

Constructive alignment of a research-informed teaching activity within an undergraduate diagnostic radiography curriculum: A reflection

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Abstract:

Aim: To evaluate the learning experience of a level 5 (year 2) student cohort within a research-informed teaching (RiT) activity and to map findings against learning outcomes and level descriptors using constructive alignment.

Method: An online questionnaire was used to explore the level 5 student experience of a Research-informed Teaching (RiT) activity. Responses were retrospectively mapped against Framework for Higher Education Qualifications (FHEQ) level descriptors for level 5 using constructive alignment.

Results and Discussion: Thirty one out of 46 level 5 students completed the questionnaire (67% response rate). Analysis of the questionnaire supported the integration of this RiT activity within the curriculum in terms of learning and research skill development by students. However, it was identified that this activity could be revised further to better align with level 5 descriptors and incorporate more higher level cognitive processes.

Conclusion: Learning outcomes for this RiT activity were constructively aligned with FHEQ level 5 descriptors. Recommendations are provided on how these could be further refined to ensure students undertake a more critical approach to the application of theory into practice. Discussion also considers how this process could be used to develop a similar RiT activity at level 6 (year 3).

Highlights

- The use of constructive alignment helped to ensure that the learning outcomes were appropriately aligned with level 5 descriptors for this research-informed teaching (RiT) activity.
- Reflection also identified outcomes that required further improvement to focus on higher-order thinking and application skills.
- This article also illustrates how this process could be used to develop a level 6 RiT activity that builds upon the learning gained at levels 4 and 5.

**Constructive alignment of a research-informed teaching activity within
an undergraduate diagnostic radiography curriculum: A reflection**

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Introduction and background

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3 Research-informed Teaching (RiT) has been shown to develop student research
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5 and communication skills as well as enhancing knowledge and understanding [1]. In
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7 2009, the BSc (Hons) Diagnostic Radiography programme team at the University of
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9 Salford, United Kingdom (UK) introduced a level 4 (year 1) Research-informed
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11 Teaching (RiT) activity within the undergraduate diagnostic radiography curriculum to
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13 engage students with research, as part of their normal teaching and learning experience.
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15 The Research-informed Teaching experience I (RiTe I) was designed to facilitate level
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17 4 student understanding of key radiographic concepts using an inquiry-based approach
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19 to learning and provided students with the opportunity to be involved with research
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21 linked with one of the department's main research foci (image quality and dose
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23 optimisation) [2-4]. Following the successful integration of RiTe I into the year 1
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25 curriculum, a similar RiT activity was introduced into the level 5 (year 2) curriculum
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27 (RiTe II). RiTe II directly builds upon the foundations of the student's knowledge and
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29 research skills obtained at level 4, as well as providing students with further learning
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31 and skill development opportunities appropriate to their level of study. The following
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33 reflective report illustrates the value of using constructive alignment to critically
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35 evaluate level descriptors and learning outcomes for a level 5 RiT activity (RiTe II);
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37 because this evaluation takes a reflective approach the pronoun 'we' is therefore used
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39 where appropriate.
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52 In the UK and Ireland, each stage within any framework of qualifications is
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54 commonly referred to as a 'level'. These levels represent bands of qualifications that
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56 share similar expectations of attainment. The framework for higher education
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58 qualifications (FHEQ) has five levels, three of which are undergraduate (4-6) and two
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are postgraduate (7-8). The learning outcomes for RiTe I were designed to meet the FHEQ level descriptors for level 4 set by the Quality Assurance Agency for Higher Education (QAA) [5]. Subsequent evaluations of RiTe I have confirmed the success of this activity [2-4]. However, in designing RiTe II we took a more pragmatic approach. Whilst we compiled a set of learning outcomes based on our own expectations of what we anticipated the students to achieve, we did not undertake a formal mapping process in matching these to level 5 descriptors, as RiTe II was considered to be a curriculum enrichment activity. Whilst it is acknowledged that there should be alignment between learning outcomes, delivery and assessment [6], we decided that because RiTe II had no summative assessment there was no requirement to provide learning outcomes from an institutional documentation perspective. Furthermore, because there was no summative assessment for RiTe II, we had no method of determining whether the learning outcomes had actually been achieved.

