eSTEeM Project Final Report

Using technology-enabled learning networks to drive module improvements in STEM

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key staff associated with the project	S215 Module Team S215 ALs (tutors) Christine Leach – tutor for signpost development, in conjunction with the module team Tom Olney, Senior Manager Learning and Teaching, STEM – discussion facilitator on learning design analytics visualisations Carol Calvert – project mentor Learning Design – support with RTSF questionnaire design, provision of supporting data, and review and feedback on the signposting material. The methodology and outcomes of the entire project, and the ULTIMATE framework, was also shared by Lesley with a Learning Design team meeting in June 2021. A STEM Data Wrangler (Doug Clow, who has since left the OU) Thanks and appreciation to eSTEeM and Carol Calvert for their infrastructure, funding, practical support and friendly encouragement in this project.
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Executive Summary

This project provides one way to answer the need to close the feedback loop between OU tutors and campus based teams, to develop a joint understanding of teaching and learning design challenges, and to put tutors as close as possible to the development of solutions.

This project used a '*learning network*' approach as a collaborative and inclusive action-oriented problem identification and problem solving process in Level 2 Chemistry, S215. The project built on and consolidated a previous eSTEeM project on identifying and addressing conceptual misunderstandings or 'Tricky Topics' in three OU modules. It is a collaboration between the STEM faculty (School of Life, Health and Chemical Sciences), and Lesley Boyd who is undertaking a PhD on collaborative action research using 'learning networks' within the OU, for equitable and inclusive problem solving and integration of views from tutors, module teams and students. This means that it provides a process for scholarship researching *with*, embracing the expertise and experience of tutors, staff tutors, module teams and students, as opposed to more traditional academic researching *on* or researching *for* (Bradbury, 2015).

In the first project, S215 tutors identified a series of Tricky Topics[1] and the tutors went on to design and implement a series of 4 intervention videos. However concerns were raised by tutors about whether Tricky Topics alone got to the 'root cause' of the complex, interrelated and somewhat intractable issues facing the module. These included:

- pace and volume of material, and students falling behind
- student preparedness
- overall study time spent including whether studying online or offline
- opportunities for consolidation or practice of concepts.

Student preparedness was felt by tutors to be getting progressively worse year on year, in what was already a packed and conceptually challenging curriculum. Learning design mapping data indicated that several Blocks contained more student workload than was appropriate and exceeded current OU guidelines. Learning design analytics visualisations indicated low VLE engagement overall, in an online only module. Thus the analytics added to qualitative feedback from tutors that pace and volume of material and student preparedness remained significant and ongoing challenges.

The tutors, staff tutor and module team participated in an unfolding collaborative inquiry process hosted in a separate VLE site, or *learning network*, where all the project data, discussion forums and online workshops could be held in one place, and visible to everyone. The purpose was to interpret the analytics, collaboratively reflect on joint experiences and insights, and decide on improvement action.

As a result, as series of 'signposting' materials were developed by a tutor for five Blocks identified by tutors and students as 'pressure points'. The signposts were promoted to students via Real Time Student Feedback (RTSF) questionnaires in the Study Planner. This communicated to students that the module team were aware of and investigating the workload issue, and provided reassurance to students who may have been falling behind. Thus targeted practical and emotional support was provided to those students requiring it.

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[1] See here for a Badged Open Course developed by the OU and hosted on OpenLearn, on *Teaching and learning tricky topics,* as a practice-based application of Threshold Concepts theory (Meyer and Land, 2006).

Signposts have been evaluated very positively by students. Tutors considered the project to be a 'welcome collaborative process' in which 'key improvements were made, for students, based directly on the project reflection and solutions put forward'. Project data formed a backbone of evidence for the module Mid Life Review, to chart the development road forward for the module. The project thus contributed to the development of the module as a whole. It is envisioned that the lessons and evidence from the project will be integrated into the forthcoming module re-write (beginning 2021-22).

The entire process was facilitated by Lesley working in conjunction with Rob, and simultaneously conceptualised using Grounded Theory Method (GTM) as part of the PhD work. This has resulted in a new conceptual framework called ULTIMATE – Using Learning Technology in Making Action-based Transformative Enhancements. The ULTIMATE framework will guide teams through a structured but flexible collaborative action research based process, which is designed to inclusively identify and address issues in complex learning design and delivery challenges. It can also be applied to other contexts and challenging scenarios which may be spread across geographical and functional boundaries.

