Original Paper

Edward Meinert[1,2], Abrar Alturkistani[1], Kimberley Foley[1], Terese Stenfors[3], Hassan Chaudhury[1], Yusuf Ermak[1], Philippe Sabatier[4], David Brindley[2]

[1] Global Digital Health Unit, Department of Primary Care and Public Health, School of Public Health, Imperial College London, W6 8RP London, United Kingdom
[2] Healthcare Translation Research Group, Department of Paediatrics, University of Oxford, OX3 9DU Oxford, United Kingdom
[3] Department of Learning, Informatics, Management and Ethics, Karolinska Institutet, Sweden
[4]Universite Grenoble Alpes, 621 avenue Centrale 38400 Saint-Martin-d'Hères, France

Corresponding Author:

Edward Meinert
University of Oxford
Email: edward.meinert@paediatrics.ox.ac.uk

# A case study examining the cost measurements in production and delivery of a blended Massive Open Online Course (MOOC) on the use of Data Science in Healthcare using Real World Evidence

Keywords: Education (MeSH); Education, Distance (MeSH); Education, Professional (MeSH); Online Education; Online Learning; Costs and Cost Analysis (MeSH); Economics (MeSH)

# Abstract

## Background

There is significant demand for trained data scientists to provide insight and analysis of health-related data. A MOOC allows a flexible means of course provision for learners, as they can undertake the learning at a time and location which is to their convenience in addition to having the possibility to collaborate with a broad number of learners face to face. Understanding the costs to deliver these courses could enable further investment in the development of these courses to replace costly and limited one-time use course implementations.

## Objective

The purpose of this study was to determine how the total costs of a blended MOOC are budgeted at project commencement and the factors influencing adherence to budget from course development to delivery.

## Methods

This study uses a mixed-methods study design, using a case study design structured for study observation of financial decision making and cost analysis (centred on variance analysis) used to analyse financial data.

## Results

The course had a positive variance to the initial budget of 16%. Stakeholder costs for subject matter expert lecturers were slightly overestimated but close to budget. Equipment and materials had a significant positive variance of 37%; the reason for this is that not all the planned equipment for the course development was necessary because there was efficiency derived in the course production and streamlining of data science modules that were thought to have required custom application development. Personnel had a negative variance of 13%; this was related to additional effort required in video editing. Additionally, the course was completed ahead of schedule and in less time than was anticipated.

## Conclusions

Although this programme was a significant undertaking in resources and scope in combining both a digital programme and face to face residential course, the project was successful in achieving its cost schedule through optimising its project management, through strong relationships of its principals and leveraging successful smaller scale learning implementations developed in previous years.

# Introduction

***Rationale***

There is a significant demand for trained data scientists to provide insight and analysis of health-related data [1]. Health presents immense challenges where data science could impact key problems and has the potential to improve the delivery of patient outcomes by increasing efficiency and effectiveness. For example, using computational methods on the vast quantity of Real World Data (that is data derived from everyday medical practice rather than clinical studies) could provide researchers with the ability to create predictive models which identify who is at risk of diabetes, and to develop preventive and personalised care for parents through mobile phone applications. A MOOC allows a flexible means of course provision for learners, as they can undertake the learning at a time and location which is to their convenience in addition to having the possibility to collaborate with a broad number of learners face to face [2]. There has been limited, but increasing use of MOOCs in a blended capacity; this type of instructional design leverages a combination of broad access to a course while using face-to-face instruction to enable reinforcement of learning outcomes [3,4]. This course type could enable cost efficiency in the production of health-related skills. Further understanding the total costs to deliver these courses could enable further investment in the development of these courses to replace costly and limited one-time use course implementations [5].

The study examines a course which develops data management skills, including frameworks for analysing and evaluating content (data) and subsequently, encouraging the uptake of data projects, innovations and entrepreneurship. To complete the course, learners were structured into teams to develop and implement a data science project. These initiatives were Real World Data projects that addressed current healthcare problems. Completion of projects put learning into practice and establish foundations for further commercial activity or research. The blended format prepared future (postgraduate students) and current healthcare professionals with the required skills and knowledge to conduct and be part of Real World Evidence (RWE) projects and will help develop them to the growing need of data analysis skills in the healthcare field.

The purpose of this study was to determine how the total costs of a blended MOOC could be calculated and the factors influencing their production and development. This study builds on the work of two previous studies by the lead author examining costs in the production of eLearning in 2016 and 2017 [6,7].

