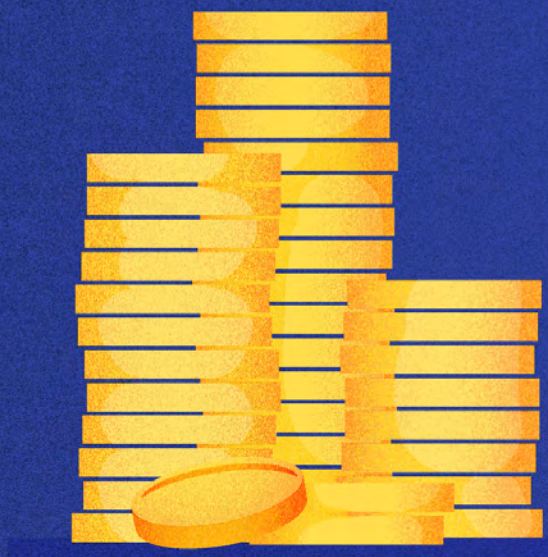
DIGITAL LEARNING FOR DEVELOPMENT



An activity-based costing approach to planning digital learning in the Global South

Eileen Kennedy

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Author
Eileen Kennedy

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ACRONYMS

ABC	Activity-Based Costing
CEA	cost-effectiveness analysis
CEI	Center for Education Innovations
CRAM	Course Resource Appraisal Modeller
MOOC	massive open online course
OECD	Organisation for Economic Co-operation and Development
TCM	Technology Costing Methodology
TDABC	Time-Driven Activity-Based Costing
TLA	teaching and learning activity
UCU	University and College Union

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1

INTRODUCTION

Consider the following scenario: a teacher has piloted an educational innovation with a group of learners in the Global South and it has proved successful. Their organization wants to scale up to all schools in the country. They work out that the cost of running the innovation combines the teacher's salary, the materials they use, and a proportion of the cost of running the school. These costs will be multiplied by every new group of learners added to the program. Now consider another successful innovation, this time involving blended learning: a successful digital intervention has been developed and is being rolled out to the other schools. Should the organization use the same approach to costing? The digital innovation took a long time for the teacher to develop, but nothing more needs to be done to share it with countless other learners. On the other hand, other teachers need to spend some time supporting the learners. This cannot be costed in the same way; the costs of development need to be separated from support. As the innovation scales, the costs of development are shared between a greater number of learners, but each group of learners still needs its own teacher to support them; sometimes, more development work is needed. The traditional approach is not helpful, because it cannot acknowledge the efficiencies of scale, or specify the different costs of the various activities involved in rolling out the innovation. What helps is identifying what is involved in each of these activities and allocating costs based on the time they take. If one considers which activities need to be performed once and which need to be repeated for each new learner, then one could make a calculation about the costs involved in both setting up and rolling out the innovation over a number of years and make realistic judgments about whether the initial investment can be recouped in the long run. This is Activity-Based Costing (ABC). If ABC were combined with an assessment of the quality of the learning experience that the innovation will provide, then one would have a solid basis to predict the cost-effectiveness of educational innovations as part of their design.

Responses to the global learning crisis have resulted in "a proliferation of promising innovations in education" (Center for Education Innovations [CEI], 2016, p. 8). The challenge is to scale up those that have been successful in local contexts. The most effective way of enabling that is to design innovations with scale in mind from the outset. Rigorous fiscal analysis is part of this. A program's affordability should be key to its adoption by governments in the Global South, since costing and cost-effectiveness analysis "can forestall adoption of effective yet unsustainable innovations" (CEI, 2016, p. 9). It is difficult to choose between interventions unless

effectiveness is considered alongside costs (Mcewan, 2012). It is also vital that scaling up does not result in quality loss, affordability, or cost-effectiveness. For a program to scale, a cost analysis needs to show that the program can expand, adapt, and sustain itself over time. An ABC approach could provide an effective response to this challenge, particularly one that weighs costs against the quality of the learning experience provided. ABC can do this by linking the actual costs of creating and supporting learners to the activities themselves, thus ensuring "accurate cost-benefit analysis and performance improvement" (Sorros, Karagiorgos, & Mpelesis, 2017, p. 310).

This report argues that an accurate approach to costing is necessary to scale up digital learning in the Global South and assesses the extent to which an ABC approach provides this. The first part outlines the role of accurate costing in scaling up digital learning and identifies the range of activities to be costed. An ABC approach to costing is then introduced. Examples of the implementation of such an approach are provided, and tools to support an ABC approach to costing in digital learning are critically evaluated. The Course Resource Appraisal Modeller (CRAM) tool (Kennedy, Laurillard, Horan, & Charlton, 2015) is presented as an accessible means to model both costs and learning quality in prospective digital learning programs and interventions, and a case study is provided to show the benefits of this approach. This report ends with a summary of the benefits and limitations of Activity-Based Costing and discusses how CRAM can be used to mitigate the latter. The next section considers the role of costing in bringing digital innovations to scale.

2

THE ROLE OF ACCURATE COSTING IN SCALING UP DIGITAL LEARNING IN THE GLOBAL SOUTH

Access to formal education in the Global South has improved dramatically. Between 1950 and 2010, the number of years in school completed by the average adult has risen from two years to 7.2 years (World Bank, 2018). This growth in school enrolment has resource implications that threaten the quality of learning available. The introduction of free primary education in Kenya in 2013, for example, led to an increase in class size but a reduction in the teacher-student ratio, straining the availability of educational resources (Tabira & Otieno, 2017).

