Department for Education

Quality assurance framework

Principles of QA for modelling and data analysis

April 2020

Contents

Foreword 3

1. Introduction 5

2. The Five pillars of the Model QA Framework 8

3. QA through the model cycle 11

4. Selecting Appropriate Quality Assurance Activities 16

5. Roles and Responsibilities 40

Appendix A: AQUA Book Types of Model 46

Appendix B: QA documentation 47

Appendix C: Change Log 48

Foreword

Analysts across the department contribute to core business, exploring and evaluating new policy options, monitoring the impact of our work, and making sure that schools and colleges get the right funding. The credibility of that analysis is key to the success of the Department. Analytical modelling underpins much of our analysis and this document sets out a consistent framework for the quality assurance of our models.

The framework sets out a more standardised approach than we have previously had but it is built around principles rather than detailed rules. It provides clarity of responsibilities and much greater visibility of our assurance work.

One key aspect of the framework is to encourage early and ongoing interaction between analytical and policy/delivery partners They need to develop a shared understanding of the problems we are trying to solve and how far models can help achieve this. We are at our best when we work together.

It also gives us a base from which we can discuss what QA activities should be carried out and what this means for uncertainties and risks that remain in the process. It is essential that we understand the strengths and weaknesses of model output in order to make the best evidence-based decisions.

Jonathan Slater
Permanent Secretary

Osama Rahman
Director of Analysis

Matt Wood
Director of Modelling and QA

Neil McIvor
Chief Data Officer

Who is this guidance for?

Everyone involved in modelling at and for DfE. This includes:

- DfE analysts, or external analysts working on behalf of the department
- Those who commission or are accountable for analytical modelling at the DfE (eg Senior Responsible Owners and policy/delivery commissioners)

The guidance may well be useful for those working in other areas. Many of the principles of good quality assurance are applicale across disciplines. Those working in data analytics and undertaking ‘simple spreadsheet calculations’ are certainly encouraged to apply this guidance to their work as much of it will be directly relevant.

1. Introduction

Quality Assurance (QA) plays an essential part in any analytical project. It is much more than 'getting the numbers right'. Effective QA ensures that decisions are made with an appropriate understanding of evidence and risks, and helps analysts ensure the integrity of the analytical output.

The key outcomes from any QA exercise are that the model output should be:

- **Fit for purpose**, with purpose defined as part of the scoping process.
- **Reliable and accurate**, as far as this is possible.
- **Transparent and accountable**. The model output should be fully approved, have an audit trail and be reproducible.

This guidance replaces the previous DfE QA Guidance published in November 2013. Although this new guidance has a different structure and feel from the old guidance, there is significant overlap in terms of what represents good QA. It should not, therefore, be onerous to move to the new framework.

The new QA framework is structured around five pillars:

- **Governance and Documentation** – so that we manage the process and its risks and can transfer knowledge about the model to other users, developers and assurers. This includes putting in place arrangements for appropriate scrutiny of the model.
- **Structure and clarity** – so that the model is easy to operate and assure, and so that changes can be made with confidence
- **Verification** – so that the model is built correctly
- **Validation** – so that the correct model is built with appropriate methodology
- **Data and assumptions** – so that these inputs are appropriately sourced, understood and signed off as fit for purpose

Section 2 provides further details of the five pillars.

It is essential that QA operates throughout the life cycle of a model. It is not something that can be added at the end. Section 3 describes the ongoing role of QA in a modelling project.

The new framework applies to all modelling activity in DfE, from small, relatively inconsequential models through to large models that are critical to the Department's operations. The extent of QA required, however, will differ significantly across our range of models. In general terms, more QA will be required for models that are bigger, more

complex, novel and important to key departmental decisions. Section 4 sets out a suite of QA activities that can be used.

QA is not the sole responsibility of analysts but the shared responsibility of analytical and policy/delivery partners. There needs to be a joint understanding of what QA will take place and the implications of that extent of QA on the use of the model output. Section 5 discusses the various roles and responsibilities of those involved in the modelling process.

What is a model?

There is no universal definition of an analytical model. The Macpherson Review described a model as a mechanism for analysing or investigating some aspect of the real world. It is usually a quantitative method, system or approach that applies statistical, economic, financial, or mathematical theories, techniques, and assumptions to process input data into quantitative estimates (see appendix 1 for AQuA Book definitions). There are typically three parts to a model:

- inputs – in the form of data (including ranges) and assumptions;
- a processing component – often through calculations; and
- outputs – the key figures (including ranges) as well as the risks and limitations of the models.

This captures a wide range of activity in DfE, from large forecasting models to small internal spreadsheets.

It is helpful to distinguish between a ‘model’ and a ‘calculation toolkit’.

- For a model, if the input data are correct and the mathematical formulae are correct, the output may still not be fit for purpose because a model has an element of approximation, abstraction, or conceptualisation of reality that may be flawed.
- For a calculation toolkit, if the input data are correct and the mathematical formulae are correct, the output will be fit for purpose.

Calculation toolkits include the allocation models, which are an important group of models that distribute funding according to an agreed formula, such as the National Funding Formula. In contrast, the Teacher Supply Model would be classified as a model. It utilises a wide range of assumptions and the validity of the output is crucially dependent on an appropriate choice of assumptions.

This guidance is intended to apply to models and calculation toolkits because QA is crucial for both. However, some of the QA processes described, in particular around the understanding and communication of uncertainty, are more relevant to models. Throughout the remainder of this guidance ‘models’ is used as a shorthand for ‘models and calculation toolkits’.

The AQuA Book describes several model archetypes that can be helpful when deciding if a particular product is a model. The list has been reproduced in appendix A.

Business critical models

Some models are so important to the Department that they are classified are business critical models (BCMs).

An analytical model is deemed to be "business critical" if it forms a fundamental part of the development or implementation of policy, which:

- materially affects the quality of education provided in our schools or the health, safety and wellbeing of children and their families; or
- relates directly to the allocation of funding to schools, colleges or other providers, or would have implications for significant levels of future expenditure; or
- where an error could produce significant legal or reputational damage to the department.

The initial commissioner of the model must decide if it is business critical. There are particular requirements relating to BCMs:

- The model must be added to the Department's list of business critical models.[1]
- A set of mandatory documentation must be kept, including use of a standardised QA log [2]. Appendix B contains a list of the mandatory documentation.
- Governance requirements, including appointing a model Senior Responsible Owner (SRO) and Analytical Assurer who must provide formal sign off before the model output is used. Table 4.1 and Section 5 provide further details.

The documentation and governance requirements represent good practice for other models and we strongly encourage their use more widely. However, we recognise that there is a certain amount of very low level modelling activity for which they would represent an unreasonable compliance cost.

[1] Contact the Model Improvement and Assurance Unit via modellingandqa@Educationgovuk.onmicrosoft.com.

