Policy Brief
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UNESCO Institute for Information Technologies in Education

UNESCO Institute for Information Technologies in Education

COST-BENEFIT MODELLING FOR OPEN LEARNING

CONTENTS:

CONTEXT AND OUTLINE OF THE PROBLEM

Open Learning uses information and communications technologies (ICT) to provide formal education for learners who are separated from their teachers and other learners in time and place. It contrasts with conventional learning, therefore, in the nature of its physical and administrative infrastructure, and in when, where, and how teachers and learners spend their time doing teaching and learning. These very different characteristics have very different benefits and cost structures in comparison with conventional methods. Understanding and achieving the cost-benefits made possible by open learning will be difficult, despite more than two decades of experience worldwide, because of the complexity of making a viable comparison. This policy briefing sets out the viable options for doing a comparative cost-benefit analysis for moving from conventional to open learning, and for improving the cost-effectiveness of open learning, so that it can make its proper contribution to achieving the UNESCO goal of Education for All.

POTENTIAL BENEFITS AND COSTS

Open learning is taken to cover all forms of flexible open and distance learning that

(a) provide teaching, assessment and certification that does not require the student to attend a campus (but may offer local study centres), and

(b) may incorporate some form of ICT in teaching and learning.

Open learning is usefully divided into **traditional** (no use of ICT), **blended** (uses ICT for resources and communication, but also uses study centres, physical materials, and fieldwork), and **wholly online** (uses only ICT for resources and communication). The value of open learning that uses ICT is its potential for **scale** (its ability handle very large numbers of students), and **reach** (its ability to provide access to education at any place at any time).

Open learning is a pressing issue because it could make a significant contribution to UNESCO's *Education for All* targets. Because of its potential scale and reach it could help in achieving the ambitious target of training the 1.9 million teachers needed for universal primary education. A US study shows that its growth rate is significantly higher than campus teaching, as it is successful in reaching those unable to study in the traditional mode of post compulsory education (Allen and Seaman, 2010). A clear framework for doing a cost-benefit analysis of online open learning in comparison with other forms of learning is therefore critical for education policy.

The forms of ICT used in open learning extend to almost all the digital technologies now available, including administrative systems, virtual learning environments, content management systems, digital libraries, interactive resources, user-generated content tools, modelling tools, and synchronous and asynchronous online collaboration and communication environments using text, audio or video, or combinations of these media.

The applications of ICT in education are many and various, therefore, which makes it complex to analyse. A telling analogy is with the use of 'paper'. The applications of ICT are as wide-ranging as those of paper; much more so, in fact, because of its remote, virtual, and decision-making capabilities. A cost-benefit analysis for the use of paper in education would be seen as an impossible task, given what we know now about its ubiquity and multiple uses. The attempt to contain the complexities of ICT in education within a cost-benefit framework is ambitious, therefore.

A **cost-benefit analysis** is taken to mean an analysis of the benefits in relation to the costs of an enterprise or project; it is similar to efficiency, or productivity, as concerning the ratio of the output to the input required to produce it.

This briefing is about **modelling** a cost-benefit analysis, as it is not possible to achieve a definitive result for all contexts. Although it is possible to specify the parameters and the relationships between them for all modes of learning, the parameter values and the evaluation of the resulting analysis will vary according to the local context. The value of a cost parameter like teacher time, or a benefit parameter like social inclusion is a matter of judgment. Direct comparisons are not possible, as most researchers conclude. For this reason it is more useful to define the parameters of costs and benefits, and the nature of the trade-offs between them, to provide a model for local interpretation (Laurillard, 2006).

Why should ICT-based open learning produce an improved cost-benefit analysis in comparison with conventional open learning or campus-based methods? To put it most simply, the reasons are found in the capability of the technology to **improve costs by operating at scale**, and to **improve benefits by supporting independent active learning**. This argument is elaborated over the next four sections before deriving the implications for policy.

FACTORS AFFECTING COSTS TO INSTITUTIONS AND STUDENTS

It is possible to list the factors affecting costs to institutions and students that are common to all contexts of open and conventional learning. This briefing categorises the factors affecting costs in relation to institutions and students. Of course, the state may choose to contribute to institutional costs and/or to students' costs, and private sources, such as companies, charities, or families may also choose to contribute to institutions and/or students. However, the core transaction in education is the activity between teachers and students so that is the focus of the analysis.

