An Approach to Curriculum Design

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1. Introduction to the design principles

The process of continuous course improvement, common to all education and training institutions, provides the framework for the approach to curriculum and course development proposed here.

The first section argues for a principled approach to teaching and learning that builds on the research on what it takes to learn. The analysis begins with the needs of the learner, and the learning outcomes they need to achieve, rather than the teaching the provider is equipped to supply. There is no single theory or principle that covers the full range of requirements on the teaching-learning process, but there is a strong consensus that has developed over the past century of educational research that learning requires a variety of approaches—not just exposition, but also inquiry-based learning, experiential learning, social learning, and collaborative learning. There are many different terminologies in the literature (see Glossary), but these aspects of the teaching-learning process together embrace the principal requirements. An important feature of the approach to teaching and learning embodied in this proposal is that assessment is integrated into the teaching and learning activities as well as being used at the end of the learning sequence to indicate the extent to which the material has been mastered.

The second section summarises the rationale for a ‘blended approach’ approach to teaching and learning, which uses an appropriate combination of conventional and digital technologies to achieve the institution’s training goals in an optimal way, both efficiently and effectively. The value of defining a set of requirements of the teaching-learning process is that it provides a common challenge to both conventional and digital technologies on the learners’ behalf. The blended approach is then developed not as a technology-led exercise, but as a learner-oriented analysis.

The learning design principles on which this approach is based are outlined below. These principles drive the overall approach, and the detail of the planning, design, delivery, assessment, and evaluation processes at each stage.

1.1. A learner-oriented approach to teaching

Principle 1: teaching and learning is designed in accordance with learners’ needs in relation to learning outcomes.

This principle simply states the basic principle of every design process that it begins with a gap analysis of the relation between initial parameters (in this case the capabilities of the learners) and the intended outcomes. The move is away from provider-led training that is design to sort learners to one that aims to helping them learn:

“The paradigm of instruction has to change from standardization to customization, from a focus on presenting material to a focus on making sure that learners’ need are met” (Reigeluth 1999).

Training provision may often develop a curriculum in terms of the expertise available, or historical requirements that no longer apply, or learner characteristics that have changed. This principle, if applied regularly, will avoid training provision becoming dysfunctional over time.

The design stages in sections 2.3 and 2.4 in particular are based on this principle.
1.2. **Active learning**

Principle 2: teaching and learning activities are designed to include both didactic and participative methods that promote individual learning capability for the future professional.

A learner-oriented approach to teaching and learning includes alternatives to didactic instruction, which give greater prominence to the need for active learning. In addition to learning through ‘acquisition’, i.e. listening, watching, reading, the learner also needs to be encouraged to engage with the concepts and skills being taught in such a way that they become embedded in their own ‘ways of thinking and practising’ (Entwistle 2005). Teaching has always required learners to practice what they have been taught by working through set examples and exercises, but this is not sufficient to ensure that the ideas become their own. Learners also need to be active learners, learning as they do in informal contexts, where they participate in their own communities, working to their own goals, reflecting on the extent to which their actions have achieved their goal, and adapting their further actions accordingly. This experiential learning in a social context is fundamental to the nature of learning. That is why learning approaches such as ‘social constructivism’, ‘situated learning’, and ‘social learning’—or learning as ‘participation’—have attracted such attention in the education literature (Sfard 1988).

However, this kind of self-directed learning is not sufficient where there are defined learning outcomes that the learner needs to reach. Learners may not know what is to be learnt, and will not necessarily know when they have achieved a goal. Didactic instruction and teacher guidance have a role to play in such situations because learning as ‘acquisition’ is important. Therefore, when there are specific outcomes required, education must embrace both didactic and participative methods of teaching and learning. By using both types of learning, it will succeed more efficiently in enabling learners to make the knowledge their own, and therefore become independent learners, able to continue extending and adapting their knowledge as professionals.

Section 4 describes the main types of learning approach being emphasised in the educational literature, and outlines their particular advantages and disadvantages. The optimal design for a course will almost invariably be a judicious mix of more than one approach.

1.3. **Blended learning**

Principle 3: teaching and learning activities are designed to exploit both conventional and digital technologies where each is most appropriate.

The conventional technologies of teaching and learning—the lecture presentation, tutorials, books, physical resources, etc.—will retain a significant place in the modern curriculum, but some activities can be replaced by introducing more use of digital technologies. They are complementary to conventional approaches, but must not be thought of as *additional*. There are few contexts in which total learning time can be increased; it is most likely that the pressure will be on reduction of learning time. This means that if digital methods are introduced they will replace some conventional methods.

The introduction of digital methods means that it becomes possible for instructors to include ‘supported open learning’ as part of their teaching. It is *open*, because it is not tied to a place – learners use study materials at any time, in any place. It is supported because the materials are prepared in such a way that they incorporate advice and guidance, and the learners are *supported* through online access to instructors and other learners.
There are three main reasons for adopting a blended learning approach to the design of teaching-learning activities: (i) it makes the logistics of the training provision more flexible; (ii) it improves the quality of the learning process; (iii) it improves the productivity of both teachers and learners.

Flexibility - learners can use digital resources at any time or place with access to a laptop or personal technology, making it possible for learners to work more at their own pace, to study more flexibly, and take part in discussion and collaboration at a distance (Bates 2005);

Quality – digital technologies bring unique capabilities to education, which improve the quality and effectiveness of the learning experience: practice with automated and individualised feedback, integration of collaboration with self study, animated presentation, and interactive simulations (Clark and Mayer 2008).

Productivity – in asynchronous online discussions, the teacher can give guidance tailored to learner needs more efficiently, and to large numbers of learners; a single digital resource can be reused and adapted in different contexts to be amortised over larger learner numbers; learners spend more of their time working at their own pace in a personalised adaptive environment, using their time better than in a single-paced whole class environment (Laurillard 2006).

This principle is carried through all the design stages, and embedded in the design tools and templates in the Course Re-design Process document. To ensure that conventional and digital technologies are used appropriately, the characteristics of each method are identified for the planning and analysis stages.

1.4. **Integrated assessment**

**Principle 4:** Assessment is built into the learning sequence in addition to establishing what has been learned at the end.

What learners will learn as the result of a particular sequence of learning activities is impossible to predict with any accuracy (Denvir & Brown 1986a, b). For that reason, a commitment to a learner-centred approach necessitates ensuring that assessment is integrated into the teaching so that we know what learners have learned before we try to teach them anything else. In short, assessment functions as a bridge between teaching and learning. It is only by assessing learners that we can establish what learners have, in fact, learned as the result of the actions of the teacher.
2. The Curriculum Design Cycle

The curriculum design cycle outlined here is an elaborated and modified version of that currently published by the Higher Education Funding Councils (HEFCE 2009).

The principal difference is the addition of the planning stages.

This approach is intended to take management and teaching staff through the design cycle, outlining each stage in the process, and linking to supporting tools for data-gathering, analysis and documentation. The approach is based on a simple navigation metaphor.

2.1. Initiate or Review the Course

Training Needs Analysis

An analysis of training needs, identified from a previous analysis, or from a recent Business Needs Analysis is the natural starting point for the review of a course or curriculum. The process establishes the overall aims, curriculum and learning outcomes for the course.

If the Training Needs are uncertain, then an online Questionnaire tool can be used to gather data and experience from different stakeholder groups. The existing course can act as a baseline against which to test current requirements, but an activity-based analysis should also be carried out to scope the full range of likely current requirements, and to ensure that unnecessary components are identified. The supervising staff in the field, and recently trained personnel would be ideal stakeholders for validating the scope of current courses where these have been not been recently updated.

Identifying the training needs at the right level of specificity is crucial to effective learning and assessment. The important point here is that we are never interested simply in learners’ ability to do what we have taught them—we are interested in their ability to generalize beyond what we have taught them to other situations. We teach learners to solve some quadratic equations not because we want them to be able to solve those particular quadratic equations, but because we want them to be able to solve other, different (although usually, not too different), quadratic equations. It is important to distinguish between the context of instruction and the context of generalization. We might teach learners the idea of a “fair test” in science in the context of investigating what combination of cold/warm and moist/dry is preferred by woodlice, but we would test their understanding of the idea of a fair test by seeing if they could devise a fair test in a different context. In this case, the learning intention is that learners are able to design a fair test. The context of instruction is woodlice habitat, but the success criterion might be whether the learner can design a fair test to determine whether the mass or the length of a pendulum has more impact on the period of the pendulum.

