QAA subject benchmark statements
for
Mathematics, Statistics and Operational Research (MSOR)

Where did they come from?
What are they?
Why might they be useful?

Martyn Parker
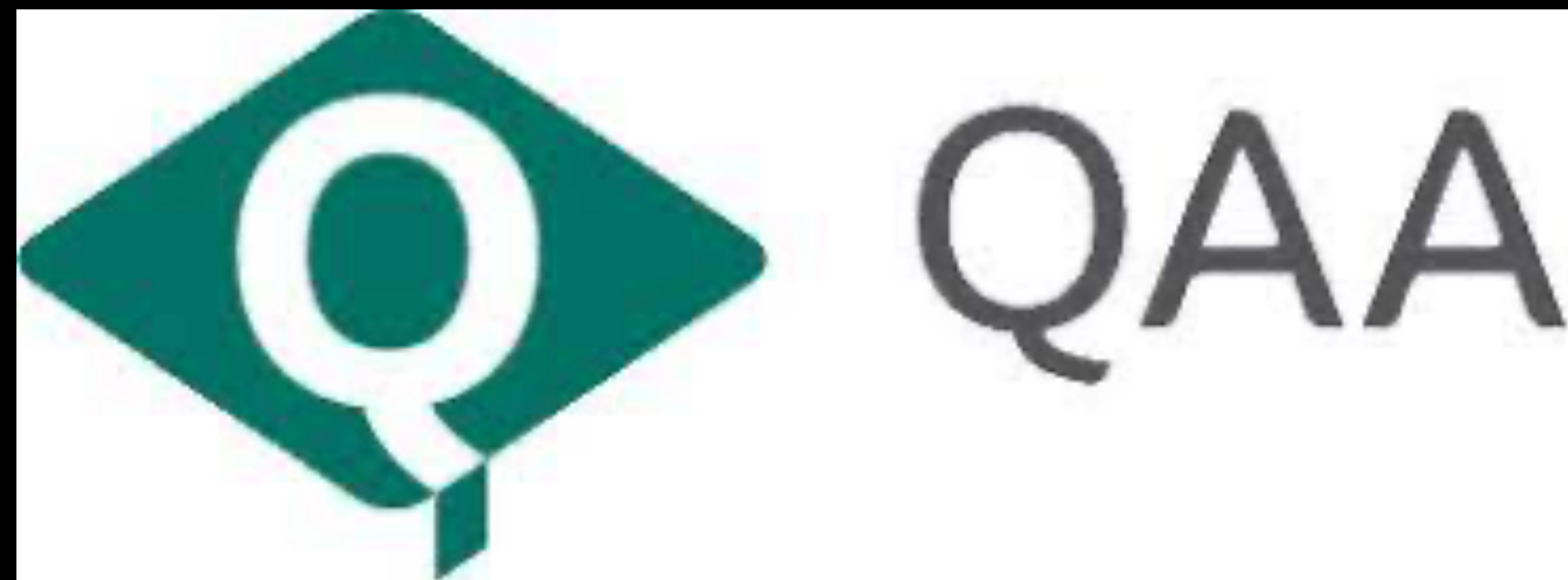Department of Statistics

Today

- Current context: QAA and OfS

- MSOR Benchmarks: how can they help us?