Support for scaled up learning could come from digital technology, however, since a global increase in digital learning opportunities has accompanied the rise in ownership of smartphones and other digital devices in the Global South (Curioso & Mechael, 2010; Laurillard, Kennedy, & Wang, 2017; Sahu, Grover, & Joshi, 2014; Shrivastava & Shrivastava, 2014). Technology could have the potential "to improve quality, increase access and reduce costs" (Garrett, 2002, p. 2) for the Global South, but each of these benefits needs to be carefully weighed. Across the world, budgets are under pressure, with public organizations expected to maximize efficiency and minimize costs (Organisation for Economic Co-operation and Development [OECD], 2016). The scope for financial investment in digital education by governments in the Global South are especially constrained (Garrett, 2002; Mosharraf & Taghiyareh, 2014). Moreover, the presence of collaborations with the private sector to provide digital learning opportunities show "limited resources for tackling educational problems" (Tabira & Otieno, 2017, p. 222).

2.1 Balancing costs with learning

While a strictly economic rationale might not be the sole driver of government investment in education (Visser-Valfrey & Compernolle, 2011), it is important to understand what makes such investment effective. Improvements in learning require the costs of the program to be considered alongside the learning benefits, but the "evidence base on costs is much thinner than that on benefits, with a tiny fraction of studies examining both" (World Bank, 2018, p. 110). Where such studies do exist, there is a lack of consistent evidence about the cost-effectiveness of digital learning interventions (Visser-Valfrey & Compernolle, 2011). Investments in equipment do not themselves lead to improved educational outcomes. For example, Cristia, Ibarraran, Cueto, Santiago, and Severín (2017) found that the One Laptop Per Child program in Peru was very successful in increasing access to computers among school children both at school and at home. Yet, while the children

increased their computer skills, the study found no evidence of improvement in learning in English and Mathematics as intended. Cristia et al. (2017) suggest that the provision of equipment needs to be combined with a "pedagogical model targeted toward increased achievement by students" (p. 318). Similarly, mixed results emerge from other studies on computer use in school (Ganimian & Murnane, 2016). However, where technology is used to support teaching practice, improved educational outcomes do result. For example, computers have been used to personalize learning, adapting to the individual needs of learners by allowing them to learn at their own pace (Kremer, Brannen, & Glennerster, 2013).

2.2 Designing digital learning at scale with costs in mind

Scaling up digital learning requires a deeper understanding of the essential elements involved in the process of "designing, delivering, financing, and enabling scaling of quality education" (Robinson & Winthrop, 2016, p. 9). It has been shown that for programs to be successful, they need external assistance beyond two years (Robinson & Winthrop, 2016). Existing knowledge of pedagogy is needed to "reduce the inefficiency of rediscovery of what does, and what does not, work best to support learning" (Hattie, 2015, p. 20) and to supply accurate costings if programs and interventions are to be financially sustained long enough to deliver results. This report argues that costing be considered part of the design process.

To illustrate, Laurillard et al. (2017) made the case that digital technology is the only way to address questions of equity in education by achieving access on a scale proportionate to demand. To ensure that a digital learning program or intervention is capable of operating at scale, one needs to ensure both quality and efficiency, since the resources available to support such programs are scarce. The design of every digital learning experience needs to attend to costs, since efficiencies can be achieved at scale, ensuring long term sustainability. However, cost-efficiency is not the same as cost-effectiveness (Meyer, 2006). If cost-efficiency is understood "as the provision of more or better learning at the same or lower cost" (Meyer, 2014, p. 94), it can be tempting to focus on quantity over quality. Yet doing so reduces the potential of digital learning for equity, since the principle of equity requires the provision of learning to all at an equivalent level of quality. Cost-effectiveness considers the relationship between what goes into and out of the educational product.

Cost-effectiveness analysis (CEA) happens after the program has run, analyzing the value of an intervention on the basis of cost and outcomes. Ex-ante cost-effectiveness is rare in education (Mcewan, 2012), but is necessary because it is too late to wait until the end of an intervention to be guided by the relationship between costs and quality. What is needed is a forward-looking way of making judgments about the cost-efficiency of digital learning, an approach that helps make costing a design decision from the outset.

2.3 How teaching activities change when learning moves online

The first step to move costing into the realm of learning design is to consider the way costs change with digital learning. These costs are "complex, fascinating, and not transparent" (Meyer, 2006, p. 91), and are different from traditional face-to-face learning. They include production costs as well as support/delivery costs, and require different specialist services. Fully online courses differ from blended courses that combine some traditional location-based instruction with online or digital elements. Meza-Bolaños, Compañ-Rosique, and Satorre-Cuerda (2016) argue that it is challenging for institutions to calculate a return on investment of their expenditure on digital learning because of the "many factors and subjective and complex characteristics to be

quantified" (p. 1109). Nevertheless, the authors insist on the necessity of trying to make a faithful representation of these factors in the context of Ecuadorian universities, where high dropout and low graduation rates mean the benefits provided by digital learning need to be accurately calculated.

In the traditional model, growth in educational productivity is dependent on more resources: more teachers are needed to teach more learners (Meyer, 2006). This model cannot scale. When learning moves online, however, technology has the potential to reach many more learners, no longer limited in size by spatial constraints of the physical classroom. For digital learning, equipment costs might appear to be the most obvious additional investment, but as Laurillard (2007) argues, equipment such as laptops and broadband internet access are not necessarily the most important cost driver for new digital learning experiences, since these have often been in place for some time. Instead, the key driver is time for teachers and other specialist staff (e.g. instructional designers) to design and then support the learning. Bates (2000) found that the division between the production and support (delivery) costs is critical:

> Because there are costs both in production and delivery of online learning, and because there are major cost differences in the requirements of different subject areas and different teaching methods, there needs to be a costing methodology and accounting system in place that allows the costs of online courses to be estimated accurately and tracked. (p. 13)

However, while provision of learning content in advance of a course run requires much greater upfront investment, these are fixed costs. A video presentation may take much longer to prepare than a presentation for a face-to-face class, but the costs will not change however many students watch it. This is very different from the variable costs of individual learner support by tutors during the run of the course. If the tutors were to provide the same level of support to each learner, the cost will inevitably rise in proportion to the number of learners. These variable costs can be seen as a vulnerability of online learning (Hülsmann, 2004), and require attention.