ULTIMATE could thus assist module teams who are facing uncertain or indeterminate learning design and delivery situations and would like to encourage and embrace the collaborative integration of insights from their tutors, students, module team and other stakeholders, whilst embracing supporting data.

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Project activities and outcomes

1. Aims and outcomes sought

The initial aim was to engage ALs with specialised learning design analytics visualisations, especially in the light of the concerns and issues which were identified in the earlier Tricky Topics project. These included pace and volume of material, student preparedness and knowledge at the start of the module, overall study time spent including whether studying online or offline, and opportunity for consolidation or practice of concepts.

Outcomes sought in this project were:

- provide evidence for module interventions or in-presentation adjustments in light of concerns raised

- pilot an integrated online discussion which will be visible and accessible to other stakeholders such as other modules or Learning Design

- inform future collaborative projects using learning networks to evaluate whether the approach is transferable within the OU and further afield.

2. Activities

The overall approach was to use a '*learning network*' within a dedicated VLE site as a collaborative and inclusive action-oriented problem identification and problem solving process in Level 2 Chemistry, S215.

Tom Olney facilitated a learning network discussion with S215 tutors early in 18J using Adobe Connect online. Three learning design analytics visualisations were presented that illustrated student workload, activity types classification and VLE engagement data (see Appendix B for a full explanation). These visualisations underscored qualitative feedback from tutors, that several blocks contained more student workload than was appropriate and exceeded current OU guidelines. There were no identifiable interventions immediately after the initial discussions using the visualisations. Instead these yielded a series of issues for further investigation and possible action, which were then managed by the project team until progress could be fed back to all participants. Tutors effectively articulated some additional questions plus barriers to their own individual agency in taking immediate improvement actions, or changes to teaching practice.

3. Findings – 18J presentation

Four issues were identified for further investigation after the 18J learning network online workshop and discussion. The respective issues, actions and progress on findings in 18J are shown below in Table 1:

	Issue	Action identified	Progress
1.	Workload / content / Tricky Topics / students frequently getting behind from early December onwards.	Signposting the most efficient way through module to help students navigate through Blocks, especially if they are feeling pressed for time. Signposts breaks content into: • pre-requisite knowledge and conceptual understanding required to study the Block • key points regularly examined • material that is crucial to learning but not directly tested • material written for interest only. The feedback from ALs and Learning Design that it would be better/easier for students to embed the signposting into module content if possible.	Christine Leach developed signposting materials for Block 9 and 10 as a trial, which were implemented in 18J as separate documents and highlighted in the Block forum and using a news alert. Christine is also now working on Block 8, integrating student feedback. Signposting of all Blocks was recommended for 2020 in the Module Mid Life Review. The module team were reluctant to embed the signposting in module content case the assessment strategy changed (which it did).
2.	Study behaviour	The project needs to find out more about: a) student study behaviour - whether online or offline b) student study choice motivations before S215 (informed by a Study Pathway analysis, see item 3 below) c) initial student reactions to the trial signposting docs Possible routes to achieve this were identified as follows: Run an RTSF (Real Time Student Feedback) questionnaire to get direct in-presentation feedback from students, tailored specifically to the jointly identified issues. In the RTSF, ask for student volunteers for a follow up online focus group session.	RTSF questionnaire was designed and approved by the Student Research Project Panel. Live on Study Planner for last two weeks of 18J presentation. 18 responses were received. The follow up focus group ran on 20th June, with 4 student attendees, plus one unable to attend who provided written

		Rob to talk to students informally at the 18J residential school and note their feedback.	feedback afterwards. Rob, Lesley, Tom and Christine also attended. A separate document details the full RTSF and focus group feedback and analysis. There was a variety of feedback re signposts, and not all students found them. Rob gained useful informal feedback at the residential school.
3.	Pre-requisite knowledge / not being sufficiently prepared for S215	Get data on all previous modules studied by S215 students: Commission two Study Pathway analysis reports from a STEM Data Wrangler, for 17J and 18J. These reports were designed to list all the previous study routes, ie both modules and presentations, taken by S215 students.	Analysis showed an extremely scattered picture of previous study pathways before S215, taken over many years. In 18J, for 160 total students there were 71 different pathways. 32% of students (51/160) on 18J took the recommended S111 – S112 - S215 path. Focus group feedback suggested that students felt that this path did not adequately prepare them, with too much of a 'step up'. Those studied A Level Chemistry felt better prepared. ALs have noted a reduction in preparedness year on year. Data provided by Learning Design illustrated a very low rate of interaction with the AYRF quiz.
4.	Can OUA better help ALs, who felt OUA analytics were sometimes contradictory due to offline study behaviour?	Tom to do an analysis using OUA to identify whether there are a significant number of successful S215 students studying offline (some ALs reported that their best students were hardly interacting with the VLE at all)	Of the top 40 students (top 25%, out of 160 at the time), only 6 students were identified using agreed parameters for studying 'offline'. Analysis therefore inconclusive but more questions were posed for further work if required.