The generic requirements identified in the training needs analysis will therefore be used to specify the assessment at the end of the course, as well as the teaching methods that will promote effective learning.

Learner Needs Analysis

The course review should have access to information about the learner population in terms of

- Relevant Qualifications – bar chart showing how many are at what level; if information is uncertain, then a Pre-Test could be used to test level against Pre-Requisites, and generate a Gap Analysis for the Cohort.
- Learner Experience – information about the relevant practical experience already gained; if information is uncertain, then learners could be asked to complete an online Questionnaire outlining which equipment, methods, etc. they have used, to what level of proficiency;
• Learner Characteristics – any cognitive disabilities should be identified to allow for differentiated teaching.

If there is a wide range of learner characteristics, e.g. level of qualification, years of practical experience, or cognitive disabilities, then a differentiated and personalised approach to the teaching provided would be desirable. For learners likely to need a higher level of support, it is possible to identify additional or remedial individual learning resources to supplement the mainstream provision. However, these are the learners least likely to be able to work unsupervised, and additional personal teaching, alongside remedial resources, would be ideal.

Learner tracking software, if provided as part of a VLE that records learner performance, can help to identify learners who may be falling behind, but this will also be picked up through the assessment activities integrated into the learning activities.

Assessment architecture

At the end of each course, a variety of methods should be used to evaluate the extent to which each individual participant has achieved the intended learning outcomes specified by the course. These methods will include both multiple-choice and constructed response formats in order to maximize validity. In addition to these “summative” assessments a variety of methods should be used to provide information to learners and teachers with information about the progress being made during learning activities, operating on a number of nested timescales.

• Hinge-point questions: For each Teaching-Learning Activity (TLA: see below), at least one “hinge-point” will be identified—this is a point in the instructional sequence where a decision needs to be taken about whether the learning is proceeding satisfactorily. In a formal lecture, a “hinge-point” might be 20 minutes into the lecture. At this point, participants will respond to a “hinge-point question”—a single item that assesses the central idea or concept taught up to that point and designed to minimize the likelihood of “false-positives” (learners using an incorrect strategy but reaching a correct answer by chance).

• Exit-pass questions: At the end of each TLA, learners will respond to an “exit-pass question”—a quick probe designed to assess the extent to which the learner has met the intended learning outcomes for the TLA to enable the instructor to decide whether it is necessary to review any of the material in the TLA before progressing on the next TLA.

• Assessment “probes”: Staff will be trained in the development of assessment “probes”: formally assessed episodes embedded in a teaching and learning activity.

• Diagnostic tests: Teaching staff will be supported in the development of diagnostic tests through well-tested protocols such as administering items in constructed-response format to a pilot group of learners, and then using the most common or significant incorrect responses as distractors in presenting the same item in multiple-choice format.

• Interim assessments: at a point somewhere between the mid-point of the module, and three-quarters of the way through the module, learners will undertake a formal, synoptic assessment of the material covered up to that point. In order to limit the workload on teachers, these will not be formally marked. Instead, teaching staff will skim through the responses of the learners in order to identify emerging issues. These will be “vertical”: to identify items that are proving more difficult than expected for the group, and “horizontal”: to identify which learners are falling behind.

• Exams: these should be generated from the learning outcomes defined for the Modules and Course.

Technology architecture

The Course will run in the context of its local technological infrastructure, which should provide instructors with, ideally

• Personal laptop for use in office, classroom, and lab
• Personal access to learning planning and design tools, and digital resources
• Online access to information and data about learners, modules, and scheduling
• Online access to learning object repositories and resources
Online access to other instructors
Online access to learners

It would also provide learners with, ideally

- Personal laptop for use in home, classroom, lab, and working environment
- Personal access to digital tools and resources for learning
- Online access to restricted information and data about learners, modules, and scheduling
- Online access to instructor
- Online access to other learners

Online access to people, data, local scheduling information, and to resources should be provided by the local VLE.

The digital tools and resources to be used on a Module would be selected according to the pedagogic and logistical requirements specified. Criteria for selection are listed in the section ‘Digital technologies for learning and teaching’.

Course requirements

The TNA and course scheduling will be the principal source of information to complete the basic requirements of the course:

- Aims – the Instructor’s intentions
- Topics – the main content topics defining the nature of the course, knowledge and skills
- Learning Outcomes – these are carefully defined descriptions of the level of knowledge and skills learners should be able to demonstrate at the end of the course; they will determine the nature of the summative assessment that will be most appropriate, and the teaching-learning activities needed
- Elapsed time – defined in terms of the start time and end time for a Module, Unit or Session, and important for scheduling the work of learners and teachers. If VLE tracking software is used then deadlines and milestones for completion of assignments will be recorded, which will be useful for planning and checking learner progress.
- Learning Time – for those teaching and learning activities that are not based on classroom contact time (e.g. asynchronous online discussion groups, or individual resource-based learning) it is necessary to defined the amount of time a learner is expected to spend on the work set, within the elapsed time for that session; or a Module that takes place over several weeks of Elapsed Time requires only a few hundred hours of Learning Time. Learning Time is equated to credit hours for accreditation purposes
- Number of learners – the total number of learners will affect the nature of the teaching methods that will be optimal for the cohort
- Staffing – at Module level there will be a Module leader and several Instructors assigned to Sessions; there will be expectations for each Module and Session of the amount of Teacher Preparation time and Teacher Presence that is needed, summing to the total staffing requirement for a Module.
- Scheduling – defined in terms of Elapsed time and Learning Time for each Module and Session; states the deadlines for assignment submission, formative and summative evaluation; takes account of the availability of staffing; if VLE tracking software is used then deadlines and milestones for completion of assignments will be recorded there, which is useful for planning and checking learner progress.
- Pre-requisites – qualifications, knowledge, skills, attitudes, and experience expected of learners entering the course.
- Assessment – standards expected; professional accreditation standards; types of assessment method needed; arrangements for invigilation and identification; standards for marking (blind marking, double marking, etc.); amount of marking needed; plagiarism detection.
Course constraints

There may be special constraints on some courses that affect the categories above, e.g. scheduling requirements for certain groups of learners, accreditation requirements of other bodies that need to be met, or dependencies on other courses or professional environments where changes may affect what is taught within a course. The Course Review process should explicitly consider each of the categories above with respect to any special constraints that may be relevant.

A further constraint may be the characteristics of the learners, which may not match the pre-requisite qualifications and experience.

Course map

By this stage there should be sufficient information for the Course Leader to be able to map the topics for the Course into the set of Modules, to be defined in detail by Module leaders. Main parameters to be decided at this stage are the pre-requisites, learning outcomes/assessment, and scheduling for each Module.

Check alignment

Module leaders would ideally meet, as necessary, as a group to check the alignment of all Modules in the Schedule, in terms of dependencies, pre-requisites, learning outcomes, topics and assessment, as the Modules develop.

2.2. Plan each Module within the Course

The Module Leader will be responsible, in collaboration with colleagues, for drafting and iteratively refining the plan, using the Module design template.

Plan logistics for each Module

For each Module the leader will be responsible, in collaboration with colleagues, for drafting and iteratively refining the plan, using the Module design template (Logistics):

Define logistical parameters

These would be listed in a standard template, to be completed for each Module.