***Objectives***

1. Identification of the components or “ingredients” for the production and delivery of a blended MOOC to form a comprehensive project budget
2. Utilisation of variance analysis of the ingredients for the cost of production and delivery of a MOOC
3. Explore the factors impacting the planning of costs for eLearning delivery

# Methods

## Design

The study focused on analysing course production budgets and their variance with post-production actuals within this form of eLearning; the course implementation took into account not only the cost of production of the online course, but the costs associated with face to face course support delivery. The study design used a case study design to track financial decision making to understand variances in costs. The study made modifications to previous study protocols to gather further evidence concerning cost variance in eLearning delivery [6,7]. The previous studies examined a Small Private Online Course (SPOC) [6] and a Massive Open Online Course (MOOC) [7], this study was novel in its investigation of a combined SPOC/MOOC in delivery. Ethical approval for the study was obtained through the Imperial College Education Ethics Research Committee (EERP1617-030).

## Methodologic framework

A case study research design was selected because the study focus was on the financial actions taken in the production and development of the course and not experimental variables in the delivery or execution of decision making.

This investigation followed a six-stage process for case study research design [8].

**Stage 1: Plan**

This study was the third study and final study executed investigating cost analysis in the production of eLearning [6,7]. On consideration of study design, we focused on a case method as this approach was successfully used in the previous studies and it was thought that by implementing the same approach, a further cross-case analysis could be executed on the completion of this study. Maintaining a governing proposition from related-research by the investigators, there was a view that there would be a negative variance (a negative variance indicates that the final costs exceeded the production budgeted costs) in production costs from the initial project budget.

The study research question centred on capturing the cost ingredients in the design, development and deployment of the course.

## Case description

The purpose of the course was to deliver an education programme via a blended format for postgraduate students and professionals in health interested in the application of Real World Evidence data analysis and in furthering their knowledge and skills to include conducting and commissioning Real World Data (RWD) analysis. A key objective of the programme was to establish a global network of people to continue and advance the dialogue on data science in healthcare. The success of the format was evaluated for education impact in order to contribute to research in the area of digital education in health, although this was subject to a separate investigation [9–11].

The content from the course develops skills in the context of RWE, including frameworks for analysing and evaluating content (data). In addition to the digital component, a Small Private Online Course (SPOC) was offered for learners to complete case studies assignment over a two-day residential programme. To complete the course, learners were structured

into teams to develop and implement data science projects centred on two case studies, the first examining a Herpes Simplex Patient Registry, the second examining telemedicine in secondary and tertiary care.

The course was developed and built from January 2018 through August 2018 and delivered to participants in September 2018 through December 2018. This course built on previous online implementations of the course developed in 2017 as part of a funded project on experiential education. The course under review in this study was produced as a consortium including HealthIQ, a specialist real world evidence data supplier, Imperial College London, University Grenoble Alpes, the University of Oxford and Karolinska Institute.

**Stage 2: Design**

The research design was focused on the investigation of total costs for production and delivery. In line with previous findings [12] and evidence demonstrating of the insufficient nature of initial budgets as means of determining the cost of educational delivery [13], the core proposition of the investigation was centred on measuring expected variance and identification of the factors causing them. To explore this proposition, the "ingredients method" [13] was used to total capture cost production against cost categories. The ingredients method examines the core composition of costs in the delivery of an education intervention; this is an activity-based costing approach which seeks to understand the core components required for delivery.

*Table 1: Case study research design [8]*

| Study question | Proposition | The case (definition) | Logic linking data to the proposition | Criteria for interpreting findings |
|---|---|---|---|---|
| How are the total costs for the production and delivery of a blended massive open online course calculated? | Actual costs and budgeted costs will vary due to the iterative nature of eLearning and underreporting of staff costs | Determination and measurement costs | Cost analysis of project costs, actual cost and underreported costs | Variance analysis of the project budget |

In order to assure the quality of the study design, three tests [8] were implemented to validate the research design quality.