Table 1. Issues, actions and progress in S215 18J

The identification of issues was framed by questions that had been posed during the discussions, to assist in the planning of actions as shown in Table 2:

Data as questions driving the plan actions category	
Possible actions	**Driving questions**
Plan and evaluate signposts intervention	1. How do students react to the signposts being trialled for Blocks 9 and 10?
Find out more re study choices before S215	1. How many S215 students are registering without completing Level 1 chemistry? 2. What is motivating student study choices before S215 (refers to Study Pathway Analysis 17J and 18J)? 3. How many students are following the recommended S111+S112 pathway (refers to Study Pathway Analysis 17J and 18J)? 4. Are students choosing the chemistry assessment options in S112? 5. How well prepared do students feel to study S215?
Find out more re online vs offline study	1. Why is VLE engagement so low, especially for an online only module? 2. How do students study online vs offline, and what resources do they download? 3. Is the module site largely an online text book? 4. How many hours are students actually studying per week? 5. Do students use notes of key topics rather than reading through lengthy online materials? 6. Are students using freely available online resources for 'nuts and bolts' chemistry? 7. How do students revise?
Clarify and resolve issues re use of OU Analyse	1. Are there a significant number of successful students who are studying offline on S215? 2. Can OU Analyse be used to identify them?

Table 2. Questions driving the planning of actions

The first RTSF questionnaire, which was run to find out more about study behaviour as shown in Table 1, was run in the last two weeks of 18J. It was specifically tailored around the identified issues and yielded 18 student responses, which we felt was an acceptable response rate for the size of the cohort (approximately 160). Combined with the subsequent online student follow up session, designed specifically around the identified issues, there were several very pertinent aspects of student feedback. A summary of the responses is shown in Box A below.

1. **Did you feel your chemistry background was adequate to prepare you for studying S215 - do we assume too much?**

This was the first time that most students (16/18) had attempted S215. Nearly all (15/18) reported that they completed the Are You Ready For (AYRF) quiz before the start. Those who had passed the recommended prerequisite Level 1 modules reported that they did not give adequate preparation for S215, with a large jump from Level 1 to Level 2.

2. **Where did you find the pressure points were, and where does the module start to get challenging?**

Almost two thirds (11/18) students found the module to be paced rather fast and would have liked more time to consolidate concepts. One third (6/18) found it to be paced about right, and one student found they had more than sufficient time. Students identified specific pressure points, especially in the workload pace in the second half of the module. Students were putting in a range of study hours per week from 8-20 hrs.

3. **Did you find it challenging to factor in study time for completing assignments? How useful or accurate did you find the advice on study time?**

This question was included to further explore the RTSF free text feedback. All students agreed that it was challenging in the follow up session, especially with proximity of assignments in conjunction with a heavier workload pace towards the end of the module.

4. **Did you use any particular strategies if you felt under pressure to complete all the material in time?**

This question was aimed at understanding how students divided their study time – between online, offline using module downloadable resources, and offline using other generally available resources. A wide variety of online and offline study patterns were reported. A reported strategy if under pressure was to work from the assignment and then go back to other materials in the Block if time, which constituted the student 'signposting themselves'.

5. **How did you use tutorials in your study, and could we be providing recorded materials in any alternative formats (e.g. MP4 audios)?**

There were requests to have more engaging videos, podcasts or MP4s, and feedback on use of other resources eg YouTube videos, and regular tutorial recordings. There was praise for the recorded revision tutorials, the Block summaries and Specimen Examination Paper.

6. **Did you find the content of the Block 9 & 10 Signposting materials useful? How might we improve them, or could you suggest a more useful alternative?**

A mixture of feedback was received, with only a third (6/18) of students reporting that they used them. Some students found the signposting materials 'fantastic' and helping to reduce workload. Others were confused as to their purpose, didn't find them, or expressed a wish for less content instead.