- Discussion/questions

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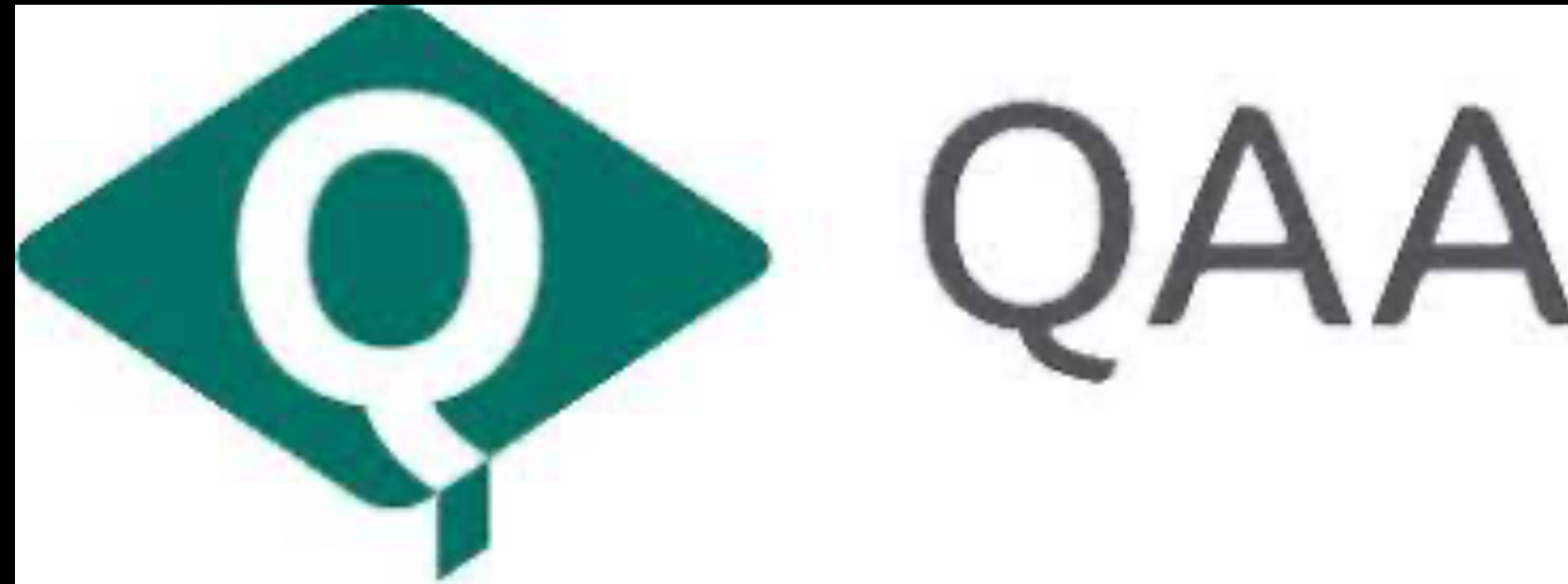
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Current Context

Quality Assurance Agency for Higher Education

- Independent charity

- Provide sector guidance in areas such as quality and standards

- Advisory, not regulatory

Office for Students

- Regulator of HE in England

- Sets conditions for registration

- Has significant power over HE

- Arose form the Dearing Report (Higher Education in the learning society,1997) with "the remit of providing assurance about standards and quality".

- Between 1997 and 2001 a set of benchmarks were developed for "quality and standards".

  - Describe the nature of study and the academic standards of graduates in subject areas.

  - What graduates might reasonably be expected to know, do and understand.

  - Not a syllabus or specification: descriptive and not prescriptive.

  - Maths, Stats and OR (MSOR) benchmarks first produced in 2002.