In response, Meyer (2006, 2014) identified four major principles for increasing teaching productivity and student learning productivity through digital technology: 1) substituting high-cost labor with technology (online modules, self-paced learning, automated grading); 2) substituting high-cost labor with lower-cost labor (peer tutors, graduate assistants); 3) substituting technology for capital space (less demand for buildings); 4) and incorporating robust learning design practices.

Transferring more of the variable costs of learning into fixed costs, therefore, is key to enabling digital learning to increase productivity. Fixed costs can be spread across many learners and amortize over repeated runs, so to allocate more accurately what part of a teacher's time is being used for one-off activities, and what part is constantly required to support students to learn with the resource, can help reveal the separate costs of setting up and sustaining learning. The more activities that can be done upfront, the less resource is required for the course to sustain over time.

This is not straightforward. Reducing the costs of teacher time to support learning may have serious impacts on the quality of the learning experience. Blended approaches often still ultimately rely on individual teachers (Bates, 2000). Blended learning also does not reduce the recurring costs of traditional delivery such as equipment and room hire. Taking these complexities into account, any understanding of the costs of digital learning requires the critical 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" (Laurillard, 2011, p. 3).

3

HOW AN ACTIVITY-BASED COSTING APPROACH CAN HELP

Traditional costing approaches attribute direct costs such as raw materials to a service, while overheads are attributed as a proportion of the direct costs. However, in complex business environments, when multiple activities are being undertaken in the provision of a service, and when overheads may be more important than direct costs, there is a need to take a more accurate approach to costing individual activities. Different activities use greater or fewer resources, take more or less time, and consume a bigger or smaller proportion of overheads, the details of which are lost in a traditional approach but may be critical in determining whether a service is profitable or not. Activity-Based Costing (ABC) is an approach that attempts to cost the service accurately on the basis of the resources it consumes (Cooper & Kaplan, 1988). ABC also makes visible the increased cost of a higher-quality service, such as bespoke tailoring versus off the shelf, since it reveals the extra time required to produce it.

Kumpu et al. (2016) used ABC to examine the relative costs for blended learning versus a traditional classroom-based approach in sub-Saharan Africa. They found that blended learning startup costs were 115% higher than for starting up and running the traditional version of the course. This included the investment in video conferencing technology, which was considered a capital cost. While this initial investment might be expected, the costs of delivering the blended learning course were double those of delivering the traditional class. The reason is the increase in teaching hours entailed in blended learning:

> This result was unsurprising, as others have suggested (blended learning) may lead to increased faculty workload due to the need to create online content and learn new technologies. (p. 7)

The authors suggested that greater familiarity with the technology over time could reduce the teaching hours. The analysis concluded that the pedagogical approach of using real-time video conferencing to connect different university sites was unsustainable as the space costs remain high in the blended learning approach, and offset savings from a reduction in teaching hours. This led the authors to question if blended learning is the best approach, despite overall staff and students satisfaction.

This application of ABC indicates that if performed without simultaneous appraisal of the pedagogical model underpinning digital learning, ABC may only tell half the story. What would have been even more beneficial is the capacity to model different blended learning scenarios, that is, different pedagogical mixes using different synchronous or asynchronous contact.

If the different costs involved in each approach could be weighed against the learning benefits of the approach, the conclusions might differ. While the current blended learning design may be unsustainable, another blended design might be able to create a similar learning experience but at a reduced cost. Blended learning might still be an effective solution, just not the version being currently adopted.

The challenges of applying ABC to learning are explored further in the next section.

3.1 The challenges of applying ABC to learning

The Greek fiscal crisis has prompted more accurate approaches to costing education (Sorros et al., 2017), since difficult economic periods demand closer attention to the hidden costs of activities. Sorros et al. (2017) proposed that ABC could help institutions improve performance or re-price outputs in order to become more sustainable or competitive. This ability to identify cost-reducing strategies can help save courses that might otherwise be running at a loss:

> Proper cost information and resource allocation offer better cost control in profitable activities identification (e.g., courses, degrees, activities). As such, ABC helps design courses with respect to their associated costs and highlights the services that need to be altered. (p. 312)

Nevertheless, the authors recognized that this detailed approach to costing is not being used across the education sector in Greece. Many institutions lack understanding of the method or the data they need to apply it, and where there was familiarity with and appreciation of the method, the complexity and costs of implementing ABC discouraged its use. Similar themes are found in the analysis by Elgammal, Zakka, El-Kassar, and Dandash (2016) of the reasons for non-application of ABC methods across all sectors in the Global South. Lack of understanding, complexity of the method, satisfaction with conventional approaches, and lack of buy-in from top management are all reasons why ABC may not be used. Even in the Belgian libraries in their study, Siguenza-Guzman et al. (2016) reported that some staff were uncomfortable being observed to document activity flows, which caused resistance and delays in data collection.

A key drawback of ABC is its reliance on staff to provide information about time spent on activities, for example, by completing timesheets, which teaching staff can resent (Meyer, 2006). Ehrmann and Milam (2003) found that in education generally, resistance to focusing on costs could be anticipated:

> Not only is it quite difficult to estimate time spent on a task, even when keeping an hourly log (which almost no-one is willing or able to do). Faculty and staff may be wary of reporting their time spent, because they may fear the consequences of the study. (p. 18)

Cropper & Cook (2000) found that teaching staff see dwelling on costs as antithetical to their role as educators:

> Put simply, staff may well resent the burden of time recording mechanisms for checking the use of their time when, in the past, they have operated under the status of 'self- validating' professionals. Moreover, they may not be in a position to state accurately how much of their time is spent on teaching and research. The two areas are not always distinct and separable. (p. 62).

Nevertheless, Meyer (2006) observed that:

> Perfect accuracy may be impossible but worth tolerating if the institution can better

understand how and when different activities contribute to costs. (p. 10)

The advantages of adopting ABC are in identifying where improvements could be made, not simply to increase profit or avoid loss, but to maintain or improve quality in a financially sustainable way. If the cost of activities were tied to the quality of the educational output, it could be more clearly observed how an ABC approach could benefit educational institutions, including teaching staff whose courses would cease to be vulnerable to arbitrary cuts and closures; the sustainability of innovative ventures could be guaranteed.