7. **If you used the print on demand service, what was your experience?**

This question was included in the follow up session to explore the RTSF free text feedback. There were some issues reported with the formatting of pages and printing of formulas.

8. **Anything else you would like to discuss**

There were two further improvement suggestions, and a universal agreement in the student feedback follow up session that despite the module being hard, all the students enjoyed it!

Box A. Summary of responses to RTSF and online student follow up session

All the participants in the project were kept up to date with these details in a project progress report at the end of the 18J presentation. Tutors were reassured that if they participated, their comments were recorded and analysed as part of the process.

The progress report and additional supporting information were also uploaded in the learning network site, so it was all held together in the same place, and the discussion and supporting data could be visible and accessible to other stakeholders such as other modules, or Learning Design.

This included initial details of the qualitative analysis process which Lesley designed, for anyone who was interested. Details of the interactive analysis spreadsheets, which underpinned the PhD research into the unfolding process of learning how to collaboratively identify issues and make improvements, were shared. The spreadsheets organised and diagrammatically illustrated the qualitatively coded feedback from the online discussions in a rigorous manner.

4.   Findings – 19J presentation

The project had now implemented trial signposting material in 18J and 19J, for three 'pressure point' Blocks - 8, 9 and 10.

Signposts were not integrated into the module materials, in the event that the assessment strategy changed. Instead they were prominently highlighted to students for Block 8 19J via an RTSF with a single question in the Study Planner, which asked them about their experiences of pace and volume of material, and offered support options accordingly. The RTSF invitation message communicated to students that this issue is frequently experienced in S215, that they are not alone in their perception, and that the module team is trialling the signposts as additional help. The other support options highlighted were the Study Buddies, and speaking to their tutor. There were 39 responses, and the results were:

Results from 19J RTSF before Block 8	
69% (27/39) - felt paced rather fast; would like more time to consolidate	
26% (10/39) - felt paced about right; had enough time	
5% (2/39) - felt they had more than sufficient time	

Table 3. Results of the single question RTSF before Block 8: S215 19J

Another RTSF was run just before Block 10, to further highlight the Block 10 signposting material. The aim was once again to acknowledge students concerns and how they might be feeling, to support the current cohort during the presentation, encourage them that an end is in sight, and to evaluate from the students' point of view. There were 25 responses. The results were as below: of those who saw and read the signposts, on a scale of 1 to 5:

Question	Scale 1 (not very helpful) to 5 (very helpful)
How helpful did you find the signposting materials for Block 8? (N=21)	Average rank 4.0
How helpful did you find the signposting materials for Block 9? (N=20)	Average rank 3.8

Table 4. Results of the RTSF before Block 10: S215 19J

However some students were still not finding the signposts even when they were advertised in Block forums, via News items and in the RTSFs, and some were not reading them all the way through.

Some highlights from the free text responses were:

Example free text responses from 19J RTSF before Block 10
'I found the Signposting for Block 8 very helpful but missed the ones for Block 9 as I was behind schedule and trying to catch up. They would be much more helpful posted in the Study Guide for the block'.
'I found the signposting material very useful, especially because I was falling behind in December. I didn't see the material until I was already partially through block 8 - probably my own fault for not reading the forum more frequently. Perhaps the signposting material could be highlighted a bit earlier, in an email from our tutors? Thanks!'
'Easy to read. Clear and concise. I think it's useful as a guide by showing which areas to cover when revising for exams and tmas'.
'Only suggestion would be that similar signposts be made available for the organic topics too!'
'Great idea and I felt I should have made more use of them! I probably studied these blocks in the same way I did the others, and then used the signposting materials retrospectively to make sure I had grasped the most important parts, rather than in advance to prioritise certain areas.'

Table 5. Example free text responses to the RTSF before Block 10: S215 19J

There were two other additional free text responses regarding the jump from S112 to S215.

All the relevant data and feedback from this project was shared with the S112 module team. An S112 eSTEeM project on assessment had previously identified that S112 pass students were almost twice as likely to withdraw from S215 as from any other level 2 module. The S112 module team were looking closely at the chemistry option, implemented a new 'taking it further' activity, and expressed an interest in the idea of signposts during informal discussions.

