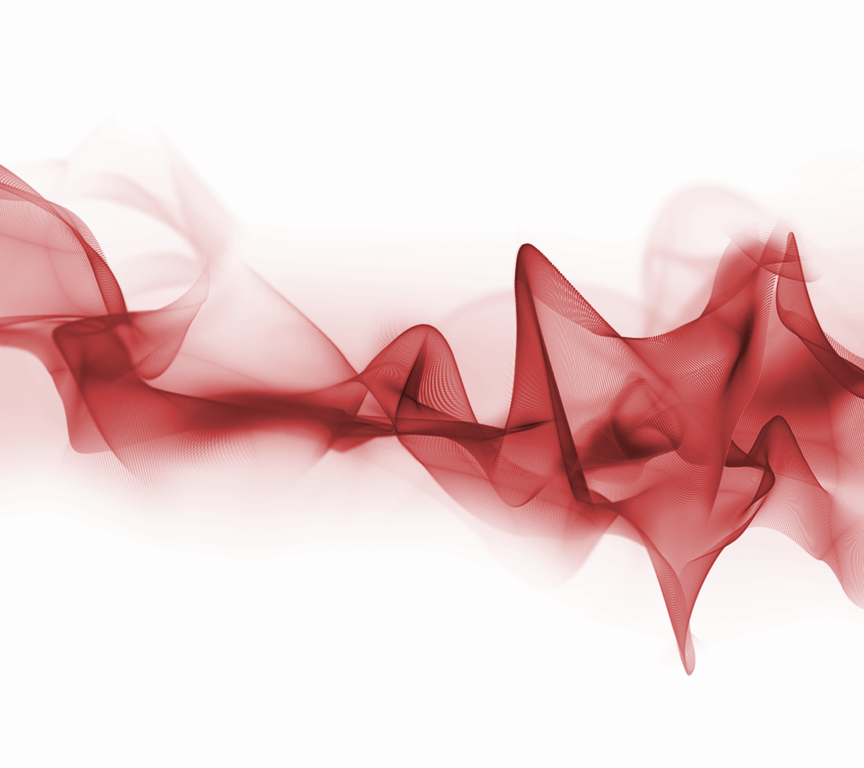
Data Quality Team

Pre-Cursory Materials to Develop a Data Assurance Team

Team Guidance



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# Data Quality Strategy - Introduction

## Data Quality Strategy Series

This document is part of an open source series of documents to facilitate the establishment of a Data Quality strategy and function within an organisation. The full open source library can be found at <https://github.com/perspicacity-ltd/DataQualityReporting>

* The series presents a set of documents as a starter for ten
* It can be used by organisations starting on their data quality journey and those who already have a data quality function
* It contains the following components of a data quality strategy:
  + Strategy & Exec Summary
  + Policy & Standard Operating Procedures
  + Technical Specification (including link to reporting suite at <https://github.com/perspicacity-ltd/DataQualityReporting>)
  + Highlight Report Template
  + Training Materials
  + DQ KiteMark Images

## A little bit about Perspicacity Ltd

Perspicacity provides decision support consultancy, coaching, & development to the NHS. They are passionate about reducing the cost of software development to the NHS and aspire to create an active community of NHS and commercial organisations. They all share a common goal of improving the quality and efficiency of patient care through better, and more informed, decision making.

Open source helps the healthcare community to do this by sharing software development, learning from each other, and help software meet the needs of every organisation without being constrained to a single solution or paying for the same piece of work over and again across different organisations.

Although these Data Quality open source products are suitable for any organisation, healthcare or not, they are here as a result of wanting to freely share Perspicacity's collective products and ideas across the NHS and to widen the benefit of good, but usually locally isolated, projects further.

Perspicacity's open source offerings can be found at <https://github.com/perspicacity-ltd>

If you'd like to find out more, please contact Matthew Bishop on 07545 878906 or [matthew.bishop@perspicacityltd.co.uk](mailto:matthew.bishop@perspicacityltd.co.uk)

# Vision and Purpose of the Data Assurance Function

## Better data for Better decisions – the vision for data quality

Not all decisions rely on systematically recorded data as their source of information. For example, a manager will use emotional intelligence, political knowledge and subject matter expertise alongside reports and information systems to decide how to make the most of their teams and assets.