- Higher Education and Research Act (2017) lead to consultation on the "Designated Quality Body" from which the Office for Students recommended the QAA for this role.
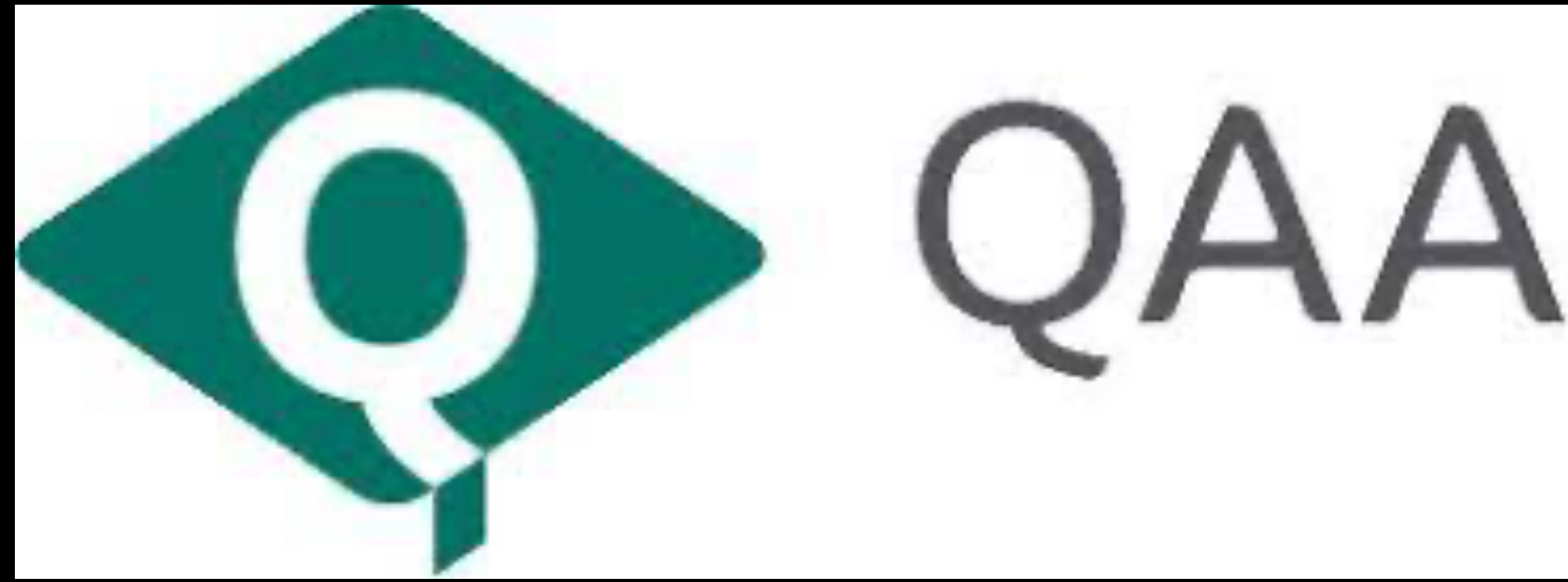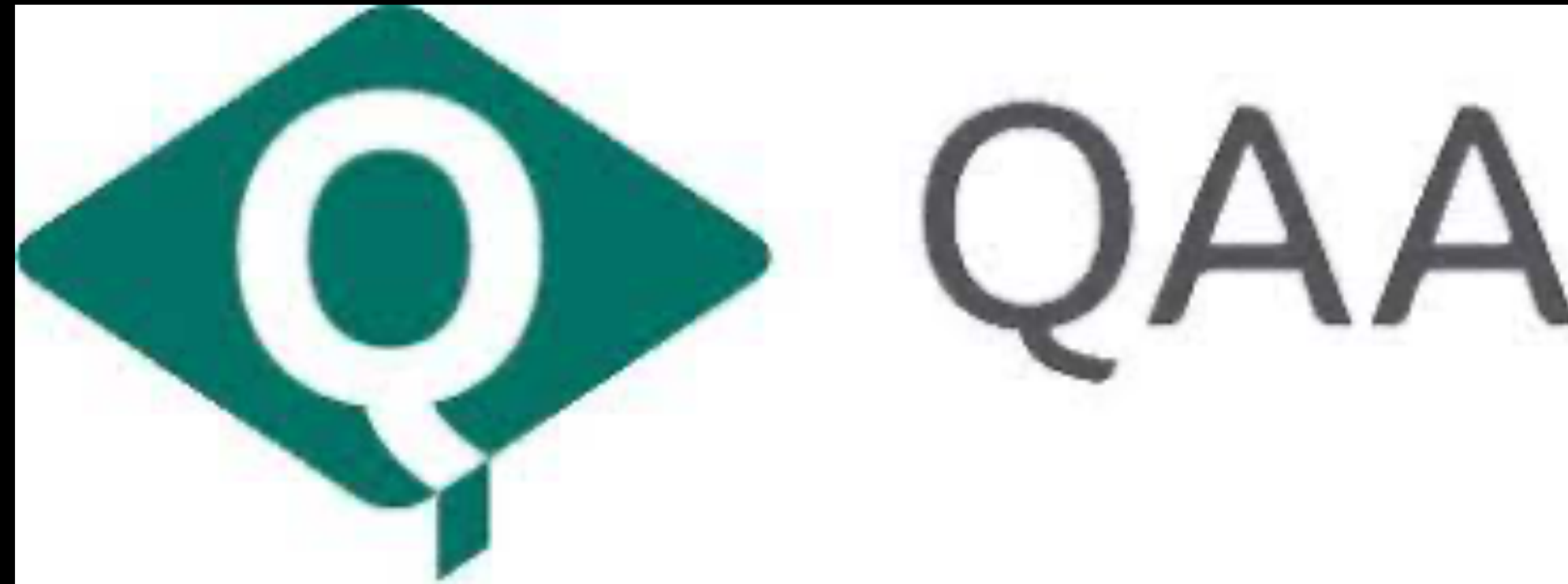
MSOR Benchmarks (More details later)

- Hierarchical subject with assimilation of earlier material essential.

- Teaching and learning depends very heavily on previously learned material.

- Applies to MSOR more than other disciplines.