[2] This can be provided on request by contacting the Model Improvement and Assurance Unit via modellingandqa@Educationgovuk.onmicrosoft.com

2. The Five pillars of the Model QA Framework

Governance and Documentation

Good governance is an essential part of quality assurance because it is the process by which risk is managed and the appropriate QA regime signed off. It is essential that all parties know and understand their responsibilities. All models will have a commissioner and lead analyst. A separate analytical assurer is required except for the most basic modelling. For business critical models, a model SRO must be appointed. More details on these roles and responsibilities are in Section 5.

Documentation is important because it allows us to transfer knowledge about the model. For example:

- Documenting the scope makes it clear what the purpose of the model is.
- Documenting the specification makes clear what the inputs and outputs of the model will be.
- A technical specification makes clear the detail of how the model operates.
- A user guide helps ensure that the model will be operated as intended.

Other documentation is required to provide a thorough audit trail (eg QA Log, Input and Assumptions Log).

The extent of documentation should be proportionate to the model activity. For small and simple models, the documentation may be part of the model itself, or might be captured sufficiently in a simple email trail (which should be recorded). For larger and more complex models, separate documentation is likely to be more appropriate. A principle of good modelling is that it should be repeatable and the documentation should capture sufficient information to allow that.

Where models are expected to be used and developed regularly, more documentation is likely to be appropriate. The technical specification is particularly important to help other modellers maintain and develop the model. The user guide is likely to be particularly important where the model is used by analysts that did not develop the model.

There are certain mandatory governance and documentation requirements applying to all models, with additional requirements for business critical models. Table 4.1 sets out QA activities for this pillar, including these mandatory requirements. Appendix B contains a list of the QA documentation and indicates which are mandatory.

Structure and clarity

Models should have a clear logical structure. Such models are more likely to be built without error and are much easier to assure, maintain and develop. A model map is a very effective way of helping people understand the structure.

There should be a clear distinction between inputs, calculations and outputs. The model should be appropriately commented throughout, taking users step by step through calculation functionality, and use a consistent format that allows other analysts to follow the logic.

Table 4.2 sets out QA activities for this pillar.

Verification

“Has the model been built right?”

These are the set of processes to be carried out to ensure that the model is implemented correctly. Developer testing will always play a key role and all models should be checked by a second analyst.

There is a wide range of verification activities (see Table 4.3). Some of the strongest verification comes from very resource intensive activities, eg an independent parallel build, and will not be appropriate in many cases. The extent of verification activity should be agreed with the analytical assurer to ensure it is a proportionate way to deliver the required assurance.

Validation

“Has the right model been built?”

These activities are to ensure that the modelling is appropriate and is a reasonable representation of the process under investigation.

It is a good idea for the model methodology to be scrutinised by someone outside of the team early on in the process before too much time is spent trying to implement a particular method. It may be worth engaging with subject matter experts both within and outside the department.

Validation also looks to assure that the outputs are reasonable. Are they in the range/direction expected? Are they consistent with previous output? Are sensitivities to key inputs reasonable? Some of these checks double up as verification, ie a model may behave in an unexpected way because the methodology itself is wrong (validation) or the implementation is wrong (verification).

As with verification, there are a wide range of possible activities (see Table 4.4) and the extent of validation activity should be agreed with the analytical assurer to ensure it is a proportionate way to deliver the required assurance.

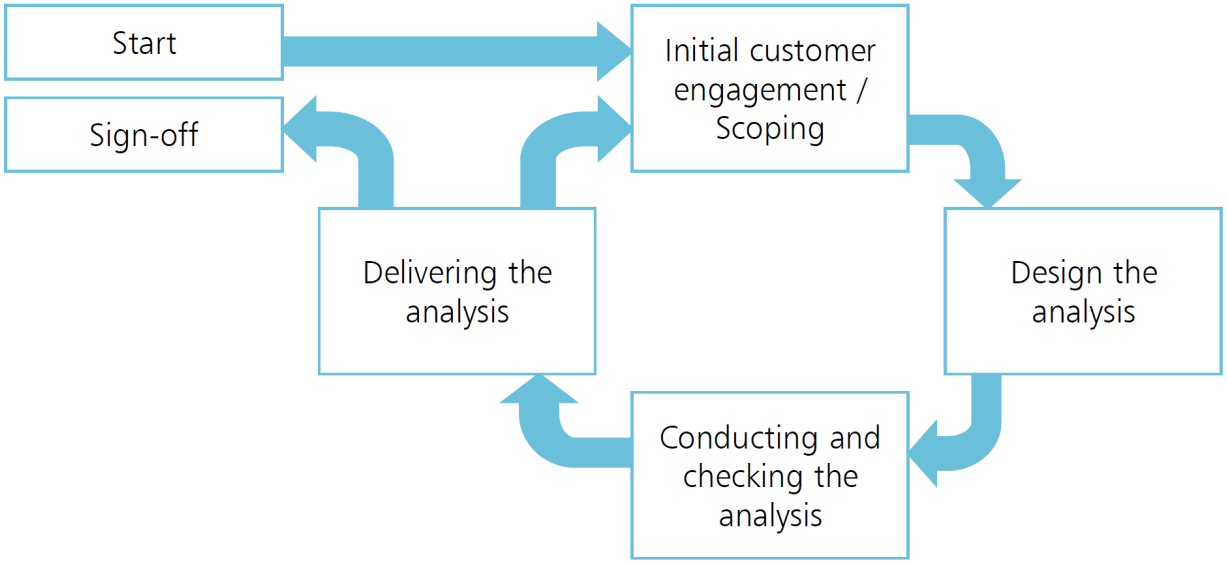
Data and Assumptions

These are the key inputs to the model and can come from many sources. Data can be checked in many ways but it is unlikely that large data sets will ever be perfect. Similarly assumptions can be scrutinised and validated but will remain uncertain. It is important to understand the quality and limitations of data sets and assumptions in order to understand their impact on model outputs. Uncertainty around data and assumptions, and correspondingly to the model output, must be clearly communicated to the model customers.

Table 4.5 sets out QA activities for this pillar.

3. QA through the model cycle

Quality assurance should be an integral part of any analytical process from the very beginning of a project. That means that good quality assurance is embedded throughout the model cycle from commissioning, through the development of the specification through design and delivery and into business as usual and review. QA should not be 'an after-thought' or something that is arranged at the last minute!



The analytical cycle is often iterative as insight is gained and the original question refined. At each part of the cycle, analytical quality assurance activities take place to ensure the analysis is fit-for-purpose. While many checks take place at the point the analysis is conducted, it is not the only place where analytical quality considerations are made e.g. the customer's insight when inspecting the delivered analysis is an important part of the process.