When the data used alongside decisions is inferior or compromised, this doesn’t render those decisions impossible, but decision outcomes can be severely compromised if made ‘in the dark’. Conversely, reliable data presents significant opportunities to enhance even the best of intuitive decisions.

The ‘Better data for Better decisions’ vision is about embedding data quality into our mindset and day-to-day work, rather than it being an extrinsic chore.

For our decision makers, this means sleeping peacefully at night knowing, rather than assuming, that there were no hidden risks in the data used to make that day’s decisions.

For the workforce who collect and use our data, this means being able to perform their duties without having to invest large amounts of unforeseen effort to correct data required to complete a task.

Focusing our attention on reducing the need to return to, and correct, an item of data ensures our decision support systems have sustainable data maintenance costs and carry the minimum of “data quality debt”. We can only achieve this by identifying and “paying off” the most costly “debts” as soon as possible, in the most cost-effective way, and learning how to reduce the chances of it happening again. This requires us to know the state of data quality, for all of our data, at any point in time and embed this knowledge into existing workflows. It requires automated processes that manage the continual monitoring of data quality issues with minimal human cost or intervention, alerting us only when errors occur, escalating when errors are critical, and directing us to the most expedient and efficient resolution.

It also requires a highly skilled team to help identify where data quality issues are impacting our decisions, guide the data owners through finding and delivering a resolution, and supporting our staff to reduce the incidence of errors.

Working on data quality may seem like a marginal benefit, or even at times a superfluous effort, but changing the way we work and think so we can turn each and every couple of minutes required to correct a data error into a split-second recollection to apply the appropriate level of diligence soon becomes hours, days, or weeks of saved effort that can be focused elsewhere. Even better, when we take the time to get our data right in the first place, we give every decision a potentially greater outcome and make our service one step greater.

The data quality strategy is the embodiment of this vision, bringing together both the areas of greatest concern and greatest potential benefit into a transformative approach.

## The purpose of the Data Assurance Function

The principal purpose of the data assurance function is to be at the forefront of delivering the Organisation’s data quality strategy; implementing the principles of the data quality policy and delivering our own responsibilities within the policy.

The Board has committed to meeting the 6 core principles of data quality, to transforming the quality of our data to become fit for a world class service, and stated the case for change to embed data quality across the organisation. Whilst it has taken steps to implement this, these are only the early steps of what will be a long and exciting journey.

## Practical delivery of the strategy

In practical terms, this means developing a team who are empowered to ubiquitously instil a data quality improvement mind-set. The Data Assurance team will need to employ three key approaches to achieve their success as they grow: Co-Location, Measurement for Improvement, and Partnership and Support.

Over and above all other challenges, the team should focus on understanding the needs and constraints of their data owners so they form a partnership of relational depth and mutual understanding, one where a request to change practice is seen as an opportunity rather than an administrative burden, one where the Data Assurance team can light a fire within the heart and mind of the organisation rather than lighting a fire underneath it.

In technical terms, this means working to build a library of specific measures that compare a multitude of data items across multiple systems. This library may have in excess of 500 data quality measures before it has reached maturity, especially for a large organisation. The measures should identify discrete records, be updated at least every day, and have a clear process to correct issues raised by the measure.

The reporting system should intuitively direct report consumers to potential data quality risks using embedded hyperlinks, have scheduled automatic error alerts sent directly to users who have complicit responsibility, and scheduled automatic escalation communications up the chain of command for measures that have exceeded control tolerances.

The reporting should drill-down to each individual record, drill-up to each KPI, and drill-across to other issues associated with the same item, for every area of reporting affected by DQ error. It should be embedded in all reporting, from board report and performance review KPIs to management summaries or work lists, and should be accessible to drill down, up or across to DQ issues with a single click.

The practical delivery of governance is perhaps the most challenging component of data quality delivery. Rarely is there a burning pressure to fix any particular DQ issue and so data quality is often superseded by other operational, financial and political pressures. The Data Assurance team should avoid aiming to raise their profile in isolation and, instead, aim to embed their insight across key political forums and offer their support to the most high profile challenges the organisation faces. Using this approach will keep consideration of data quality in mind

# Developing a responsive and facilitative Data Assurance function

The data assurance team aspiration is to be at the heart of the success of data quality improvement, inspiring colleagues with an enthusiasm for positive change through transparency and an evidence based approach. Obviously they can’t do this on their own and their relationship with the data owners is the lifeblood of their change mind-set, a relationship underpinned by being regularly visible amongst their stakeholders. Coupled with a library of data quality measures, and resource to help effect correction of data quality issues, makes for a responsive and facilitative data assurance function.