*Table 2: Research design tests (Adopted from [8])*

| Test | Description |
|---|---|
| Construct validity | The purpose of a construct validity test is to demonstrate that data sources are triangulated from multiple sources [8]. |
| External validity | The purpose of an external validity test is to demonstrate how principal findings could be extensible [8]. |
| Reliability | The purpose of the reliability test is to show how the activities of the study can be replicated [8]. |

**Stage 3: Prepare**

A study protocol modified from the previous cost investigations (Appendix A) was used to manage the study process. Levin's [13] model for cost measurement was used to analyse budget vs actual spend; it implements an activity-based costing standard costing accountancy approach, which assigns costs as they are consumed per implementation area [14–16]

**Stage 4: Collect**

***Data collection***

The data collection strategy was executed from a *realist* perspective to capture the decision making of the course designers centred on cost attributes. In order to control selectivity and reporting bias, data was triangulated following construct validity tests. A traceability log was maintained linking the study questions to the relevant data sources and the study findings.

**Stage 5: Analyse**

Data analysis centred on three cost categories in the design of the pre-production budget submitted to the funder.

Category A: Concept and measurement of costs

The pre-production budget was analysed for the following ingredient categories: 1) personnel, 2) estate charges, 3) equipment and materials, 4) indirect costs and 5) stakeholder costs.

Category B: Placing values on ingredients

With the full cost of production defined, values were associated with each ingredient sub-category to reflect the chargeable cost.

Project costs will be recorded in EUROS because the majority of activity spend was transacted in EUROS.

Category C: Analysing costs

The course was analysed for the one-time implementation cost of the project in 2018. The course had a pilot implementation in 2017 and had continuation funding for 2019, but the 2017 and 2019 cost elements were not taken into consideration as previous studies focused on one-year implementation costs. In order to track cost variance, variance analysis of the budget to the incurred costs was reviewed on a quarterly basis.

Variance = Actual spending – Budgeted spending

**Stage 6: Share**

The findings of the variance analysis and analysis of reasons leading to variation were presented in a draft case report. The key findings for this report were prepared for publication for a peer-review journal (this manuscript).

# Results

**Course production costs**

Category A: Concept and measurement of costs

*Table 3: Ingredient categories*

| Ingredient categories | Cost components |
|---|---|
| Personnel | University staff |
| Estate charges | IT services charges |
| Equipment and materials | Course production equipment, application development costs for the creation of software to support the MOOC |
| Indirect costs | University overheads |
| Stakeholder costs | Staff for third party subject matter consultancy |

Category B: Placing values on ingredients

Upon completion of the analysis of the ingredients of the course production, the initial budget was created and submitted to the funder.

*Table 4: Ingredient Costs of a blended MOOC in RWE*

| | Cost in 2018 |
|---|---|
| Personnel | € 102,041 |
| Estate charges | € 12,625 |
| Equipment and materials | € 244,517 |
| Indirect costs | € 88,317 |
| Stakeholder costs | € 50,000 |
| | € 497,500 |

Category C: Analysing costs

Budget variance analysis

Budget variance was tracked regularly throughout the project. The research team monitored the budget regularly with the course team and the initiative had a negative variance until the final three months of the initiative. The ingredient costs variance analysis is shown in Table 5. In contrast to two separate case studies [6,7] examining the implementation of eLearning, this case demonstrated a positive variance to the initial budget of 16% (the cost of the project was below the planned budget). Stakeholder costs for subject matter expert lecturers were slightly overestimated but close to budget. Equipment and materials had a significant positive variance of 37%; the reason for this is that not all the planned equipment for the course development was necessary because there was efficiency derived in the course production and streamlining of data science modules that were thought to have required custom application development. Personnel had a negative

variance of 13%; this was related to additional effort required in video editing. Additionally, the course was completed ahead of schedule and in less time than was anticipated.

*Table 5: Ingredient Costs variance analysis*

| | Budget | Actual | Variance | Var % |
|---|---|---|---|---|
| Personnel | € 102,040.75 | € 115,432.00 | € 13,391.25 | 13% |
| Estate charges | € 12,625.00 | € 12,625.00 | € 0.00 | 0% |
| Equipment and materials | € 244,517.19 | € 153,432.00 | -€ 91,085.19 | -37% |
| Indirect costs | € 88,317.06 | € 88,317.00 | -€ 0.06 | 0% |
| Stakeholder costs | € 50,000.00 | € 48,342.00 | -€ 1,658.00 | -3% |
| | € 497,500.00 | € 418,148.00 | -€ 79,352.00 | -16% |

The construction of the cost ingredients and subsequent cost analysis underwent three validation tests:

A. Construct validity test: The data sources for each ingredient category were sourced from 1) The initial project budget, 2) reported submitted costs, 3) a time log of worked, and 4) a third-party work-log of the activities of sub-contracted courses. The final case report was reviewed to ensure accuracy. (YE, HC)
B. External validity test: The same process used in two previous cases was replicated [6,7] and application of Levin's ingredients method for education intervention analysis demonstrated a common analytic framework transportable to other eLearning studies.
C. Reliability test: A minor variation of the previous study protocols executed was used and stored as the governance framework for the study.