Figure 1 Commissioning analysis (AQUA Book Ch3)

Model Specification

The aim of model scoping and specification is that all parties (commissioners, analysts, wider stakeholders, analytical assurers) are sure that the problem has been well articulated and that the proposed outputs will provide new evidence or deliver necessary data. The process required to agree a scope and specification will vary greatly but can involve early analysis, using small-scale models or problem structuring methods to agree key objectives and priorities. It is as important to agree what is in scope as what is out of scope to avoid spending analytical resource on projects that do not contribute to the evidence base. Analysts should not be afraid of suggesting heuristic models that will articulate a problem area where delivering a precise answer would be costly in terms of resource and not essential for decision making.

Clear model scoping and specification documents enable analysts to summarise concisely what a model should and should not do, and why. It is essential that analysts produce such documentation and gain sign-off from SROs/stakeholders before embarking upon a long-term model-building project. In particular, effective documentation can help prevent misunderstandings around what is required, what will be produced, and when it is needed to be produced by.

As model scoping and specification documents are produced at the start of a project, analysts should already be thinking about quality assurance:

- What type of model are you likely to build? Are there individuals in your division/directorate/department that have relevant experience?
    - If so, are they likely to be available to assist with QA when you need them?
    - Given QA may take a few days, it is important not to *assume* they will be available when you require their assistance.
- Are all relevant individuals involved in the project and aware of the modelling that you are undertaking? This could include data experts, policy stakeholders, and potential model customers.
    - Do you have an analytical 'challenge' function/role within the scope of the project? I.e. an analyst to provide objective challenge of the data, assumptions, and methodology that you are using.
- As part of the scoping and specification documents you should seek to identify the level of QA needed and ensure that your SRO and stakeholders are content with this.
- Are there particular risks associated with the project? If so, the scoping document should attempt to list them and outline some potential mitigation strategies.

Selecting a methodology

There will often be several methods suitable for modelling the problem. In some cases the specification will dictate the methodology but in others you will be selecting from a shortlist of techniques.

We recommend that you seek views from across the analytical community (internally or cross-government) before committing to a specific method. This stage of model development is often underplayed with choices limited to techniques the analyst has already used, or a technique the analyst is keen to explore. A discussion with other analysts and / or your analytical assurer will help to challenge any biases as well as potentially introduce reasonable alternatives.

When choosing a methodology, you should consider:

- Are there examples of this method being applied to the problem archetype?

- Will the available data support the method? (Or will new data need to be derived / collected?)
- Will the tools available support the method?
- Is the level of abstraction appropriate for the model requirements?
- Will using the method introduce a key person risk and if so what can be put in place to manage this?
- Can you identify analysts who will be able to carry out any independent quality assurance functions?

Selecting a tool

Across the department we have access to several modelling tools – Excel (and the PowerTools), R, Python, STATA, SPSS and SQL. When choosing a tool consider:

- Whether there is a local preference (for example a team that has chosen to develop models in R but not Python)
- Will the tool deliver the required outputs, with appropriate access where required?
    - Do you need a user-friendly front end or dashboard? How much interaction with the model will non-experts be expecting to have?
- Is the tool appropriate for the methodology?
    - Based on the technique chosen to tackle the problem – which tools can and cannot do this, and of those that can what are the pros and cons? (e.g. stocks and flows modelling)
    - How much data is there – is it too much for Excel to handle?
    - Which other software / databases will the tool need to interact with?
- Is there sufficient expertise within the team (or will training will be required)?
- Can you identify analysts who will be able to carry out independent QA?
- Are there any security concerns?

Model Governance

Roles and responsibilities are discussed in Section 5. As with other aspects of QA, model governance should be proportionate to the risk and complexity of the model. Some examples include:

Governance	Activities
Ad-hoc modelling request	The commissioner sends an e-mail requesting small-scale analysis of an established dataset. The analyst agrees the specification by email and sets out what QA will be in place. The results of the analysis, along with modelling caveats and sign-off are emailed to the commissioner with the AA copied in.
Project Board	The SRO decides that model governance falls within the scope of an existing project board that they chair. A sub board is formed to provide challenge and scrutiny and model outputs are presented to the main board along with any decisions or issues for discussion. This is advantageous as the board contains the main model users as well as the input data owners.
Model specific steering group	Whilst the model is being developed, it is overseen by a steering group that can provide challenge, clarification and feedback. Once the SRO and the Analytical Assurer have signed off the model and the final product is handed over, this group meets periodically for model review. Day to day the SRO is responsible for the use of the model.
Analytical board	The model is part of a wider group of related models. The model SRO/s and analytical leads agree to form a board to oversee the development and use of all the models. This group is able to ensure that any common assumptions or inputs are used consistently and ensure that model development is complementary and efficient. This wider group of analysts is also well placed to discuss methodological approaches and tool selection

Quality Assurance after delivery

The QA plan should extend to the intended use of the model once delivered. This could include:

- Updating the model data or assumptions on an ad hoc or regular basis
- Support of the model (where the model will be operated by other analysts / non-analysts
- Use of the model to answer policy questions or correspondence
- Regular “major review”
- Closing a model

Section 4 describes QA activities that support these post-delivery activities. Where the model is to be operated by others, the model caveats and protocol for using model outputs must be agreed with the SRO and passed on with the model. The model SRO remains responsible for uses of the model (for example where outputs are used to support recommendations in ministerial submissions or answer correspondence).

Major review should be planned at key points, for example prior to funding allocations or fiscal events, or in order to incorporate a change to the specification, or at regular intervals. It should at minimum include a review of the specification – is the current model still meeting the brief? Is the specification still relevant; likewise the assumptions and the input data?

Models may have a fixed life span. For example, they may have been created to support a specific policy problem and have no wider application or a work stream may be shut down. In either case, a model should be properly archived with all the associated documentation with reference to departmental record keeping rules. If retained, it must be very clear that the model is no longer live in order to prevent inadvertent use.

Example: Budget forecasting with monthly updates:

> The forecasts for numbers of open academies are run every month. As a business critical model, the initial set up included a full QA across all aspects of the model. This included planning for the monthly update cycle. Each month the inputs are refreshed and the new outputs are shared. The model documentation includes a protocol for proportional tests on this monthly update. This model has a steering group lead by the SRO which meets quarterly (and in the lead-up to planning events such as business planning) to ensure that the model remains fit for purpose, reporting model performance and reviewing assumptions. Any new outputs or requests for information are cleared with the SRO (or their delegate).
>
> Recently the steering group agreed that it was time to move the model to a new platform because the specialised software had limited availability, was only used by two or three analysts in the department and had limited capacity for future development. This was treated as a major review and the specification and QA plan were updated before the work was undertaken. The methodology was not in scope for the review.

4. Selecting Appropriate Quality Assurance Activities

The AQUA Book refers to “Analysis with RIGOUR” (see box). It is important that Quality Assurance activities are proportionate, relevant and support the overall purpose of the model. In this section, we suggest activities that can support model quality assurance across the five pillars and discuss the documentation that will help you in communicating and recording the process.