- Module Identifier and name
- Module leader
- Learning Outcomes
- Number of Sessions
- Elapsed Time
- Learning time
- Number of learners
- Staff time allocated
- Staff involved
- Schedule Start and End Dates for the Module
- Learner characteristics (from internal documents, or questionnaire)
- Pre-Requisites (GCSE Maths, grade C?)
- Summative assessment (hours, periods)

Check sequence and alignment across Modules

Check the sequence of Pre-Requisites and Learning Outcomes across Modules, and ensure that each Module builds on previous Modules appropriately, and no Module contains unnecessary Learning Outcomes. This is essentially a content analysis that has to be done by the Instructors. It is not a pedagogical analysis, but does require an awareness of the level of prior understanding needed for the material within a Module, and, the level of understanding expected of learners by the end of the Module. These interdependencies between the Modules need to be agreed, and adjustments made, so that the teaching is coherent and complete across all the Modules.
A flowchart or Gantt chart or Course Map could be used, to show how Learning Outcomes need to build across the Course.

**Define pedagogical parameters**

This stage defines the Aims, Topics, Session Types, Sessions, Learning Outcomes, Assessment, and Learning Approach (see template in Course Re-design Process). These will be derived from the Course information, but customised for each Module.

**Check internal alignment**

Checking internal alignment of Aims, Topics, Session Types, Learning Outcomes, Assessment and Learning Approach is to ensure that the Module plays its intended role in the overall Course. It is a logical analysis; there is no specific pedagogic issue to address other than ensuring that they are coherent.

**Plan Sessions and Session Types for the Module**

For each Session, or group of sessions, the Module Leader assigns an Instructor to be responsible for developing the Session teaching and learning activities in detail. The Module Leader assigns the number of Class hours and summative Assessment hours for each Session, to ensure an initial balance across the Module, and Session Instructors begin with these parameters.

As the design develops, Session designs may feed different requirements back to Module level, allowing iterative design, until the Module Leader has achieved a balanced design across the whole Module. A spreadsheet can be used to help with planning (CompModules.xls).

Planning at Module level will

- Schedule Sessions: start and end times and dates for each Session, deadlines for assignments and assessment.
- Select a mix of Session Types, e.g. Supervised classes, Unsupervised group work; Unsupervised digitally supported individual work; Supervised individual work, etc, each impacting differently on the use of staff and learner time, and the nature of the learning experience.
- Assign Learning Time for each Session, and an outline of the Teaching-Learning Activities to be use, which will be further designed by the Session Instructor.
- Compare alternative planning of TLAs for the Module, especially those that model a shift from conventional to blended methods (see Comparing conventional and digital methods).

**Evaluate Module design**

When the Module Leader has assembled all the Session plans from Instructors, it will be possible to assess the balance of time and resources across the Module. They can evaluate the Module design (e.g. using a spreadsheet tool, CompModules.xls) to determine the optimal design, in terms of likely pedagogical benefit to the learner, and the costs of staff and learning time.

**Evaluate and Review Course Design**

This is to ensure that the Course is designed as well as possible prior to delivery, and learner evaluation. It will be carried out by all Module leaders when all Module plans have been drafted, to ensure alignment of pre-requisites and learning outcomes, balance of staff and learner time, and mix of learning experiences. Course Review should take place annually, involving all Module Leaders.

**Evaluation with learners**

The evaluation data to be collected on the effectiveness of the design should be defined for each Module and Session, making use of VLE data-gathering where available.
2.3. Plan Sessions within a Module

**Plan logistics for each Session**
For each Session the Instructor will be responsible for all the Sessions it contains, in collaboration with any colleagues also teaching on it, for drafting and iteratively refining the plan, using the template for Session design (Course Re-design Process).

**Define Session parameters**
These would be listed in a standard template, completed for every Session or group of sessions, in the light of the overall Module parameters.

- Identifier
- No. of Sessions, or groups of sessions
- Elapsed time
- Learning time
- Number of learners
- Staff time allocated
- Staff involved
- Schedule for sessions and assignments
- Learner Characteristics
- Pre-requisites
- Contribution to Module assessment

**Check sequence across Sessions**
Check sequence of Pre-Requisites and Learning Outcomes across Sessions within the Module, to ensure that each builds on previous ones appropriately, and Topics align with requirements.

**Design the pedagogical parameters**
This stage refines the definitions of Aims, Topics, Learning Approach, Learning Outcomes, and Assessment (see template in Course Re-design Process). These will be derived from the overall Module parameters, but customised for each Session or group of sessions.

**Check internal alignment of Learning Outcomes, Topics, Session Types and Assessment**
This is to ensure that the Session (or group of sessions) plays its intended role in the overall Module (see checklist in Course Re-design Process).

**Plan Teaching-Learning Activities (TLAs) for the Session(s)**
For each Session, or group of sessions, the Instructor responsible develops the TLAs in detail, beginning with the parameters defined in the Module plan.

As the design develops, Session designs may feed different requirements back to Module level, allowing iterative design, until the Instructor has achieved a balanced design across their Session(s). A spreadsheet can be used to help with planning (CompSessions.xls).

Planning at Session level will

- Select a mix of TLAs corresponding to the Session Types selected
- Select new Session Types as necessary to optimise the design
- Assign Learning Times for each Session Type
- Design a sequence of Teaching-Learning Activities (TLAs), e.g. tutor presentation, tutor-led discussion, resource-based group work, etc. appropriate for the intended learning outcome.
- Compare alternative planning of TLAs for the Session, especially those that model a shift from conventional to blended methods (see ‘Comparing conventional and digital methods’).
Develop Tools and Resources needed
Find and adapt appropriate tools and resources for the Session (see sections on Digital technologies and Websites).

Evaluate Session Design
This is to ensure that the Session is designed as well as possible prior to delivery, and learner evaluation. This is the stage at which the design is ready to check against the other Sessions in the Module, to ensure they all remain in alignment. This preliminary evaluation may lead to revisions to any part of the design process above.

2.4. Develop

Manage the design and development process
Each member of staff responsible for development will use the draft Plan for their Module or Unit to develop the detailed designs of how each Session will be taught, the resources to be used, the teaching resource needed, and the draft schedule. There would be support for this process from design tools such as templates, spreadsheet models, and online design tools (especially those available in the VLE).

The instructor/developer will present draft plans and documents for discussion to regular meetings until agreement is achieved. If parts of the Course are to be reconfigured, there could be considerable negotiation of the movement of Topics and Learning Outcomes across Modules.

The documents generated can also be used for communication with the client in early stages of design, to ensure their expectations are being met.

Schedule planning meetings and milestones
Using preferred local methods for planning and scheduling meetings, deliverables, and production milestones, the key stages would be: initial set-up, first draft of documented plans, client draft for negotiation, and final draft.

Most documentation for the design, development and delivery of the Course is likely to use digital tools, such as word processing, spreadsheets, and other online tools. These can easily be shared using a secure online site on the staff intranet, to enable the teaching team to collaborate easily as designs develop. This kind of system, if managed by the Course Leader, will assist the control and management of versions of Course documents, the negotiation of alignment of Topics and Learning Outcomes across the different Modules, and the implications for scheduling.

Agree draft plan for Course, Modules, Sessions
This is the provisional output from the Planning stage, documented as notes of meetings, and as completed checklist, spreadsheet, and scheduling tools.

2.5. Approve

This stage depends on local conditions for approval of Course designs, but is likely to include the documentation for the final drafts of Course, Module, and Unit plans being sent to the approval body.

2.6. Implement

[The detail for this section is highly dependent on local conditions and procedures. The main steps are identified, but this section will need to be completed in collaboration with local staff]
Communicate
Share plans with teaching staff and stakeholders; Respond to any concerns identified…

Resource
Identify resources needed; Ensure resources are available…

Deliver
Carry out teaching and learning, and summative assessment; Collect learner performance data…

Support
Identify learner support needed from formative assessment; Assign support tasks to staff…

Assess
Administer assessment tasks, building in the necessary time for any remedial action needed.

2.7. Evaluate and Review

Once the Course and Modules are running with learners the evaluation can begin collecting data. The main measures that will assist the formative development of the teaching will be: learner performance in coursework; learner performance in summative assessments; time taken by learners and teachers; resources consumed; learners’ attitudes to the teaching and assessment; stakeholder evaluation; instructors’ and Course and Module leaders’ assessments.

Evaluation
The cycle of evaluation can take place at each level: Unit, Module and Course, enabling small-scale and larger-scale modifications to be carried out as appropriate.

