Module 2: The techniques of cost analysis

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Module title: Techniques of cost-analysis

This module introduces you to the elements of cost-analysis. They consist essentially of three parts: (i) how to draw up a budget; (ii) the treatment of capital costs; (iii) basic cost equations.

- The first three discussion units relate to the first part (drawing up a budget): **Unit 1** introduces into modeling costs, for which **Unit 2** offere a generic template; **Unit 3** classifies the cost items to prepare the cost analysis.
- The second part (treatment of capital costs) shows how to process capital costs (**Unit 4**); in **Unit 5** we look at simple depreciation while in **Unit 6** we show how costs are annualized.
- The third part (basic cost equation) starts by indtroducing the Total Cost Equation (**Unit 7**) and then in **Unit 8** proceeds to the Average Cost Equation. **Unit 9** introduces the concepot of Marginal Costs; **Unit 10** Semivariable costs. The third part is wrapped up by **Unit 11** where we describe other visualizations of the basic cost parameters such as Perraton's Costing Cube.
- The treatment corresponds largely to chapters 1 to 6 in our textbook Rumble (1997). I recommend also to read chapters 7 to 10 which are not so extensively treated here.

The module is also closely related to the guide I developed for the *Commonwealth of Learning*. I posted it as a WBT.

Costing open and distance learning
at: http://www.uni-oldenburg.de/zef/cde/COLproject/web-col/index.htm

The *value added* is that the various sections of the guide serve here as *main topics* for the discussion in the classroom. Knowing you as a very active class I am sure we will get a lively discussion.

38.46 %5 of 13 topics complete
Show data table for This chart displays the number of completed topics versus the total number of topics within module Module 2: The techniques of cost analysis..

List of Topics and Sub-Modules for Module 2: The techniques of cost analysis

- Module 2 - Readings

  Adobe Acrobat Document

  Actions for 'Module 2 - Readings'

- Module 2 Unit 1: Modeling costs

  Discussion Topic

  Drawing up a budget for developing a course is a dynamic rather than a static process. You start by defining what type of courses you want to develop; then you identify the activities required to realize it and the costs involved in doing so - we call this the *'ingredients approach*'.

  In planning a course one probably would want to compare different options (e.g. in terms of media or level of student support). The uncertainties (risks) that are involved suggest that you need to take a modeling rather than budgeting approach. So, in addition to looking at the basics of budgeting, this section will provide you with a foretaste of modeling.

  The ingredients approach

  Preparing a course is not too different from preparing a meal. You need to decide what to cook before you buy the ingredients. This explains why Levin (1983) refers to this method as an **ingredients approach**. In order to draw up a budget for an ODL course, you need to

  - decide what you want to teach (what activities are involved),
  - identify what ingredients are needed for that in terms of
    - human resources
    - premises and accommodation
    - equipment and furniture
    - stocks, supplies, consumables, and expenses
  - specify the quantities needed of each item, and
  - find out their respective costs.

Modeling costs

It is, however, not always possible to specify all parameters in advance. The quantities of some items, for instance, depend on how many students will be attracted to the course. Moreover, the costs of some ingredients may change. Because this is so, it makes sense to **model** the costs. Modeling costs refers to creating mathematical equations (e.g. the 'total cost equation' or the 'average cost equation'), the parameters of which are specified by the ingredients approach. To move from describing the costs of the ingredients to modeling the cost behavior requires that:

- the costs are classified in categories (e.g. fixed/variable, capital/operating)
- cost items within categories are aggregated and
- the resulting figures finally inserted in the mathematical equation.

All this will be described in the section *Elements of cost-analysis*. In the text that follows we will introduce a basic scenario to help make these theoretical ideas concrete.

Please, post questions and comments you may have with respect to **modeling costs.**

_____

References:
-- Levin, H. M. (1983). *Cost-effectiveness: A primer*. London: Sage.

- Module 2 Unit 2: Generic template

Discussion Topic

When reporting costs in distance education it helps to develop a template which reflects the main cost drivers in the system. We therefore revisit the definition of Keegan (1990) and look at Rumble's 'rich picture' of distance education systems (Rumble, 1997). Based on this we develop a first generic template for reporting costs.

Defining Open and Distance Learning

Keegan's **definition of distance education** includes the following elements:

1. the quasi-permanent *separation of teacher and learner* throughout the length of the learning process (this distinguishes it from conventional face-to-face education);
2. the influence of an *educational organization* both in the planning and preparation of learning materials and in the provision of student support services (this distinguishes it from private study and teach-yourself programmes);
3. the use of *technical media* - print, audio, video or computer - to unite teacher and learner and carry the content of the course;
4. the provision of *two-way communication* so that the student may benefit from or even initiate dialogue (this distinguishes it from other uses of technology in education)
5. the quasi-permanent *absence of the learning group* throughout the length of the learning process so that people are usually taught as individuals and not in groups, with the possibility of occasional meetings for both didactic and socialization purposes.(based on Keegan (1990, p.14); emphasis added)

This definition can be interpreted under the perspective of developing a generic costing template for distance education systems: While (1) provides a sort of 'minimalist definition' of distance education which is to be elaborated in the subsequent points; (2) marks the importance of a providing institution. In terms of cost-analysis this relates to the institutional *overheads* or (with respect to courses) *indirect costs*; (3) refers to the cost drivers of course development, which are *direct costs*. (4) refers to the direct costs of course presentation (delivering the study material and supporting students' learning). (There is a fifth point stipulating the quasi permanent absence of a group in the process of learning which became obsolete in times of CMC and videoconferencing.)

Rumble (1997, p. 6) identifies four systems: the materials subsystem, the students' subsystem, the logistical and the regulatory subsystems.