This was related to previously reported feedback from the S215 student follow up group at the end of 18J, that they felt this path did not adequately prepare them, with too much of a 'step up'. Those who have studied A Level Chemistry felt better prepared. However Study Pathway Analysis reports showed an extremely scattered picture of previous study pathways before S215, taken over many years. In 18J, for 160 total students there were 71 different pathways. Only 32% of students (51/160) on 18J took the recommended S111 – S112 - S215 path.

As a result of the positive feedback for the signposts in 19J, a further two – for Blocks 5 and 13 – were produced over summer 2020 for incorporation into the 20J presentation. [Note that due to previous re-arrangements in the order of the Blocks, they are not numbered sequentially].

During 20J,after the funded project work had completed, the module team invited responses from students about the ongoing helpfulness of the signposting material within the relevant Block forums. The following responses were received:

Example responses from invitation to comment in 20J Block Forums
'Using the less detailed signposting document was helpful in knowing which areas needed to be properly understood i.e. how cations can be amphoteric. I was able to spend more time on this while writing up my notes and less time on the non-crucial and extended areas. I'll refer to these from now on for every block!!'
'Thank you for this. I'm feeling quite overwhelmed with the volume of material to get through before the 1st TMA so this is very helpful as something is going to have to give'.
'Ditto [....]'s comments. These signpost docs are a lifesaver. Thank you'.
'This is so incredibly helpful. I am reading through all the material but know i know where to focus and spend my time on when i dont really understand a section. Thank you so much!'
'This is very helpful, thanks! But may I ask, how come these docs appear only in 5 of the blocks of the module?'
'Thank you! I'm really struggling with having enough time to manage this course and this helps immeasurably when I'm in a time crunch and "something has to give" by helping me know what's most essential to understand and what I can skim through'.

Table 6. Example responses from invitation to comment in 20J Block Forums

These responses indicated that students who could benefit from targeted support were continuing to find the signposting materials useful in 20J.

5. Overall Evaluation

The overall process was evaluated with tutors at the end of 19J. The evaluation questions were based on personal reflections, reflections for S215, and reflections on wider transferability. The three key aspects to take away from the evaluation feedback were:

a) the 'signposting' materials and the Tricky Topics videos were evaluated as helpful interventions for S215. A further suggestion was put forward which was the production of an overall signposting document for tutors, to facilitate ongoing targeted tutor support for those students requiring it, using the signposting materials.

b) tutors welcomed being a part of the collaborative and equitable discussion and problem-solving process followed in the project. They reported both the Tricky Topics and learning design analytics workshops and discussions to be very useful. They appreciated being a closer part of the team, being listened to, and being part of formulating and implementing solutions.

c) there was a perception that more could be done, and that perhaps the project would yield further impact and benefit by continuing. This would harness the collaborative process as a more routine way of working in S215, and potentially provide a model for other modules. The signposting intervention is already of interest to S112.

Additional reflection from the project leader and MTC perspective was added during 20J. Extracts from all the project feedback are shown in Appendix C. The joint reflections indicate that it has facilitated significant development and growth for all the project team members and participants, and development of the module as a whole.

6. Summary of Findings

The integration of the tutor, student and module team voices has led to collaborative learning about the complex, interrelated and somewhat intractable issues which the module team and faculty management had been facing. Signposting interventions have enhanced the student experience, provided targeted practical and emotional support to those students who require it. Signposting has also informed possible interventions in the precursor module S112. Joint reflections in this project indicate that it has facilitated significant development and growth for the project team members and participants, and development of the module as a whole. Tutors have been empowered to use their teaching experience, provide insights and contribute towards the development of solutions. In addition learning design analytics have been embraced as supporting data, within a structured but flexible problem identification and problem solving process which has been owned by the module team and project participants.

7. ULTIMATE framework

The entire process was facilitated by Lesley working in conjunction with Rob, and simultaneously conceptualised using Grounded Theory Method (GTM) as part of her PhD work. This has resulted in a new conceptual framework called ULTIMATE – Using Learning Technology in Making Action-based Transformative Enhancements. The ULTIMATE framework and associated practical guidance can support teams through a structured but flexible collaborative action research based process, which is designed to inclusively identify and address issues in complex learning design and delivery challenges. It can also be systematically applied and adapted to other contexts and challenging scenarios, which may be spread across geographical and functional boundaries.

ULTIMATE could thus assist module teams who are facing uncertain or indeterminate learning design and delivery situations and would like to encourage and embrace the collaborative integration of insights from their tutors, students, module team and other stakeholders, whilst embracing supporting data.