## Steps to DQ Measurement for Improvement

Nobody wants to worry that data they use to make their decisions is correct, but moving data quality from an unknown quantity to a specific and focussed approach allows for a fully cognisant approach to decision making with no hidden surprises.

A standalone DQ reporting suite of specific measures is required, one that compares a multitude of data items across multiple systems. It’s not expected that every measure in the reporting will represent a current data quality problem. In fact, a mature reporting approach relies upon it – knowing, rather than hoping, that there are no problems is the best way to be assured about data quality.

The Data Assurance team should lead the organisation through a methodical process to build this suite of measures, pledging to ensure at least 50 are processed per year. In reality, some can be delivered more rapidly and we would expect to see approximately 100 measures within a year of the reporting framework being built. As the library reaches maturity over the course of the next 10 years, it is likely to have in excess of 500 data quality measures and we would expect to see approximately 200 measures meeting the core DQ needs of the organisation within the next three years.

There are **three steps** to measuring a data quality issue – identifying and cataloguing the problem, investigating it and quantifying it. Each of them has a set of associated questions. These are the first 3 steps detailed below.

### Identify and catalogue the problem - What is the problem?

Identifying data quality problems, or potential problems, is the first step in tackling data quality. Measures of data quality need to be built for every issue that can be found. This will be discovered during co-location within the organisation, regular 1-1 meetings with key stakeholders, and attendance at key forums such as performance reviews or committees.

When identifying and cataloguing problems, it is important to identify which of the six main characteristics are applicable.

### Investigate the problem

When investigating problems, there are five critical questions to answer:

Where does the problem originate?

Investigating the origin of a problem is done by the Data Quality analysts, in collaboration with the data owner, working through the 7 points of failure to identify where the error occurs (see appendices).

Why does the problem occur?

Once the origin of the problem has been ascertained, the DQ analyst will observe the processes at the "point of failure" to find out why the problem occurs.

How do we solve the problem?

Once the DQ analyst understands why the problem occurs, they can work with the data owner and system owner to appraise options to alter processes at the "point of failure".

Who are the stakeholders?

Once the problem and resolution is fully understood, the DQ analyst can propose the most appropriate "Executive Domain owner" - the directorate to which the DQ issue principally belongs. This should be agreed with the executive sponsor as soon as reasonably possible, preferably at the regular 1-1 executive meetings.

At the same time, it is important to formalise the data owner(s) and system owner(s)

What is the impact of the problem?

Together with the data owners, the DQ analyst then needs to describe the business impact of not assuring the data quality for the issue.

### Quantify the problem

When quantifying the problem, there are five critical questions to answer:

1. How many records have a problem?

Once the DQ analysts know how the problem occurs, a sample record in a test instance of the system should have the problem deliberately created. The data from the sample record should be taken both before and after the problem is deliberately created. Using the before and after data to determine what uniquely identifies the records with errors, a SQL script can be written to establish a method to measure prevalence. If an inconsistency-driven method cannot be found, then an event-driven method should be sought. Failing that, a validation methodology should be established to set up an audit.

1. When does the problem occur?

Ideally, there is an audit trail or timestamp within the data that identifies when the data quality error occurred. It is often the case that audit trails or timestamps are unavailable to quantify the incidence of the problem, in which case a newly identified presence of an errorful record within the data warehouse is the next most suitable option to identify incidence. As a final alternative, if the rate of correction is known, then the correction rate plus any change in the prevalence over the same period of time can be used to infer the incidence.

1. What level of prevalence is acceptable?

This threshold is ultimately to be decided by the data owners in context of the impact of the problem. There are many ways for this to be evaluated. The primary approach should be to use 6-sigma statistics to assure the threshold as a percentage of the overall dataset or determine the threshold on the basis of the cost of an error to the business.

Using the same approach, it should be decided what the escalation path is for the measure and at what levels of prevalence an issue should be escalated up the chain of command. There can be a different number of levels for each measure, each with its own thresholds and stakeholders who should be escalated to. The stakeholders should be determined at the same time the escalation path is decided.

1. What is the appropriate solution?

Out of the options appraisal undertaken during investigation, the data owner should decide which resolution option is the most appropriate response to the problem.