Evaluation methods should include

- records of marks for assignments and assessment;
- examiner’s reports on which questions were most difficult, and what kinds of errors were made that should be addressed by the teaching
- online records of learner progress through the materials and any online tests
- online questionnaires for each Session, Module and for the Course overall

Review
Instructors would be responsible for reviewing the data collected, and deciding the changes that can be made within their Sessions.

Module Leaders and the Course Leader respectively, would take responsibility for the final review of Modules and the Course overall, based on the data gathered, and enabling revisions to be made in time for the next run.
3. Levels of Learning Design

3.1. Modules

It is assumed that all Modules are the same type – a mix of classroom, practical, computer-based, and online sessions, mostly Instructor-led, with some coursework set for formative assessment. Summative assessment may need to be considered separately, especially for accreditation purposes, but formative assessment is treated as a form of session type, or teaching-learning activity.

3.2. Sessions

Modules may be broken down into Sessions, or groups of sessions, each of which is organised around a Topic, or sometimes a member of staff, or sometimes a theme of work. A Session may be made up of several different Session Types, e.g. a Session on the Topic of Signals Processing could include a preparatory session of private independent study of a book, followed by a class session with an Instructor, followed by a supervised group practical session, then a test that learners take in their own time by a certain deadline, i.e. four different Session Types, but together constituting all the teaching and learning relating to that Topic.

3.3. Session Types

Session Types are standard descriptions of the different types of teaching carried out, and will be specific to each organisation and discipline area. They are differentiated in terms of their logistical requirements, such as rooms, special equipment, asynchronous online access, class, group or individual learning, as these affect the staff resource needed, the way learners spend their time, and the nature of the learning experience.

<table>
<thead>
<tr>
<th>Session Types</th>
<th>Instructor Contact or Not</th>
<th>Class, Group, or Individual</th>
<th>Conventional or Digital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervised class</td>
<td>T</td>
<td>C</td>
<td>C or D</td>
</tr>
<tr>
<td>Supervised group</td>
<td>T</td>
<td>G</td>
<td>C or D</td>
</tr>
<tr>
<td>Supervised individual</td>
<td>T</td>
<td>I</td>
<td>C or D</td>
</tr>
<tr>
<td>Unsupervised group work</td>
<td>N</td>
<td>G</td>
<td>C or D</td>
</tr>
<tr>
<td>Unsupervised individual work</td>
<td>N</td>
<td>I</td>
<td>C or D</td>
</tr>
<tr>
<td>Summative assessment</td>
<td>T</td>
<td>I</td>
<td>C or D</td>
</tr>
</tbody>
</table>

The Session Types above can be sub-divided into the familiar conventional formats in place in most teaching institutions, such as teacher presentations (e.g. lectures), seminars, project assignments, and these are listed below under Teaching-Learning Activities. They can also be enhanced through the use of digital technologies, either in whole or in part, which can affect the logistical properties of a session, e.g. a supervised class can be conducted using a synchronous online meeting environment, enabling teacher and students to work together at the same time, but
in different places, requiring no classroom provision. Alternatively the session could be conducted asynchronously, requiring the same time from each participant overall, but offering greater flexibility over when they engage. These different types of teaching and learning activity are described under ‘Teaching-Learning Activities’.

## 3.4. Teaching-Learning Activities

### Logistical properties

As with Session Types, Teaching-Learning Activities can be differentiated in terms of their logistical properties.

Location is important, and is defined here in terms of whether the TLA needs a classroom, has Tutor support either synchronously or asynchronously, has digital support of some kind, or is unsupervised, i.e. can study (e.g. at ‘home’). Digitally-supported (D) work means that the teaching-learning activity may be synchronous or asynchronous, i.e. Instructor and learners need to coincide, or can work at any time; it may also refer to digital tools, resources, or environments that are used by learners unsupervised, but which support their learning in some way.

Group size will vary a lot, depending on local circumstances, and will affect both the quality of the learning experience (smaller groups are usually better), and the amount of Instructor time needed (larger groups are usually better for reducing Instructor time).

<table>
<thead>
<tr>
<th>Teaching-Learning Activities</th>
<th>Class, T-supported, D-supported, Unsupervised</th>
<th>Group size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutor presentation</td>
<td>Class, D</td>
<td>20</td>
</tr>
<tr>
<td>Tutor-led discussion</td>
<td>Class</td>
<td>20</td>
</tr>
<tr>
<td>Resource-based supervised individual work</td>
<td>Class, D</td>
<td>20</td>
</tr>
<tr>
<td>Resource-based supervised group work</td>
<td>Class, D</td>
<td>20</td>
</tr>
<tr>
<td>Resource-based unsupervised individual work</td>
<td>U, D</td>
<td>1</td>
</tr>
<tr>
<td>Resource-based unsupervised group work</td>
<td>U, D</td>
<td>2</td>
</tr>
<tr>
<td>Reading and Preparation</td>
<td>U, D</td>
<td>1</td>
</tr>
<tr>
<td>Formative practice, peer-assessed</td>
<td>U, D</td>
<td>1</td>
</tr>
<tr>
<td>Formative practice, tutor-assessed</td>
<td>U, D</td>
<td>1</td>
</tr>
<tr>
<td>Adaptive resource-based individual work</td>
<td>U, D</td>
<td>1</td>
</tr>
<tr>
<td>Adaptive resource-based group work</td>
<td>U, D</td>
<td>2</td>
</tr>
<tr>
<td>Tutored online discussion</td>
<td>T, D</td>
<td>10</td>
</tr>
</tbody>
</table>
### Teaching and Learning (pedagogic) properties

The pedagogic properties of TLAs can be differentiated in many ways. A proposed simplification is offered in the Table below where they are categorised in terms of the nature of the learning they are likely to elicit. Learning through acquisition, inquiry, discussion, experience and production, are all common forms of learning we seek to support in professional development. They are defined here as follows.

#### Acquisition

Learning by listening, reading, watching. The learner needs to actively engage with the presentation, and the Instructor has to encourage their attention and interest by structuring and presenting the ideas and information appropriately. It is the predominant form of learning in a formal context.

#### Inquiry

Learning through inquiry provides the learner with a focus for their inquiry, resources they will need, and a proposed method of working to guide their learning process. It refers to the active learning needed to complement learning through acquisition. The resource may include the Instructor, but would tend to focus on books, papers, reports, and digital resources. The main role of the Instructor is to ensure that the resources needed are available, the focus is well-described, and the process is well-supported, enabling learners to be guided if needed. Working in a library, or with a textbook, are the familiar forms of learning through inquiry; working with online resources, digital libraries and search engines to ensure their understanding.

#### Discussion

Learning through discussion is used for meeting the requirements of the social constructivist approach to learning, which recognises the importance and value of the social aspects of learning. Learners are given a topic, and use the discussion process to practice describing, or articulating their understanding, listening, commenting, and negotiating ideas. The role of the Instructor is to guide the focus of the discussion, to suggest whether it take the form of a debate or a dialogue, and to ensure that learners reflect on what they learned.

#### Experience

Learning through practice, or experience, is essential if theory is to be grounded in practice, or if its application to practice is to be fully understood. Learners will typically be given an exercise to carry out in some task environment, designed to link to the theoretical concepts they have to learn. The role of the Instructor it to ensure that the experience does indeed link to the theory, and that the learner is suitably challenged to connect it to the theory, that they have feedback, either from the environment, or from the Instructor, to enable them to reflect and extend their theoretical understanding, and that they have the chance to revise their actions in the light of feedback in order to improve their practice.

#### Production

Learning through production refers to activities where the learner demonstrates the outcome of their learning, typically by producing something, e.g. an essay, a report, or a design. The process should enable the learner to consolidate what they have learned, perhaps over more than one topic, and linking theory to practice. It should provide a more satisfying output than
simply working through a set of exercises. The process of synthesising their ideas in order to articulate or express what they have learned, should challenge and motivate the learner to reflect on the depth of their understanding, and send them back to the inquiry, experience, or discussion activities if they are uncertain.