The ULTIMATE framework is shown in Figure 1. A larger version is available as an Excel spreadsheet file on the eSTEeM project page at https://www.open.ac.uk/about/teaching-and-learning/esteem/projects/themes/technologies-stem-learning/using-technology-enabled-learning-networks-drive-module.

CONSTRUCTING AND IDENTIFYING ISSUES (eg design and delivery challenges in Level 2 Chemistry)

eg pace and volume of material
student knowledge at start of module
study behaviour online vs offline
keeping to study timetable
overall study time spent
use of downloadable module resources
communication in tutor group forums (TGFs)
use of OU Analyse: confusing to apply to students who study offline?
tutor marking of TMAs
student drill and practice of concepts
list of challenging Tricky Topics for students
additional issues, eg software for student use

DISCUSSION STRATEGIES

eg ask a question
share an artefact
identify issue or observation re artefact
make an improvement suggestion
show agreement or support of issue
update an artefact
root cause questioning

are a way to

integrates into

TUTOR EXPERIENCES

STUDENT EXPERIENCES

MODULE TEAM EXPERIENCES

EXPECTATIONS AND EMOTION   adds weight to

ULTIMATE LEARNING

PLANNING ACTIONS

1. Plan signposting intervention
2. Find out more re prior study pathways
3. Find out more re online vs offline study
4. Clarify and resolve issues re use of OUA

EVALUATING ACTIONS

1. Evaluate signposts with students
2. Evaluate entire process (both Phase 1 Tricky Topics and Phase 2 signposting) with participants and stakeholders

IDENTIFICATION OF ADDITIONAL ROLE PLAYERS   is a stage of

is a part of

eg Learning Design central unit
follow on module team
precursor module team
Academic registration

are used for

are a result of

REFERENCE TO UNIVERSITY PRACTICE

REFERENCE TO STUDENT PRACTICE

SUPPORTING DATA AND TOOLS

PRACTICAL IMPROVEMENT OUTCOMES

1. Learning Design analytics visualisations (eg mapped workload vs average VLE usage per week)
2. Tutor feedback in online workshop
3. Tutor feedback in learning network discussion
4. Summary document of issues raised
5. Study Pathway Analysis 2017 and 2018 (17J and 18J)
6. Data re Are You Ready For quiz engagement
7. Analysis of offline study using analytics dashboard
8. Informal feedback from students at the Residential School
9. Results of Real Time Student Feedback (RTSF) questionnaires re workload and signposts
10. Feedback from online student follow-up focus group
11. Periodic project progress reports to all participants
12. Student evaluation of signposts
13. Participants' evaluation and reflection on project
14. Practical guidelines for future learning network facilitators
15. Project final report added to Scholarship Exchange [institutional repository for sharing of projects]
16. Stakeholder/wider reflection

1. Signposting materials for 'pressure point' Blocks
2. Implementation of Tricky Topics videos designed and delivered by tutors
3. Evidence for Module Mid-Life Review [institutional quality enhancement (QE) procedure]
4. In-presentation targeted support for students
5. Help to inform proposed changes in precursor module
6. Development of the module and module team as a whole
7. Tutor empowerment and professional development