Level descriptors

The QAA in the UK uses qualification level descriptors to provide a point of reference for the setting and assessing of academic standards in higher education. These threshold standards are used to develop programme learning outcomes to appropriate levels and content [7]. Level descriptors can therefore be considered to be generic outcome statements of what a learner is expected to have achieved at the end of a level of learning and were developed as a guide to the writing of learning outcomes for modules to ensure that these subscribe to a particular higher education level, a process that is essential for functioning within a credit framework [8].

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Level descriptors are presented in two parts, with the first part being a statement of outcomes (achievement of which is assessed) which a student should be able to demonstrate for the award of the qualification at that level. The second part of the descriptor is a statement of the wider abilities that a typical student would be expected to have developed. Typically, programmes leading to higher education qualifications (particularly those taken over a number of years such as radiography), include learning that is progressively more challenging. For the award of a higher education qualification at a particular level, the outcomes of this learning must reflect the qualification descriptor for that level [9]. For example level 4 students are expected to demonstrate *‘Interpretation and evaluation of knowledge; structured communication and coherent argument’* within their area of study, whilst at level 5 a key characteristic or differentiator is the *‘Critical understanding, analysis and evaluation of knowledge; application of outside its original context; communication and argument in a variety of forms’* [5, 7].

Learning outcomes

Learning outcomes are statements that are used to express what is expected that students should be able to do or demonstrate at the end of a learning period. There are various definitions of what is meant by a learning outcome, but it is agreed that learning outcomes focus on what the student has achieved and not just the content of what has been taught [10,11].

Learning outcomes can be traced back to the *behavioural objectives* movement of the 1960s and 1970s in the United States of America (USA). A key advocate of this movement was Mager [12] who proposed writing specific statements about observable

1 outcomes or *instructional objectives* [10,12]. By using instructional objectives and
2 performance outcomes Mager [12] attempted to define the type of learning that would
3 occur and how that learning would be assessed. Unfortunately, this can lead to
4 outcomes and objectives (usually a specific statement of teaching intention or teacher
5 centred approach) being used interchangeably or worse as a compound phrase
6 (outcomes/objectives). This can cause problems in that objectives can be written in
7 terms of teaching intention or in terms of expected learning which can cause confusion
8 when developing modules or learning activities [11]. Although they both relate to the
9 product of learning and have similar meanings with regard to educational intent, the use
10 of terminology within learning outcomes emphasises student achievement and what
11 should be learnt rather than taught [11]. Learning outcomes are therefore statements of
12 what a learner is expected to know, understand and/or be able to demonstrate after
13 completion of a process of learning [10]. Table 1 provides a comparison of learning
14 outcomes and objectives.
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36 **[Insert Table 1 here]**
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40 **Levels of outcome and taxonomies of learning**

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42 As discussed earlier level descriptors provide an indicator of demand,
43 complexity, depth of study and learner autonomy required for the award of a
44 qualification at given level or advancement to the next level. These add to the
45 transparency and clarification of the learning process by providing a structure to guide
46 progression in learning at different levels [14]. However, when writing learning
47 outcomes it is important to consider that these are expressed at the appropriate level of
48 learning and complexity [7].
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1 Bloom's taxonomy of educational objectives [15] is frequently used for writing
2 learning outcomes. Bloom's taxonomy is considered a major work with regard to
3 concern for levels of achievement as a statement of leaning outcomes and originally
4 focused on the *cognitive or knowing domain of learning*. Bloom suggested that in this
5 domain understanding ranged over six levels of learning from the lowest level (factual
6 knowledge) to increasingly more cognitive tasks such as the evaluation of information
7 [15]. At the lower cognitive levels, students have learning which relates to gaining
8 knowledge and understanding. With greater conceptual and intellectual challenge
9 levels, students learn to carry out the higher level activities of synthesis and evaluation.
10 Bloom's taxonomy describes how learners can build upon former learning to develop
11 more complex levels of understanding, by the arrangement of the various thinking
12 processes in a hierarchy. Each level within this hierarchy depends on the student's
13 ability to perform at the level or levels that are below it [10]. Anderson *et al.*, [16]
14 revised Bloom's taxonomy by changing the names of the 6 domains from noun to verb
15 forms or action words in order to promote a more active form of learning to **facilitate**
16 **students being able to demonstrate a learning outcome at the end of an activity** (Table
17 2). These verbs can be used to help frame learning outcomes for different level
18 descriptors (demonstration of higher order learning or achievement) by their use at the
19 appropriate cognitive level. They also help to ensure that learning outcomes produce the
20 result which is appropriate for the level of achievement intended, [14,15].