The Teaching-Learning Activities listed below are categorised according to the type of learning they are most likely to elicit. These are not hard and fast definitions, as the particular pedagogic experience will depend on how exactly the Instructor designs it, so the table can only be a rough guide. The important aspect of designing learning is that the activities should cover the range of different ways of learning, as this makes it more likely that the learner will succeed in achieving the learning outcomes intended.

<table>
<thead>
<tr>
<th>Teaching-Learning Activities</th>
<th>Learning through:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acquisition</td>
</tr>
<tr>
<td>Tutor presentation</td>
<td>✓</td>
</tr>
<tr>
<td>Tutor-led discussion</td>
<td>✓</td>
</tr>
<tr>
<td>Resource-based supervised individual work</td>
<td>✓</td>
</tr>
<tr>
<td>Resource-based supervised group work</td>
<td>✓</td>
</tr>
<tr>
<td>Resource-based unsupervised individual work</td>
<td>✓</td>
</tr>
<tr>
<td>Resource-based unsupervised group work</td>
<td>✓</td>
</tr>
<tr>
<td>Reading and Preparation</td>
<td>✓</td>
</tr>
<tr>
<td>Formative practice, peer-assessed</td>
<td>✓</td>
</tr>
<tr>
<td>Formative practice, tutor-assessed</td>
<td></td>
</tr>
<tr>
<td>Adaptive resource-based individual work</td>
<td></td>
</tr>
<tr>
<td>Adaptive resource-based group work</td>
<td></td>
</tr>
<tr>
<td>Tutored online discussion</td>
<td>✓</td>
</tr>
<tr>
<td>Student online discussion</td>
<td></td>
</tr>
</tbody>
</table>
Formative practice,  
computer-assessed  

<table>
<thead>
<tr>
<th></th>
<th>✓</th>
<th>✓</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summative assessment</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

These pedagogic and logistical properties of the different activities are used in the Comparative Modelling tool (CompSessions.xls) to assist in evaluating the likely benefits of the way a Session has been designed.

### 3.5. Formative assessment

A further set of Teaching-Learning Activities are those that run as formative assessment methods. They are classed as Teaching-learning Activities (TLAs) rather than with Summative Assessment because they are essentially methods of learning, whose primary task is teaching rather than testing. Black and Wiliam (2009) conceptualise formative assessment in terms of five key strategies:

1. engineering effective classroom discussion, questions, and learning tasks that elicit evidence of learning;
2. providing feedback that moves learners forward;
3. clarifying and sharing learning intentions and criteria for success;
4. activating students as owners of their own learning; and
5. activating students as instructional resources for one another.

The first three apply to tutor-led formative assessment, and can be applied to classroom interactions as well as market assignments, tutorial supervisions, and online Instructor-learner discussions. The last two can be applied in both conventional and technology-based methods as aspects of peer assessment (Black and Wiliam 2009). We can also add ‘computer-assessed’ methods, without involvement from either Instructor or peers, and these are covered in the section on comparing conventional and digital methods.

**Formative assessment, tutor-assessed**

Supervised class sessions can incorporate formative assessments in several ways, both to assist the learner in checking how well they are understanding, and also to provide feedback to the teacher, enabling them to adjust their teaching to learners’ apparent needs.

- **Hinge-point questions**: For each Teaching-Learning Activity at least one “hinge-point” should be identified—this is a point in the instructional sequence where a decision needs to be taken about whether the learning is proceeding satisfactorily. In a formal lecture, a “hinge-point” might be 20 minutes into the lecture. At this point, participants would respond to a “hinge-point question”—a single item that assesses the central idea or concept taught up to that point and designed to minimize the likelihood of “false-positives” (learners using an incorrect strategy but reaching a correct answer by chance).
- **Exit-pass questions**: At the end of each TLA, learners could be asked to respond to an “exit-pass question”—a quick probe designed to assess the extent to which the learner has met the intended learning outcomes for the TLA to enable the instructor to decide whether it is necessary to review any of the material in the TLA before progressing on the next TLA.
- **Assessment “probes”**: These are formally assessed episodes embedded in a teaching and learning activity.
- **Diagnostic tests**: These should be designed according to well-tested protocols, e.g. items are administered in constructed-response format to a pilot group of learners; then, using the most common or significant incorrect responses as distractors, the same items can be presented in multiple-choice format.
Formative assignment, peer-assessed

For complex conceptual work in engineering and mathematics, learners need to work at their own pace. Large classes make this difficult, but a combination of Instructor presentation, resource-based individual work, and formative assessment makes self-paced learning feasible. The method is sometimes referred to as the ‘Keller Plan’ (Gibbs and Jenkins 1992). In a one-hour class, the Instructor may present for 20 minutes, then set a 10-30 minute practice task, with learners using a study guide or book, with a short test (say 2-3 questions). When the first learner has finished the test they take it for marking to the Instructor, and if they have a good understanding, they also become a ‘tutor’ who can mark other learners’ work, or help them if they need it. After 30 minutes, all learners should either have become tutors or had their work assessed, or had help from a tutor. The final 10 minutes can either act as a buffer if more time is needed, or be used by the Instructor for debriefing, further input, or class discussion.

Summary

This section has shown some of the ways in which assessment can be built into the learning sequence, in addition to the summative assessment carried out at the end of each Module, in line with design principle 4. Formative assessment should dominate the time spent on assessment, as this provides more value for the learner.

Summative assessment should take up no more than 5% of total learning time, unless there are special conditions. To ensure the full value of summative assessment it is essential that test questions should be generated from the learning outcomes defined for the Modules and Course, and should test how well an individual can perform the actual job of a maintainer at sea rather than testing academic knowledge in isolation.

4. Learning Approaches

Each learning approach outlined here prioritises different roles for teachers and learners. The definitions of pedagogic characteristics define them in terms of the key activities undertaken by teachers and learners. Advantages and disadvantages for each type of approach are listed. It follows that a mix of learning approaches is the best option for most Courses.

In all cases, learning technologies offer the logistical advantages of flexible time and place, and continual access to digital materials or captured discussions.

4.1. Didactic Instruction

Didactic instruction is also referred to as ‘instructivism’ or ‘instructionism’. Learners learn through listening, watching and reading, i.e. learning through acquisition of knowledge and concepts.

Pedagogic characteristics

Teacher-defined goals and topics; knowledge and concepts are presented to class through talking, or through reading, or through demonstrations; exercises set for learners to practice using the concepts or develop the skills; feedback is from the teacher.

Advantages

It exposes learners to what there is to know and understand.

The teacher can demonstrate the relevance of the knowledge and skills being learned.

The teacher models the optimal way to think about and apply the knowledge.

Disadvantages

Learners must follow the teacher’s narrative, with little opportunity to ask all the questions they may need to ask.
The teacher is responsible for providing all the feedback and guidance, making the learner less inclined to think for themselves.

4.2. Problem-based Learning

Problem-based learning is similar to inquiry-based learning, or scenario-based training, in the sense that the learner is focused on solving a problem, or finding out something specific. It is linked to learning through inquiry, though is also usually focused on producing an output, as in learning through production.

**Pedagogic characteristics**

Teacher-defined goal to develop the skills of inquiry or problem-solving; the knowledge and concepts being learned need to be used, but may not be taught explicitly, and must be accessed, selected, and applied by the learner; learners may work individually but often work in pairs or groups. In the latter case this is similar to ‘collaborative learning’.

**Advantages**

It makes theory and abstract concepts meaningful by applying them in practice.

It enables learners to develop new knowledge for themselves in the absence of a teacher.

Learners can practice using their theoretical knowledge to find a solution, or find a result.

It can be used to prepare learners for complex material, by getting them to think through the problem for themselves, discover the difficulties, and therefore be ready and interested to be told how to overcome them, even if the concept or theory is complex.

**Disadvantages**

It is be time-consuming for learners to carry out, so must be tailored to fit the value of what they are likely to learn.

Learners may not approach the problem efficiently, and may need guidance throughout the process as they learn the ways of thinking and practising involved.

4.3. Social learning

Social learning is also referred to as ‘social constructivism’. It is important because it emphasises the social character of learning – that in order to comprehend someone else’s idea (such as a theory, or formalism, or formal representation) it is important for the learner to articulate and exchange their own conceptualisation of it, as this requires and motivates the construction of the concept. It is therefore closely associated with learning through discussion. The social process itself motivates this iterative construction of the idea through argument and discussion.