Analysis with RIGOUR:

Quality analysis needs to be repeatable, independent, grounded in reality, objective, have understood and managed uncertainty, and the results should address the initial question robustly. In particular, it is important to accept that uncertainty is inherent within the inputs and outputs of any piece of analysis. It is important to establish how much we can rely upon the analysis for a given problem. (AQUA Book 1.10)

What QA should we carry out?

In common with most projects, modelling will often involve a trade off between time, resource and quality. Discussions about desired and achievable levels of QA should take place at the very start of a modelling project. The reality is that most modelling will be carried out under time and/or resource pressure and we will not be able to carry out all the QA activity we would ideally like to. In these circumstances, QA activities will need to be prioritised based on the risk of not carrying them out. Sometimes, it may not be possible to carry out what might be seen as the minimum reasonable QA. If this is the case, it is essential that decision makers are made aware of the consequences of the limited assurance on the reliability of model output.

Reflecting the rich variety of modelling that takes place within the department, this section is not prescriptive about the QA activities that should be undertaken. Model leads and SROs must agree what activity is appropriate to each model and the main QA activities should be planned in advance.

Tables 4.1–4.12 describe a number of QA activities listed by the relevant pillar from the QA framework.[3] It should not be seen as a list of recommended activities. Indeed, to carry out all of the activities for a single model is almost certainly disproportionate. Neither is it an exhaustive list. There are other activities that may be appropriate.

[3] Some activities cut across more than one pillar. They are listed under the pillar which they have the strongest association with.

There is, however, a core of QA activity that must be part of every model. These core activities include:

- Scoping / specification
- Recording of inputs and assumptions
- Use of coding / spreadsheet standards
- Developer testing
- Testing by a second analyst
- Version control
- Communication of limitations / uncertainty
- Sign off and an appropriate audit trail

There are additionally some activities that are essential to all business critical models and to models for making financial allocations. Details of these mandatory requirements are indicated in the following tables of QA activities.

Do I really need to do all the mandatory activities?

That should certainly be the aim. Many of the mandatory activities are natural parts of any modelling process so shouldn't represent a major compliance cost. However, we recognise that a lot of the modelling done in DfE is carried out under significant time pressure. The mandatory activities should not be seen as a barrier to producing analysis – it will usually be better to provide some analysis with appropriate caveat than none at all.

Where you haven't carried out all the mandatory activities, you must bring this to the attention of the Model SRO and Analytical Assurer so that they can consider the impact on whether they can sign off the model output. In turn, they must ensure decision makers know the extent of the QA carried out and the risks involved in using the output.

Many of the activities can be carried out in various levels of detail.

For example, the scope of a simple model could be captured in a single email from commissioner to modeller. In contrast, a scope document for a more significant model might run to several pages, eg including extensive background to the problem being considered and setting out the detailed requirements of all stakeholders. You should look to take a proportionate approach.

Within your teams, you may wish to adopt a standing QA plan.

This plan should describe how you will approach quality assurance for ad-hoc modelling requests or models with a very limited scope or short development time (typically less than one week). The plan should be agreed with the senior analyst in your area (usually a G6 or DD) and with regular commissioners. It should include all the elements above and set up what sign-off would be required before the outputs can be used.

Table 4.1: Documentation Activities

Activity	Details	Why to carry out	Mandatory for
Scope and specification	(Scope) Discussion between those involved in the modelling and the use of the output to understand the questions to be answered and agree what the model will and will not do. (Specification) Capture key details such as timescales, resources, key inputs (including policy levers) and outputs, outline methodology, high-level model diagram, required level of accuracy	A clear, shared understanding reduces the risk that the model will not meet the ultimate needs. Wide interaction reduces the risk that requirements are not captured. Agreement on requirements and boundaries allows for proper project planning	All
User guide	Instructions to allow use of the model without reference to the developers. Can range from very simple (eg locations of key inputs and outputs and what needs to be changed to rerun the model) up to detailed instructions.	Reduces the risk of the model being used incorrectly. Particularly important where the model will be used by those who did not develop it or by many users. Reduces the business continuity risk associated with regular users being unavailable	All
Technical guide/ specification	Details of how the model has been implemented, ideally accompanied by a plain English commentary. Level of detail will vary according to circumstance. A very detailed technical specification should allow independent rebuild of the model (eg for parallel run purposes).	Allows future developers to understand, maintain and update the model. Significantly reduces key person risk. Allows detailed scrutiny of the implementation. Plain English assists with scrutiny by non-analysts. Particularly useful if the model will be updated regularly.	BCM

Activity	Details	Why to carry out	Mandatory for
Handover plan	A plan for replacing key people in the modelling process. Consider whether knowledge is too concentrated on key people. Strongly linked to having good documentation.	Mitigates the business continuity risks relating to key people.	BCM
QA plan	An overview of the QA activities to be carried out at each stage, including timescales and likely assurers. Those carrying out the QA need to have the relevant skills. The QA plan should be reviewed if the scope or specification of the model changes.	Allows Analytical Assurer and SRO to determine that the QA approach will meet the requirements of the project. Allows time for sufficient QA to be factored into the overall project plan.	All (but note proportionality)
Record of QA, including a QA log	Details of the QA work carried out throughout the process. Should be kept up to date throughout the project. The QA log should record the overall QA position of the current version of the model. QA relating to updates between versions of the model should be recorded and referenced (or included) on the main QA log.	Provides a clear audit trail. This allows the analytical assurer and SRO to sign off the work and will be critical if the work comes under subsequent scrutiny. Provides clarity on what has (and has not) been checked and so avoids the risk of sections slipping through the gaps.	All QA Log mandatory for any model with 3+ days resource

Table 4.2: Governance Activities

Activity	Details	Why to carry out	Mandatory for
Establish governance arrangements	The SRO should agree the governance arrangements at the commissioning stage. Governance should cover all phases of the model cycle including the development, operation, ongoing maintenance and review. For some models the SRO will provide all the necessary governance, for others a broader group will need to be part of the decision making process. The governance arrangements will include many of the activities below and those related to documentation above. There should be clear assignment of the various modelling roles (AA, SRO, lead Analyst etc). See Section 5 for further details.	Clear governance arrangements should ensure that all the relevant assurances can be obtained in order to sign off the model. Clear understanding of roles ensures that they are carried out	All BCMs require identification of specific role holders
Analytical assurer statement	A statement from the analytical assurer on the level of assurance that can be given to the model. The statement should set out clearly: the scope and level of QA carried out; the key uncertainties and residual risk; and an opinion on whether the model and output are fit for purpose.	Provides clarity on the status of the model. A key requirement for the SRO to consider model sign off	BCM

