Case study 2

A course in mathematical modelling offered by the Faculty of Computing and Mathematics of the Open University/ United Kingdom

This course aims at learners who use mathematical reasoning but are interested in extending it to a wider realm of applications. It is also expected to be interesting for teachers teaching A-level applied mathematics.

The course concentrates on the development of mathematical models for real-world applications. The applications are largely taken from physics covering statics, Newton's laws, and oscillations as well as the motion of rigid bodies. The mathematical techniques required for this extend from numerical methods, differential equations, and linear algebra to advanced calculus.

The course is a level two course and carries 60 CAT points. Students are advised that the course is likely to require a minimum of 448 student learning hours: i.e. at least 14 hours per week for 32 weeks). It counts towards a BA/BSc/MMath.

Resource media: inputs and costs

The course consists of seven blocks. Each of them contains four units of printed texts and one CD-ROM. Further audio-visual media (TV and videocassettes) are added to enhance the learning. A summary of the fixed costs is given in table CS 2.1.

Fixed costs of development

The main teaching resource remains the printed text. With 28 units of about 50 pages each a student has to work through a formidable 1 400 pages of mathematics teaching.

Table CS 2.1: Fixed costs of development

Fixed costs	Type	Amount	Unit cost	Total
Salaries	Academic staff; support & secretarial staff, editorial and design			1 777 392
Development	Consultants			51 030
	Other			48 402
	Subtotal			99 432
Production	Fixed print	(28 units & supplements)		33 558
	CD ROM	Up to 7		283 000
	TV	4 x 25 min	50 784	203 136
	Video	10 hours		380 000
	Subtotal			899 694
	Total fixed costs			2 776 518

Source: OUUK budget data of this course; all costs in £'98; NB Budget costs reflect internal charges, which may differ from actual costs.

Interactive CD-ROMs enhance the printed texts. The CD-ROMs were developed partly in co-operation with the BBC partly by the computing department of the OU. They are supported by Mathcad Pro7 software.

Variable costs of production

The input in resource media for this course is considerable. The participation rate is estimated to be about 1 000 students per year over 8 years. The number of students for whom materials have been prepared up to now were 1 795. This is the basis on which the variable costs incurred up to now have been calculated.

Hence the variable cost for 1 795 students amount to £171 064. We may also estimate the total variable cost for the whole lifetime of the course on the basis of 8 000 students. This would amount to 8 000 x £ 36.43 = £291 440.

However, the variable costs of production are not the only variable costs. We have to consider the variable costs of student support and the costs of distribution. (We had to neglect distribution costs; as the course was just being launched at the time of our case study, cost data were not available.)

Table CS 2.2: Variable costs of production

Print	Variable costs per student	No of students		Costs
Units	10.70	1 795	2 runs	38 413
Supplementary texts	4.65	1 795	1 run	8 347
Subtotal	15.35			46 760
Video cassettes				
E90	2.13	1 795	2 copies	7 647
E120	2.60	1 795	2 copies	9 334
E180	3.43	1 795	1 copy	6 157
Subtotal	8.16			23 138
CD-ROM				
CD-ROMs	1.17	1 795	8 discs	16 801
Software licences	11.75	1 795	4	84 365
Subtotal	12.92			101 166
Total	36.43			171 064

Source: OUUK budget data of this course; 1998. NB Budget costs reflect internal charges which may differ from actual costs.

Student support: inputs and costs

Student support consists of three elements: (i) eight tutor-marked assignments and (ii) fifteen face-to-face tutorials and (iii) a summer school.

Tutor-marked assignments

The marking of assignments (TMA) is part of a process of teaching. It involves much more than pointing out errors. The assignments are marked with great care and are commented on in detail. To mark an assignment costs £12 in TMA fees payable to the tutor plus an additional element for student related expenses the tutor may incur (£0.75). Given the number of assignments (eight), we have 8 x (£ 12 + £ 0.75) = £ 102 as corresponding unit cost due to TMAs.

Tuition

The hourly rate for tuition is £25.49, and fifteen contact hours are provided for. Since about twenty students form a group, the unit cost per student due to the total of fifteen hours tuition is £382/20 = £19. Together with a student-related fee of £15 we have a unit cost due to tuition of £34. The unit costs of TMA and tuition amount to £136. The results are summarised in table CS 2.3.

Table CS 2.3: Student support: inputs and costs

Number of inputs	Type of inputs	Costs of inputs
	Tuition	
15 x	Contact hours @ £25.49 per hour	382
20 x	Student related fees @ £15.40 per student	308
	Subtotal tuition	690
	Unit tuition @ 20 students	35
	TMA	
20 x	TMA fee	1 920
20 x	TMA expenses	120
	Subtotal TMA	2 040
	Unit TMA	103
	Total unit costs of student support	138
	Total unit cost (inc unit production cost)	174

Source: OUUK budget data of this course. NB Budget costs reflect internal charges, which may differ from actual costs.