**Pedagogic characteristics**

The goal is for learners to achieve mutual understanding through discussion of a teacher-defined topic; learners articulate and challenge each others’ ideas, and thereby develop their own concepts more clearly; feedback is from peers; the amount of guidance from the teacher is relatively undefined, though in practice usually necessary.

**Advantages**

It enables learners to practice talking about the ideas involved, which in itself can reveal to them where their understanding is poor.

Hearing other learners articulate their ideas on the topic can help to elaborate their own understanding.
**Disadvantages**

Learners can lead each other astray through mutual convergence on a shared misconception, making it important that the teacher is able to monitor the process.

**4.4. Experiential Learning**

Experiential learning is similar to situated learning, learning through practice, and constructionism. It is designed to locate conceptual learning in the learner’s experience, enabling them to make the appropriate links between theory and practice. It is therefore closely associated with learning through *practice*.

**Pedagogic characteristics**

Teacher-defined goal to achieve an output, where the task practice environment is designed to reveal the knowledge and concepts to be learned; feedback is given by the environment in relation to the extent to which learners’ actions achieved the intended goal.

**Advantages**

It makes the theory and conceptual knowledge being learned more meaningful, as it has the effect of explaining previous experience, or instantiating ideas in current experience.

If the task practice environment is well designed, and gives clear feedback on their actions, the learner will see the result of incorrect actions or practice in a way that is meaningful, and suggests what they should do to improve their actions. Being able to self-regulate and correct their own work is in itself rewarding.

**Disadvantages**

Setting up a good practice environment can be complex or even risky, depending on the nature of the knowledge and skills being learned.

It is be time-consuming for teachers to design, and learners to carry out, so must be tailored to fit the value of what they are likely to learn.

**4.5. Collaborative Learning**

Collaborative learning combines social learning with experiential learning or inquiry-based learning in the sense that learners work together in pairs or small groups to produce an output of some kind. It could be something as extensive as a report, or as specific as a problem-solution, or an explanation. Its value is that it combines the value of all the other approaches. It is therefore closely associated with learning through *production*.

**Pedagogic characteristics**

Teacher-defined goal to achieve a collective output through learners working together, discussing and challenging each others’ ideas and products in the process; feedback is partly in the form of the apparent success of the output in achieving the goal, and also from the teacher’s evaluation of its quality and the process the learners undertook.

**Advantages**

It has the same advantages as the other approaches, with the additional one that it gives learners experience and practice in team working.

**Disadvantages**

It has the same disadvantages as the other approaches, with the additional one that if the team does not work well together individual learners are disadvantaged.
5. Comparing conventional and digital methods

5.1. Alternative teaching methods

Approaches to teaching and learning have been classified as either acquisition-oriented or participation-oriented, and both types play important complementary roles in education: using only one of them diminishes the value of the learning experience (Sfard 1988). The majority of teaching in formal education has historically been acquisition-oriented, so to ensure a better balance it is useful to plan for a combination of teaching methods that include those that are participation-oriented. Participation-oriented methods can be further sub-divided into learning through inquiry, discussion, practice, and production, as in section 3.4. Examples of the range of teaching methods to be considered can be structured as in Table 1.

<table>
<thead>
<tr>
<th>Learning through</th>
<th>Teaching through</th>
<th>Value to learner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition</td>
<td>Lecture, presentation</td>
<td>Access to new ideas and concepts, enabling inquiry, discussion, practice and production</td>
</tr>
<tr>
<td>Inquiry</td>
<td>Case study, tutorial, guided investigation, library resources</td>
<td>They are focused on a goal or question which motivates their use of the resources provided</td>
</tr>
<tr>
<td>Discussion</td>
<td>Class discussion, small group discussion</td>
<td>The learner is motivated to articulate their understanding, defend it in light of questions, and create challenges to others</td>
</tr>
<tr>
<td>Practice</td>
<td>Exercises, practicals, labs, simulations</td>
<td>The learner is challenged by the task goal set to use their conceptual understanding to achieve the goal, with feedback providing the motivation to improve their performance</td>
</tr>
<tr>
<td>Production</td>
<td>Essay, report, problem solution, design, quiz, exam</td>
<td>The requirement to produce a product of their learning motivates further inquiry, discussion with others, and repeated practice.</td>
</tr>
</tbody>
</table>

Table 1: A classification of teaching methods in terms of their principal value to learners

Combinations of these types of learning are also prevalent in the education literature, particularly 'project-based learning', which sets up a team to investigate a question or issue, combining inquiry learning with discussion learning; and 'collaborative learning', where students work together to achieve a goal, combining learning through discussion, practice and production. The purpose of such a classification is simply to provide a check on whether there is a reasonable balance of different types of learning within a module, to ensure that learners are both motivated and enabled to learn.

Teaching methods can also be thought of in terms of the degree of personalisation, social learning, and standard learning they offer:

- Personalised learning – means better use of learner time, immediate and personal feedback on their performance, self-paced learning, choice of topic, which tends to be labour intensive for the teacher

- Social learning – means engagement with other learners, creating a sense of community participation and professional acculturation, each assisting the other, which helps to reduce pressure on teacher time
Standardised learning – means that every learner receives the same experience, which may be less good use of learner time, but is efficient in terms of the use of teacher time.

However, these definitions depend as much on the size of the learner group, and the way teacher time is used, as on the teaching method itself. A lecture presentation to a group of 10, which allows a lot of Q&A time offers more ‘social learning’ than one to a group of 100, where students spend most of the time listening, even if questions are allowed, so the latter is more ‘standardised’ for all students. Class exercises can offer ‘personalised learning’ if the teacher can spend time with each student who needs help, but not if the class is too large, or there is too little time allotted.

Conventional courses typically make extensive use of learning through acquisition in the form of lecture presentations, practice in the form of class exercises and labs, and production in the form of exams. An approach to an alternative course design would consider how these methods could be optimised to

- ensure they are as personalised and social as possible,
- support more formative assessment and independent learning, and
- improve the balance of the learning experience by introducing more inquiry and discussion learning.

5.1. Alternative teaching methods

The Teaching-Learning Activities above can be sub-divided into the familiar conventional formats in place in most teaching institutions, such as lectures, seminars, workshops, etc. They can also be enhanced through the use of digital technologies, either in whole or in part, and these formats are defined here, and in the section on Formative assessment.

**Online supervised discussion**

Learners are divided into groups of up to 20 to discuss a topic or section of the course. The size of the group will affect the number of groups the Instructor has to ‘visit’. An active learner group may need to be split into smaller groups to ensure that there is not too much for the learners to read, and it is a genuine discussion. On the other hand, if the group is not highly active, then 20 can be sufficient to keep it going.

All learners would need access to an online environment that supports them in exchanging ideas, questions, comments, issues, opinions, and explanations.

The role of the Instructor can be crucial in moderating the work of the group – to introduce the topic, to keep them on task, to guide their discussion, and to correct any misconceptions that arise (Salmon 2003).

**Online student discussion**

Once learners have become acculturated to working and supporting each other online, they are able to have productive discussions without Instructor intervention. However, it is still valuable for the Instructor to manage the process, and enable learners to check ideas or information with them. One technique is to direct learners to discuss among themselves, online, in small groups, but to post to a common course site the questions they have that arise and they want answers to. This enables the Instructor offer answers that benefit all groups, but also to minimise the amount of time they have to check through learner discussions. It puts on the learners the responsibility of knowing when they need help (Salmon 2002).

**Online collaborative project**

Learners are divided into groups of, say, 5, to discuss a topic or section of the course. The size of the group should reflect the typical size of teams in the related professional environment, as a major benefit of this Session Type is the opportunity to practice team-working. The role of the Instructor here is to propose the structure of the way learners should work: specifying the Learning
Outcomes, the goal of the project, what they should expect to produce and submit to the instructor, how long they have to do it, what kinds of activities they should undertake.