Activity	Details	Why to carry out	Mandatory for
Challenge session and Sign off panel	An opportunity for additional scrutiny of the modelling and the QA carried out. The challenge session would typically involve the SRO and working-level stakeholders with the sign off panel involving the SRO and key senior stakeholders.	Provides an additional level of assurance from wider stakeholders. Likely to be of most value when the modelling underpins significant expenditure/funding or very high profile policies. Helps SROs to provide their final sign off.	
SRO (or equivalent) sign off	A statement from the SRO (or other owner if no SRO) that the model output is fit for purpose. The purpose should be clearly specified at the scope/spec stage and in the sign off because a model fit for one purpose may not be fit for another.	The owner should take formal responsibility for the use of the model output.	All Formally documented for BCMs
Audit of QA	A review of the QA arrangements for the model conducted outside of the team developing the model. This can be carried out by an external organisation, DfE's internal QA team (when functional), other DfE analysts or internal audit. Note the Analytical Assurer will carry out similar activities within the team.	May identify gaps in the QA that can be addressed, either for the current modelling or at a future update. This is a resource intensive activity (and potentially expensive if an external organisation is used) and most likely to be considered when the highest level of assurance is required, eg because the modelling is high risk or high profile.	
Authorising use of model output	SRO or commissioner should have a process for authorising the use of output. This could be by a generic sign off for certain types of work or sign off for each individual use. Decision makers should expect to see evidence of authorisation.	Helps prevent analysis being used inappropriately	All

Activity	Details	Why to carry out	Mandatory for
Convey uncertainty	Ensure that model outputs are communicated with reference to uncertainties and limitations. Work up the chain to ensure that this information is not lost as the analysis is used by decision makers.	It is essential that decisions are made with a full understanding of the strength of the evidence. Poor decisions may result if undue precision is attached to model output.	All
Risk log	Capture the risks relating to a modelling project. Your risk log might be specific to the model or sit within a wider programme. Model specific risks can relate to data, assumptions, modelling resources.	Risks should be appropriately managed and mitigated	BCM
Periodic review of model	For models with ongoing use, a review of the model scheduled in advance.	Models may become out of date over time, through data, assumptions or methodology. Review helps ensure the model remains relevant and credible.	

Table 4.3: Control Activities

Activity	Details	Why to carry out	Mandatory for
Version control	Within a model (or within a team) you should establish how you will record major and minor changes to the model using incremental version control. A log of changes should be maintained. It is best practice to embed the version control documentation within the model. Ideally, any outputs or use of outputs should reference the model version. In some circumstances, it may be necessary to have separate logs of model versions and model runs.	Provides clarity on what has been changed since a previous version, helping to ensure that all required changes have been made and can be communicated. Allows return to previous version if changes are not required, incorrectly implemented or have been unintentionally implemented. Allows you to ensure each change can be quality assured. Allows you to account for previous results.	All
Change control	A process for authorising changes to be made to the model before development takes place and/or for signing off changes that are made. Where used, it should be integrated into the version control and access arrangements.	Prevent unauthorised changes and gives clarity on the status of development. Typically used for ongoing, especially high profile, modelling where an accurate up to date model must be kept available.	
Access arrangements	Consider whether access needs to be restricted. Restrictions could apply to read or write access. Data sets, models or outputs should be named according to government protective marking guidelines. Ensure the model is available to those who need to use it.	Restricting access helps prevent unintentional or malicious changes. Providing access helps ensure the most recent version of the model is utilised.	All
Knowledge and Information Management (KIM)	Model should be stored in accordance with departmental guidelines.	Ensures that the model can be found in the future. Facilitates sharing and collaboration.	All

Table 4.4: Clarity Activities

Activity	Details	Why to carry out	Mandatory for
Model map / Process diagram	A tool for visualising the logical flow of a model, often developed as part of the initial scoping phase	Assists with general understanding of the system and helps communicate the model to others. Highlights the key interactions within the model and helps identify potential impacts of any changes being made This can be particularly important if you are developing a suite of connected models or using a coding environment.	BCM
In-model comments	Description of the model's operation and other useful information embedded into the model itself, eg code comments or comment boxes in Excel.	Makes it much easier for other users and developers to understand the working of the model	All
Formula presentation	Calculations should be set out clearly. Steps should follow a logical order, with each step having a clear purpose.	Formulae that are well structured are more likely to be correctly implemented and are easier to assure and amend.	
Parsimony	Models should be as simple as they reasonably can be. Redundant parts of models should be removed.	Unnecessary complexity increases the chance of error.	

Activity	Details	Why to carry out	Mandatory for
Units, labels, names and parameters	Use of a consistent labelling/naming convention for ranges and user-defined variables and parameters. An index of names and/or a key may be helpful. Check that logic of calculations agrees with labelling and names. The rules for any conventions should be clearly documented.	Helps avoid errors from inconsistent units. Helps others follow the model through, making maintenance, development and assurance easier. Eases process for model updates.	

Table 4.5: Structure Activities

Activity	Details	Why to carry out	Mandatory for
Spreadsheet Standards	Follow best practice guidance	Following standards helps achieve a good structure that makes models easier to develop and assure.	All (if using Excel)
Coding best practice	Follow best practice guidance. Ensure a consistent approach is used throughout.	Following standards helps achieve a good structure that makes models easier to develop and assure.	All (if using code)
Formatting	Relevant parts of the model should be easy to find. Numbers should be rounded appropriately.	A user-friendly model reduces the risk of user error. Excessive detail can be mistaken for accuracy.	
Locking down (and limiting ranges)	Only allows users to change inputs.	Clarifies what the user should be doing, reducing the risk of error.	

Table 4.6: Verification Activities

Activity	Details	Why to carry out	Mandatory for
1st modeller testing	The first modeller should carry out some self-checking, eg that the correct data and assumptions are being used, that these are being imported into the model correctly, that formulae behave as intended. There are a number of activities that may be appropriate, including those listed below.	Identify and remove errors. The first modeller cannot transfer responsibility for accuracy by passing the model for further testing.	All
2nd modeller testing	The detailed implementation should be thoroughly checked by a 2nd analyst. In Excel, all unique formulae should be checked and that these formulae have been copied down/across properlyAll coding should be fully checked. Consider (amongst others): • Are inputs being read in correctly? • Are the correct time periods being considered? • Are the calculations consistent with the technical specification? Can they be separately reproduced? • Are units being treated appropriately?	Identify and remove errors. It is extremely difficult to implement a model without making an error. Checking by the original developer is often ineffective. The details of all modelling should be agreed between two analysts.	All
Removal of spreadsheet errors	Ensure errors such as ***#REF!*** are removed.	At worst, errors may compromise the working of the model. At best, they impact the confidence of users/assurers.	All (if using Excel)

Activity	Details	Why to carry out	Mandatory for
Tracking through example inputs	Enter some example inputs and follow the calculation process through the model. Are all calculations as expected?	Identify and remove errors. Some errors (eg wrong signs) are difficult to identify by studying formulae but will be apparent when considering examples.	
Off-model testing	Replicating calculation functionality on another platform.	Identify and remove errors. Being able to reproduce functionality in a different way provides additional assurance. Often worth considering for particularly important or complex sections of the model. Has some of the benefits of parallel build without being so resource intensive.	
Auto-checks	Checks built into a model that can highlight possible problems. Examples can include: • Warnings that expected inputs are missing. • Check sums when data has been split in different ways. • Conditional formatting (Excel) • Sparklines (Excel)	Helps to identify user and/or model errors.	
Regression testing	A set of tests run after development work, eg running the model using one or more reference input sets, which produce known output.	Identifies what has changed in the model so the developer can check that there have been no unintended consequences.	