**Project management**

The Digital Education Research Team at Imperial College's Global Digital Health Unit was responsible for course production among the university consortium. Other vital stakeholders contributing to the educational videos were subject matter experts in their fields including an RWE consultant, clinical data analyst and a healthcare regulator. The RWE consultant was a Chief Commercial Officer at an organisation dedicated for the commercial use of RWD in the industry, and he has been in the post for at least two years at the time of the course development. The clinical data analyst had experience leading clinical trials since 2007, and the healthcare regulator had more than five years' experience in developing policy solutions for healthcare systems. It was important to note that this course team working together had previously worked together on the delivery of health data science courses. The project management accounted for contingency in the course development and used iteration with principal stakeholders to ensure the course was developing in line with the learning objectives

The instructional design for the course used the Analysis, Design, Development, Implementation and Evaluation (ADDIE) model, with the project divided into seven key delivery phases to complement this structure:

1. Marketing -where the course is advertised to the target audience;
2. Design -where the instructional design will be finalised and storyboards created for online learning;
3. Production -where course content is produced, and the course build on the FutureLearn Learning Management System MOOC platform;
4. Beta Trial -where the course is trialled/tested by a sample of users to test and fixes made;
5. MOOC Go-Live Round 1 -where the course is run for the first cohort and fixes made as required;
6. MOOC Go-Live Round 2 -where the course is run for the second cohort and the blended face to face course run;
7. Evaluation - where the both MOOCs are evaluated for impact on learners.

*Table 6: Project delivery phases*

| | **Activity** |
|---|---|
| 1 | **DESIGN PHASE** |
| 1.1 | Instructional Design Document |
| 1.2 | ADDIE Framework Checklist |
| 1.3 | Finalise Instructional Design Strategy |
| 1.4 | Create Storyboard to include guidelines and scripts |
| 2 | **PRODUCTION PHASE** |
| 2.1 | Record all videos |
| 2.2 | Edit all videos and create transcripts |
| 2.3 | Build course on LMS |
| 3 | **BETA TRIAL PHASE** |
| 3.1 | Test each component of each page |
| 3.2 | Fix and test any defects |
| 3.3 | Make any mandatory changes |
| 4 | **COURSE MARKETING PHASE** |
| 4.1 | Create content for emails, tweets, posts, website etc |
| 4.2 | Distribute adverts periodically |
| 4.2 | Update course register |
| 5 | **MOOC GO-LIVE ROUND 1** |
| 5.1 | Release Module 1 content and manage issues and queries |

| | |
|---|---|
| 5.2 | Release Module 2 content and manage issues and queries |
| 5.3 | Release Module 3 content and manage issues and queries |
| 5.4 | Release Module 4 content and manage issues and queries |
| 5.5 | Release Module 5 content and manage issues and queries |
| 5.6 | Evaluate and fix any issues |
| 6 | **MOOC GO-LIVE ROUND 2** |
| 6.1 | Release Module 1 content and manage issues and queries |
| 6.2 | Release Module 2 content and manage issues and queries |
| 6.3 | Release Module 3 content and manage issues and queries |
| 6.4 | Release Module 4 content and manage issues and queries |
| 6.5 | Release Module 5 content and manage issues and queries |
| 6.6 | Evaluate any issues and create a fix list |
| 7 | **EVALUATION PHASE** |
| 7.1 | Complete literature review |
| 7.2 | Complete ethics application |
| 7.3 | Conduct interviews and review transcripts |
| 7.5 | Collect all data to analysed |
| 7.6 | Analyse data |
| 7.7 | Produce findings |

Participant information

Five-thousand and thirty-six learners participated in the MOOC from September to December 2018. Of the 5036 learners, 12% completed the course. The course completion ratio was in-line with completion rates for MOOCs [17], where although there is a high uptake of initial learners, completion of course activity ranges from 8% to 20%. One blended residential course was held in November 2018, with the participation of 14 learners.