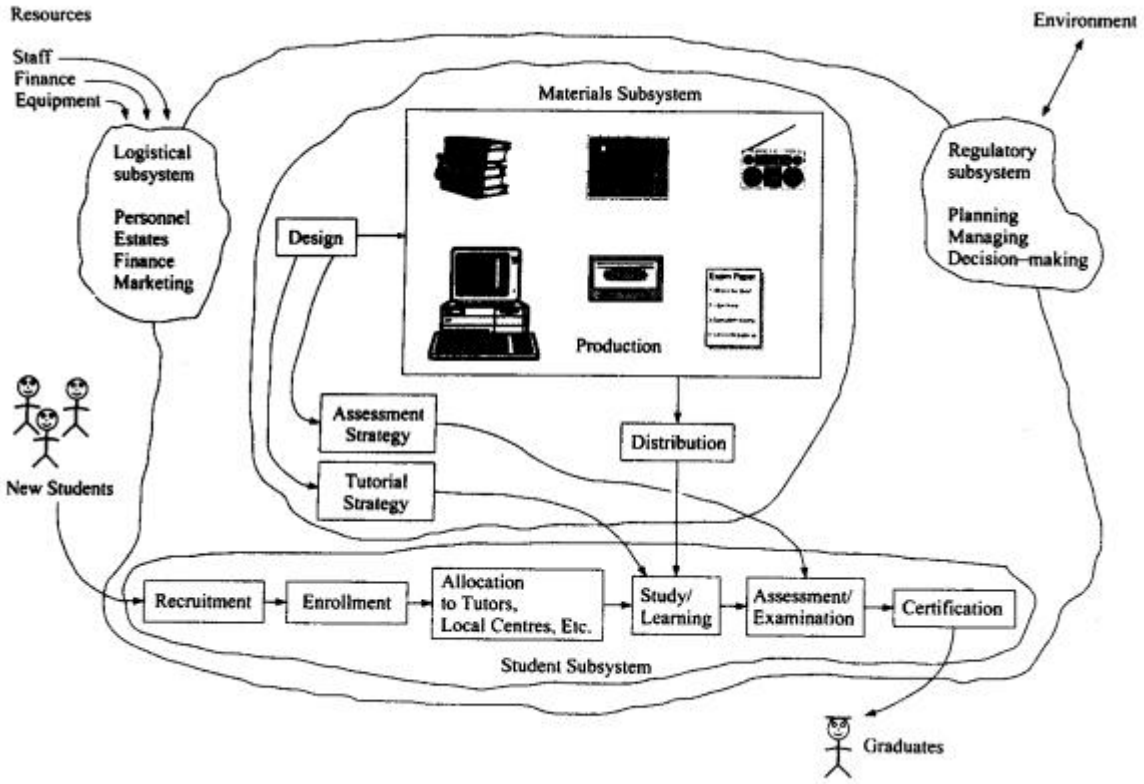

Figure 1: Distance education - a rich picture

Direct costs of development

If we focus on the two main subsystems while keeping in mind the definition of distance education, the following format seems appropriate for reporting costs: The activities in the materials subsystem relate to the development of course content (couzrse material) which is distributed to the learner via different media such as printed study guides, audio or video tapes, or CD-ROMs. **Course material development costs** will be a main heading in our costing template. The costs associated with development (as opposed to the costs associated with distribution) are essentially fixed costs (i.e., independent of the number of learners using the content.

The cost drivers for the development of course material depend very much on the type of media used. For print-based courses the main costs are:

- authoring the texts (sometimes involving subject experts and instructional designers)
- editing
- desk top publishing

Since most other media include at least some printed complementary material, authoring and layout are cost drivers in almost all cases.

Radio or TV production involves all sorts of media specialists. In both cases production overheads may have to be included if the production facilities are located in the institution.

Using computers may involve high programming costs, especially if multi-media materials are developed. On the other side, if computers are used mainly for communication purposes, development costs are lower since commercially available platforms (LMSs) provide the necessary facilities.

Direct costs of presentation

Distance education includes the costs of two-way communication to support the learner (Keegan, 1990). In the following we call the process of teaching a course (based on the pre-prepared materials) 'course presentation', which includes all the costs of tutoring and student support. The **course presentation costs** will be a further main heading in our costing template. The costs of student support depend strongly on the number of students in the system. Generally, the costs of student support are variable costs.

Typical cost drivers are *tutor marked assignments* (TMAs), counselling and tutoring. Costs will also be affected by whether students are to learn individually or in groups. Even in traditional correspondence courses there are often options to join evening classes at *regional learning centres* or enrol in *summer schools* (e.g. to prepare for examinations).

Indirect costs (overheads)

There are a number of costs, which do not arise directly from a specific course. Such costs are classified as *indirect costs* or *overheads*. They include buildings (such as offices), equipment (servers, radio transmitters) or services (cost of the director). Whether such costs should be included when budgeting for a particular course will depend on the purpose of the costing exercise; how they are to be treated depends on the nature of the respective cost driver (e.g., a *capital* or an *operating cost*).

Obviously, in a full cost-analysis, indirect costs should be included. However, when budgeting for a particular course or when comparing courses with different combinations of media, overhead costs can sometimes be ignored since they do not affect the comparative cost of the different approaches. If overheads are to be included they then have to be shared in some way between the different courses. Sharing out overheads is a fairly complex activity and may involve methods such as 'activity based costing' (ABC).

Generic costing template

The above classification can be taken as a generic costing template for a distance education course. There are the indirect costs relating to the institutional overheads, and the direct costs for (1) the development of materials, and (2) the costs of course presentation. If we measure the *volume of activity* by the number of students enrolled in the courses, costs of development are fixed (i.e. they do not change as the number of students changes), while costs of course presentation vary strongly with the volume of activity (i.e., the larger the number of students, the larger the presentation costs become). This will be an important point to remember when the cost-structure of distance education is analyzed in terms of the composition of fixed and variable costs. - This allows us to produce our first generic template (Table 1).

Table 1: Generic costing template

	Units	No of units	Cost per unit	Total costs
Indirect costs Overheads				
Direct costs				
Development costs				
Presentation costs				

The template reflects the three main elements that we have identified so far:

9. The indirect costs (overheads) of the institution.
10. The development of the materials.
11. Delivering the material to the students and communicating with them (course presentation costs).

Please, post questions and comments you may have with respect to the generic template.

References:

-- Keegan, D. (1990). *Foundations of Distance Education* (2nd ed.). London: Routledge.
-- Rumble, G. (1997). *The costs and economics of open and distance learning*. London: Kogan Page

- Module 2 Unit 3: Classifying costs

Discussion Topic

Cost-analysis needs to record costs in a comprehensive manner and then classify them in a way, which facilitates modeling. In order to record costs in distance education we

suggest the use of a generic template that distinguishes between **direct costs and indirect costs**. *Direct costs* refer to:

1. Developing course material.
2. Teaching the course (course presentation).

Indirect costs include overheads which do not directly contribute either to the development of the course material or to the actual teaching of the course.