Activity	Details	Why to carry out	Mandatory for
Parallel build (ie dual or triple build)	Independent parallel build of a model by an analyst with no involvement in the primary model. The output should be compared and models amended until the output matches. When comparing the output it is important to keep an open mind about which model is likely to be correct.	This is a powerful method for identifying errors in the calculation aspects of a model because truly independent builds are unlikely to make the same error. It is however quite resource intensive and should only be employed where the SRO and Analytical Assurer have agreed it is necessary. This is most likely to be appropriate where it is essential that the outputs are as accurate as possible (as in financial allocations). It is less likely to be appropriate when modelling an inherently uncertain system where an improvement in accuracy may be lost in the overall uncertainty.	Allocation models
Usability testing	Checks that users will be able to operate the model as intended, eg: • Does the interface allow all necessary inputs to be changed and the output identified? • Does the model run without bugs? • Do all parts of the interface operate? • Are there restrictions to prevent illogical inputs? • Is run time reasonable?	A model that is difficult to operate is more likely to lead to user errors. This is particularly important where users are separate from developers and/or output will be used without further scrutiny.	

Activity	Details	Why to carry out	Mandatory for
Internal audit	A review of the implementation of the model (or part of it) carried out by someone within the department.	Provides additional assurance. Most likely to be considered where a very high level of assurance is required, eg for high cost or high profile projects.	
External audit	A review of the implementation of the model (or part of it) carried out by someone outside the department.	Provides additional assurance. Most likely to be considered where a very high level of assurance is required, eg for high cost or high profile projects, and there are external stakeholders who place high value on external scrutiny.	
Transparency – Publication of results	Results of the modelling are put in the public domain or shared with stakeholders.	Allows independent scrutiny of results. Stakeholders may identify errors that can then be removed.	

Table 4.7: Validation Activities

Activity	Details	Why to carry out	Mandatory for
Consideration of alternative methodologies	Assessment of the merits of different approaches to modelling the system.	Guards against using modeller's default option. Reduces the risk of an inappropriate approach being used.	
Methodology challenge session	Scrutiny of the proposed methodology by other analysts. Larger models may benefit from a methodology panel, possibly with experts from outside the department. Challenge should take place early in the process to avoid wasted effort developing inappropriate approaches.	Guards against using modeller's default option. Reduces the risk of an inappropriate approach being used.	BCM
Model behaviour	Checks that the model behaves as expected when inputs are varied. Can you explain why the output has changed as it has? (magnitude, direction)	If the model behaviour cannot be explained then the methodology may be inappropriate and the output unreliable.	
Stakeholder sense checks	Do those who understand the real world system that is being modelled believe that the output looks reasonable?	Those with knowledge of the system will often have a better feel for its operation than those analysing it for the first time.	All
Comparison with past results	Can the changes since a previous run of the model be explained? Does the model produce similar answers to previous models if historic data is used?	Adds to credibility of model if changes can be explained.	All (where past results exist)
Comparison with actual historical data	How accurately does the model perform against historical data? Review (or perform) checks assessing how the model predicts known history, both on data available during development and since implementation.	Adds to credibility if the model compares well against actual data. Conversely, the output of a model that does not perform well must be treated with caution.	

Activity	Details	Why to carry out	Mandatory for
Comparison with alternative models	How does the model output compare to other existing models, either internal or external?	Adds to credibility of model if output is similar. Provides additional context of uncertainty if models differ and both are considered reasonable models. This helps avoid undue precision being attributed to output.	
Re-performance testing	Building a shadow model implemented in a different, often much simplified, way and comparing output. Can the differences in output be explained by the different methodologies?	Similar to comparison with alternative models but such models will not always exist.	
Extreme value testing	Consideration of how the model reacts to inputs at the extreme ends of reasonable ranges (or to other extreme values such as zeroes or negative values). Is the behaviour as expected or explainable?	Tests the robustness of the model, in particular whether assumptions remain reasonable in all scenarios. It might be necessary to restrict ranges and/or provide additional caveat around scenarios outside of the normal range.	
Assessment of model performance	Agree how you will test model performance against the real world system (eg for a forecast model, at what point will you compare the model against actual data?)	It is valuable to test and understand how a model compares to actual observations. For models with ongoing use, this can provide assurance on the appropriateness of the model, or otherwise, and can lead to improvements in the model.	BCM with ongoing use

Activity	Details	Why to carry out	Mandatory for
Model walk through	Go through the model step by step to consider how the model is operating. Likely to include running some example inputs and considering the results of different stages of the modelling. Walk throughs can involve policy colleagues, where the emphasis is likely to be on the implementation of the policy, and analysts, where the emphasis is likely to be on the detailed implementation of calculations.	This is a good way to test that there is a common understanding of the specification and that the model complies with it. Unexpected results may result from errors or indicate that the model is inappropriate	
Internal peer review	Typically a high-level sense check of results by someone with relevant experience outside of the immediate work but within the department. May involve more detailed examination of model	Additional review provides extra assurance. It is often useful for someone not involved in the detail to consider whether output seems reasonable.	
External peer review	Typically a high-level sense check of results by someone with outside the department. May involve more detailed examination of model	Additional review provide extra assurance. It is often useful for someone not involved in the detail to consider whether output seems reasonable. This would be considered when the most relevant expert is outside the department or when there are external stakeholders who place high value on external scrutiny.	

Table 4.8: Validation Activities - Uncertainty and Limitations

Activity	Details	Why to carry out	Mandatory for
Sensitivity testing	Run sensitivities on key parameter/assumptions within the model. Should focus on a reasonable range of values to give a reasonable distribution of outcomes. Are forecasts compared to actual outturn data in order to inform future uncertainty? May involve Monte Carlo simulation.	Provides information on the range and likelihood of outcomes. Helps with the communication of uncertainty and limitations. Consideration of the range of outcomes also acts as a check on the validity of the model.	All[4] (at least one of sensitivity or scenario testing)
Scenario testing	Consider a range of reasonable scenarios to illustrate possible outcomes.	Provides information on the range of outcomes. Helps with the communication of uncertainty and limitations. Consideration of the range of outcomes also acts as a check on the validity of the model.	All[4] (at least one of sensitivity or scenario testing)

[4] This may not be required for a calculation toolkit, such as a formula allocation model, where the only uncertainty comes from the quality of the data. However, the impact of any data quality issues must be understood and communicated.