TAKING ACTIONS

1. Implement signposting interventions
2. Commission Study Pathway Analysis reports
3. Design RTSF questionnaire tailored to issues
4. Commission analysis of VLE behaviour using OU Analyse: do succcessful students study offline?
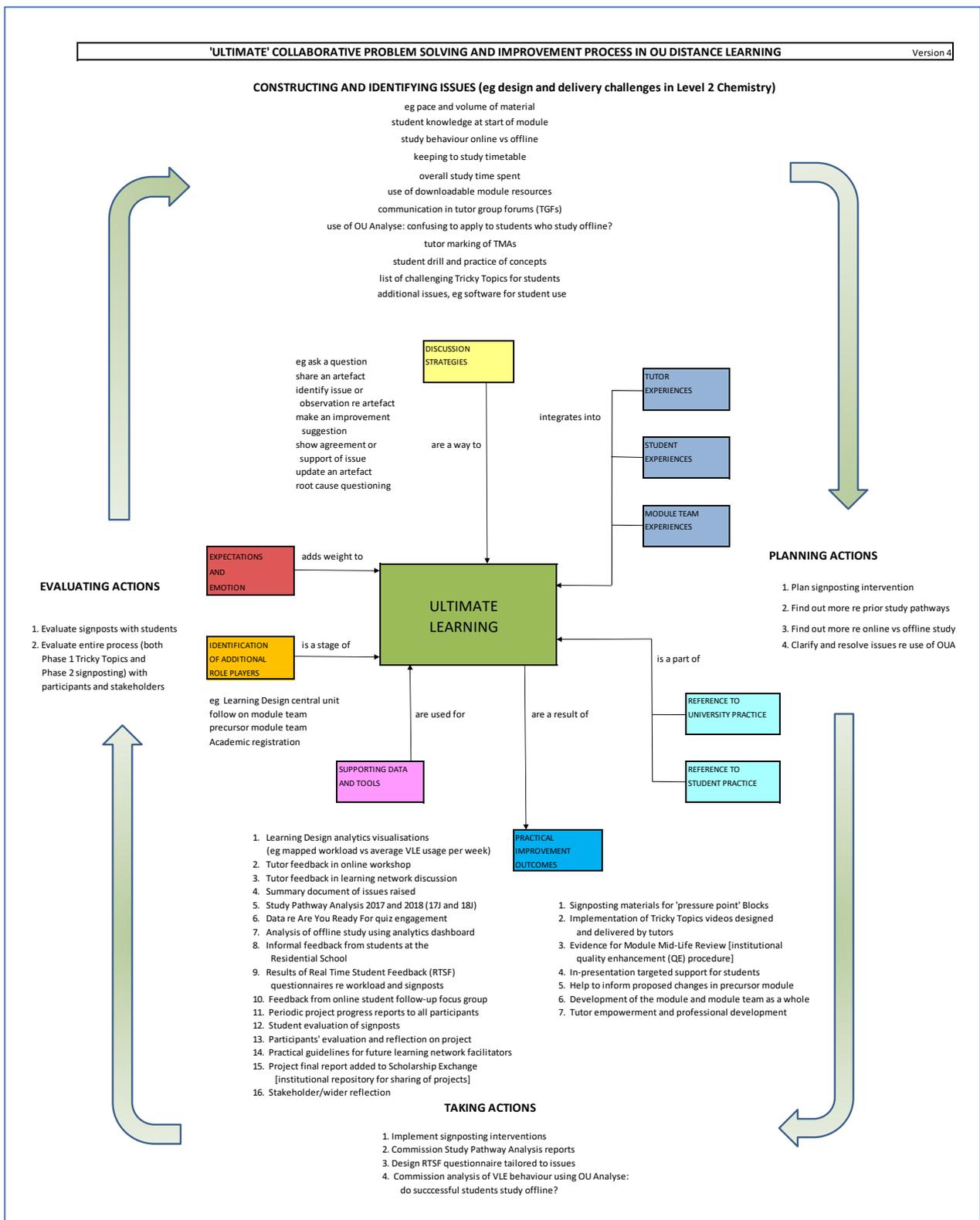
Figure 1. ULTIMATE conceptual framework of a collaborative problem-solving process in distance learning design and delivery [adapted from Spradley's (1979) semantic relationships].

ULTIMATE - Using Learning Technology in Making Action-based Transformative Enhancements

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8. Impact Evaluation

The project was evaluated against its own set of impact criteria as shown in Table 7 below. The first item relates to the preceding project which used a similar collaborative and equitable action research approach. Tutors have therefore designed and provided the interventions in each of the two projects.

	Summary of impact achieved for Module S	
	Type of impact	Description of impact
1.	Module intervention	Implementation of four Tricky Topics videos designed and delivered by tutors.
2.	Module intervention	Implementation of signposting materials for five Blocks in the module identified as 'pressure points'.
3.	Integration of feedback on identified issues	A new process has been established that collaboratively identifies or *constructs* challenging issues of concern for the module, and integrates feedback from different types of role players [tutors, module team and students] on the identified issues.
4.	Provision of explanatory data on issues of concern	Additional data has been provided in commissioned reports to clarify the complex nature of student preparedness and previous study pathways, and to help tease out the nature of student online and offline study.
5.	Provision of evidence for institutional quality enhancement (QE) procedure	Combined feedback from the tutors, module team and students used as a key backbone of the evidence for module interventions and adjustments in the module Mid Life Review.
6.	Tutor empowerment and professional development	Tutors have been provided with a means via the new process to exercise their teaching experience and subject expertise, to feel a part of the module team, and to be a crucial part of development and implementation of solutions. They have also been introduced to institutional data and learning design analytics of interest.
7.	Student empowerment and benefit from *in-presentation* targeted support	Students were given the opportunity to participate in targeted real-time questionnaires and in a dedicated student feedback follow up online session. This feedback has been used to provide an increasingly nuanced level of practical and emotional support for their concerns regarding pace and volume of material, via real time questionnaires delivered *during* as opposed to *at the end of* the subsequent module presentation or delivery.
8.	Helped to inform proposed changes in precursor module	The project has helped to inform proposed future changes in the precursor module with regard to signposting implementation.
9.	Development of the module and module team as a whole	By following the collaborative and equitable process, the module has benefitted from *organisational learning,* where this is defined as 'a process of individual and shared thought and action' by Rashman et al., (2009). Interesting ideas for further development or actions have been received from tutors during evaluation.