Instead of activities being observed by management, which would always be challenging within the educational context, ownership of the costing process should be in the hands of teaching staff themselves. Being able to see improvements in the quality of courses and the conditions required for their longevity would help teachers judge whether to embark on projects, and could contribute to their own sense of security in a time of precarious employment.

3.2 The promise of Time-Driven Activity-Based Costing

A further drawback of using ABC is its complexity. It takes time for organizations to implement, and a high level of commitment to change from existing systems. A typical approach to implementing ABC is to survey staff to ascertain the proportion of time spent on a particular activity, which is difficult to do. A simpler approach, proposed by Kaplan and Anderson (2004), uses a framework with only two parameters: the cost of the time unit for supplying capacity, and the time it takes to perform the activity. In teaching terms, this could equate to the cost of a teacher per hour, and the time it takes to grade an assignment. Instead of surveying staff, this approach, known as Time-Driven Activity-Based Costing (TDABC), estimates how long each activity takes: "precision is not critical; rough accuracy is sufficient" (Kaplan & Anderson, 2004, p. 133).

The use of TDABC in academic libraries was evaluated by Siguenza-Guzman et al. (2016), who found it to be a powerful tool to understand the costs of different services, providing information to managers to identify best practices and make agile improvements. The authors argued that this is especially valuable at a time of increasing organizational complexity, which "comes in the form of retooling traditional services, creating new services, as well as shrinking budgets" (p. 239).

The simplicity of the time-based approach could therefore have potential in the Global South. This approach could benefit not simply those involved in financial decision-making in governments and organizations, but also teachers themselves, particularly those who are involved in designing and supporting innovative digital learning interventions. Both the design time and support time for digital learning are often severely underestimated, creating stressful working conditions for staff. TDABC could help teachers argue for fairer workload distribution or appropriate salary. Institutions are also often unwilling to invest in the infrastructure required for digital learning (e.g. new specialist job roles) because of the short-term expense. However, being able to accurately predict the return on investment over several runs of an online course or of scaling up a digital intervention could change this. In this way, the ABC approach could be of most use to institutions involved in developing digital learning, which tend to involve the tertiary education sector and their partners (e.g. nongovernment organizations). The next section evaluates tools developed to cost the transition to online and digital learning to consider their applicability.

4

COSTING MODELS FOR DIGITAL LEARNING USING AN ACTIVITY-BASED COSTING APPROACH

Meyer (2006) has argued that costing models have overlapped, and ABC approaches have influenced various models including The Flashlight™ Cost Analysis Handbook (Ehrmann & Milam, 2003) and the Technology Costing Methodology Handbook (Jones, 2004). These two models are assessed below to evaluate their applicability in costing digital learning in the Global South.

4.1 The Flashlight™ Cost Analysis Handbook

The Flashlight™ Cost Analysis Handbook provides "basic spreadsheet models to collect data and build ratios and equations that relate different variables and cost drivers" (Ehrmann & Milam, 2003, p. 5). The major benefit of the Flashlight™ model is to help an organization reveal and adjust cost-drivers, or elements of an activity, that "if changed, would have a significant impact on the resources needed" (p. 11), which could benefit organizations in the Global South seeking to identify opportunities where moving online could result in efficiencies. The handbook suggests tweaks that users can make to reduce cost drivers, for example, increasing the allocation of students to individual teachers, or removing photocopying costs by putting materials online.

The handbook argues for organizations to encourage staff to conduct self-studies because of the difficulties of obtaining data about the resources consumed in the process of performing activities, including how much time people spend on a task. The authors suggest that studies motivated by an individual or a team's desire to increase their own productivity or their project's sustainability are likely to be more effective than those imposed on them. In the context of the Global South, this is not only the most realistic method since it is unlikely that additional resources will be available to provide an external observation of activities, but engaging teachers themselves in thinking about costs means that issues of financial sustainability can be embraced at the very outset of an initiative by the very people who will be teaching or supporting the learning. In addition, teachers themselves need to know that the heavy investment in time that is being asked of them will create a sustainable course. Changing modes of teaching can have an impact on continued employment, and the nature of that employment can change. This is especially true for the increasing number of hourly paid, precarious, or adjunct staff (Hurlburt, 2016; University and College Union [UCU], 2016).

In addition, the authors of the handbook underline that an ABC approach does not dictate what to do. There are times when more expensive activities are justified. For example, an analysis could focus on ways of reducing burnout among staff or make time more satisfying and productive. Such an insight could be used to argue for the benefits of adopting an ABC approach to staff who fear attention to costs is inevitably a way of reducing quality or staffing. Moreover, this is not just another way of using ABC, but implies another dimension to sustainability. An ABC approach need not simply be used to highlight areas where costs may be reduced, but also to shed light on the labor entailed in creating and supporting digital learning so that it can be properly acknowledged, supported, and compensated. This may entail finding ways of reducing time-consuming activities through technology, or making sure faculty members are adequately paid for doing the work. If activity-based modelling is only aimed at identifying time-saving measures, faculty members might be concerned that the process will result in the elimination of their job.

However, The Flashlight™ Cost Analysis Handbook recommends a team approach to costing, implying a large organization with a well-developed infrastructure, potentially reducing its usefulness for the Global South.

4.2 Technology Costing Methodology Handbook

The aim of the Technology Costing Methodology (TCM) Handbook is to specify conditions necessary for digital teaching and learning methods to become cost-effective (Jones, 2004). The resulting methodology is a standardized way to compare costs of classroom-based and alternative (digital) forms of education. Like the Flashlight™ model, it has its basis in ABC as a way of identifying activities necessary for creating alternative forms of education, listing expenditures related to them, and recommending procedures for converting expenditures into activity cost data. The approach could help organizations planning digital learning in the Global South to organize their cost data to inform decision-making.