1. How much effort is required to resolve the problem?

Once the appropriate solution has been determined, a small time & motion study should be undertaken to determine how much time, on average, it takes to correct an error-full record. Multiplying the prevalence and incidence by the average correction time will provide a quantified prevalence and quantified incidence in person-days.

Establish prevalence and incidence escalation thresholds to manage the workload of each measure

## Steps to Partnership and Support for Validation and Correction

In order to help business partners achieve assurance of their data quality, the data assurance team need to support data owners to achieve a sustainable level of data quality. This is achieved not only by actual correction of data, but also by preparing business cases, co-ordinating correction exercises and subsequently monitoring the incidence and prevalence. Whilst this doesn’t relieve management of the most challenging elements of data quality, it does allow them to only concern themselves with data quality at a point of need.

There are **three steps** to supporting business partners with data quality: deliver correction with internal resource, preparing a business case if internal resource is insufficient, co-ordinating DQ improvement projects and managing sustainability. These are the last 3 steps detailed below.

### Deliver correction with internal resource, or prepare the business case for a DQ improvement project

When delivering correction with internal resource, the team will need to design weekly work plans to deliver their monthly correction hours and be ready to prepare highlight reports showing progress against trajectory on prevalence and incidence targets

If there is insufficient internal resource to deliver a DQ improvement project, a business case will need to be prepared to achieve project funding.

When preparing a business case to set up a DQ improvement project, there are three critical questions to answer. The answers to these questions can then be inserted, along with some narrative from the investigation, into a boilerplate business case template that will be the starting point for data owners to submit to the relevant committee(s):

1. What does do nothing look like?

Using recent averages and trend analysis of prevalence and incidence, profile the prevalence trajectory if nothing is done. If there are known implications of the cost of errorful records (e.g. the income cost of missed activity, the safety cost of missing protection plans, or lost efficiency from unspecific patient alerts), then quantify the cost of not solving the problem in quality, operational, reputational and financial terms

1. How much will the correction cost?

For projects where the source systems require correction, use an analysis of the current prevalence and time & motion effort data to quantify the cost of setting up a DQ improvement project. The costing analysis should include time to train new temporary or permanent staff members, reduced rate profiles of correction whilst learning the correction process, the core prevalence reduction, the cost of incidence over the period of prevalence correction, the cost of transition to internal management, and the cost of user retraining to reduce incidence.

For projects where the point of failure is system based, assist the accountable office responsible for the system for a cost to rectify the point of failure.

1. What is the timescale of correction? (Data Assurance team)

For projects where the source systems require correction, use the costing analysis to profile a prevalence trajectory. Where the point of failure is system based, assist the accountable office responsible for the system to determine a timescale to rectify the point of failure.

### Manage sustainability

Once a data quality issue has been brought to a sustainable level, the aim is to keep it there. This involves monitoring all measures against their thresholds and escalating any measures whose prevalence continues to increase:

1. Who will deliver the regular prevalence correction?

Each measure should have a staff group responsible for correcting errors. This will be agreed with the data owners. Ideally each DQ record will identify the user who made the error so that the record can be returned to the user for correction.

Who will action increases in prevalence or incidence?

Although the DQ reporting will allow managers to monitor their own DQ performance, the Data Assurance team will continually monitor all measures against the thresholds established when the measure was quantified. For each measure the data owner should also agree additional thresholds, past which the issue will be escalated to a manager. The first level of escalation should always be the staff group responsible for correcting errors and the last level of escalation should always be the executive sponsor.

Ideally this will be delivered by automated alerts from the DQ reporting system – where this is not yet possible, alerts should be sent out by the Data Assurance team.

Identify and support repeated errors

Reporting should be built, where possible, to individually identify users who make mistakes whilst collecting data. Those with unimproved error rates should receive more focussed one-on-one training, delivered in collaboration with their line managers.

### Co-ordinate DQ improvement projects

Most improvement projects will have had a business case established in advance of the project start and, where this has happened, the details of the business case can be used in populating the project plan. Each DQ improvement project must answer the following six questions:

1. How do we achieve the intended improvement?

For projects where the source systems require correction, there should be a documented corrections process and training material to correct the prevalence.

For projects where the point of failure is system based, there should be a method statement for the intended improvement

What is the timeline of delivery for the project

For projects where the source systems require correction, there should be a target prevalence and incidence trajectory. Where multiple teams are delivering the correction, the prevalence and incidence trajectories should be profiled for each team involved.