The basic unit of cost for both conventional and open learning is the **per capita cost**. It is common to all systems of post-compulsory education that there will be per capita income (from student fees and/or state support), and per capita benefits (for the student, and from them to the workforce and the wider community), so a per capita unit is a useful common measure for evaluating the cost-benefit. This section outlines the main ways in which ICT-based open learning can achieve reductions in the per capita cost.

A critical definition for open learning is the distinction between the **fixed costs** of the resources and tools students use, and the **variable costs** of the per learner support provided by teaching staff. The distinction is important for comparing open learning with conventional modes because open learning achieves improved cost-benefits partly by **transferring activities from variable costs** to fixed costs, and achieving economies of scale through larger student numbers.

Table 1: Factors affecting costs of provision of all forms of learning

Cost categories	Factors affecting	
	Fixed costs per course	Variable costs
Teaching activity	• Teaching and specialist staff design and development of resources and learning activities • Specialist staff for design and development • Reuse of existing resources and designed activities • Amount of formative evaluation and redesign • Updating and maintenance • Differential grades of teaching staff for different teaching activities	• Group size for teacher guided activities • Cohort size for supervision and marking • Degree of teaching involvement in the types of teaching-learning and assessment activities used • Differential grades of teaching staff for different teaching activities
Teaching infrastructure	• Share of institutional physical and technical infrastructure • Staff development and support needs	• Group size for classroom and lab-based activities • Cohort size for network support • Cohort size for equipment, materials, licences, delivery of materials
Administration	Share of administrative infrastructure for market research, marketing, recruitment, enquiries, enrolment, registration, QA, validation, accreditation	• Cohort size for administrative processing of enrolment, registration, student support, accreditation • Cost of student drop-out
Students' costs	Cost to student of course fee, equipment and materials	• Cost to student of access via travel, online communications • Opportunity costs of time spent on course-related activities other than studying

Table 1 summarises the factors affecting fixed capital and production costs, and variable recurrent and delivery costs for teaching activities, teaching infrastructure, administration, and students' costs. These have been compiled from a range of studies of open learning (Pelgrum and Law, 2003; White, Warren, Faughnan, and Manton, 2011). The same analysis could be carried out using these factors for all forms of provision, whether conventional campus-based, traditional open learning, wholly online, or blended open learning, providing a common basis for comparison between them.

The per capita cost for a course can be calculated in terms of the cohort size for that course (see Laurillard, 2006) as

(The cost of designing and developing resources and activities) / cohort size

- the per-student time for individual support
- (the per-group time for group teaching support) / group size
- (the course's share of institutional physical, technical and administrative infrastructure) / cohort size
- the per-student cost of administration and materials
- the cost to the student of studying on the course.

The per capita cost depends on the cohort size, and this will be different according to whether the 'student' is the **student who enrolled**, or the **student who completed** (Hulsmann, 2004). Clearly the latter is a tougher test, and is likely to depend on the quality of learner support. Student drop-out is an important test of the true benefit of a course, so it would be wrong to achieve a good cost-benefit figure on the basis of enrolment, especially as drop-out can be high in open learning contexts. Conversely although a model may appear expensive because it has high labour costs attached to tutorial groups and formative assessment, this may be a good investment if the per capita cost is related to the tougher tests of performance, such as successful learning outcome, student retention and completion, or graduate employment. For this reason, the cohort size used should be the **number of students who completed**. This means that a cost-benefit analysis for planning and investment purposes must be differentiated from a post hoc analysis, and should take into account worst-case as well as best-case scenarios for student numbers.

The **duration of the course** as the unit of analysis should be as short as possible while still being meaningful. In all modes of learning students may interrupt their study, and it can take many years for them to complete a degree programme or qualification, especially in the context of open learning. For this reason a part-year course rather than a multi-year programme would offer a more robust measure for a comparative analysis with traditional modes, where interrupted study is less likely.

The period of analysis must take into account the fundamental difference between conventional and open learning: for the latter the majority of the teaching is developed in the form of resources and designed activities, in advance of the course start, and these may be little changed in later re-runs, except to update them. Therefore open learning has high up-front development costs and low ongoing costs, while conventional learning has low up-front development costs and high ongoing costs for each re-run. In general, it is reasonable to assume that by the third re-run of a course the ongoing costs should have reached a stable state. Clearly, **the number of course re-runs** is a critical unit of analysis. For an open learning course the per capita cost overall is much improved if the development costs are amortised over a large number of re-runs.