- MSOR courses should be designed to follow a logical progression, with prerequisite knowledge demonstrated as secure.

- Sets the threshold graduate characteristics for an MSOR degree.

- **Mission**: "ensure that every student, whatever their background, has a fulfilling experience of higher education that enriches their lives and careers."

- Objectives

  - All students, from all backgrounds, with the ability and desire to undertake higher education, are supported to access, succeed in, and progress from higher education.

  - All students, from all backgrounds, receive a high quality academic experience, and their interests are protected while they study or in the event of provider, campus or course closure.

  - All students, from all backgrounds, can progress into employment, further study, and lead fulfilling lives, in which their qualifications hold their value over time.

OfS (2023), Our Strategy.

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Office for Students

- Conditions for registration are monitored continuously through Key Performance Measures.

- Monitors and can intervene and sets conditions for continued registration.

  - Can include enforcement action.

- Conditions include student outcomes, e.g. new outcome assessment and condition B3:

"in the OfS's judgement, the outcome data for each of the indicators and split indicators are at or above the relevant numerical thresholds"

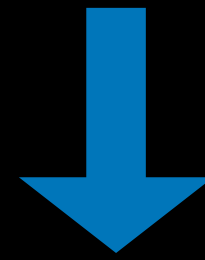OfS (2022) Securing student success: Regulatory framework for higher education in England, 24 November 2022

OfS (2023) Registration with the OfS

OfS (2023), Monitoring and Intervention.

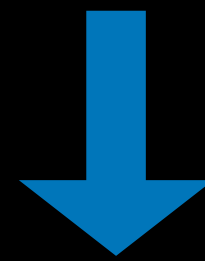OfS (2023), Student outcomes assessments commencing in 2024.

Office for Students (OfS)

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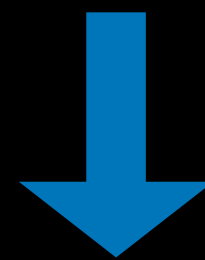**University**

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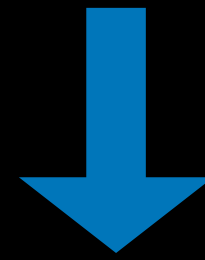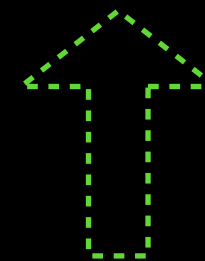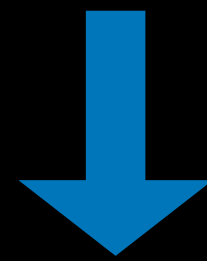
New initiative

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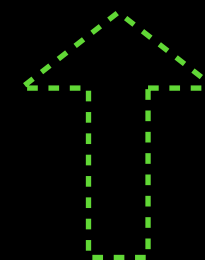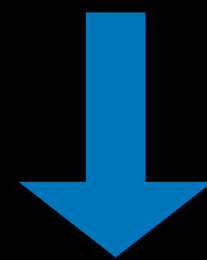
Departments

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- Current context: QAA and OfS

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- Discussion/questions

How can they help?