For projects where the point of failure is system based, there should be a system specification and milestone delivery timeline

Who will correct the prevalence?

A resource plan should be provided for each team involved, detailing the individual team members and what weekly hours / days they are planned in for.

What project assurance is required

For projects where the source systems require correction, there should be a weekly QC of records from the previous day’s work sheet to check the work being delivered.

For projects where the point of failure is system based, there should be appropriate unit / integration / system / acceptance tests and code reviews to assure the project at each milestone.

How do we know the project has been successful

There should be a quantitative definition of success for the project. For projects where the source systems require correction, the minimum definition will be achievement of the target prevalence and incidence rates. Where the point of failure is system based, the minimum definition will be success in all unit, integration, system and acceptance testing.

How do we reduce the risk of this issue re-occurring? (DQ analyst in agreement with system users)

For projects where the source systems require correction, an approach should be agreed with data owners to reduce incidence of the error. This should primarily target reductions in duplicated effort and should avoid ongoing correction wherever possible. Business processes and training materials should be re-written to minimise the risk of error with training being delivered to all users. Users with unimproved error rates should receive more focussed one-on-one training, delivered in collaboration with their line managers.

For projects where the point of failure is system based, there may be no definitive way to reduce potential risk, but it may be possible to schedule scripted tests to capture an issue as soon as it arises.

## Data Assurance Team Co-Location

Ownership of data quality should always sit with those who own the data, so the true location of the data assurance function sits not within a corporate function, but spread diffusely across the organisation - Improvements in data quality can’t be delivered from an ivory tower. Instilling that sense of ownership and their co-operation is critical to the Data Assurance team’s success. If the Data Assurance team are to impart a data quality improvement mind-set across the organisation, they will need great relational depth with the wider staff base. Co-Location is a crucial element to build relationships – it allows learning about the challenges people face and understanding of how processes work, so when a data quality issue is found you can help identify a solution which is relevant and beneficial. Even better, being at the cutting edge of delivery allows you to actively identify potential data quality issues before they become a problem, rather than trying to manage them afterwards.

The Data Assurance team should aim to spend 40% of their time with team colleagues and spend the rest hot-desking within another team. Even if they are just getting on with their own work, it is important that they have a constant presence and demonstrate openness and availability – this will inspire their stakeholders to be open (important for admitting there have been mistakes!) and facilitate availability when they need help.

## Where is the boundary of the Data Assurance function

It is important that we draw a boundary around the Data Assurance function. They will exist as the resource to measure and monitor data quality whenever the trust thinks something is wrong.

This will include facilitating data quality improvements by building and maintaining DQ reporting, building template business cases, and providing limited resource to support correction and as a DQ assurance SME (be invited to identify DQ in normal workflows).

Ownership of the data quality will always belong to the business owners and prioritisation of the limited resources of the team will need to be made in a formal forum where stakeholders are able to attend.

There will also be limited resources to guide users who repeatedly generate data quality errors, but this will only occur where there are existing re-training opportunities. Line management should always be notified of users who repeatedly generate errors and the Data Assurance team will only provide evidence to the line manager to facilitate performance management. No performance management will be undertaken by the team and staff with repeated errors more than three times in a six month period should be escalated for formal management.

There will be extremely limited resources for quality control (QC) of information system policies, procedures and training guides. No actions will be accepted by the team, but they will provide their advice on best practice.

There will also be extremely limited resources for IT teams to request quality control (QC) for reference data changes, system upgrades, system implementations or data migrations. Again, no actions will be accepted by the team, but they will provide their advice on best practice within available resource. Further demand for this requirement can only be accepted with a business case to backfill or provide the required resource, for which the Data Assurance team will assist with a business case and subsequent recruitment.

# Appendices

## Where does the problem originate? – 7 Potential Points of Data Quality Failure

The six main characteristics of Data Quality (as explained in the Basic Data Quality Induction) can manifest in one of 7 points along the chain of data custody, from data collection to reporting. Whilst ultimate ownership of the data in the source system always belongs with the business users, the responsibility to resolve data quality issues depends on who has the authority over the point of failure. For example, there is no point in asking an end user to correct data caused by a system bug – the system simply will not allow correction of the data quality issue. Each of the 7 points of failure has a distinct set of methods to correct data quality issues.