## Discussion

### Principal findings

Previous research suggested that the total cost to deliver the course would result in a negative variance of the budget; throughout the project lifecycle, the project was on track to have a negative variance until the final three months of the initiative. It is important to note the principal reason for the positive variance was due to less work required in technology, although this was gained through the teamwork of the project participants. Because personnel costs had a negative variance, this demonstrates that there were more upfront work and effort within communication and course building, but this additional work netted inefficiency in the materials categories. In reviewing the case results, three principal findings were derived influencing the production budget composition and adherence to plan:

1. **Cost-efficiencies in the delivery of a course piloted in previous years**
   This programme began as a pilot initiative in 2017 implementing a limited small private online course on the edX platform. Although in 2018 the learning content was changed entirely, re-platformed to the FutureLearn platform and expanded in complexity, the programme team benefited through the refactoring of the existing course material. Had the course been entirely built from scratch, it is probable that there would have been increased costs in third-party stakeholders and personnel in the development of the initiative.

2. **Experience and relationship of the course learning team**
   Related to the point regarding previous pilot implementations, the course team had extensive experience working with other. Because of this time working together and experience of delivery in other eLearning initiatives, this resulted in efficiency in the course production and expectations surrounding content and delivery timescales.

3. **Project and budget management**
   The project management accounted for contingency in the course development and was built with repetitive checkpoints resulting in two-week "sprints" which had the course material regularly reviewed by principal stakeholders to ensure the course was developing in line with the learning objectives. This use of iteration and review by the project time, in addition to the use of a constant reprioritising of activities using agile methods, lead to efficiencies in the project budget, which had already accounted for contingency in the schedule. The high interaction between stakeholders also meant that planned costs in application development were reduced through alternative solutions to address learning objectives that were not anticipated at project commencement.

### Strengths and limitations

The strengths of this study are that it provided a rigorous examination of a novel implementation of eLearning via a blended Massive Open Online Course. The case method was previously tested in two previous studies [6,7] and refined in this study to ensure the accuracy of reported costs in a more sophisticated eLearning from the previous studies.

There are three primary limitations we noted with this study. The first is that the study did not take into account the impact of the previous pilot implementation or a planned

subsequent run of the course delivery. Such a multi-year cost analysis could have demonstrated that the overall programme costs had a favourable variance from costs. The reason a decision was made not to include the preceding information was there was the unavailability of data from the pilot years to complete the cost analysis, and in the subsequent deployment of the course, there were significant changes planned to the course implementation that was not available at the time of the drafting of this report. The second limitation was that there was not a qualitative investigation into the attitudes and perceptions of the course implementers to their decision decisions. At the onset of this investigation, a decision was made to focus on the analysis of methods for cost capture in the planning and execution of budgets; this decision was maintained in this case study, but further work could have provided further insight into the course budgetary decisions. A third limitation of this study is because the core team was composed of team members who had extensive previous relationships, the way in which this impacted the effort associated with this course could be a significant variable not seen in previous cases; additionally the reduction in costs required for equipment may be overstating the positive variance as there was not an unfavourable variance in the amount of time required to deliver the course.

## Conclusions

In order to execute a project within the allocated cost parameters requires a combination of skills that enable the people, process and technology to deliver the requirements of the initiative and within a predicated framework. Although this programme was a significant undertaking in resources and scope in combining both a digital programme and face to face residential course, the project was successful in achieving its planned cost schedule through optimising its project management, leveraging strong relationships of its principals and building on successful smaller scale learning implementations developed in previous years. Such iterative and incremental course planning could get similar results in the development of similar eLearning programmes.

*Acknowledgements*

Mel Toumazos provided detailed data contributing to the study in her design, development and deployment of the online course.

*Author's contributions*

EM conceived the study topic, wrote the first draft, responded to feedback and the principal investigator on the research project. PS and TS were a co-investigators on the development of the course. TS drafted related background on the course implementation and separate drafts under course evaluation (not in the scope of this study). DB, KF, TS, AA, YE and HC reviewed the completed draft manuscripts and provided feedback on iterations. EM is the guarantor.

*Conflicts of interest*

There are no relevant conflicts of interest, financial or other types of relationships that may influence the manuscript declared by authors.

*Funding statement*

This project was supported by the European Institute of Innovation and Technology – EIT Health Knowledge and Innovation Community and the Higher Education Funding Council for England (HEFCE) – Catalyst Fund.