21 **[Insert Table 2 here]**

22 However, although Bloom's taxonomy is useful for planning and writing
23 learning outcomes, it was criticised for excluding other domains of learning. Bloom and
24 his co-workers extended the taxonomy to include the *affective* and *psychomotor*

1 domains. The affective domain is concerned with the emotional component of learning
2 and ranges from basic willingness to receive information to the integration of beliefs,
3
4 ideas and attitudes. The psychomotor domain emphasises physical skills involving co-
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6 ordination of the brain and muscular activity and is commonly associated with areas of
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8 learning such as health sciences, art, and engineering [14,10].
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11 12 13 14 **Constructive alignment** 15

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17 When designing learning outcomes for an educational module or programme of
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19 teaching and learning these should be co-ordinated with the assessment task. Biggs [18]
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21 refers to this process as constructive alignment. The word constructive refers to the type
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23 of learning and what the learner does, with alignment referring to what the teacher does
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25 [10]. Biggs [18] states that traditional transmission theories of teaching ignore this
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27 alignment and that teaching, learning and assessment should all be co-ordinated to
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29 support student learning. There are three basic tasks involved in the constructive
30
31 alignment process. These include clearly defining the learning outcomes, designing
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33 assessment criteria for students to demonstrate that they have met these and developing
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35 teaching and learning methods that are likely to ensure that the learning outcomes are
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37 achieved by meeting the assessment criteria [10] (Figure 1).
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46 **[Insert Figure 1 here]**
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50 Constructive alignment is student-centred in that it is what the *student does* that
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52 is responsible for their learning. The role of the teacher is to create an appropriate
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54 learning environment in order to engage the student in learning activities that enable
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56 them to meet the learning outcomes. As discussed previously Bloom's Taxonomy [15]
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is often used as a basis for categorising outcome statements according to the cognitive ability they elicit and can help with this alignment process [20].

Learning outcomes for RiTe I (level 4)

Using Bloom's revised taxonomy as a framework, the learning outcomes for RiTe I were written in the cognitive domain. This was to ensure the demonstration of knowledge and appraisal of the underlying concepts and principles associated with exposure factor manipulation, image quality and measurements of Dose Area Product (DAP) by students at the appropriate level. Within RiTe I students are required to demonstrate an ability to evaluate and interpret the effects of altering peak kilovoltage (kVp) with a fixed milliamperage second (mAs) on perceptual image quality and DAP using an anthropomorphic phantom. In addition to this students are also required to present, evaluate and interpret the data they have collected as part of a formative assessment.

Students are provided with a week-long set of structured activities and work in small collaborative learning groups. They are provided with learning materials, tutorial support and supervision suitable to their academic level. RiTe I is further supported by a summative written assessment task (experiment report) in order to demonstrate proficiency and learning of these learning outcomes at the required level. Formative assessment for RiTe I involves a two hour plenary session where students give a group presentation of their research to members of the academic staff and PhD students as well as their peers. Published evaluative research of RiTe I has demonstrated that these learning outcomes are understood by students and help to enhance their learning and research skill development [3,4]. The learning outcomes are constructively aligned and

1 assessed with the FHEQ level descriptors for higher education qualifications at level 4
2 [9] (Table 3).
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7 **[Insert Table 3 here]**
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10 **Learning outcomes for RiTe II (level 5)**

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14 Within RiTe II, students further explore the effects of altering X-ray exposure
15 factors on image quality and radiation dose along with assessing lesion visibility using
16 an anthropomorphic chest phantom (Kyotokagaku N1 “LUNGMAN”). Students
17 calculate the effective dose (E) from DAP measurements using a Monte Carlo (MC)
18 mathematical model. The visual analysis of image quality and lesion visibility is
19 assessed using a two-alternative forced choice (2AFC) methodology which measures
20 human observer visual assessment [21]. However, it must be acknowledged that when
21 we set out the learning outcomes for RiTe II the level of task complexity (e.g.
22 calculating E) was considered for level 5 FHEQ level descriptors, but not at the
23 cognitive level. This was because we considered it to be a curriculum enrichment
24 activity. As a consequence some of the learning outcomes used for RiTe II were the
25 same as those used for RiTe I e.g. ‘*Collect data for analysis by undertaking the*
26 *research experiment*’ with some minor changes to others.
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48 As with RiTe I, RiTe II is delivered over one week with students working in small
49 collaborative learning groups with learning materials and tutorial support suitable to
50 their academic level. There is also more emphasis on independent learning and problem
51 solving. Formative assessment (as with RiTe I) is a two hour plenary session. Students
52 also present a short individual self-reflective report of their experiences and new
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1 learning which can be added to their personal development portfolio. However, unlike
2 RiTe I there is no summative assessment.
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9 **Method**