Table CS 2.3 makes it possible to calculate the variable costs for student for 1 795 students and equally predict the total variable costs for 8 000 students due to student support. The figures are

1 795 x £138 = £247 710 and 8 000 x £138 = £1 104 000.

The total variable cost due to production and student support for 1 795 students are £418 774 (see table CS 2.2), for 8 000 students £1 395 440.

The following cost analysis includes an estimation of the projected total direct costs of the course, the average cost (including the average cost function) and the various costs per student learning hours.

Total direct costs

A synoptic view of the direct course costs, fixed and variable is given in table CS 2.4.

Table CS 2.4: Total direct costs

Type of costs	Number of students 1 795	Number of students 8 000
Fixed costs	2 776 518	2 776 518
Variable costs	415 184	1 392 000
Total	3 088 848	4 268 518

Source: OUUK data of this course.

Average cost per student

Since the fixed costs as well as the total variable costs per students are known, we can calculate:

For $s = 1\,795$

$$AC = \frac{£\,2\,776\,518}{1\,795} + £\,172 = £\,1\,547 + £\,172 = £\,1\,719$$

and for $s = 8\,000$

$$AC = \frac{£\,2\,776\,518}{8\,000} + £\,172 = £\,347 + £\,172 = £\,519$$

Costs per student learning hour

Since the course is likely to take at least 448 student learning hours to complete, the cost per student learning hour for the whole course is at most:

$$\text{Cost/SLH(course)} = \frac{£2\,776\,518}{448} = £6\,198$$

The OU does not specify the amount of study time to be devoted to each medium. However, using our conversion norms for media input into student learning hours, we get 28 units at 10SLH = 280 SLH; 10 hours video = 10 SLH; 2.4 hours TV= 2.4 SLH. The SLH generated by the CD-ROMs have been estimated to be in the range of half an hour to two hours per week, i.e. between 14 and 56 hours. Altogether this amounts to between 306 and 348 SLH.

$$\text{cost/SLH(media)} = \frac{£\,2\,776\,518}{306} = £\,9\,074$$

or

$$\text{cost/SLH (media)} = \frac{£\,2\,776\,518}{348} = £\,7\,979$$

The cost per medium cannot easily be disaggregated since the development of each medium did draw academic staff time to an extent, which cannot be identified. Therefore the following estimates must be considered as minimal.

Since the CD-ROMs are interactive, the respective student learning hours are difficult to determine. Course designers assume that a student spends over a period of 28 weeks between half an hour and two hours using the CD-ROMs

This would mean that the total input of seven CD-ROMs provide for a learning time of 1/2 x 28 SLH= 14 SLH or 2 x 28 SLH = 56 SLH. Consequently we have:

For SLH = 14 we get

$$\text{cost/SLH(CD - ROM)} = \frac{£283\,000}{14} = £\ 20\,414$$

for SLH = 56 we get

$$\text{cost/SLH(CD - ROM)} = \frac{£\ 283\,000}{56} = £\ \ 5\,054$$

The cost per student learning hour per hour television can be inferred from table CS2.1. Since the fixed costs of development for 4 x 25 min TV were given as £ 203 136, and 2.4 x 25 min =60 min or an hour, we have, assuming SLH is equivalent to viewing time:

$$\text{cost/SLH(TV)} = £\,50\,784 \text{ x } 2.4 = £\,121\,882$$

The cost per student learning hours per video also can be inferred from table 2.1. Always assuming SLH is equivalent to viewing time, we have:

$$\text{cost/SLH (Video)} = \frac{£\ 380\,000}{10} = £\,38\,000$$

NKS Distance Education in Norway: two case studies

'NKS Distance Education' (in Norwegian: NKS Fjernundervisning) is part of the NKS group. Its history goes back to 1914 when E.G. Mortensen founded a correspondence school in Oslo, which became widely known as NKS. In 1986 the NKS College started as a private but publicly accredited provider in for post-secondary education. It has its own publishing house, opened in 1992 a branch in Budapest (Hungary) and a Business Institute and a Business school founded in 1993 and 1996 respectively.

As a private institution NKS must be quite alert to its markets. This is reflected in the organisational structure where separate departments are cultivating the relationships to different market segments (e.g. the corporate market, the market of public-sector institutions, learners who want to learn in mixed mode or alone). Consequently NKS is able to provide for long-term classical curricula as well as responding to short-term demands reflected in the labour market.

We were able to look at two courses. One, the Norsk course provides post secondary education for adults, the other provides teacher training for primary school teachers. Both courses were largely print-based but included videocassettes.