## References


1. Ransbotham S, Kiron D, Prentice PK. The Talent Dividend [Internet]. MIT Sloan Manag Rev. 2015 [cited 2018 Jan 12]. Available from: https://sloanreview.mit.edu/projects/analytics-talent-dividend/

2. Margaryan A, Bianco M, Littlejohn A. Instructional quality of Massive Open Online Courses (MOOCs). Comput Educ 2015 Jan 1;80:77–83. [doi: 10.1016/j.compedu.2014.08.005]

3. Phan T, McNeil SG, Robin BR. Students' patterns of engagement and course performance in a Massive Open Online Course. Comput Educ 2016 Apr 1;95:36–44. [doi: 10.1016/j.compedu.2015.11.015]

4. Israel MJ. Effectiveness of Integrating MOOCs in Traditional Classrooms for Undergraduate Students. Int Rev Res Open Distrib Learn [Internet] 2015 Sep 29 [cited 2019 Feb 2];16(5). [doi: 10.19173/irrodl.v16i5.2222]

5. Sousa A, Scheffler RM, Nyoni J, Boerma T. A comprehensive health labour market framework for universal health coverage. Bull World Health Organ 2013 Nov 1;91(11):892–894. PMID:24347720

6. Meinert E, Eerens J, Banks C, Car J. A case study examining the cost measurements in production and delivery of a Small Private Online Course (SPOC) for teaching administrative staff to engage with young patients. JMIR Med Educ 2019;(In review).

7. Meinert E, Alturkistani A, Murray KA, Sabatier P, Car J. A case study examining the cost measurementss in production and delivery of Massive Open Online Course (MOOC) for teaching the relationship between health and climate change. JMIR Med Educ 2019;(In review).

8. Yin RK. Case Study Research and Applications: Design and Methods. Sixth edition. Los Angeles: SAGE Publications, Inc; 2018. ISBN:978-1-5063-3616-9

9. Alturkistani A, Majeed A, Car J, Brindley D, Wells G, Meinert E. Data collection approaches to enable evaluation of a Massive Open Online Course (MOOC) about data science for continuing education in healthcar. JMIR Med Educ 2019;(Forthcoming, in press).

10. Alturkistani A, Car J, Majeed A, Brindley D, Wells G, Meinert E. Determining the Effectiveness of a Massive Open Online Course in Data Science for Health. Madrid, Spain; 2018.

11. Meinert E, Alturkistani A, Car J, Carter A, Wells G, Brindley D. Real-world evidence for postgraduate students and professionals in healthcare: protocol for the design of a blended massive open online course. BMJ Open 2018 Oct 4;8(9):e025196. PMID:30287615

12. Meinert E, Reeves S, Eerens J, Banks C, Maloney S, Rivers G, Ilic D, Walsh K, Majeed A, Car J. Exploring the Cost of eLearning within the field of health professions education: key findings from A systematic scoping review. J Med Internet Res 2019;(In review).

13. Levin HM, McEwan PJ, Belfield CR, Bowden AB, Shand RD. Economic Evaluation in Education: Cost-Effectiveness and Benefit-Cost Analysis. Third edition. Los Angeles: SAGE Publications, Inc; 2017. ISBN:978-1-4833-8180-0

14. Kaplan RS. Flexible budgeting in an activity-based costing framework. American Accounting Assn; 1994.

15. Mak YT, Roush ML. Flexible Budgeting and Variance Analysis in an Activity-Based Costing Environment. Account Horiz Q Publ Am Account Assoc 1994;8(2).

16. Mak YT, Roush ML. Managing activity costs with flexible budgets and variance analysis. Account Horiz 1996.

17. Li Q, Wan F. A Case Study of the Characteristics of MOOCs Completers: Taking an Online Professional Training MOOC for Example. 2016 IEEE 16th Int Conf Adv Learn Technol ICALT 2016. p. 503–505. [doi: 10.1109/ICALT.2016.2]

# Appendix A: Case Study Protocol

Structure adopted from Yin [8]

This study protocol is a modification of protocols previously developed for analysis for use in eLearning implementation [6,7].