The handbook provides detailed advice to help identify both the activities involved in providing a course and the likely objects of expenditure entailed in doing so. This process allows the total cost associated with a specific course to be calculated, along with the average cost per student.

The TCM approach handles the way technology-supported courses can achieve efficiency through scale by providing a model for understanding the relationship between costs and enrolments of students as a step function as courses add sections. However, this model appears to be premised on a regressive pedagogy dominated by tutor instruction rather than one that encourages active learning. The model therefore suggests that "Internet-based courses" may add additional enrolments "without consideration of 'sections'" (Jones, 2004, p. 9) in order to acknowledge that the high costs of development may be offset by high rates of enrolment. This is not necessarily the case. Various levels of tutor support may be needed for online students, for example, in facilitating discussions or personalized feedback on formative tasks and assignments. Depending on the kind of course created and the learning experience designed, these costs can rise considerably as student numbers increase.

4.3 Beyond a spreadsheet approach to costing

These two ABC informed models provide a methodology for conducting ABC analysis. Although they provide example spreadsheets, they do not provide further practical help, which is necessary if non-specialists such as teachers are to engage with issues related to costing. Neither model engages with pedagogy. Yet, informed costing decisions require

an understanding of the learning experience that the expenditure is likely to achieve, for example, whether an increase in expenditure on expensive personalized tutoring could have important implications for course equality and sustainability. The TCM and Flashlight™ model lack the ability to relate pedagogical decisions to costs, and so cannot show the resulting learning experience. Moreover, meaningful decision-making about the use of technology, particularly when related to sustainability, needs to account for the ways that technology can provide quality learning at a reduced cost. Neither model is able to do this. While the handbooks provide advice to simplify the process of costing digital learning, the process would still be too challenging for the majority of staff. What could be most useful to teachers is a software-enabled tool that helps users step through the process of both conducting an ABC analysis and representing the likely quality of the learning experience that results.

A simple-to-use software tool accessible to all staff, not just those involved in finance or management, and that can model both pedagogy and costs, would address these shortfalls. The next section discusses such a tool, the Course Resource Appraisal Modeller (CRAM), which provides digital support for analyzing the costs and benefits of learning in different modes (Kennedy et al., 2015).

4.4 The Course Resource Appraisal Modeller

The CRAM tool was developed in response to the difficulty of conducting ABC and the lack of pedagogy that underpins ABC models. Existing tools and advice help identify the activities that need to be costed but do not assist with the process of estimating the costs. This means that costing remains a specialist management activity, not something routinely considered when proposing to launch a new online course or digital learning experience. The CRAM tool brings together pedagogy and an ABC approach to costing, so that costs may be considered alongside the desired learning experience. This is achieved by the tool supporting users to first design the teaching and learning activities (TLAs) that will feature in the course or intervention, and then to estimate the time that staff will need both to create them and support them as they run. Having entered the data, which include basic data related to cohort size, credit hours, and student fees, CRAM performs calculations to provide an analysis of both the costs and the designed learning experience to the user.

The design process invites users to select from a library of TLAs or create something new by combining any of six learning types: acquisition, investigation, discussion, practice, production, and collaboration. These are drawn from the Conversational Framework (Laurillard, 2012), a model of the conditions necessary for learning to take place. Since the design of activities has implications for costs as well as learning, the user is prompted to decide whether the activities will be personalized, or provided the same to all learners, or user groups. This in turn has implications for feedback – whether it comes from the tutor, the computer, or from peers. The TLA is visualized in the form of a pie chart to represent the proportion of learning types involved in the experience.

The analysis of costs in CRAM is time-driven. Users of CRAM are invited to estimate the staff hours necessary to prepare the activity, and then to support the activity during the course. For example, an online discussion activity may take 0.5 hours for a teacher to prepare, but 1.5 hours to support, depending on how much individual feedback to learners is being provided. By contrast, a five-minute video may take as long as 15 hours to prepare but negligible time to support once created. The user is then prompted to consider how the times will change in the second and third runs of the course or iterations of the digital learning activity, given the resources have already been created, but support activities may need to be performed again. Different levels of expertise may be required for

different aspects of course production. For example, a more experienced academic might create presentations, while staff with less experience might support discussions. As a result, the tool prompts the user to assign tutor preparation and support at staff occupying different pay scales.

The user is provided with feedback in terms of learning experience, staff time, learning hours, and the total income and costs over three runs of the course. The total learner time allocated to the six learning types is shown in a course level pie chart. The total feedback derived from tutor, computer, or peer is shown in a column chart. The total personalized, social, or undifferentiated learning experience is shown in a bar chart. These graphs give a sense of whether the digital learning experience is likely to produce the desired learning outcomes. A summary table is also produced showing the break-even point at which the course becomes financially sustainable, which may not happen in the first run because of the size of the initial investment. Later runs may recoup initial losses.

However, if the course still appears too expensive to be financially sustainable, the combination of Time-Driven Activity-Based Costing and the Conversational Framework embedded in the tool allows users to identify pedagogical choices that may ameliorate costs, while preserving the quality of the learning experience. For example, if a formative production activity with personalized tutor feedback proves too costly, computer-based or peer feedback could be substituted, with the revised learning experience presented again in the various charts, and the total costs recalculated.

The CRAM tool was developed as a Java-based digital tool available for free download. Once installed on a computer, it can produce editable costing files that can be shared, or exported as reports in MS Word, for example, to accompany new course proposals. Table 1 summarizes the features of CRAM in comparison with the Flashlight™ and TCM approaches to highlight applicability of all three tools to costing in the Global South.

As a software-enabled application that is simple enough for teachers to use, and which takes into account the projected learning experience alongside costs, CRAM has advantages over both Flashlight™ and TCM for planning digital learning in the Global South.

