{1}{x} \sqrt{X(1-x)} \) D) \( \frac{1}{x} \sqrt{X} \)

No. 3 \( \cos^2 \sqrt{x+z} \) is equal to
A) \( \sqrt{x} \cos \sqrt{x+z} \) B) \( \cos(\sqrt{x+z}) \) C) \( \cos(\sqrt{x+z}) \) D) \( 2 \cos(\sqrt{x+z}) \)

No. 4 \( (\sqrt{x})^3 \) is equal to
A) \( x^3 \) B) \( x^2 \) C) \( x^3 \sqrt{x} \) D) \( x^2 \sqrt{x} \)

No. 5 \( \log x + \log x^2 \) is equal to
A) \( 2 \log x \) 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) \( 0.02 \) B) \( 0.002 \) 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 \( \frac{0.0032 \times 5.71}{4 \times 0.04} \) is equal to
A) \( 1.042 \) B) \( 1.142 \) C) \( 1.142 \) D) none of these

No. 9 Which of the following is a solution of the equation \( x^2 - (x-2)(3-x) = 8 \)?
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) $\sqrt{3}$ cm²  B) 4.5 cm²  C) $9\sqrt{3}$ cm²  D) $\frac{9\sqrt{3}}{4}$ cm²

No. 12 Only one of the following is true. Which is it?
   A) $x = 3.14$  B) $\frac{9}{17} \times \frac{4}{5} < \frac{5}{6}$  C) $\tan 45^a = \frac{\sqrt{2}}{2}$  D) $\frac{7}{12} < \frac{8}{15} < \frac{2}{5}$

No. 13 $0.00125 \times 10^{-4}$ is equal to
   A) 125  B) 12.5  C) 125  D) 0.125

No. 14 If $v = u + at$, express $a$ in terms of $u$, $v$ and $t$.
   A) $\frac{v - u}{t}$  B) $\frac{u}{v - t}$  C) $\frac{uv}{t}$  D) $\frac{v - u}{t}$

No. 15 Given that $s = \frac{r^2 - q^2}{2r}$, find $s$ when $r = 3$, $q = 3$ 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 $x$:
   \[ \frac{x+1}{x-3} + 3 = 5 \]
   The solution is
   A) 5  B) -1  C) $\frac{17}{4}$  D) none of these

No. 17 $z^6 + z^4$ is equal to
   A) $2^{11}$  B) $2^{2h}$  C) $4^n$  D) none of these

No. 18 $\sqrt{0.00016}$ is equal to
   A) 0.0126 approx.  B) 0.04  C) 0.00016 approx.  D) 0.004

No. 19 Simplify $(1^2 - 3)(2 - 2)^2$.
   A) $t^2$  B) $t^2$  C) $t^4$  D) $t^6$

No. 20 The area of a circle of diameter $d$ is
   A) $\pi d^2$  B) $\frac{2}{\pi} d^2$  C) $\pi d^2/2$  D) $\pi d^2/4$
   -72-

No. 21 $\frac{\log 20}{\log 5}$ equals
   A) $\log 4$  B) $\log 15$  C) 4  D) none of these

No. 22 $2\pi$ radians = $360^a$, so $60^a$ is closest to
   A) 0.5 radians  B) $\frac{1}{2}$ radians  C) 1.5 radians  D) 2 radians

No. 23 The value of $4 \times 10^3$ divided by $8 \times 10^7$ is
   A) $5 \times 10^{-9}$  B) $5 \times 10^{-3}$  C) $2 \times 10^4$  D) $2 \times 10^{-4}$

No. 24 $\sin \frac{\pi}{2}$ is equal to
   A) $\sin \frac{\pi}{4}$  B) $\sin \frac{\pi}{2}$  C) 0  D) $\frac{1}{2}$

No. 25 In the triangle $\triangle A$ is equal to
   A) $\frac{3}{4}$  B) $\frac{2}{4}$  C) $\frac{2}{3}$  D) none of these

No. 26 Express $0.01 m^3$ in cm³
   A) 1 cm³  B) $10^3$ cm³  C) $10^4$ cm³  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) $2\sin x - 1$  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) $x < 2$  B) $x < 2$  C) $x > 0$  D) none of these
### Appendix B

<table>
<thead>
<tr>
<th>Correct Answer</th>
<th>Number Choosing Each Answer</th>
<th>Total Number Attempting Question</th>
<th>Success Rate (per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>B</td>
<td>26</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 1</td>
<td>15</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 2</td>
<td>16</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 3</td>
<td>18</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 4</td>
<td>16</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 5</td>
<td>18</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 6</td>
<td>19</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 7</td>
<td>17</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 8</td>
<td>16</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 9</td>
<td>18</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 10</td>
<td>17</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 11</td>
<td>19</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 12</td>
<td>16</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 13</td>
<td>18</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 14</td>
<td>17</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 15</td>
<td>19</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 16</td>
<td>16</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 17</td>
<td>18</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 18</td>
<td>17</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 19</td>
<td>19</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 20</td>
<td>16</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 21</td>
<td>18</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 22</td>
<td>17</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 23</td>
<td>19</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 24</td>
<td>16</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 25</td>
<td>18</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 26</td>
<td>17</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 27</td>
<td>19</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 28</td>
<td>16</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 29</td>
<td>18</td>
<td>102</td>
<td>73</td>
</tr>
<tr>
<td>QUESTION 30</td>
<td>17</td>
<td>102</td>
<td>73</td>
</tr>
</tbody>
</table>

### REFERENCE


Mathematics Department, University College Cork.