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11 An online questionnaire was developed to evaluate the student learning
12 experience of a level 5 RiT activity (RiTe II). The questionnaire design was informed
13 by a previous online questionnaire used to collect data from a level 4 RiT activity (RiTe
14 I), although some questions were amended or added to elicit responses based upon
15 knowledge transition from level 4 to level 5 [3]. The questionnaire was piloted with five
16 students not in the cohort being evaluated to ensure that participants would interpret
17 questions in the same way. No adjustments were made prior to administration. Some
18 questions were negatively worded in order to reduce acquiescence bias. The
19 questionnaire was delivered online using the Bristol Online Surveys (BOS) website
20 (<https://www.onlinesurveys.ac.uk/>). It contained 20 closed questions with a free text
21 option to allow students to expand upon their responses. The closed questions were
22 divided into 3 constructs - *Student Experience of the level 5 RiT activity, Teaching and*
23 *Learning within the level 5 RiT activity* and *Research Skill Development and the level 5*
24 *RiT activity*. A five point Likert rating scale was used, ranging from strongly disagree
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51 The whole level 5 student cohort (total of 46 students) was asked to complete
52 the online questionnaire. This was made available for 8 weeks before being closed. All
53 students shared a common characteristic, in that they all had previously experienced a
54 RiT activity at level 4 (RiTe I). All students were asked to complete the questionnaire
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1 following their participation with RiTe II. Ethical approval (HSCR12/12) was granted
2 by the University. All students were provided with a participant information sheet and
3
4 hyperlink to undertake the questionnaire. The information sheet included details
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6 concerning the purpose of the research, what would happen should they take part and
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8 who to contact for further information. All participants were assured of anonymity and
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10 confidentiality, with each participant having a unique identifier (e.g. participant 1). A
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12 reminder was sent out on two separate occasions (at 4 weeks and 6 weeks) in order to
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14 increase participation.
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22 **Results and discussion**

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24 Thirty one out of a cohort of 46 year 2 students completed the questionnaire
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26 (67% response rate). Analysis of the questionnaire supported the integration of RiTe II
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28 within the curriculum in terms of learning and research skill development. Responses
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30 were retrospectively mapped against FHEQ level descriptors for level 5 using
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32 constructive alignment. The learning outcomes and how well these related to the student
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34 experience at this level was also reflected upon and whether there was a need to change
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36 or add learning outcomes to this activity. A summary of the questionnaire data and how
37
38 the learning outcomes align with expected level 5 descriptors is discussed below.
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46 Twenty nine students (94%) agreed that they could see the relevance of RiTe II
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48 within the curriculum and 30 students (97%) agreed that they understood how RiTe II
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50 linked with RiTe I. Twenty nine students (94%) agreed that they felt the experience had
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52 helped them to further understand the influence of exposure factor selection on image
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54 quality and patient radiation dose and how this might be applied in clinical practice.
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56 These results align with level 5 FHEQ level descriptors which state that students should
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1 demonstrate ‘*knowledge ... of the well-established principles of their area of study*’ and
2 demonstrate the ‘*ability to apply underlying concepts and principles outside the context*
3 *in which they were first studied*’ [9].
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10 Twenty seven students (87%) agreed that they found the research within RiTe II
11 to be stimulating and interesting, with 30 students (97%) finding the content to be
12 relevant to their learning. Twenty nine students (94%) agreed that they had gained an
13 increased awareness of the methodological issues associated with the research. Only 2
14 students (7%) agreed that it had not developed their research skills. 27 students (87%)
15 agreed that it helped to develop their critical questioning skills. This is important as it
16 confirms that the learning outcomes for this activity aligned with the FHEQ level 5
17 descriptors concerned with the ‘*knowledge of the main methods of enquiry in the*
18 *subject*’ and demonstrating an ‘*ability to evaluate critically the appropriateness of*
19 *different approaches to solving problems*’; ‘*undertake critical analysis of information*’
20 and ‘*an understanding of the limits of their knowledge*’ [9].
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39 FHEQ level 5 descriptors also state that students should be able to ‘*effectively*
40 *communicate information, arguments and analysis in a variety of forms, deploy key*
41 *techniques of the discipline effectively*’ and ‘*develop existing skills*’ [9]. Twenty six
42 students (84%) agreed that working in small collaborative learning groups was a
43 positive aspect of RiTe II, with 27 students (87%) also agreeing that they enjoyed
44 managing their own learning (self-directed learning) and undertaking research. Twenty
45 nine students (94%) also agreed that it had been beneficial in supporting and stimulating
46 ideas for their final year level 6 (year 3) dissertation project. Finally, 26 students (84%)
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agreed that being able to use research skills was seen as an important part of their career development.