In 2017, funding from UCL Information Services Division allowed for a redesign of CRAM as an online version available to UCL staff via an institutional shibboleth log in. The new tool launches as a UCL service in 2018. UCL has committed to make the code for the tool freely available for adaptation and reuse by other institutions when thorough user testing is completed and bugs are ironed out. The next section details an example to demonstrate how such a tool could be used.

	ABC-based	Helps identify cost drivers	Informs scaling up	Software /app support	Costs related to pedagogy
Flashlight	Yes	Yes	Yes	No	No
TCM	Yes	Yes	Yes	No	No
CRAM	Yes	Yes	Yes	Yes	Yes

Table 1. *Features of ABC tools applicable to the Global South*

5

CASE STUDY: APPLYING THE CRAM TOOL TO SCALED-UP DIGITAL LEARNING

To demonstrate the benefits of an activity-based costing using CRAM, the new online version of the CRAM tool was used on a recent University of London on-demand massive open online course (MOOC) called "Get Interactive: Practical Teaching with Technology". "Get Interactive" was designed as a professional development course for teachers in the higher education sector, based on a previous smaller-scale, online course created by the Bloomsbury Learning Environment, a learning technology collaboration among the Bloomsbury Colleges of the University of London. The MOOC was designed to be low-cost, using the course itself as a model for the tools that were featured. There was relatively little use of professional video, which was confined to the introduction and summary units of each of the three weeks, and used for recording three sets of panel discussions with experts for each week. The professional video services were costed at £3,500 in total, as non-staff costs.

The remainder of the resources were screencast videos, and a range of practice, production, and collaboration activities (e.g., using a wiki or Padlet). There was a peer review assignment. The course was designed using the Conversational Framework to create a robust and varied learning experience on a limited budget. As shown in Figure 1, the CRAM tool helped represent activity-based costing by allocating proportions of learning types from the Conversational Framework.

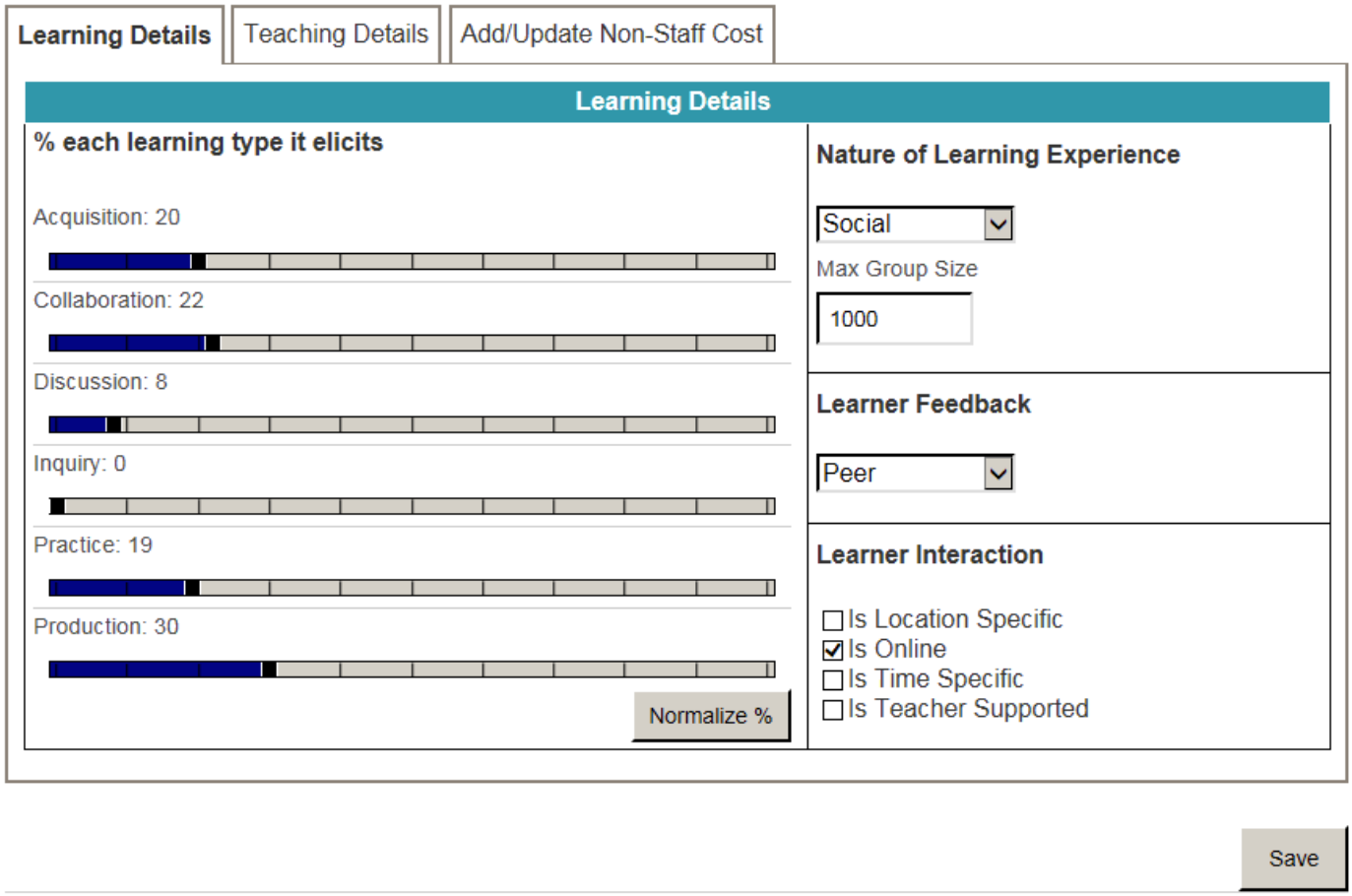
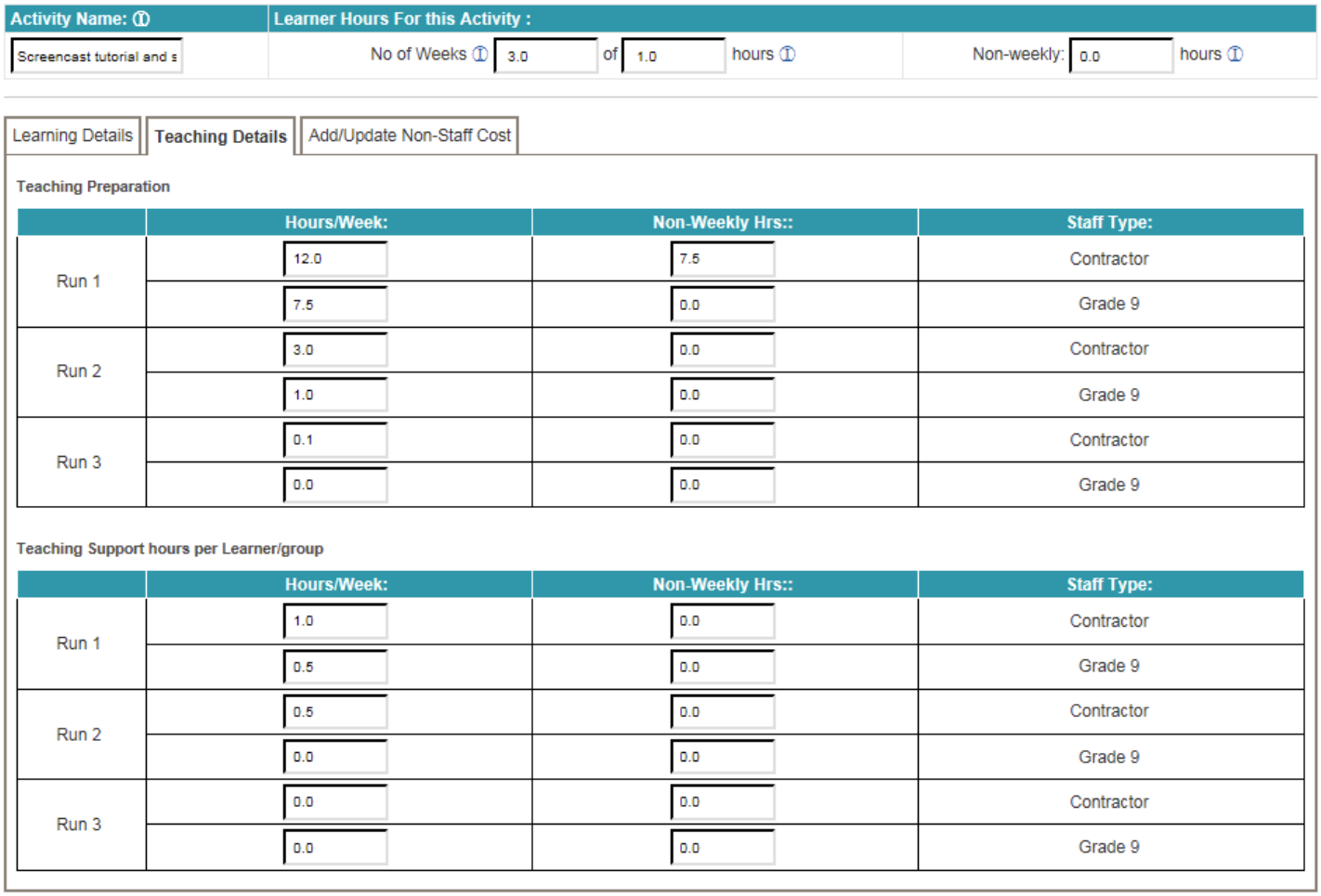