After recording all the various costs we classify them into:

1. Operating and capital costs.
2. Fixed and variable costs.

After recording all the various cost items we proceed to classifying and analyzing them. The categories of cost-analysis are: **Operating and capital costs** on the one hand, and **fixed and variable costs** on the other. You should think of them as two binary distinctions *which are independent from each other!* ('Independent' like fat and lean on the one side, and blond and black haired on the other side. The fact that someone is fat does not imply that he/she is blond etc.) Similarly, capital costs may be fixed or variable, and variable costs may be operating costs or capital costs.

You can think of it in terms of a double entry table:

Examples	Capital costs	Operating costs
Fixed costs	Buildings	Time of managing director
Variable costs	Experimental kits (leased to students)	Assignment marking

Reading the table per column:
Capital costs relate to items which have a value over more than one financial period.
- Buildings, for example, are used over many years. This means you cannot, having built a classroom charge the cost of construction to the first year of using it (or to the first cohort of students).
- Experimental kits are likely to be used over a shorter time span. But if they may be leased to different generations of students, again you cannot charge their costs to the first cohort of users and hence they are to be classified as a capital cost.

Operating costs:
- A director is a staff member getting an annual payment representing the directors work in the financial year under consideration (hence: his/her salary is not a capital but an operating cost. We later distinguish operating costs further in recurrent and non-recurrent operating costs; the cost of a director is to be classified as an operating recurrent cost.)
- Paying a tutor for marking an assignment is even more short term and does not create a value 'consumed' over several financial years.

In reading the table per column the relevant parameter is *time*. Cost items which are of value over more than one financial year are classified as capital costs; where this does not apply we speak of operating costs.

Reading the table per line:
Fixed costs:
- If you get some more students, you do not have immediately to construct new classrooms. This means that relative to the main type of activities of an institution, i.e., teaching students, the cost driver (buildings) can be considered as fixed.
- Neither you need a new managing director when you enrol more students. Again the costs of a director can be regarded as fixed cost.
Variable cost per student:
- The second row comprises costs which vary with volume of activities (i.e., in our case: number of students. The more students you enrol in your scinece course, more experimental kits are to be distributed or the more assignments have to be marked.
Hence reading the table per row *number* is the relevant parameter. Costs related to items whose numbers depend on the volume of activity (number of students) are called variable costs per student; costs of items which are independent from the volume of activity (number of students) are classified as fixed costs.

You can look at the double entry table in the following sense: the horizontal dimension is about **costs and number**: to which extent costs are sensitive to volume (we go into that in later main topics). The vertical dimension is about **costs and time**: when costs are incurred and over which period the correspondent value is consumed. The relation of money and time is apparent in the concept of interest: If I need to borrow money from the bank it is not sufficient that I give back the money later on but the bank will charge interest. It will not help here to discuss to which extent interest reflects some intrinsic property of money (some cultures such as medieval Christianity some Islamic cultures condemn interest as usury); we take interest here as a reality of modern life. It reflects the fact that the value of money depends on time. Having $1000 now is better to have $1000 in five years.

Activity: Operating costs can be recurrent or non-recurrent. Find examples of recurrent operating and non-recurrent operating costs.

- Module 2 Unit 4: Capital costs

Discussion Topic

We know that money has something to do with time. If I need to borrow money from the bank it is not sufficient that I give back the money later on: the bank will charge interest. This reflects the fact that the value of money depends on time. Having US$ 1000 now is better than having US$ 1000 in five years.

The distinction between capital costs and operating costs is based on a convention about the *financial year*. If the value corresponding to the costs is consumed within the same

financial year in which the costs are incurred, we refer to them as *operating costs* (or *revenue costs*). If this is not the case, we speak about *capital costs*. Operating costs can be recurrent or non-recurrent. A ream of papern for example can be classified as a *non-recurrent* operating costs. The salary of an administrator would be a recurrent operating cost.

Activity A3:
Classifying cost drivers as capital and operating costs.

This activity asks you to classify some costs into categories.
Open the Excel file A03 for this activity.
You should use copy and paste to copy the items from the list into the categories.
You can classify the same item into any number of categories.
Click here

The question is to which financial year costs have to be charged. For operating costs the answer is quite simple since the costs are incurred during the same period in which their correspondent value is consumed. If a teacher is paid for marking an assignment he/she renders a service to a student in a particular year. A director is paid for the work he/she does in the correspondent financial year.

Slightly more difficult it is to treat capital costs. You may develop a CD-ROM in two years and use it for the next eight years. To which year do you charge the costs? To the year the cost is incurred (in terms of actual expenditure) or to the years the created value is consumed? In the next discussion unit we look at various ways of treating capital costs.

Listening to below recording guides you in doing **Activity 3** (cost classification).

// Archive Info
Name: Activity 3 - 02/08/2012 11:41
URL:
http://umuc.wimba.com/launcher.cgi?room=thuelsmann1_01_2012_0208_1141_10
Room ID: thuelsmann1_01

You are welcome to comment on eventual observations you made in doing the activity. But activities are generally for self-control. You need not to show successful completion of the activity, especially if several examples were already posted.

- Module 2 Unit 5: Depreciating capital costs

Discussion Topic

We are now looking into the treatment of capital costs. We ended up in the last discussion unit asking to which year already incurred capital costs are to be charged. The basic idea is that capital costs represent a value consumed over several years. The rule of thumb is charge the proportion of the incurred cost to the period that proportion is consumed. There are several different ways of doing this, such as:

1. Simple depreciation
2. Social discount
3. Annualization.

Simple depreciation

Simple depreciation divides the costs by the number of years during which the item is to be used. In the case of a computer this might be three to five years. For example, if a computer costs US$ 2000 and is to be used for five years, then the depreciation value ('depreciation rate') would be US$ 2000/5 = US$ 400. This is the value to be charged in each of the financial years.