Free-text comments by students included:

Participant 1: *'I feel that I have further improved team working skills'*

Participant 2: *'Research skills have improved... Presentation skills have also improved, because I was able to present with confidence'*

Participant 3: *'I feel I have gained an increased understanding when applying exposure factors to obtain a radiographic image.... This knowledge can be carried forward and applied under supervision on clinical placement as a student and as a qualified healthcare professional in the work place'.*

However 1 student did comment that:

Participant 4: *'I don't think I got as much benefit from it as I could have if part of my role had been to do the Excel stuff or learn the [dose calculation and image appraisal] software. Instead I spent most of my time researching and putting the PowerPoint together'*

What have we learnt from this evaluation?

Developing as a critically reflective academic contributes to excellence in teaching, and improved educational outcomes. Analysing one's own learning and teaching practices (and the understanding of these) also contributes to effective teaching practice within the curriculum [22]. By retrospectively mapping the learning outcomes, undertaking a student evaluation and reflecting upon this, it was found that there was

1 constructive alignment between the learning outcomes and FHEQ level 5 descriptors for
2 this RiT activity. However, upon further reflection it was felt that we could further
3
4 revise and incorporate more of the higher level cognitive processes within the learning
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6 outcomes for RiTe II using Bloom's taxonomy (Evaluating and Creating). We also felt
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8 that there was an absence of a learning outcome for students to discuss how their
9
10 learning and experience might contribute towards their own current and future practice
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12 following RiTe II, despite student agreement in the questionnaire that they felt able to
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14 apply this knowledge in the clinical environment. Indeed student feedback tended to
15
16 focus on how this knowledge might be used to help with their final year research
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18 dissertation. Some of the learning outcomes will now be amended to reflect this and an
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20 additional learning outcome will be included that requires students to consider how
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22 RiTe II might contribute towards their practice (Table 4).
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31 **[Insert Table 4 here]**
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36 Another point for consideration is the generation of a summative assessment
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38 process that constructively aligns with the learning outcomes for this activity in order to
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40 ensure that students demonstrate these. Both RiT activities are under review as part of a
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42 Periodic Programme Review and Re-Approval (PPRR) for a new undergraduate
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44 programme in 2017 and this provides an opportunity to reassess this aspect of both
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46 activities. Within both RiT activities it could also be argued that students are
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48 demonstrating learning outcomes in the psychomotor domain [9]. Again there may be a
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50 need to consider the learning outcomes for both and how these might better align within
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52 this domain.
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Currently there is no RiT activity for level 6 (year 3), although students do undertake a summative dissertation as part of a research methods module. This is individually focussed and the learning and assessment process may present a mismatch with best practice in research and clinical practice – unlike both RiTe I and II there is no collaborative learning or team working on their research dissertation. However, consideration needs to be given that in order to achieve constructive alignment there is a need for a variety of assessment methods as a narrow range of assessments will only assess a narrow range of skills [22]. Nonetheless, Okubo *et al.*, [23] state that team based learning supports the acquisition of clinical reasoning skills by students which is difficult to achieve in lectures or a tutor-centred learning approach. There are also a number of benefits with using team based research strategies where diverse perspectives based on prior experiences or methodological skills can help to solve a problem and enable the sharing of expertise or knowledge. Using team based research also avoids the premature convergence on conclusions, by providing critics who may identify potential problems and additional opportunities during a project [24, 25]. The level 6 descriptors (or at any level) do not include team-based research. However, a UK Diagnostic Radiography benchmark states that one of the skill sets should be “*effective skills in communicating information, advice, instruction and professional opinion to colleagues, patients, clients, their relatives and carers; and, when necessary, to groups of colleagues or clients.*” [26]. Therefore, this is an area worthy of further exploration within the concept of further integrating a RiT activity within the curriculum at level 6. The format and resourcing of this would need to be considered alongside the learning outcomes and assessment to ensure that these were constructively aligned against the appropriate level 6 descriptors and encompassed higher level cognitive skills and any relevant psychomotor and affective domain skills. Based on current experience, this is