The **trajectories for per capita costs against cohort size** are very different for conventional and open learning because the latter has a higher proportion of fixed costs. However, this depends on the cohort size: one study concluded that for up to 20 enrolments, face-to-face had a lower per-student cost whereas for over 30 enrolments online learning had a progressively lower per-student cost (Bates, 2001). Figure 1, based on this analysis, illustrates how the two trajectories compare as student numbers increase.

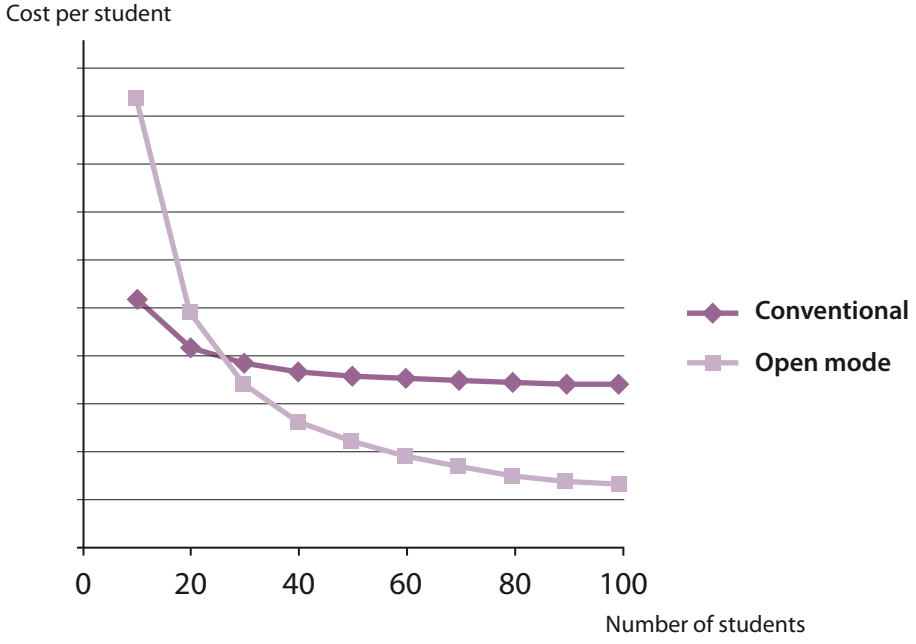

Figure 1: A lower cost per student for open learning for large cohorts is possible because of the higher proportion of fixed costs

Its lower trajectory of per capita cost against cohort size is one reason why open learning is important for achieving the *Education for All* target of training a very large number of teachers for primary education.

ICT can support high student numbers because online delivery and communication is possible without large-scale and costly estates and buildings. This means it should be possible to achieve **economies of scale**, where the costs of provision are amortised over larger student numbers.

It has also been proposed that **economies of scope** (of materials) can improve per capita costs by reducing production costs through reuse or sharing of existing materials (Morris, 2008). The 'open education resources' (OER) movement (Lane, 2010) is providing the shareable resources that would make this feasible if it succeeds in engaging the teaching community. This is conditional not just on agreeing common technical standards and open licensing (Lane, 2010), but also on the more difficult task of acculturating the teaching community to the idea of sharing and building on others' teaching.

Cost analyses will be affected by how the **return on investment** is handled (Bates, 2001). In traditional university budgeting procedures, for example, there are historic top-down funding flows that obscure the relationship between the activity and its value, and therefore make it difficult to relate the return on investment in an open learning course to the activity that produced it. A direct link between the two could encourage a focus on ways of working that provide a better yield (Bates, 2001).

TYPES OF BENEFIT TO STUDENTS AND INSTITUTIONS

The types of benefit to students and institutions can also be developed to be applicable to all forms of provision of campus-based and open learning. There are three main categories of benefit, each of which is elaborated below in terms of the types of benefit discussed in a range of reports and studies (Bates, 2001; Kukulska-Hulme, 2010; Laurillard, 2006; Pelgrum and Law, 2003).

Performance – quality of the learning experience for teachers and learners; active independent learning; community of learners; learning outcomes; student satisfaction; staff satisfaction; social and cognitive legacy (who and what you know); impact on learners' life and work; student retention; organisational innovation; organisational efficiency;

Logistics – access to geographic areas; access to socio-economic groups; flexibility in time, place, and pace;

Societal impact – social mobility, workforce skills, workplace learning, employment levels, environment, institutional reputation.