In other words, each year, the value of the computer diminishes by US$ 400. This is illustrated in Table 4. The *written down value* (last line of Table 4) illustrates how over time the initial value is consumed / 'eaten up'. This is the meaning of *depreciation*: the value diminishes over time. The written down value corresponds to the remaining, the un-depreciated part of the value.

Value type	Amount	Year 1	Year 2	Year 3	Year 4	Year 5
Initial value	US$ 2000					
Depreciation value	US$ 2000 / 5 = US$ 400	US$ 400	US$ 400	US$ 400	US$ 400	US$ 400
Written down value		US$ 1600	US$ 1200	US$ 800	US$ 400	US$ 0

Depreciation is mainly important when auditing. We include it here since we want to introduce the *social discount* which helps to understand annualization.

Capital costs and social discount

Theoretically you use up a value equivalent of US$ 400 in the first year remaining with an un-depreciated remainder of US$ 1 600 at the end of the first year. It is as if, in each period, you pay only for the value consumed in that period. The un-depreciated part of US$ 1 600 could earn interest if kept in a bank. The next year you could earn interest on the new un-depreciated value -- US$ 1 200. This part could remain in the bank for two

years earning interest accordingly. Table 5 illustrates the idea of the 'social discount rate', which varies over the years but is generally higher than the depreciation rate.

Value type		Year 1	Year 2	Year 3	Year 4	Year 5	Total
Initial value	US$ 2000						
Depreciation value	US$ 2000/5 = US$ 400	US$ 400	US$ 400	US$ 400	US$ 400	US$ 400	US$ 2000
Written down value		US$ 1600	US$ 1200	US$ 800	US$ 400	0	
	Compounded at 5%	US$ 1680	US$ 1323	US$ 926	US$ 486	0	
	Forgone interest	US$ 80	US$ 123	US$ 126	US$ 86	0	
Social discount	Depreciation rate + forgone interest of un- (!) depreciated part	US$ 480	US$ 523	US$ 526	US$ 486	US$ 400	US$ 2415

In this case the rate to be charged per year varies considerably. This is, however, due to the variation in forgone interest to be charged to the different years. But such variation seems to suggest that each year a different size of value is consumed while in fact this value is about the same in each year. While it makes sense (under certain conditions we will specify later) to account for forgone interest on capital costs it is implausible to charge starkly differing rates to the different years while the value consumed is largely the same in each year. (From a practical point of view the value of your computer remains largely the same over its life time.) This contradiction that the depreciation rates under the social discount calculation leads to varying rates while in fact it should be largely the same, leads to annualization. Annualization takes into account the forgone interest but produces identical rates over the years the item is used.

Activity A4:
Depreciating capital costs

1.	*This activity allows you to depreciate capital costs.*
2.	*Open the spreadsheet Activity A04.*
3.	*Type in your own values for the amount and the number of years.*
4.	*If you want to increase number of years, you can extend the table to the right by selecting the Year 5 cells and dragging them to the right.*

5. *You should make sure that the last written down value is always zero*

Click here

Depreciation is a rather straightforward procedure. As **activity**, please, experiment with the spreadsheet. If you have conceptual questions, please ask and comment. You also may view the recording below.

// Archive Info
Name: Activity 4- 02/08/2012 12:17
URL:
http://umuc.wimba.com/launcher.cgi?room=thuelsmann1_01_2012_0208_1217_24
Room ID: thuelsmann1_01

Alternatively, you can watch the recording via the following file (it is also possible to download it and view it e.g. with Windows Media Player):

Activity 4:
https://drive.google.com/file/d/0BztDZO8ZN6kbOVZpSkxNMG5Ea0U/view?usp=sharing

You are welcome to comment on eventual observations you made in doing the activity. But activities are generally for self-control. You need not to show successful completion of the activity, especially if several examples were already posted.

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- Module 2 Unit 6: Annualizing capital costs

Discussion Topic

Capital costs correspond to a value created which is consumed over a time *exceeding* one financial year. This means that we need to discuss which proportion of the cost is to be charged to which financial year. The guiding principle is that the value consumed should be charged to the period during which it is consumed.

We already discussed *simple* depreciation. It means: You buy a computer you depreciate it over, say, four years. The services it renders each of these years are more or less equal. Hence you divide the initial value buy the time it will be used. This is the *depreciation rate*. It is charged equally to each year of use.

But the slightly theoretical consideration under the heading of the social discount rate illustrates that simple depreciation may make a mistake: it underrates the costs in the sense most economics today use the term costs, i.e., as *opportunity costs*. Buying the

computer freezes $2000 over four years; money which otherwise could have earned interest. You need to take account of the *foregone interest*. The social discount rate does this. Unfortunately it shows that the forgone interest varies leading to annual charges which vary substantially while the value drawn from the computer is fairly constant.

Annualizing capital costs

Annualization means that capital costs are not simply depreciated but that the forgone interest on your initial investment is taken into account. (But different from the social discount annualization rates, like depreciation rates, are equal for each year the item is used. This corresponds with the assumption that equal value is derived from the item during the time it is used.) - To take into account the *opportunity cost of lost interest* and at the same time arrive at *constant rates of annualization* (reflecing the constance of value derived from the item) is done by a so called *annualization* formula.

$$a(r, n) = \frac{r(1+r)^n}{(1+r)^n - 1}$$

The formula looks complex but effectively it takes into account *foregone interest*. In contrast to the social discout rate a*nnualization distributes the effects of the foregone interest in such a way that the annualization rate for each year is the same*.

(For those with a stronger math background and interested in understanding the formula I attached word document where the formula is arrived. Nothing what you find in the attachment is necessary in the following.)

Value type	Amount	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Initial value	US$ 2 000						
Depreciation value	US$ 2 000 / 5 = US$ 400	US$ 400	US$ 400	US$ 400	US$ 400	US$ 400	US$ 2000
Social discount	Depreciation + forgone interest	US$ 480	US$ 523	US$ 526	US$ 486	US$ 400	US$ 2415
Annualization	r = 5%	US$ 462	US$ 462	US$ 462	US$ 462	US$ 462	US$ 2310

The following activities propose you first to explore the effect of interest (Activity 5), then compare annualization and simple depreciation (Activity 6); (you may also listen to the recordings on Activities 5 and 6; see below); in Activity 7 you learn how to calculate the table of annualization factors based on interest rates and shelf life of the item under consideration. Finally, we ask when to use simple depreciation and when we should annualize.