1 something that can be achieved by the careful deliberation over what students need to
2 be able to demonstrate (learning outcomes) and how these align against level 6
3 descriptors and assessment criteria (Figure 2).
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9 **[Insert Figure 2 here]**
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18 **Conclusion**

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20 **Level 5 student evaluation determined that the learning outcomes for RiTe II**
21 **constructively aligned with what the students felt that they had learnt or were able to**
22 **demonstrate following their experiences with this activity. It also identified areas that**
23 **require further improvement (for example some of the learning outcomes could be re-**
24 **written with a focus on higher-order thinking and application skills). If learning**
25 **outcomes are written within a very narrow framework, this can limit learning and may**
26 **result in a lack of intellectual challenge for some students [9].** By reflecting upon and
27 using a constructive alignment framework to assess this RiT activity, we have been able
28 to confirm that although not explicitly specified at the beginning of the task, relevant
29 learning outcomes were ultimately realised and linked well with the appropriate level
30 descriptors. However, it also highlighted to us that further refinements were needed to
31 ensure students undertook a more critical review of how the knowledge and skills
32 gained from this activity could be used in their own practice. Another potential
33 limitation is a lack of summative assessment to determine whether there is a true
34 alignment between the learning outcomes, learning activities and demonstration of these
35 by students and this is an area for further development.
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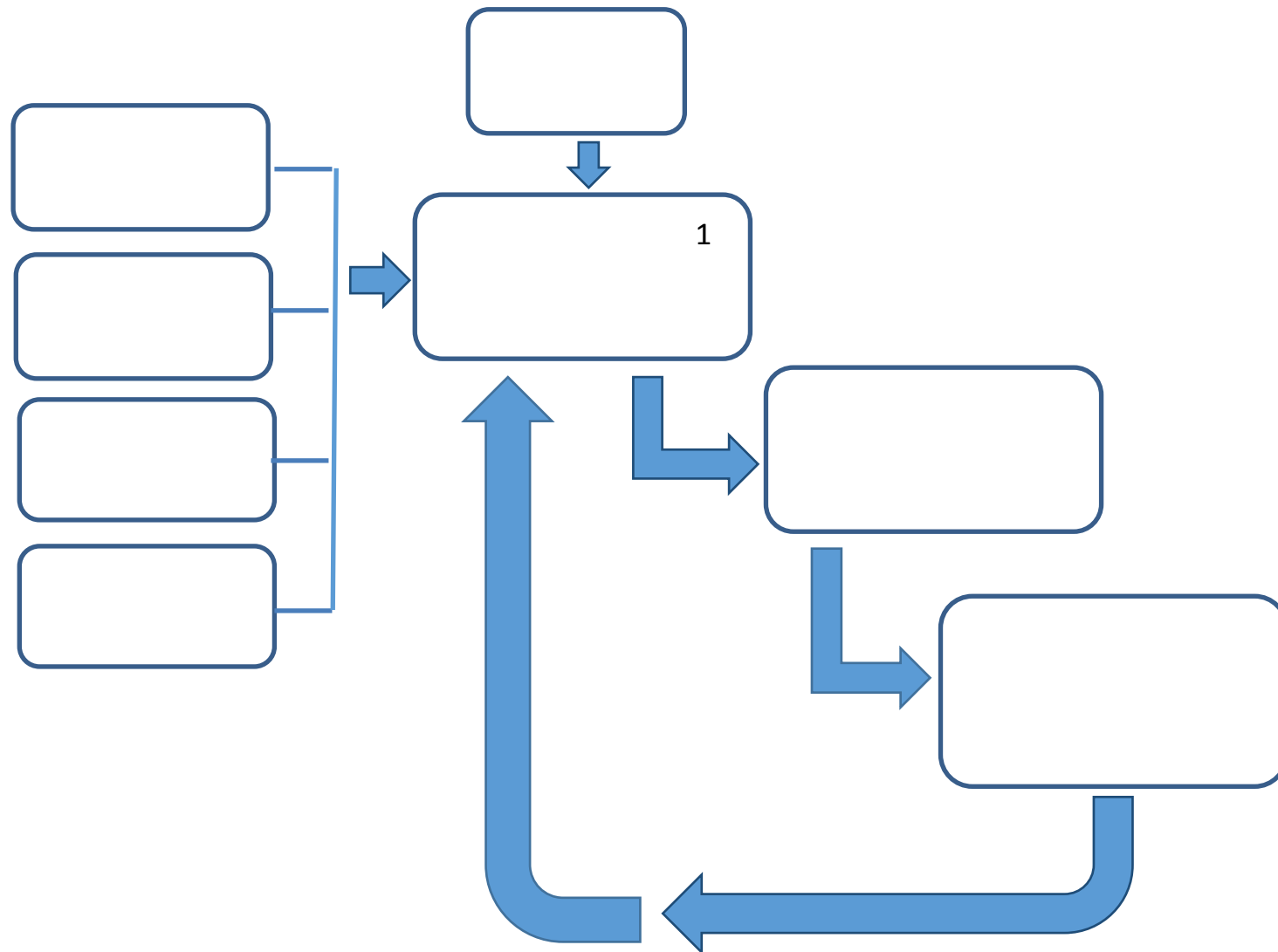
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Figure 1