The societal benefits of social mobility and an educated workforce that Education for All aims to achieve can only be made possible through the logistical benefits of widening access to education. ICT in open learning contributes to this by providing the flexibility and local access that makes it possible for people to study alongside work and family commitments, i.e. at low **opportunity cost** to the student. However, this is critically dependent on the provision of equipment and connectivity at low cost to those potential students, often the responsibility of government agencies.

ICT contributes to the performance benefits by enhancing the quality of the learning experience in many ways, if its wide-ranging capabilities are properly exploited. The pedagogic value of social constructivist learning, which fosters active independent learning through interaction between students, through the application of theory to practice, and through reflection and adaptation of practice, is well served by the judicious exploitation of learning technologies, as just a few examples illustrate:

Active learning – using multimodal technologies of dissemination and representation to present concepts, ideas and analyses in ways that engage learners' attention by including analytical and inquiry learning activities that learners can work through at their own pace,

Independent social learning – using online technologies enable learners to benefit from their participation in academic social networks, and better access to peer support, so that learner support can be extended beyond the teacher to other learners.

Adaptive, personalised learning – using simulation and modelling environments that provide intensive practice on intellectual or skill-oriented challenges with meaningful personalised feedback adapted to learner input, so that learners use their independent learning time more.

Collaborative learning – using user-generated content tools (e.g. digital documents, virtual 3D environments, videos, spreadsheets), and online discussion environments to enable learners to work together on sharing and building a product of their collective understanding or skill, to submit to their peers for constructive comment, and then to the teacher for formative feedback.

Learning technologies offer a wide variety of affordances such as these, which enable the teacher to design powerful learning activities that enable their students to work independently as individuals or in groups. If they are set up and managed by the teacher and explicitly followed through as an aspect of the way the course develops, these techniques can relieve the teacher of some of the pressures of learner support.

It is this capability of ICT to enable the teacher to represent their teaching *without their personal physical presence* that makes it viable to transfer teaching from variable-cost activities (such as lectures, labs, tutorials) to fixed-cost activities (such as multimodal web resources, simulations, peer support activities), and still maintain, or even improve the quality of learning experience.

The fixed cost of designing and producing the tools, environments, or activities can be high, but they can be rich enough to provide many learners with many hours of productive learning activity that does not involve the teacher, and yet has high value for the learner because of the adaptive feedback and/or their interaction with other learners. If these benefits are achieved, and if student numbers are high, then per capita costs can be low enough to achieve an improved cost-benefit analysis.

The achievement of these kinds of pedagogical benefit is critically dependent, however, on the way the technology is used, which is governed by factors such as the goals of instruction, quality of pedagogy and teacher effectiveness (Tamim, Bernard, Borokhovski, Abrami, and Schmid, 2011).

Understanding the importance of these benefits will help to avoid the bad ways of reducing the costs of teaching. The largest cost is tutoring and marking time, and if this were to be reduced by offering a 'less constructivist environment, such as converting open-ended exam questions, or group projects, into computer-marked multiple choice questions, this would seriously under-exploit the capabilities of ICT, and seriously undermine the value of the teaching. The cost would be lower but the benefits would be much lower, yielding a poorer cost-benefit analysis.

It is equally important to be vigilant about teacher time. Open learning is different from face-to-face provision and, when an institution offers both modes, teaching staff may find themselves drawn into making too many individual responses to students, and doing more essentially administrative tasks with students, which becomes more rather than less costly (White et al., 2011).

THE RATIO OF BENEFITS TO COSTS

Improving the ratio of benefits to costs, in any activity, means finding the acceptable balance between the two. The costs are the total of fixed costs (which are not dependent on the volume of activity) and variable costs (in this case the cost of activities that relate to each individual student). Figure 2 illustrates the relationship between costs and benefits. The aim is to keep the costs as low as possible without reducing benefits too far; or rather, to keep the benefits as high as possible without increasing costs to unaffordable levels. In education we seek the optimal balance.