Activity A5:
Calculating interest

This activity enables you to calculate compound interest using the formula. The result is shown in the graph.	
1.	*Open the spreadsheet Activity A05*
2.	*Type in your own values for the amount and the interest rate*
3.	*You can use Ctrl+t to show a 50 year scenario from which you can see that the interest rises exponentially rather than linearly*

Click here

Activity A6:
Comparing depreciation and annualization

This activity enables you to compare depreciation and annualization.	
1.	*Open the spreadsheet Activity A06.*
2.	*Enter your own interest rates, number of years and amounts.*
3.	*Observe how the annual values differ for depreciation and annualization.*

Click here

Activity A7:
Producing a table of annualization factors

This activity enables you to produce a table of annualization factors for various rates of interests and numbers of years.

Use the spreadsheet Activity 07 for this.

Start in Table 1
Replace the red interest figure with the rate that you wish to use.

Go to Table 2
Type the interest rate that you are using so that it replaces one of the rates already in
Table 2

Go back to Table 1
You now need to copy the a(r, n) values (but not the formulae behind them) from Table 1 to your chosen column in Table 2. To do this you must use Copy/Paste Special/Values Only. You will find this under the Edit drop-down menu.

Note
You cannot set r = 0 since this would lead to a division by zero. If no

interest is taken into consideration annualization coincides with depreciation.
Click here

Annualize or simply depreciate?

When would it be appropriate to annualize, and when would simple depreciation do? You need to consider the following:

If decisions on large capital investments are to be made and there are real alternative options - i.e., the money is not ring-fenced and could genuinely be used for something else - then it is sensible to annualize since these figures include the opportunity costs and might tip the balance towards an alternative option.

If, however, there is no real alternative and the institution is not allowed to use the money for other than the specific purposes under consideration, it does not make sense to annualize

The generic costing template and the capital costs/operating costs distinction

The table below classifies some cost drivers that you are likely to come across when using the generic costing template and shows the distinction in each case between capital and operating costs.

		DIRECT COSTS		INDIRECT COSTS
		of development	of presentation	overheads
Capital costs		Authoring a text		Building costs, server costs (buying)
Operating costs	recurrent	Authoring a text	Staff costs (tutors)	Director's salary
	non-recurrent	Authoring a text (outsourced)		

Essentially non-recurrent operating costs can be treated along similar lines as capital costs.

You may find the concept of annualization difficult to understand. Calculating the annualization factors will be done using Excel. Focus on the conceptual understanding. It may help if you try to formulate your own definition of annualization. You also may view the recordings since they may help you with the activities.

// Archive Info
Name: Activity 5 - 02/08/2012 12:45
URL:
http://umuc.wimba.com/launcher.cgi?room=thuelsmann1_01_2012_0208_1245_12
Room ID: thuelsmann1_01

Alternatively, you can watch the recording via the following file (it is also possible to download it and view it e.g. with Windows Media Player):

Activity 5:
https://drive.google.com/file/d/0BztDZO8ZN6kbTExDNkhYc1l0REU/**view?usp=sharing**
// Archive Info
Name: Activity 6- 02/08/2012 14:02
URL:
http://umuc.wimba.com/launcher.cgi?room=thuelsmann1_01_2012_0208_1402_38
Room ID: thuelsmann1_01

You are welcome to comment on eventual observations you made in doing the activities. But activities are generally for self-control. You need not to show successful completion of the activity, especially if several examples were already posted. However, if you have any questions and comments you are welcome to share them.

Attachment: Annualization

- Module 2 Unit 7: Total costs

Discussion Topic

Possibly of even greater importance than the distinction between **capital costs** and **operating costs** is the distinction between **fixed costs** and **variable costs**. You will see that the main argument for the cost-efficiency of distance education - the expectation that distance learning generates *economies of scale* - rests on this distinction.

The distinction relates to 'volume of activity'. The principal activities of a distance teaching institution consists in teaching students. Hence **fixed costs** are those which do not increase with the *volume of activity* of the institution, i.e. the number of students taught. Development costs of teaching materials are fixed costs in this sense: You need only *develop* the study guides once for a particular course and they can be used by many learners over a number of years. Of course, you would have to reprint them as new students enroll but the development costs remain a one-off. The costs for reprinting and posting the materials to the students are examples of **variable costs**. Ideally, all costs can be classified as either fixed or variable. However, some costs are classified as semi-

variable. These are costs, which are fixed up to a certain threshold. Typical semi-variable costs are costs of class tutors.

Activity A8:
Classifying cost-drivers as fixed or variable costs

1. Open the spreadsheet Activity A08.	
2. Classify each cost driver in the list as follows:	
	select an item from the list
	copy and paste it onto the stars of one of the categories
	the evaluation will tell you whether you have correctly categorized the item.

Click here

Total cost equation

For the time being we will focus on fixed and variable costs only. In this slightly simplified case the total costs are the sum of the fixed and variable costs:

Total costs = Fixed costs + Variable costs
TC(N) = F+V*N
Where: TC = Total costs; F = Fixed costs; V =Variable costs per student; N = Number of students; TC(N) denotes that the Total Costs are a function of the number of students served.

Note well that the VxN for *Variable costs* is a composed term in which V stands for *Variable cost per student* and N for *Number of students*. (Example: if it costs US$ 4 per student to replicate some content on a CD-ROM and post it to the respective student, it costs US$ 400 to do the same for all hundred students you may have in the same course. The respective Variable costs run up to US$ 400, or US$ 4 per student times 100, the number of students.)

Activity A9:
Exploring the Total Costs equation

This activity allows you to vary the fixed and variable parts of the cost equation so that you can see how the graph of the costs varies.	
1.	*Open the Excel spreadsheet A09.*
2.	*Try changing the variable costs per student. What happens?*

3.	*Try changing the fixed costs. What happens?*
(If you want to understand the maths behind this, you may recall that the equation	
	$TC(N) = F + V \times N$
is a linear equation of the form f(x) = kx + c where c is the intersection with the y-axis and k is the gradient (slope) of the graph. In our case the constant is F which identifies the starting plateau of the costs, while V (variable cost per student) is the gradient. The higher the value of V, the steeper the gradient.)	