University

↓ ↑

New initiative

↓ ↑

Departments
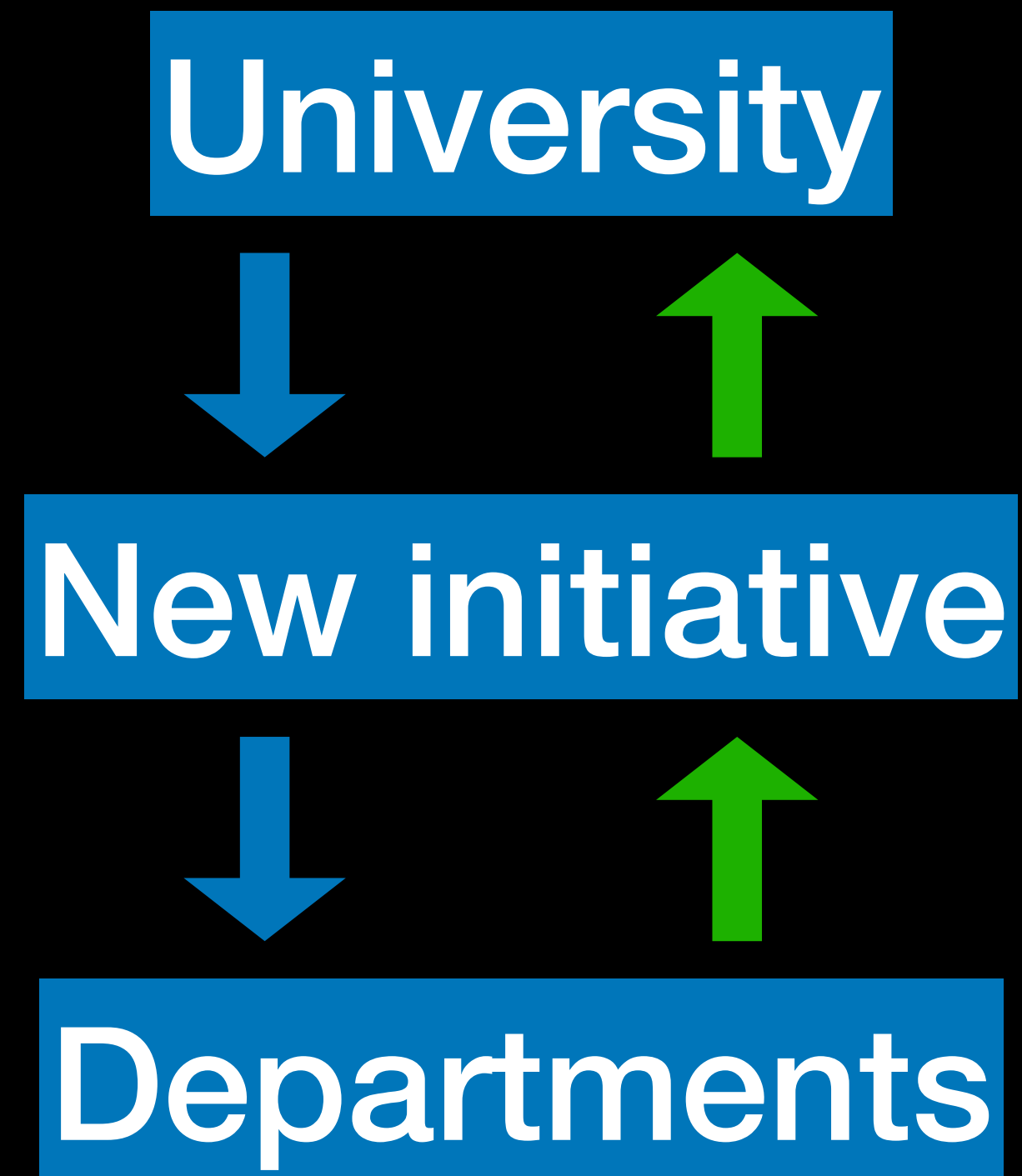
- Context and purposes of a MSOR degree

- Distinctive features of MSOR courses

- Content, structure and delivery

- Benchmark standards

- New sections designed to help contextualise MSOR approaches to "new initiatives".

- Greater employer/student involvement.

Example: Distinctive Characteristics

It is an inherent characteristic of the subject that an individual student's performance may vary greatly over different modules. This non-uniform profile of attainment is a characteristic feature of MSOR.

An important characteristic of the discipline is the cumulative nature of the subject; modules often require essential background knowledge and have strict formal prerequisites. It follows that it is quite normal, and often necessary, to teach very similar subject matter in different years.

Example: Design

No attempt has been made to construct a comprehensive listing of subject-specific knowledge for all courses covered by this Statement. Such a listing would be far too prescriptive, may well force unnecessary and undesirable modifications in some existing courses, and would confer no positive benefits.

…common ground is linear algebra, calculus, probability and some programming.

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Example: Delivery

Students benefit from seeing arguments developed by tutors in 'real time' and it is common for tutors to present extended arguments in classes, particularly in lectures.

A range of different teaching spaces are typically required for MSOR classes. These include, but are not limited to, lecture theatres with suitable boards and projection facilities, computer laboratories, and rooms with adaptable table and chair configurations to facilitate peer discussions or group work. Where a board-based approach is adopted, considerable board space may be required for the display of the teaching material. It is sometimes necessary to display distinct material simultaneously, such as digital output from specialist software at the same time as arguments being written on boards. Teaching spaces may require appropriate facilities for this as well as equipment to allow useful recordings of relevant sessions to be made.

Example: Reading Lists/Workload

Typically, MSOR staff develop bespoke resources, such as lecture notes and practice questions, for each module rather than following a specific reference. This is a consequence of modules being specifically developed to fit within the overall course design of the provider, including the prerequisite structure, and a desire for greater flexibility over teaching resources. Consequently, MSOR staff need to routinely update materials and practices in response to both developments in domain knowledge and pedagogy.