Figure 1. *Designing the activities in CRAM by allocating learning types and interaction/feedback detail*

The tool helped in estimating hours spent in preparation and support of the activity over three runs. This was performed by the teachers in the course, and cross-checked after the course runs with records of time spent. Figure 2 shows the screen that helps the teacher input hours for preparation and support for a specific activity.



Activity Name: ⓘ	Learner Hours For this Activity :		
Screencast tutorial and s	No of Weeks ⓘ 3.0	of 1.0 hours ⓘ	Non-weekly: 0.0 hours ⓘ

Learning Details | **Teaching Details** | Add/Update Non-Staff Cost

Teaching Preparation

	Hours/Week:	Non-Weekly Hrs::	Staff Type:
Run 1	12.0	7.5	Contractor
	7.5	0.0	Grade 9
Run 2	3.0	0.0	Contractor
	1.0	0.0	Grade 9
Run 3	0.1	0.0	Contractor
	0.0	0.0	Grade 9

Teaching Support hours per Learner/group

	Hours/Week:	Non-Weekly Hrs::	Staff Type:
Run 1	1.0	0.0	Contractor
	0.5	0.0	Grade 9
Run 2	0.5	0.0	Contractor
	0.0	0.0	Grade 9
Run 3	0.0	0.0	Contractor
	0.0	0.0	Grade 9

Figure 2. *Teaching details input screen*

On-demand Coursera MOOCs are open to a new cohort once every four weeks. Income from the course comes from MOOC participants purchasing certificates. Of this income per certificate (£39), half is allocated to the University, and half retained by Coursera. However, a very low proportion of participants choose to purchase a certificate (1.1%), which when spread over a cohort of 1,000 students was input as £0.25 per participant.

The CRAM tool provides feedback on both the course quality and its financial sustainability. Figure 3 shows the breakdown of learning types in the course in the form of pie chart.