Click here

TC(N) =F+V*N is a linear function which means that its graph is always a straight line. If you already have completed the activity you may have noted that, the factor *V* affects the slope (angle of inclination) of this straight line: The higher the value of *V*, the steeper the angle of inclination of the straight line representing TC.
F on the other hand defines the plateau, i.e., the starting level of the straight line. Generally educational planners try to include as many students as possible but at the same time they try to keep total costs down as much as possible. The important observation in this context is that eventually *V* may be more decisive than *F*. You may start at a higher initial cost level, but if *V* is lower, there will be an intersection point beyond which the function with the lower gradient (i.e. value for *V*) will have a lower unit cost per student. This can be seen more clearly when we look at the average cost function.

- Module 2 Unit 8: Average costs

Discussion Topic

The total costs equation leads to the other important equation about **average costs**. Average costs are total costs divided by the number of students N.

Average costs per student = Total Costs / Number of students
AC(N) = TC/N
AC(N)= (F + V x N) / N = (F/N) + (V x N) / N
Hence:
AC(N)= F/N + V

Where AC= Average costs; F = Fixed costs; V = Variable costs per student and N = Number of students; again AC(N) indicates that AC is a function of N.

It is important to understand this equation clearly, because it provides highly relevant guidelines for cost-efficient course planning. The important point is what happens to average costs as *N* increases:

As *N* increases, *AC* decreases, other things being equal.
The effect is the more remarkable the higher the upfront fixed costs of development are. If F is high and V is low AC(N) produces a curve that decending from the high level of F quickly to the level of V which it approaces 'asymptotically' (comes nearer without touching or crossing V).

This is what is meant by **economies of scale**. A measure of scale economies is F/V.

The right-hand side of the equation is made up of two components. The first, *F/N* decreases as *N* increases. The second, *V*, does not change as *N* increases since it is the variable cost per student.

This result is often described as the fixed costs being 'spread over more students'. Each student is charged a part of the fixed costs. The more students there are, the less a single student costs (the lower could be the fees).

This is what educational planners want: falling unit costs (another espression used for the variable cost per student V). Mathematicians like to look at extremes and ask what would happen if we were to increase the number of students *ad infinitum*. The answer is that, in this case, the first term (*F/N*) approaches zero or, in mathematical language, the average costs 'converge to' *V*.

Activity A10:
Exploring the Average Costs equation

The average costs graph (Figure 1) shows how cost-effectiveness arises from increasing student numbers.

1. *Open the spreadsheet Activity A10.*
2. *Try different values of F and V to see how the graph changes.*

Note on the maths

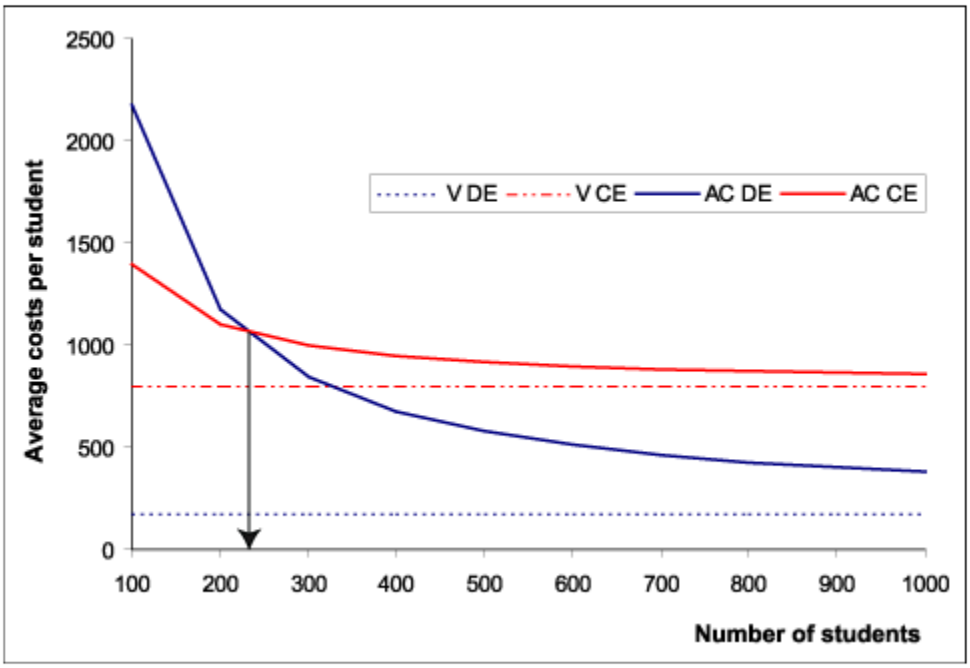
The AC equation is an algebraic transformation of the total cost equation (TC).

You can see from the graph that the line is asymptotic - that is, it tends towards the long-term value V but never quite reaches it.

AC is only defined for N> = 1. AC(1) = F + V. Since often V is almost negligible, AC(1) is approximately F while AC(N) for very big N is approximately V. This differential between F and V identifies the scope for any economies of scale.

Click here

Average costs and economies of scale



In the above example the **red lines** refer to **conventional education (CE)** and the **blue lines** to **distance education (DE)**.
AC DE stands for the *Average Costs per Student in Distance Education* and V DE for the *Variable Costs per Student in Distance Education*.
Similarly AC CE stands for the *Average Costs per Student in Conventional Education* and V CE for the *Variable Costs per Student in Conventional Education*.
The interpretation of the figure is the following: Since V DE is smaller than V CE and AC CE cannot fall below V CE, the graph of AC DE will, if student numbers are large enough, fall below the graph of AC CE (towards V DE).
At the intersection point you find a downward pointing arrow which marks the *break-even point*. The break even point marks the number of students, beyond which (in this case) AC DE undercuts AC CE.