### System User Error

This is the most frequently exposed point of DQ failure – a user records values in an information system inconsistently with the definition of that value, misses recording it entirely, records it with the wrong degree of accuracy (e.g. only recording the pounds and not the pence of a financial transaction), takes too long to record it, or changes the way events are evaluated over time.

The resolution is simple in principle - correct the error. However, this can still involve significant correction resource costs or complicated correction processes. Sometimes the information systems can be scripted at the back end to correct the data at source - this opportunity should always be sought and implemented wherever the value of correction outweighs the risk of creating alternative errors. Automated processes (usually screen / keyboard macros) can also sometimes be employed to achieve correction at the system front end. Failing this, manual correction is the only available option.

### System Bugs

This common point of DQ failure is one that data owners are often powerless to resolve directly.

The resolution will initially require thorough investigation and documentation of the workflows that lead to the error, before and after pictures of the underlying data, and repeatable tests that demonstrate all manifestations of the error in the data. Once this documentation has been handed to the system developers, the task principally becomes one of managing timelines and expectations.

### System Extract Errors

This is the ‘E’ or Extract part of ‘ETL’, the component where we take data from one system and transfer it to another, usually a data warehouse. In an organisation with a high degree of informatics maturity, these errors are extremely rare and usually identified with system alerts. It’s certainly not impossible for these to occur, however, usually when information system reconfigurations / upgrades occur or when information maturity is still developing.

Resolution is effected via scrupulous, row-level (RBAR), data comparison between the source data and the extracted data. Test driven development should be employed during this process to ensure future fault trapping is automated and process error handling should be configured to fail the process or quarantine errored records with an associated alert to system admins.

### Data Processing Errors

This is the ‘TL’ or Transform and Load part of ‘ETL’, the component that takes extracted data and prepares it to meet an import specification before loading it into a system, usually a data warehouse. Although it’s not common to find catastrophic instances of data processing errors, it is more frequent than you would hope to find smaller errors, even in an organisation with a high degree of informatics maturity.

Resolution starts by checking that the load happens correctly with no dropped records or missing data items. The next step is to undertake a methodical theoretical interpretation of the input based specification compared to the source system specifications to ensure the transformation meets both specifications. If there are no transformational errors followed by testing the six main characteristics and three additional characteristics against the source system to ensure the source system data meets the source system specifications - Sometimes, this requires redefinition of the source system specifications to make it fit for purpose or meet emerging needs.

### Report Preparation Errors

Report preparation errors are most easily conceptualised as analytical errors. They occur in datasets built up to produce a specific analysis from more simple analytical datasets, for example:

* + a demand forecast taken from historical activity alongside co-varying environmental factors (weather, local traffic conditions, special cause variation etc)
  + building a pathway from discrete events captured in multiple systems (emergency calls, vehicle location, clinical information, handover information and hospital outcomes)

It is quite common for these analyses to incorrectly factor co-variance or to miscalculate a derived measure. Resolution here is as wide and varied as the analyses being performed. The most pragmatic approach is to test analytical output against the real world, both qualitatively using the experience of subject domain experts and quantitatively using all 9 characteristics of data quality.

### Reporting Errors

Reporting errors occur when a presentation layer misrepresents the data underlying the report. Occasionally these errors occur when processing that should happen in the system extract, data processing or report preparation layers is built into the reporting layer instead - Some reporting technology facilitates, or even promotes, this misappropriated processing. Coherence and Adaptability, of the three additional characteristics, are of significant importance here.

Resolution of reporting errors is the same as that of report preparation errors - test analytical output against the real world, both qualitatively using the experience of subject domain experts and quantitatively using all 9 characteristics of data quality.

### Report Interpretation Errors

Report interpretation is, ultimately, an individual issue, but there are certainly some reports that lend themselves to clearer and more consistent interpretation. However, there are some analyses that present concepts that are either new, abstract or have implications that are difficult to grasp. Clarity, of the three additional characteristics, is of significant importance here.

Resolution comes down to 2 approaches: education and transparent documentation. Report interpretation errors occur most identifiably in forums where performance is reviewed or decision making occurs and it is critical to attend these forums in order to identify these errors. These errors are the only ones that can’t be measured in the library of measures, so it is imperative they are met with sensitively presented challenges to interpretation and offers of additional educational support following identification.