Constructive alignment describes the relationship between three elements:

1. The learning outcomes are formulated first. From these the assessment criteria are developed.
2. Once an appropriate assessment regime has been designed. Activities are organised that will teach the students how to meet the assessment criteria (and learning outcomes).
3. What the teacher does and what the students do are aimed at achieving the learning outcomes by meeting the assessment criteria. This takes advantage of the known tendency of students to learn what they think will be assessed (backwash).

Figure 1. An overview of constructive alignment and factors (1-3) that may influence module design. (Adapted from [18,19])

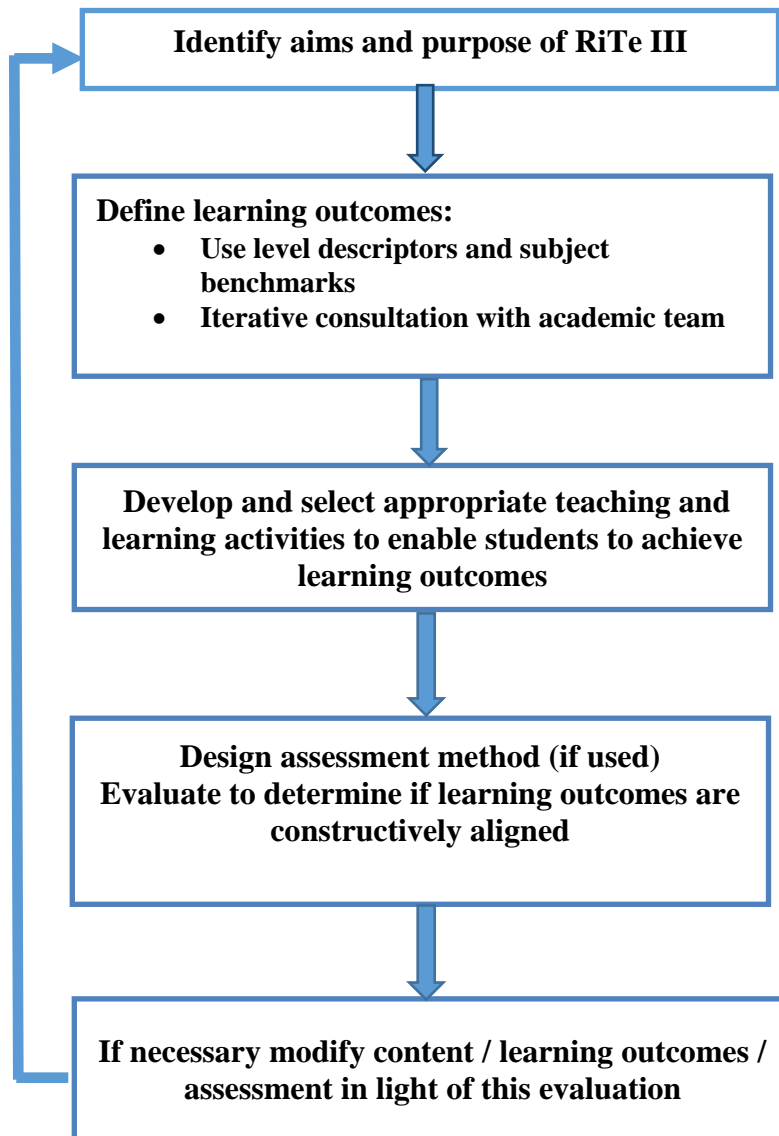


Figure 2. Flowchart summarising proposed the steps involved in the development of constructively aligned learning outcomes, teaching activities and assessment for a level 6 (year 3) RiT activity (Adapted from [10]).

Learning outcome	Equivalent learning objectives
At the end of this activity you will be able to demonstrate the effects of changing kVp and focal spot size with a fixed mAs on dose area product (DAP) and image quality.	<p>At the end of this activity you should be able to:</p> <p>Describe the effects of changing kVp and focal spot size with a fixed mAs.</p> <p>Describe their effects on image quality and dose rea product (DAP).</p>

Table 1. Comparison of learning outcomes and objectives using the research-informed teaching learning activity as an example (Adapted from [13]).

Table 2

Level	Examples of appropriate verbs
6. Synthesis / Creation (<i>Advanced</i>)	Hypothesise, Design, Construct, Devise
5. Evaluation	Appraise, Argue, Assess, Conclude, Critique
4. Analysis	Analyse, Appraise, Classify, Compare
3. Application	Apply, Choose, Compute, Demonstrate
2. Understanding	Classify, Describe, List, Report, Discuss
1. Remembering (<i>Basic</i>)	Recognise, Identify, Define, Recall

Table 2. Hierarchy of the cognitive domain and verbs appropriate to different levels. (Adapted from 12,13,19).

Table 3

FHEQ level 4 descriptors	Learning outcomes for RiTe I (using Bloom's taxonomy in the cognitive domain)	Stage of Bloom's taxonomy for each in the cognitive domain	Assessment tasks