Table 4.9: Validation Activities - Transparency

Activity	Details	Why to carry out	Mandatory for
Publication of methodology	Technical specification (or similar) put in the public domain or shared with stakeholders.	Allows independent scrutiny of methodology. Stakeholders may provide useful challenge. Increased public confidence.	
Publication of usable version of model	Full or partial version of model put in the public domain or shared with stakeholders.	Allows independent scrutiny of modelling. Stakeholders may provide useful challenge. Increased public confidence.	

Table 4.10: Data Activities

Activity	Details	Why to carry out	Mandatory for
Validation of input data	Checks on the completeness and accuracy of the input data, eg are there the right number of schools in the data set; do schools have a reasonable number of pupils?	Reduces the risk of errors in the data. The level of checking will be very dependent on circumstance. More checking is likely to be appropriate when the data is a critical input. Less checking may be required on published data sources (as it may be possible to rely on the checking already done).	All
Check consistency with original data sources	Check that the data in the model looks like the data in its original format, eg are there the same number of data points; are totals the same?	Moving data into or out of a model are common sources of errors.	BCM
Assessment of data quality	Consideration of whether the data are accurate and what any uncertainties will mean for the model output. RAG rating can be helpful.	It is very rare that data will be error free. Decision makers need to know how robust the model output is.	BCM
Sign off by data owners	Data owners may be able to sign off their data as being fit for purpose. It is essential that they understand the purpose and it may be helpful to engage with the data owners on the details of the modelling being carried out.	Avoids the need to repeat validation checks. Reduces the risk of data being used inappropriately.	BCM
Record of transformation	Document details of how data has been transformed.	Ensures that the new form of data is understood. Allows checks against original data to be undertaken.	

Activity	Details	Why to carry out	Mandatory for
Identification of data sources within a log	A record of which data sources are used in the modelling and where the data has been obtained from.	Helps ensure correct data has been loaded into model. Allows work to be reproduced to account for previous results. Allows stakeholders to review the data sources.	All
Verification that data remains appropriate	An assessment of whether the data is appropriate when a model is updated or used for a different purpose.	Use of inappropriate or out of date data can invalidate model output.	
Plan for updating data	Some data is regularly updated, eg pupil projections. Updates of the model can be timetabled to allow for new data that becomes available.	Prevents the model becoming out of date.	
Record of decisions and key information	Important information may come to light during data processes. This should be recorded on the data log.	Prevents important information being lost, eg when the modelling team changes.	

Table 4.10: Assumptions Activities

Activity	Details	Why to carry out	Mandatory for
Identification of assumption sources within a log	A record of where assumptions have been taken from and how they have been derived. Any particular assumption may need to include incorporate information from different sources (eg when there is not a single data series that provides everything we need). The method for doing this, eg weighting given to different elements, should be recorded. Social research may be particularly helpful when deriving assumptions relating to behaviour change, eg on the introduction of a new or amended policy.	Allows scrutiny of assumptions. Helps ensure correct assumptions have been loaded into model. Allows work to be reproduced to account for previous results.	All
Check derivation of assumptions	Confirmation that assumptions have been derived in line with agreed methodology.	Reduces the risk of errors in derivation of assumptions	
Challenge by stakeholders	Opportunity for various stakeholders to challenge whether the assumptions seem appropriate.	Reduces the risk of using inappropriate assumptions, which may in turn lead to inappropriate output.	
Assessment of robustness	Consideration of the uncertainty around the assumptions and what this will mean for the model output. RAG rating can be helpful	Understanding the robustness of assumptions will help assess the certainty around the modelling output.	BCM
SRO sign off	Confirmation from the model owner that they consider assumptions to be fit for purpose	Ensures owner is content that assumptions are appropriate. Improves accountability.	All

Verification that assumptions remain appropriate	An assessment of whether the assumptions are appropriate when a model is updated or used for a different purpose.	Ensures owner is content that assumptions are appropriate. Improves accountability.	
Plan for updating assumptions	Some assumptions, or their underlying data sources, are regularly updated, eg OBR financial forecasts. Updates of the model can be timetabled to allow for new assumptions that become available.	Prevents the model becoming out of date.	
Record of decisions and key information	Important information may come to light during assumption processes. This should be recorded on the assumptions log.	Prevents important information being lost, eg when the modelling team changes.	

Table 4.12: Data and Assumptions Activities - Transparency

Activity	Details	Why to carry out	Mandatory for
Publication of data and assumptions used in model	Data (summaries) and assumptions put in the public domain or shared with stakeholders.	Allows independent scrutiny of data and assumptions. Stakeholders may provide useful challenge. Increased public confidence.	

5. Roles and Responsibilities

5.1 Roles in the DfE context

There are a variety of roles in any modelling project. These can include:

- ***Commissioner***, who sets out the required analysis
- ***Lead analyst***, who leads the development and operation of the model
- ***Other analysts***, who assists the lead analyst
- ***Model SRO***, who has overall accountability
- ***Analytical assurer***, who provides the technical assurance
- ***Policy assurer***, who ensures policy intentions are incorporated
- ***End users***, who will make decisions based on the output
- ***Finance business partners***, who are an important group of users for some models

Table 5.1 contains further details of the responsibilities of some of these role holders.

For all modelling, there will be a commissioner and an analyst. Most modelling will require direct involvement from a separate analytical assurer who is a senior analyst that is not directly delivering the analysis (the seniority required will vary but for BCMs usually the AA will be at least G6). For some routine or smaller modelling tasks, teams might wish to set up a standing QA plan under which the analytical assurer can delegate responsibilities and need not be directly involved.

For business critical models, a senior responsible owner (SRO) of the model must be appointed. The model SRO must be sufficiently senior to take responsibility for the model and how it is used. In practice, this means that the role should be held at Deputy Director level or above. For non-business critical modelling, we recommend that there are always clear lines of accountability. Appointing a model SRO is a good way of achieving this but is not mandatory.

In DfE, the model SRO is typically the senior policy official in charge of the policy or programme that will use the model output. In this set up, the model SRO will rely on the analytical assurer for technical sign off. However, the model SRO can be from the analytical side (possibly the analytical assurer), in which case the model SRO will rely on the commissioner and other senior policy officials to ensure that policy intent and implications are fully understood within the modelling. It may be worth nominating a policy assurer who will formally sign off that the model meets the policy intent. (The policy assurance role would generally fall to the model SRO under the usual policy ownership approach.)

The table below identifies the key responsibilities of those involved in modelling. See the AQuA Book for further details (in particular paras 2.11-2.23 and 6.16-6.19). Where a model SRO is in place, a number of the Commissioner's responsibilities will transfer to the model SRO. In some cases, the same person may hold both roles.

Models with multiple users

The sign off of any model is specific to its purpose. Where it is used for a separate purpose, a separate sign off is required. It is strongly recommended that a model SRO is appointed where the model is used for multiple purposes. Further guidance on this situation can be found in the Macpherson Review (paras 2.55-2.58).