It is important to note that *AC cannot fall below V, however large the number of students becomes!* The variable costs per student therefore represent a bottom line, below which the average costs per student cannot fall. This implies an important strategic guideline:

- **To lower average costs per student keep variable cost per student low.**

The other strategic guideline has already been mentioned:

- **To bring the average cost per student down, increase the number of students.**

This guideline needs some additional comment. The figure above shows that economies of scale vary according to the number of students already enrolled. The higher the number of students, the lower the average costs reduction effect of including another student**.** Hence you have to judge whether it makes sense to increase student numbers when the effects of the economies of scale are already largely exhausted.

Of course, the number of students cannot be increased at will. You need to attract students and marketing efforts themselves are a cost factor and may not succeed in increasing numbers at an economic cost: Students may prefer multi-media courses with high level of learner support. If you want to offer this in order to attract further students you will need to increase *V* or *F* or both. Hence, it is important to keep in mind that *N, F, V* are not independent. The behavior of *N* is influenced by *V* and *F*. If you lower one of these parameters, students may walk away from your course and the plan to lower average costs may backfire, because the lower number of students means that fixed costs can be spread only over fewer numbers such that average cost per student will rise, possibly initiating a vicious circle.

Activity: Explain in your own words the difference between variable costs, variable costs per student and average costs. Can the average costs fall below the marginal costs? Can the average costs fall while the total costs rise?

- Module 2 Unit 9: Marginal costs

  Discussion Topic

  We need to include a definition of marginal costs since the term is gaining importance in distance education. Strictly speaking **marginal cost** means **the cost of including one more student in your system**. We can express this like this in mathematical language:

  MC = TC (N + 1)- TC (N) = [FC + V x (N + 1)] - [FC + V x N] = FC - FC + V x (N + 1) - V x N = V
  Where MC = Marginal Costs

  The equation shows that the cost of including one more student (i.e. the *marginal costs*) in your system is equal to the *variable cost per student:* MC = V. The interesting point here is that fixed costs do not impact on marginal costs. Offering something at marginal costs therefore strictly speaking means to offer it at a price that makes no contribution to fixed costs.

  Fixed costs in distance education are mainly related to development costs. Saying you offer something at marginal costs often implies that you are willing to write-off the development costs.

Question: Marginal costs are often also referred to as aggregate unit costs. Is there a difference between variable cost per student and marginal costs?

- Module 2 Unit 10: Semi-variable costs

  Discussion Topic

  We have treated fixed costs and variable costs so far as a binary distinction. This means any cost driver can either be treated as fixed cost or as variable cost per student, as F or as V. This is a little unrealistic. In practice, many costs are **semi-variable.** Such costs are fixed up to a certain threshold.

  For example, you can increase the number of students in an online seminar without adding another class as long as the number of students is below the maximum class size. Beyond this size you need to start a new class and employ an additional tutor.

  The graph of a semi-variable cost takes the form of a *step function*: within limits you may increase volume of activity (i.e. number of students) without raising costs. At a certain threshold costs will jump.

  Formally, we define the semi-variable cost function as follows:

  SV = [N/G] x SN

  Where: SV = Semi-variable Cost; G = Group size; V = Variable costs per student; N = number of students; [N/G] = Number of groups (the square brackets signify the process of rounding); SN = Semi-variable Cost per Group

  Note that the number of groups (or classes) needed is defined by the number of students in the system and the maximum group size.

  Theoretically, it can be argued that 'all costs are semi-variable'. Most cost drivers are to some extent affected by an increase in the volume of activity if only the increase is big enough. It may be that the concept of semi-variable costs has been ignored in distance education for so long because distance learning was largely seen as 'individual studies'. Nowadays it is increasingly cohort-based. In this case the notion of semi-variable cost as distinct from fixed and variable costs per student becomes more and more important.

  Total Costs = Fixed costs + Semi-variable costs + Variable costs

  TC = F + [N/G] x SN + V x N

Where: TC = Total Costs; F = Fixed costs; SN = Semi-variable cost per group; N = number of students SN x [N/G] =Semi-variable costs (i.e. Semi-variable cost per group x number of groups); V x N = Variable costs (i.e. Variable cost per student x number of students)

Activity A11:
Exploring the effects of group size (TC)

This activity explores semivariable costs.	
1.	*Use spreadsheet Activity A11 for this.*
2.	*Try changing the group size.*
3.	*Then try different combinations of fixed cost, variable cost, semivariable cost and group size.*
4.	*Observe what happens in each case.*
In ODL systems with little or no group work, semivariable costs are not very important and can usually be ignored.	
When there is a significant amount of group work, semivariable costs become important. You can see why as you change the input values in this spreadsheet.	

Click here

This leads to a modification of average costs also:

AC = TC/N
AC = F/N + ([N/G] x SN) / N + (VxN)/N
AC = F/N + SN/G + V

Activity A12:
Exploring the effects of group size (AC)

This activity looks at the effect of group size on the average cost equation.
1. Use the spreadsheet Activity 12 for this.
2. Try different group sizes to see their effect on average cost.
The effects of group size on the graph are generally less visible.
Click here

Question: Traditional distance education was not cohort-based. There were no classes and sections. Only the recent revolution in information and communication technologies (ICT) made cohort-based DE an option. As a consequence, the question of appropriate class size becomes important. Using the conceptual apparatus we have so far why the concept of semi-variable costs will gain in importance?

- Module 2 Unit 11: Perraton's costing cube

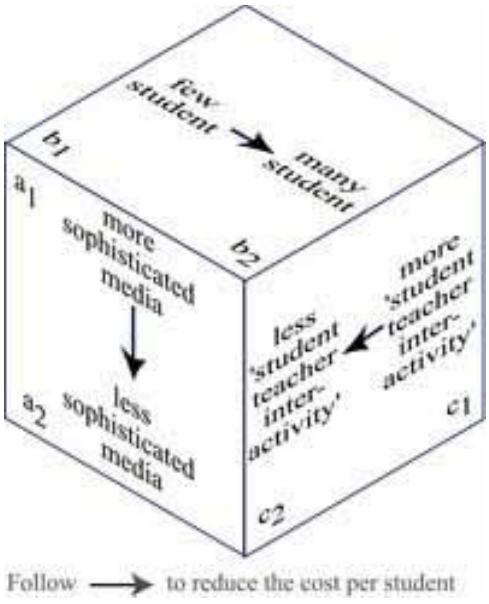
  Discussion Topic

  This main topic introduces two visualizations which I found quite convincing.