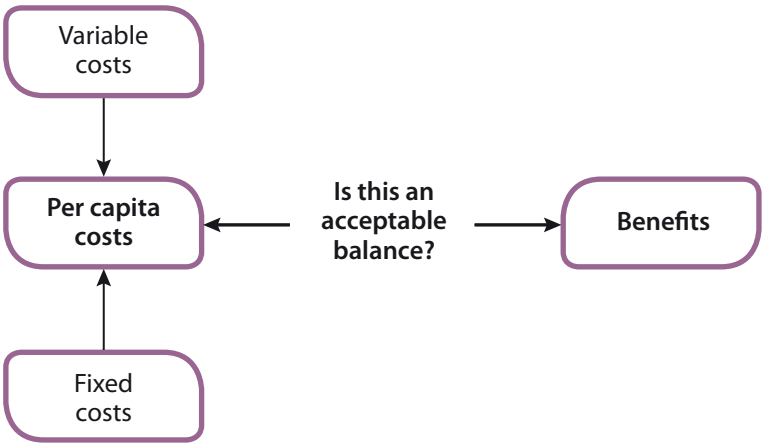

Figure 2: Improving the ratio between costs and benefits means reducing the one as far as possible while keep the other as high as possible

There are several ways to improve the ratio of benefit to cost, as Table 2 shows. ICT is an important force in education because it can contribute to each of them. In each case we have to be imaginative in working out what capabilities of digital technologies can be exploited to reduce costs or increase benefits, or both.

Table 2 illustrates how an improved cost-benefit analysis can be achieved in each case through making use of the capabilities of digital technologies, e.g. to provide multimodal electronic documents, online academic communication tools, and adaptive personalised learning.

Table 2: Methods of improving a cost-benefit analysis using ICT

Improved cost-benefit analysis	ICT role in the improvement
An acceptable reduction in benefit for considerably lower cost	Convert all printed material to digital, online and reduce storage and delivery costs; there is a reduction in benefit because students often need to print the materials to be able to study them properly
The same benefit at lower cost	Convert all assignment creation, submission, and marking processes to online only; students usually create their assignment digitally so there is no reduction in benefit here
A greater benefit at lower cost	Convert variable costs of teaching to peer teaching, by structuring a hierarchy of online peer discussion groups, to produce one group output for feedback by the teacher, reducing teacher time and increasing active student learning
A much greater benefit for slightly higher cost	Invest in high quality interactive learning materials and systems that provide personalised learning and result in higher student retention and lower per capita costs

PROBLEMS WITH THE CURRENT APPROACH

Poor understanding of the costs of teaching and administration for conventional and open learning, makes it difficult to carry out meaningful cost-benefit comparisons, and to manage the improved cost-benefits that should be possible by using ICT for open learning. Improved cost-benefits will not be achievable without changing the historic top-down budget processes practised by educational institutions, and without strong project management (Twigg, 2003; USDoE, 2010). Box 1 shows what can be done with strong project management.

Box 1: Reducing costs for large cohorts

30 projects of course redesign

50,000 students nationwide

Savings of $3.6 million per year

Using

Whole course redesign – staff share development and delivery

Active learning – replacing lectures with activities

Computer-based learning resources with testing and feedback

Mastery learning – to pace achievement of objectives

On-demand help – replacing lectures with online tutor groups

Alternative staffing – peer mentors as well as academics

(Twigg, 2003)

Conventional institutions that also use blended and open modes of learning do not collect financial metrics in sufficient detail to be able to extract information specific to open learning, which is neither properly costed within the activities of departments, nor captured and valued within official reward structures. ICT infrastructure has been emphasised at the expense of a focus on pedagogy and staff development, and so is not properly integrated into the practice of curriculum design where it could make an impact (Pelgrum and Law, 2003; White et al., 2011).

POLICY RECOMMENDATIONS

It is important to establish an approach to investment and costing for all modes of teaching and learning if there are to be meaningful comparisons between the alternatives of conventional, blended, and open learning.

A cost-benefit framework must evaluate the balance of costs, both fixed and variable, against the value of the benefits to students and the institution. It must also take account of the ways in which ICT can be used to reduce costs and increase benefits, suggested in this briefing. The reduction of costs for maintained or improved benefits can be achieved through the judicious use of ICT, but several critical dependencies have been identified, and these constitute the main policy recommendations for state, government agencies, and institutions:

a) Manage the digital infrastructure to reduce students' ICT access costs
b) Invest in and manage teaching development and teacher training to ensure ICT increases active and personalised learning
c) Increase and carefully design peer support activities to reduce costs and increase social and collaborative learning
d) Increase group sizes to reduce variable costs, while maintaining the quality of the learning experience through more social and collaborative learning
e) Convert all student services to online to reduce variable costs
f) Increase student numbers and retention to reduce per capita costs
g) Convert all resources to digital to reduce fixed costs
h) Promote reuse and sharing of resources among teachers to reduce fixed costs
i) Establish a more direct link between teaching activity cost and return within institutional budgeting to encourage collaboration.