The online environment used for this should enable learners not only to discuss their work, but also to share their outputs. The aim should be to produce something (e.g. a report, a design, a solution, an analysis, a powerpoint presentation, a website, or even just an agreed explanation of a phenomenon or concept). It follows that the learners should be able to create and exchange their drafts within the online environment. The process should run in a similar way to a class-based collaborative project, but taking advantage of the online environment (such as GoogleDocs) to record and track their work.

**Adaptive resource-based individual work**

An interactive and adaptive program or digital tool can offer a highly supportive session type for the learner studying alone. This is because the computer can respond immediately to their input. There are many such resources available in learning object repositories (see Section 6), although they are of varying quality. It is expensive and time-consuming to develop these digital materials, so it is very important to begin by reusing and adapting existing resources. If the Instructor is working either in the classroom, or online with learners, it is possible to guide their use of a digital resource, in the same way as they do with a textbook – it may not be perfectly designed for the course, but can still be of value.

**5.2. Alternative assessment methods**

In line with the fourth design principle, assessment should be integrated into the teaching and learning activities of the course as well as being used at the end to test the extent to which the material has been mastered.

At the end of each course, a variety of methods should be used to evaluate the extent to which each individual participant has achieved the intended learning outcomes specified by the course. These methods will include both multiple-choice and constructed response formats in order to maximize validity. Exam questions should be generated from the learning outcomes defined for the Modules and Course, and should test how well an individual can perform the actual job of a maintainer at sea rather than testing academic knowledge in isolation.

In addition to these ‘summative’ assessments a variety of methods should be used to provide learners and teachers with information about the progress being made during learning activities.

**Formative assessment, computer-assessed**

Using the protocol mentioned above (administer items as constructed response to a pilot group, and then use the common or significant responses as distractors) a bank of multiple-choice tests related to particular course content can be built up quickly. Once developed, these can be scored rapidly using scanning software and hardware, such as GradeCam.

E-assessment, where the computer delivers and marks the assessment, is now widespread in HE and FE, for summative as well as formative assessment, and there are many tools now available to support instructors in creating online multiple choice tests, which can help learners test their own understanding and readiness for summative assessment (JISC 2007).

**Formative assessment, peer-assessed**

Since peer assessment takes the form of students marking and commenting on each others’ work against a given set of marking criteria, this can be handled effectively through online methods of communication. It serves the same purpose of alerting students to alternative ways of working, and motivating more careful working. When the exchange of outputs and comments is asynchronous, learners have time to focus and reflect on their comments. Some teachers also require contributions of this type as part of the assessment for a course. As this is intended to be a formative process, the quality of comments would not form part of the summative assessment of the learner.
5.3. Conventional and digital teaching and assessment methods

A blended approach to teaching and learning will look for ways of improving quality and efficiency by replacing some of the conventional methods with digital methods. The reasons for attempting this are that digital methods

- can improve the degree of personalisation
- introduce more active learning
- support online discussion and collaboration for social and flexible learning
- amortise the cost of developing instruction across larger student numbers.

The last reason is not relevant in a context where there is no expectation of increasing student numbers. This makes it difficult to achieve efficiency gains from the introduction of new technology, as there is an inevitable increase in staff workload in the innovation required. However, this can be offset by more use of interactive programs and formative assessment to support personalised learning, and online discussion to support social learning where learners are able to help each other. More use of active learning should also improve the quality and level of the learning outcome.

A conventional format for class-based teaching is shown in Table 2, where 4 periods are used for a combination of presentation, individual work, and some group work. This is based on what might be done for a unit on theory needed for practical applications of some kind.

<table>
<thead>
<tr>
<th>Session Planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching and Learning Activities</td>
</tr>
<tr>
<td>Tutor presentation</td>
</tr>
<tr>
<td>Class-based individual work</td>
</tr>
<tr>
<td>Tutor-led discussion</td>
</tr>
<tr>
<td>Tutor presentation</td>
</tr>
<tr>
<td>Class-based individual work</td>
</tr>
<tr>
<td>Tutor-led discussion</td>
</tr>
<tr>
<td>Tutor presentation</td>
</tr>
<tr>
<td>Class-based group work</td>
</tr>
<tr>
<td>Tutor-led discussion</td>
</tr>
<tr>
<td>Tutor presentation</td>
</tr>
<tr>
<td>Tutor-led discussion</td>
</tr>
<tr>
<td>Formative practice, tutor-assessed</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Table 2: Conventional classroom teaching over 4 periods

An alternative approach might be to make use of interactive digital resources, and an online discussion forum, which enables learners to work independently, supported by the feedback from the interactive program, and by discussion with their peers. This is shown in Table 3.
## Session planning

<table>
<thead>
<tr>
<th>Teaching and Learning Activities</th>
<th>Time (mins)</th>
<th>Resources</th>
<th>Teaching plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptive resource-based individual work</td>
<td>15</td>
<td>Online interactive resource</td>
<td>Study guide: Sets the goal for learners to achieve, using the resource; discuss answers online.</td>
</tr>
<tr>
<td>Student online discussion</td>
<td>15</td>
<td>VLE</td>
<td>Students discuss and help each other online</td>
</tr>
<tr>
<td>Adaptive resource-based individual work</td>
<td>15</td>
<td>Same online resource</td>
<td>Study guide: Return to tutorial resource. Sets further goal.</td>
</tr>
<tr>
<td>Student online discussion</td>
<td>15</td>
<td>VLE</td>
<td>Students asked to discuss their findings and agree questions to ask in class</td>
</tr>
<tr>
<td>Tutor-led discussion</td>
<td>15</td>
<td>Slides</td>
<td>Discuss questions and present application to interpreting the behaviour of a practical system</td>
</tr>
<tr>
<td>Classroom-based individual work</td>
<td>15</td>
<td>Handout</td>
<td>Students work through exercise</td>
</tr>
<tr>
<td>Formative practice, peer-assessed</td>
<td>15</td>
<td>Test paper</td>
<td>Students take test, get it marked, mark others' tests</td>
</tr>
<tr>
<td>Tutor-led discussion</td>
<td>15</td>
<td>Slides</td>
<td>Q&amp;A to consolidate theory</td>
</tr>
<tr>
<td>Tutor presentation</td>
<td>15</td>
<td>Slides</td>
<td>Presentation of next stage of theory</td>
</tr>
<tr>
<td>Classroom-based individual work</td>
<td>15</td>
<td>Handout</td>
<td>Students work through exercise</td>
</tr>
<tr>
<td>Formative practice, peer-assessed</td>
<td>15</td>
<td>Test paper</td>
<td>Students take test, get it marked, mark others' tests</td>
</tr>
<tr>
<td>Tutor-led discussion</td>
<td>15</td>
<td>Slides</td>
<td>Q&amp;A to consolidate theory</td>
</tr>
<tr>
<td>Formative practice, computer-assessed</td>
<td>30</td>
<td>Online tutorial program</td>
<td>Work on online tutorial and test</td>
</tr>
<tr>
<td>Student online discussion</td>
<td>15</td>
<td>VLE</td>
<td>Students asked to discuss and help each other prior to test</td>
</tr>
<tr>
<td>Formative practice, tutor-assessed</td>
<td>15</td>
<td>Online test</td>
<td>Test to submit for marking</td>
</tr>
</tbody>
</table>

**Total** 240

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### Table 3: Blended teaching over 4 periods

The blended model has planned for the same amount of learning time, but with the first and last periods running as digitally-supported individual and group work. The introduction of learning technologies achieves several different kinds of benefits:

- There is less reliance on the teacher to supervise the trainees’ work, but they are kept active and supported by the motivating qualities of an interactive program, and by the support from other students in a structured discussion environment.
The online test can be computer-assessed, and as such may be able to generate new tests, so that if a trainee does poorly they can revise and retake until they score better. This offers personalised support to the learner, to ensure they remain motivated to do the test, even if they are not in a supervised class.

The value of the online discussion forum is that trainees can learn from each other, and for those who offer help, the task of explaining to another is of value as a learning experience in itself.