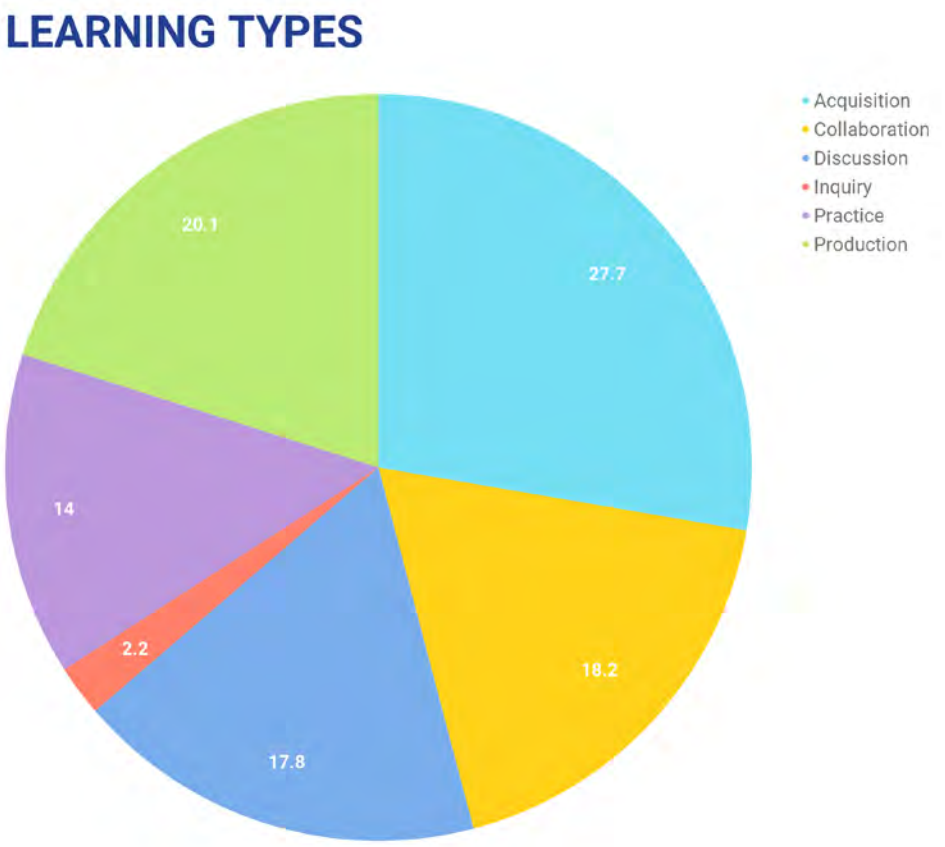


Figure 3. *Proportion of learning types*

The summary report, as shown in Figure 4, breaks down costs and income over the three runs. The University of London provided grant funding of £13,000 for developing the course, with some additional support from the Bloomsbury Learning Environment. The funding facilitated the appointment of a consultant who created the course; the design and management of the project was supported by two other members of staff. The teacher costs for the course over three runs show a much higher preparation cost in the early runs, which decreases but does not completely disappear by the third run. For each run every four weeks, three hours are needed to attend to the activities and respond to participants. For example, there may be queries relating to the peer review activity, or external links may need to be replaced.

While it is clear from the analysis that the initial investment is unlikely to be recouped, CRAM also shows that the course income, though modest, easily covers the ongoing cost of course maintenance. It shows that following receipt of funding, the course can support itself, and even create employment opportunities. Feedback from the CRAM tool shows that the course can be modelled to provide a quality learning experience and be financially sustainable. The model helps identify the high costs that may need to be reduced, and also any pedagogical implications of making the changes. As a result, activity-based costing using CRAM can be a straightforward way of planning for sustainable and quality digital learning which expands access and helps achieve equity.

Summary Report

Export to Excel

Run No	Learner Count	Preparation Hours	Support Hours	Non-Staff Cost	Cost per Learner	Total Income	Total Cost	Difference	Running Total
1	1000	372	60	3,500	19.74	250	19,736.67	-22,986.67	-22,986.67
2	1000	29.4	23.1	0	2.03	250	2,032	-1,782	-24,768.67
3	1000	0.9	2.1	0	0.12	250	120	130	-24,638.67

UPDATE

Figure 4. *Summary report of costs for three runs*

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CONCLUSION

Bringing effective educational interventions to scale requires that they be designed from the outset with scale in mind, which includes a detailed costing analysis (CEI, 2016). This report has shown that a Time-Driven Approach to ABC has potential to provide accurate costing of digital learning in the Global South. This approach can promote cost-effectiveness by showing how costs can be adjusted in ways that both preserve the quality of the learning experience and aid sustainability.

However, the major drawbacks of the ABC approach lie the complexity of the process of identifying activities and costs. The use of a tool such as CRAM, which simplifies the process of identifying activities and their costs can go a long way to address these issues. The CRAM tool can put the process of costing in the hands of the teacher, and support the teacher create quality and sustainable digital learning. In addition, by putting cost analysis in the hands of teachers and course leaders, CRAM promotes ownership. Instead of creating anxiety about external observers, teachers are in control of the important issues of time and cost that have implications for both the quality and continuation of their employment, and for the capacity of learners to benefit from the program or intervention. This approach would also reduce the burden on management and finance departments, who would benefit from understanding more accurately what is involved in digital learning.

To be effective in facilitating a greater understanding of the sustainability of digital learning, ABC analysis needs to be conducted alongside an analysis of the quality of the digital learning experience. The Conversational Framework has already established which elements need to be put in place when designing quality digital learning (Laurillard, 2012). By incorporating activity-based cost analysis alongside the Conversational Framework, the CRAM approach to modelling learning benefits and teaching costs can predict both the quality and sustainability of the learning experience. Such an approach can be an effective first stage to a full Cost-Effectiveness Analysis to be completed after the program has run.

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ABOUT THE AUTHOR

Eileen Kennedy is a Senior Research Associate based at the University College London Institute of Education (UCL IOE) specializing in digital higher education. She has worked on Learning Designer and CRAM, which are projects at UCL Knowledge Lab to develop learning design and costing tools to support the move to online learning. She is currently doing research on the transformative potential of scaling up digital learning with CGHE. In addition, she does research on participatory approaches to using digital higher education to meet the challenges of mass displacement in Lebanon with the RELIEF Centre.

Foundation for Information Technology
Education and Development, Inc. (FIT-ED)
3/F Orcel II Building. 1611 Quezon Avenue Quezon City 1104 Philippines
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