The policy recommendations are shown in Figure 3, to illustrate the means by which per capita costs are kept as low as possible, and benefits to students are kept as high as possible.

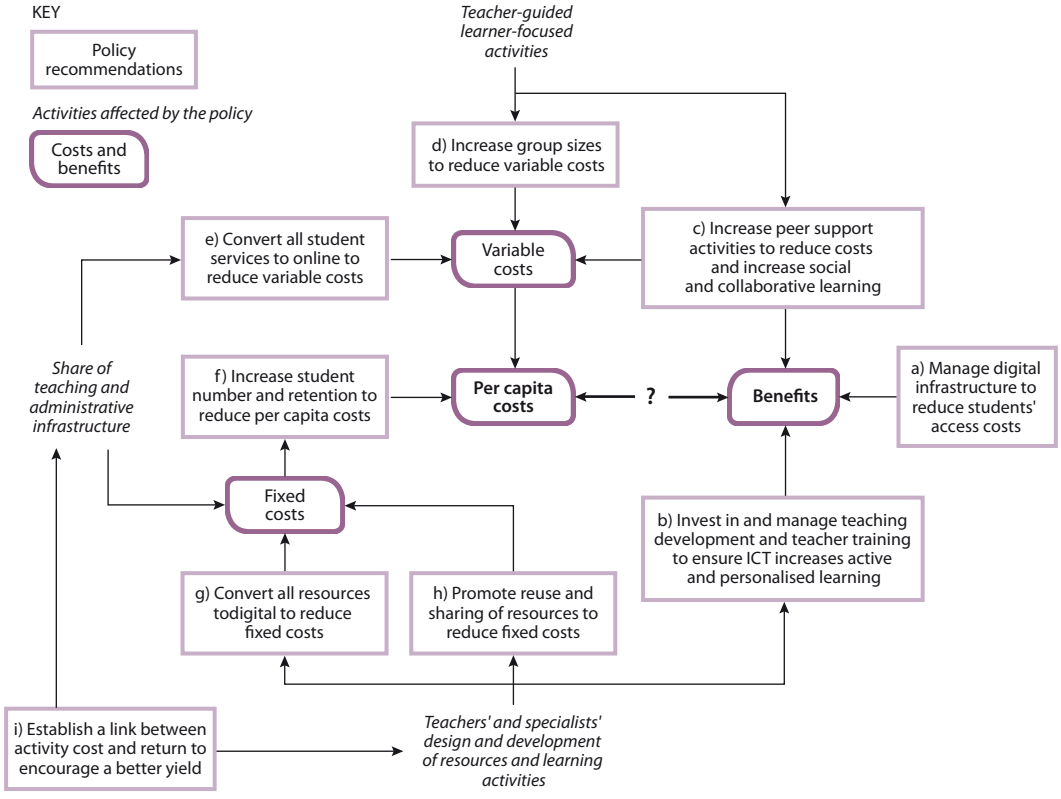

Figure 3: A cost-benefit framework for ICT in open learning, showing how policy recommendations a) to c) improve the benefits, and d) to i) manage the costs

This policy briefing sets out what it takes to do a comparative cost-benefit analysis for moving from conventional to open learning. It also demonstrates what is needed to turn this into effective action on behalf of learners worldwide. The policy recommendations above are well within the capability of professionals at each level of action, but they do require commitment, planning, and monitoring. By this means it is possible to improve the cost-effectiveness of open learning, so that it can make its proper and potentially highly effective contribution to achieving the UNESCO goal of Education for All.

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Open learning provides flexible remote access to learning that enables people to study and achieve qualifications ‘any place, any time’. Information and communication technologies make this possible by providing online access to the digital resources and student-tutor communications needed for study.

The growth of open learning is already outstripping the growth of campus learning, but economic viability is often difficult to achieve for the full range of the curriculum. Initial costs are high and must be managed over the long term to be sure that ICT yields its two main benefits: access to education for large student numbers, and high quality support for independent learning.

This policy briefing provides a model and recommendations that keep per capita costs as low as possible and learning benefits as high as possible, by fully exploiting what ICTs have to offer.

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