<p>Knowledge of the underlying concepts and principles associated with their area(s) of study, and an ability to evaluate and interpret these within the context of that area of study</p> <p>An ability to present, evaluate and interpret qualitative and quantitative data, in order to develop lines of argument and make sound judgements in accordance with basic theories and concepts of their subject(s) of study</p> <p>Use their knowledge of the subject and its techniques in a routine manner to evaluate and formulate a range of arguments and solutions to problems and issues of a routine nature</p> <p>Communicate the results of their study and other work accurately and reliably, and within structured and coherent arguments;</p>	<p>Demonstrate <i>the effects of changing kVp and focal spot size with a fixed mAs on dose area product (DAP) and image quality by undertaking a guided research experiment design.</i></p> <p>Collect <i>data for analysis by undertaking a research experiment.</i></p> <p>State and explain <i>the experimental design process and data analysis by the guided review of related literature and collaborative group work.</i></p> <p>Discuss and describe <i>what is meant by image quality and the key concepts of radiographic image quality.</i></p> <p>Discuss and describe <i>what affects radiographic image quality and DAP.</i></p> <p>Summarise <i>the data collected, analyse and present this with regards to the effects of radiographic image quality and DAP when changing kVp (with a fixed mAs) and focal spot size.</i></p>	<p>3. Applying; 4. Analysing</p> <p>5. Evaluating; 3. Applying</p> <p>1. Knowledge; 2. Understanding</p> <p>2. Understanding; 1. Knowledge</p> <p>2. Understanding; 1. Knowledge</p> <p>5. Evaluating</p>	<p>Formative discussions via student presentations</p> <p>Experiment report writing workshop</p> <p>Summative written assessment (experimental report)</p>

Table 3. Constructively aligned level 4 descriptors with learning outcomes for RiTe I, the stage of cognitive domain for each learning outcome and assessment tasks. Learning outcome verbs (learning activity) highlighted in bold, its object (content and context) highlighted in italics.

Table 4. Level 5 descriptors with current and proposed revised learning outcomes for RiTe II, the stage of cognitive domain for each learning outcome has been retrospectively mapped using Bloom’s taxonomy. Learning outcome verbs (learning activity) highlighted in bold, its object (content and context) highlighted in italics.