**Section A. Overview of the Case Study**

1. Mission and goals reflecting the interest of the case study's sponsor (if any) and audience
    - The objective of the case study is to inform the way future costs would be budgeted in the development of online learning. The research forms part of a broader investigation into the costs associated with the production of online learning; the main focus of this report was to collect primary evidence in the construction of these costs to allow for further research comparing results to other online learning implementation types.
2. Case study questions and propositions
    - Study question: How are the total costs for the production and delivery of a massive online course calculated?
    - Proposition: Actual costs and budgeted costs will vary in the production/delivery of this course type

      The state of the literature indicates challenges in the capture of total costs for the production of online learning, despite standard methods for cost calculation [12]. The reason for this variance is likely because the skills required to create robust instructional learning design and to capture costs are different, and educators are not trained on cost accounting methods.
3. A theoretical framework for the case study essential readings
    - The analytical framework for this investigation is based on cost analysis methods underpinning education economic evaluation developed by Levin [13], which extends standard costing and variance analysis principles of activity-based costing [14–16]. Defining core costs are critical to performing further economic evaluations, though it is important to note that the scope of this research is limited to cost identification and not further economic analysis (e.g. cost-benefit analysis, cost-effectiveness analysis, cost-utility analysis, cost-feasibility analysis)

| Cost Categories | Objectives |
|---|---|
| A. Concept and measurement of costs | 1. Describe the concept of costs<br>2. Show the inadequacy of budgets for cost analysis<br>3. Present a methodology for measuring costs<br>4. Identify categories of cost ingredients<br>5. Describe sources of cost information |

| | |
|---|---|
| B. Placing values on ingredients | 6. Describe the purpose and principles for determining the values of ingredients<br>7. Present methods for placing values on specific types of ingredients |
| C. Analysing costs | 8. Summarise the application of cost methodology with the use of a cost worksheet<br>9. Show how to analyse the distribution of cost burdens among different stakeholders<br>10. Address cost estimation for multiyear projects<br>11. Illustrate the estimation of costs under uncertainty<br>12. Present different ways of using costs for decisions |

13. Role of protocol in guiding the case study research
    - The protocol was developed at study commencement to demonstrate the way costs would be captured and analysed in the study. This protocol, in addition to a protocol for qualitative and quantitative analysis of learning impact, were drafted and submitted to peer review by the Imperial College Education Ethics Committee. The role of this protocol is to memorialise the intend methods, have them undergo peer review to validate the research design and serve as the framework for the investigation. Any deviations are to be documented and submitted for review.

**Section B. Data Collection Procedures**

14. Key stakeholders
    a. Research team: responsible for collecting field work
        i. EM – Lead researcher
        ii. PS – Co-investigator
        iii. TS – Co-investigator
    b. Course team: team observed in the case study
        i. KF – Research associate
        ii. AA – Research assistant
        iii. HC – Subject Matter Expert
        iv. YE – Subject Matter Expert
        v. MT – Business analyst
15. Data collection plan (covers the type of evidence to be expected, including the roles of people to be interviewed, the events to be observed, and any documentation to be reviewed in the field)
    a. Evidence to be expected
    Costs incurred in the production of the online course. This will be calculated using three different data sources to provide triangulation of results

b. Events to be observed
   While the course implementation will be observed and additional studies completed investigating the education impact, the scope of this study is centred on the cost decision making, and the way production impacted cost delivery. Therefore, the observation scope for this study will be focused on reported costs and the way these correlate data to time actuals.
c. Documentation to be reviewed
   The project budget, actual costs and timesheets will be reviewed for this study. While there will be a review of the completed course and observation of the way the course uptake is completed, the latter shall be excluded from this study. A traceability log will be maintained in excel linking the research questions to data sources and the study findings.

16. Expected preparation before fieldwork (identified specific information to be reviewed and issues to be covered before fieldwork)
    (1) Confirmation of the initial budget from the funder
    (2) Confirmation of appointment of course delivery team
    (3) Ethical approval

**Section C. Protocol questions**

17. Study question: How are the total costs for the production and delivery of a small private online course calculated?
    a. The costs shall be measured, ingredients captured and analysed to understand the factors impacting course production
    b. Data shall be collected to support the cost analysis categories
    c. The corresponding evidence will be used to summarise ways cost capture practices could be improved

**Section D. Tentative Outline for the Case Study Report**

18. The audience for the report and stylistic preferences for communicating with the audience(s)
    a. The case report will be presented as a manuscript for publication in a peer-reviewed journal. The audience will be an academic audience with the intent to inform future practice for the development of online learning
19. Case Report Format
    a. The case report will be structured as a standard research report, covering an Introduction/rationale, Methods, Results, Discussion and Key findings against a research question.