For each teaching method used, it is possible to estimate the proportion of learning through acquisition, inquiry, discussion, practice and production. These can be entered as parameters in a spreadsheet model (CompSessions.xls), which can then calculate the relative proportions of how students spend their time in these two models. Figure 1 shows the comparison between them.

Figure 1: Comparison of the learning experience for the teaching plans in Tables 2 and 3

The blended learning plan elicits much more active learning because of the amount of time spent on learning from the interactive resource, and from practice exercises in class. The two plans can also be evaluated in terms of the degree of personalisation and social learning they support, as shown in Figure 2.

Figure 2: Comparison of the degree of personalisation and social learning offered by the teaching plans in Tables 2 and 3

By assigning estimates of teacher preparation and presentation time to each of the teaching methods used in the two plans, it is also possible to compare the teacher time needed, as well as the time learners spend in class. These are shown in the Table below.
Table 4: Comparative time for the two models

These figures are based on assumptions about how much teacher time it takes to prepare materials, and also assume that existing interactive resources are being used, so that no resource development time is included, only the time needed for researching and finding it.

The modelling tool from which this data is generated is customisable by instructors for the conditions of each Module on the course. The saving in staff time here is achieved by making use of existing resources, and by using the motivating qualities of online discussion groups and interactive programs to support the trainees in non-classroom study. The actual savings in terms of staff time will depend on careful planning of the changes to teaching methods, on whether suitable online resources can be found for a topic, on whether trainees are able to work independently, and on whether they have access to online resources.

It is also possible to model the changing costs over time of the conversion to greater use of digital technologies, to allow for some staff preparation of digital resources in the first year (such as online quizzes, conversion of slides to online interactive tutorials, etc.), where this investment can be amortised over later years, with the same material being re-used with very little staff time required for updating, and less time for presence in the classroom. An example of this type of modelling is shown in Table 5, for an IOE course, which demonstrates that staff costs can be high in the first year as resources are developed for the first time (there will be more for a wholly online distance learning course than for a blended course, which is only partly online). In the second year there are likely to be revisions, while by the third year it should have settled into running with only minor updating, at a lower cost in staff time. Of course when student numbers can increase once the course is running, the unit cost can fall much further, but this is unlikely to be the case for the RN context, unless there are materials that can be used in several different courses.

<table>
<thead>
<tr>
<th></th>
<th>Initial run</th>
<th>Second run</th>
<th>Nth run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Student hrs</td>
<td>Break-even fee</td>
<td>Student hrs</td>
</tr>
<tr>
<td></td>
<td>Teacher days</td>
<td></td>
<td>Teacher days</td>
</tr>
<tr>
<td>Staff cost per day</td>
<td>£300</td>
<td></td>
<td>£300</td>
</tr>
<tr>
<td>ASSIGN Student numbers</td>
<td>15</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Model 1: Conventional methods</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learner time</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Teacher time</td>
<td>47.3 (£947)</td>
<td>31.4 (£628)</td>
<td>27.69 (£554)</td>
</tr>
<tr>
<td>Model 2: Blended learning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learner time</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Teacher time</td>
<td>55 (£1,104)</td>
<td>22 (£437)</td>
<td>16 (£327)</td>
</tr>
<tr>
<td>Model 3: Distance learning</td>
<td>300</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Learner time</td>
<td>300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher time</td>
<td>58</td>
<td>£1,164</td>
<td>21</td>
</tr>
</tbody>
</table>

**Table 5: Reducing annual costs of innovation over time, for different models**

The relatively high stable-state cost of the conventional model is due to the teacher’s presence in classes, while the relatively low cost of the distance (wholly online) model is due to the relatively high proportion of fixed costs of materials that can be reused. It is the development of these online materials in the first year that causes the high initial cost. These figures are only indicative of the relative costs, as local institutional contexts will determine absolute costs.

### 5.4. Summary of implications

From this section we can conclude that there are five main ways to provide a more efficient learning experience for trainees:

- reduce the curriculum through careful analysis of what is actually needed for the user requirements;
- once the curriculum is determined, restructure the sequence of learning outcomes to locate underpinning theory with the relevant applications, to improve meaningfulness and retention of the concepts and skills;
- introduce more inquiry-based and discussion-based learning to foster independent learning, and to build a professional learning community among trainees where they can all benefit from helping each other;
- change the balance of assessment periods to include more formative assessment, tutor, peer, and computer-assessed
- convert some of the classroom-based sessions to online collaborative learning, and to computer-supported individual learning, to increase the personalised and social learning, and better address learners’ individual needs.

The implications for staff suggest a reduced workload, once the conversion to a leaner and fitter course has been completed. This may enable them to offer more personalised support for individuals who have particular difficulty, or to develop new courses to support new user requirements.

### 6. Digital technologies for learning and teaching

This section lists the Tools and Resources that can be used to support all levels of learning and teaching in a Course, Module, or Session.

#### Lecturer’s resources

Notes, Powerpoints, Handouts, Guides, FAQs, Blog

#### Message systems

SMS, Twitter, Email

#### Discussion environments

Webinar, Chat room, Skype, Discussion board, Discussion forums, Webinars

#### Physical resources

Specialised equipment, Books, Articles, Reports, Reference works, Computers,, Interactive whiteboard, Handhelds, mobile devices, Cameras

#### Places

Libraries, Museums, Collections, Field sites
**Digital resources**
Powerpoint, Podcast, Multimedia resources, Virtual environment, Digital library, E-books, Learning Objects repository, Assessment Bank, Websites, Newsfeeds, Writing tools

**Adaptive digital resources**
Single-player/ Multiplayer game, Simulation, Modelling tool, Tutoring program

**Digital tools**
Statistical analysis, Data analysis, Spreadsheet, Search engine, Remote instrumentation, Dialogue tools, Audience Response Systems, Survey tool, Citation tools,

**Collaboration environments**
Online whiteboard, Wiki, GoogleDocs, Social bookmarking, Collaborative writing tools, Argumentation visualisation tools, E-tivities, Jigsaw groups, Google jockeying, WebQuests, Digital storytelling

**Computer-based assessment tools**
Quizzes, MCQs, Audience response systems, Essay analysis tool

**Design tools**
Presentation tools, Authoring tools, Multimedia presentation, Blog, E-Portfolio, Website creation tools, Concept- mapping tools
7. Websites for teaching and learning resources and tools

The following websites are a selection of those most commonly used in further and higher education courses in the UK.

Higher Education Academy, Engineering Subject Centre:
http://www.engsc.ac.uk/er/engmath/index.asp; http://www.tech.plym.ac.uk/maths/resources/PDFLaTeX/mathaid.html

The International Journal of Engineering Education link to online resources:
http://www.ijee.dit.ie/interact.html

JORUM Engineering: http://open.jorum.ac.uk/xmlui/handle/123456789/32

MERLOT: http://engineering.merlot.org/


OpenLearn: http://openlearn.open.ac.uk/

Amazon books: http://www.amazon.co.uk/

Google
Glossary

7.1. General

Cohort
The group of learners studying together, and being assessed together, over a period of time

Learning Approach
The general pedagogic approach for a Unit of Learning, using terms derived from best professional practice, and from the educational literature

7.2. Levels of Design

Course
A Course contains several Modules
Elapsed time is months/weeks

Module
A Module contains several Sessions, or groups of sessions
Elapsed time is weeks/days

Session
A Session contains one or more Teaching-Learning Activity Types
Elapsed time is days/hours

Teaching-Learning Activity Sequence
A Teaching-Learning Activity Sequence is designed to achieve a specified Learning Outcome, and contains several Teaching-Learning Activities
Elapsed time is hours/minutes

Tools and Resources
Physical and digital tools and resources needed for a learning activity (see Section 6).
Elapsed time may be the same as learning time, depending on how the tool or resource is used. A book will be available for the elapsed time of a whole module, while parts of it will be used for a specified duration of learning time by learners working on a particular Activity.

7.3. Time concepts

Elapsed Time
The Start Date and Time, and End Date and Time for a Unit of Learning

Learning Time
The time a learner spends learning in some way, whether this is in class, online, or elsewhere
References

HEFCE. (2009). Managing Curriculum Change: Transforming curriculum design and delivery through technology. JISC.