Example: Economic model of returns to education:

> The Central Analysis Unit has developed a model that estimates the lifetime productivity benefits of policy interventions. They have made it available to use throughout the department and it forms an important part of policy development. The model is owned by CAU who separately sign off each use of the model to ensure that the output is fit for the proposed purpose. (An alternative approach to SRO sign off for models with multiple users is for the main sign off to describe in detail what the model can and can't be used for.)

Models developed/maintained in Finance teams

This guidance applies to such models. Although 'analysts' in the traditional sense may not be involved, the roles and responsibilities should be assigned using similar principles.

Models developed/maintained by third parties

This guidance applies to such models. Where the model is business critical, a model SRO from within DfE should be appointed to be accountable for the model. We strongly recommend that third parties use the standardised QA documentation. This makes it easier for suitable assurance to be achieved and also for the model to be brought in house if that is desirable in the future.

Example: Student loan sale model:

> The sale model is developed and maintained by UKGI, who are a key advisor to DfE in the sale process. The model SRO is a DfE role and the SRO is ultimately responsible for ensuring the model is fit for the purposes of internal decision making and providing information to possible investors.

Table 5.1: Modelling roles and responsibilities

Role	Key responsibilities
Commissioner	• Communicate the question/problem to the analyst, including the criticality and the required accuracy • Determine whether the model is business critical • Establish appropriate governance structure* • Ensure appropriate time and resources are available for the modelling and QA* • Actively engage with the analyst throughout • Agree the scope with the analyst* • Identify stakeholders and their requirements • Sign off use of data sources and assumptions* • Consider/challenge emerging results and assist with the interpretation of results • Consider whether output meets requirements and provide feedback to analyst • Sign off that model output is fit for purpose* • Ensure onward communication of outputs is appropriate, with appropriate commentary on accuracy, uncertainty, risks and limitations* **responsibility of the SRO where that role exists, though the Commissioner is likely to be involved*

Role	Key responsibilities
(Lead) Analyst	• Understand the question/problem and requirements • Documentation (scope, specification, data and assumption logs) • Develop specification from scope • Develop QA plan • Deliver model • Collect data and understand quality • Engage subject matter experts as appropriate • Carry out QA in accordance with plan • Record deviations from specification and/or QA plan and agree with Commissioner and/or Analytical Assurer • Communicate the results of the modelling, with appropriate commentary on accuracy, uncertainty, risks and limitations
Model SRO (mandatory for business critical models, otherwise optional)	• Responsible for the model throughout its life cycle • Establish appropriate governance structure • Ensure appropriate time and resources are available for the modelling and QA • Agree level of QA and ensure appropriate time and resources are available for the modelling and QA • Agree the scope and specification with the analyst • Sign off use of data sources and assumptions • Signs off that model output is fit for purpose • Ensure onward communication of outputs is appropriate, with appropriate commentary on accuracy, uncertainty, risks and limitations • Sign off use of modelling output

Role	Key responsibilities
Analytical Assurer	• Assure scope meets requirements • Assure specification is appropriate and meets scope • Assure QA plan is appropriate to support decision making • Assure that the QA plan has been followed, including an appropriate audit trail • Provide analytical sign off that the model is fit for purpose, clarifying the risks associated with the analysis
Policy Assurer (often the model SRO)	• Assure policy requirements are captured in the scope • Assure policy intent has been implemented in the model
Finance Business Partner (optional, most likely for forecast models)	• Feed in requirements • Understand uncertainty of output

5.2 Who can I talk to?

If you need any help with QA arrangements, eg:

- How to use the documentation
- Appropriate governance arrangements
- What QA activities to undertake
- Putting together a methodology challenge panel
- Finding internal/external peer reviewers and auditors

Contact the Model Improvement and Assurance Unit via: modellingandqa@Educationgovuk.onmicrosoft.com.

Appendix A: AQUA Book Types of Model

Box 2.B: Types of model

Policy simulation: to better understand policy options that drive government decisions. Ministers make policy decisions based on assessments of the likely cost and impact of policy choices. For example, the Intra Government Tax Benefit Model is used to analyse the distributional impact of tax and benefit changes.

Forecasting: to predict the future and inform today's policy choices. For example, demographic projections are essential to understand future cost pressures for education and healthcare. Equally, DECC use the updated Energy and Emissions Model to forecast the energy demand and emissions by fuel type and business sector under existing firm and funded policies.

Financial evaluation: to better understand future liabilities or costs. For example, modelling to understand the future cost implications of current pension commitments or the future cost of decommissioning existing nuclear energy plants.

Procurement and commercial evaluation: for the letting and management of large contracts, and to ensure value for money – for example, where a key service is to be contracted out as in the case of railway franchises or where a major IT upgrades/ new system is being introduced.

Planning: to make workforce decisions which affect the delivery of future services. For example, these models may be used to assess the number of trainee teachers, doctors and nurses required to deliver education and healthcare into the future.

Science based: to better understand and simulate the physical environment, in order to evaluate possible solutions or to mitigate potentially devastating impacts – for example, climate change and flood risk.

Allocation of funds: to determine how funds allocated to departments are then distributed to, for example: local authorities, schools or across the health service. These models are essential to ensure funds are allocated properly across the country to underpin local service delivery.

Conceptual: to help understand the key influences that are important to a system being modelled. A variety of problem-structuring techniques are used to develop conceptual models.

Appendix B: QA documentation

Documentation

- QA log* [5]
- Record of QA*
- QA Plan*
- Scope and specification*
- User guide*
- Technical guide/specification
- Input and Assumptions log*
- Analytical Assurer statement
- Model SRO and Analytical Assurer sign off*
- Risk log

All documentation listed above is mandatory for business critical models.

*This documentation is mandatory for all models.

There is no mandatory format, other than the standardised QA log which must be used for all models that take 3+ days of resource to develop. In particular, they need not be standalone documents.

[5] This can be provided on request by contacting the Model Improvement and Assurance Unit via modellingandqa@Educationgovuk.onmicrosoft.com

Appendix C: Change Log

Version	Date	Details of changes included in update	Author(s)
0.1	24 June 2018	Initial version tabled to AC SMT	Kate Watson and Matt Wood (et al)
1.0	25 July 2018	Updated for comments received through AC SMT and Steering Group consultation. Prepared for soft launch	Matt Wood
2.0	21 March 2019	Updated for full launch	Matt Wood
2.1	2 April 2020	Updated for publication on .GOV.UK	Leanne Sunter

Acknowledgements: this guidance has been developed with input from other Government Departments, in particular BEIS and DfT. We thank the authors of those documents for making their work available.

Department for Education

About this publication:

enquiries www.education.gov.uk/contactus

download www.gov.uk/government/publications

Reference: DfE-00069-2020

Follow us on Twitter:
@educationgovuk

Like us on Facebook:
facebook.com/educationgovuk