Example: Skills

A number of general skills are to be expected of all MSOR graduates, although these are likely to be developed to different extents in different courses. These lead to competencies that enhance the general employability of MSOR graduates and include:

- study skills, particularly including the ability to learn independently
- the ability to work independently with patience and persistence, pursuing the solution of a problem to its conclusion
- efficient management of processes and deadlines
- adaptability, in particular displaying readiness to address new problems from new areas
- the ability to transfer knowledge from one context to another, to assess problems logically and to approach them analytically
- highly developed skills of numeracy, including being thoroughly comfortable with numerate concepts and arguments in all stages of work….
- the ability to apply specialist software appropriately information technology (IT) skills

Example: UG Research

A characteristic of MSOR is that significant quantities of domain knowledge and practice of associated skills are required before a student is able to independently and meaningfully engage with solving more advanced problems, especially in more abstract areas. Providers should prioritise equipping students with the discipline-based skills to enable them to independently learn MSOR content and recognise that in doing so their provision is enriched by the nurtured potential of their students.

Example: Assessment

MSOR has important general characteristics which pervade the culture of the discipline and can be taken to apply to all specific courses as intended learning outcomes. For example, minor symbolic differences can radically change the intended meaning, and in applications inaccuracy can have very serious consequences.

Controlled conditions, such as those provided by traditional invigilated examinations, are often essential. For example, the nature of the subject means that sometimes students can be expected to provide an answer which is very close to a model answer. Such controlled conditions also help ensure that only work produced by students themselves is being assessed…

Example: Assessment

In MSOR, assessment marks can **span the entire percentile range**. It is possible for an MSOR student to produce a solution that is entirely correct and therefore warrants being awarded full marks. It is an inherent feature of the subject that the **performance** of an individual student may **vary significantly between modules** and a student's marks on some modules may not be aligned with their overall performance…

…MSOR is often best served by allowing examiners to **judge the overall performance of a student against the learning outcomes for the whole course by using averaging or preponderance systems which take an overall view of a student's achievements**…

…some aspects of **provider-wide assessment regulations** might be less applicable in MSOR than other subjects and **may need to be adapted** to take account of the inherent nature of the discipline, otherwise the professional judgement of the examiners (internal and external) could be seriously compromised.

Example: Accessibility

Mainstream adaptive technologies, for example learning management systems, screen readers and automatic captioning software, often do not effectively support MSOR content. To mitigate this deficiency:

- providers should acknowledge the special needs of MSOR and the deficiencies in many adaptive features of mainstream technology by providing additional resources which may not be needed by subjects where the medium is primarily text based
- academic staff will require specialist technical support to solve particular digital accessibility challenges
- staff and students are likely to need special hardware and software to better access MSOR content.

Those in support roles, including scribes, notetakers, readers and communication support workers, need to have an understanding of MSOR terminology and symbolism since even minor symbolic differences can radically change the intended meaning.

Example: ESD

The following are examples of how MSOR methods may be linked to sustainability issues.

- Pollution levels connected with transport could be reduced by applying fluid dynamics to improve aerodynamic efficiency or optimisation algorithms to reduce delays in networks.
- Population dynamics can be modelled using ordinary differential equations in the context of species growth and decline, using SIR (susceptible, infected, removed) models in the context of epidemics or using network theory applied to ecosystems.
- Automated diagnosis based on medical images may be achieved using classification algorithms and low rank approximations of images using matrix factorisation.
- There are various mathematical models for climate forecasting, such as those based on Navier-Stokes equations, and extreme value theory to estimate the risks of weather events.
- Machine learning, artificial intelligence and data science have many applications in sustainability in the contexts of, for example, energy, resource management, biodiversity, crop yields and climate.
- Pure mathematics is applied in cryptography and blockchain techniques, which have significant environmental consequences.

Example: Inclusive Education

…might give consideration to good practice in areas such as the following:

- Environment
- Recruitment
- Delivery
- Curriculum
- Employability
- Assessment
- Support

The London Mathematical Society (LMS) runs a Good Practice Scheme supporting women's careers in MSOR…

Summary

MSOR Benchmarks

- Owned by the sector.

- Have never told us what to do.

- Can help us in the fast moving regulatory environment.

- Discussion/questions

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