  - *Perraton's cube* which is another way to express the lessons implied in the *average cost* formula.
  - *Daniel's triangle*s express what many distance educators see as the essential advantage of distance education: it can both widen access and improve quality, while at the same time reducing average cost per student.

  Perraton (2000, p.137) has portrayed the relation between **volume**, **media sophistication** and (student-teacher) **interactivity**. His cube (Figure below) has three dimensions and the arrows show the direction to go if you want to reduce the cost per student (his 'efficiency path').

  Perraton's Costing Cube

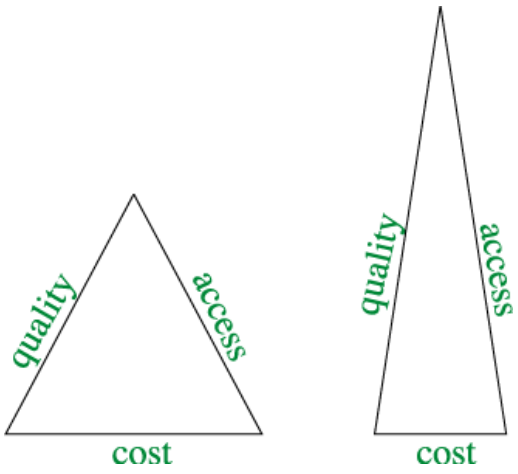
  Hilary Perraton's cube guides you in how to achieve low *average cost per student*. But you need to realize that (i) the number of student cannot be determined by the planner; it is not a radio button which can be tuned to the volume you want. And indeed, if you reduce media sophistication the course may lose attractiveness which in turn my lead to dropping student enrollment. That means: all the parameters in the model (N, V, F) are interdependent.

This means that Daniel's triangle (below) is not a truism which can be proved just by juggling mathematical equations. To which extent it has been realized in some cases, and can be realized in others, is a matter of empirical investigation.

In fact, Perraton's visualization is very close to the average cost formula. The *fixed costs* in distance education are generally related to *media sophistication*, the variable cost per student is strongly influenced by the level of *interactivity between teacher and student*. (The cube is slightly modified. The original cube speaks only about face-to-face tuition. However, meanwhile we can sustain responsive teacher-student interaction at a distance (e.g. videoconferencing, online conferencing). But all these forms of interactivity between students and teacher, irrespective of the technology used, claim the *teacher's time* and thereby increase *variable cost per student*.) The Internet and videoconferencing influence the cost per student as much as face-to-face tuition does. The number of students, varying from few to many, is explicitly referred to in both models.

John Daniel portrays these expectations by his *eternal triangles* (or *iron triangles*) as in the figure below. The meaning is the following: In traditional education, cost, quality and access are generlly linked in a lockstep manner. It is a sort of 'iron rule' that you cannot increase access or quality without costs or reduce costs without loss of quality and so on. Distance education allows an escape of the iron triangle. According to Daniel (2001) the cost structure of distance education allows costs to be reduced while at the same time increasing access and quality. This reflects our theoretical expectations, but it makes assumptions that may not apply in each and every context.

The cost-quality-access triangle



To sum up the conclusions from this excursion to theory: Distance education is seen as having a different cost-structure than conventional education. *Cost structure* in this context has a precise meaning: it refers to the composition of fixed and variable costs in the total or average cost formula. Distance education is seen as having generally lower *variable cost per students*. This is seen as its strategic advantage. Even though often distance education may require a higher up-front investment in technology infrastructure and course material development, these higher fixed costs could be spread across many

learners. The high level of fixed costs is often seen as a guarantee for quality. The rationale for expecting distance education to be more cost-effective than conventional teaching is the combination of comparatively low variable cost per student and high fixed costs safeguarding quality (effectiveness). High quality and low costs can only be achieved in large systems; this has a further positive and intended effect: increasing access.

Summary and caveat:

2. Distance education often (not always!) has a different *cost-structure* than conventional education.
3. Cost-structure in this context refers to the composition of fixed and variable costs in the total or average cost formula.
4. Distance education generally has a lower variable cost per student than conventional face to face education. This is its strategic economic advantage. Even though often distance education may require a higher up-front investment, these initial higher costs can be spread across many learners.
5. The high level of fixed costs is often seen as a guarantee for quality. The rationale for expecting distance education to be more cost-effective than conventional teaching is the combination of comparatively low variable costs per student and high fixed costs safeguarding quality (effectiveness). High quality and low costs, according to this line of thinking, can only be achieved in large systems which have a further positive and intended effect: increasing access.
6. One further comment and *caveat*: The efficiency path would lead to lower average cost per students. Given the enormous demand for education (and the 'perverse way' of rising unit costs mentioned by Coombs (1985)), the capacity of distance education to bring down average costs per student is closely related to its remit to broaden access to education. Especially, in developing countries coping with large numbers is one of the main reasons to turn to distance education (Perraton, 2000). However, planners should be aware that lowering average costs per student in this model is achieved by expanding the system, which, in turn, raises total costs. (This caveat to any cost-analysis, exclusively singing the praises of distance education for lowering unit costs, is forcefully developed in Butcher & Roberts (2004).)

Questions:

- Compare the Costing Cube to the AC equation. In which sense we can say that the cube can be seen as a visualization of the AC formula?
- How would you define scale economies in your own words? Why is it important?
- Even if Daniel's triangle applies and DE brings down average costs per students are there circumstances under which you would not recommend an institutional design based on scale-economies?

References:

-- Butcher, N., Roberts, N. (2004). Costs, effectiveness, efficiency. In H. Perraton, Lentell, H. (Ed.), *Policy for open and distance learning*. London: RoutledgeFalmer.
-- Daniel J. (2001, January). *Technology and education: Adventures in the eternal triangle*. Paper presented at the LearnTec, Karlsruhe.
-- Perraton, H. (2000). *Open and distance learning in the developing world.* London: Routledge.
-- Coombs, P. H. (1985). *The world crisis in education: the view from the eighties.* New York Oxford: Oxford University Press.

- Discussing the Mock Assignment Discussion Topic

  Discussion Topic

  I'm Done

  Dear all,

  Questions to the mock assignment please post as a response to this discussion topic.

  Kind regards
  Thomas