Table 7. Summary of practical improvement outcomes (impact) achieved for S215

The Impact Evaluation Framework (IEF) provided by Minocha (2021) within the [Badged Open Course on Scholarship of Teaching and Learning in STEM](#) has also been used to self-evaluate the impact of this project. The IEF consists of 12 evaluation impact criteria, each in the form of a question. These have been reproduced in Table 8, with the self-evaluation assessment against these criteria for this project.

Evaluation of impact using the Impact Evaluation Framework (IEF) provided by Minocha (2021)		
1.	What has been the impact on student experience?	Guidance: pre-registration; induction; curriculum design; design of assessment; learning design; student engagement with course content; student engagement with the technological intervention; and student satisfaction rate. *Signposts have been evaluated very positively by students, and have provided reassurance and practical targeted support to students who may have been falling behind. Tutors considered the project to be a 'welcome collaborative process' in which 'key improvements were made, for students, based directly on the project reflection and solutions put forward'.*
2.	What has been the impact on student retention and progression?	Guidance: student registrations; average marks as compared with previous year(s); module completion rate; module pass rate; student retention rate; and student progression. *The implementation of signposting material and better understanding of pinch points and study behaviour are all helpful contributions and (although difficult to demonstrate cause and effect) should positively effect retention moving forward.*
3.	Is there evidence of excellence in teaching?	Guidance: student skills-set (e.g. academic writing; critical thinking; reflection; problem-solving; group-working; digital literacy); student employability; evidence of research-informed teaching; data for assessments (e.g. UK's TEF), programme reviews and accreditation processes; inter-disciplinary collaborations in teaching; accreditation against professional standards; informing policy development internally at the level of department, faculty or University; and informing policy development externally (in another institution or in the sector). *– Not as yet.*
4.	Has there been an influence on discipline-based teaching, research and practice?	Guidance: change in the ways in which subject concepts are taught; interest/confidence in discipline-based research; inter-disciplinary collaborations in research; uptake of outputs in industry practice. *It is envisioned that the lessons and evidence from the project will be integrated into the forthcoming module re-write (beginning 2021-22). Signposting of all Blocks was recommended in the Module Mid Life Review. The project was a collaboration between the STEM faculty (School of Life, Health and Chemical Sciences), and Lesley Boyd (IET) who has undertaken a PhD on collaborative action research using 'learning networks' within the OU, for equitable and inclusive problem solving and integration of views from tutors, module teams and students.*

5.	Have you disseminated the project outcomes?	Guidance: number of publications from the project/initiative and impact factor of individual journals/conferences; publications with students as co-authors; Google Scholar analytics or other institutional analytics (e.g. OU's ORO) on downloads of reports/publications; and sharing of novel research methods/strategies for conducting SoTL.
		Lesley has presented at numerous internal and external events and conferences to disseminate the approach. Rob has presented the approach at two Module Team Chair training events (2019 and 2020) and a STEM teaching conference in 2020. See Appendix D for a list of dissemination activities. Lesley published a work-in-progress paper in Journal of Interactive Media in Education (JIME) in 2019 – see References.
6.	Have the outcomes of the project been adopted by other educators?	Guidance: adoption of the outcomes internally (within the institution) to improve assessment, curriculum design in the same discipline or in other disciplines; adoption of the outcomes externally (outside the institution) to improve assessment, curriculum design in the same discipline or in other disciplines.
		The unfolding problem-solving process which took place as a result of the insider action research has been conceptualised using a rigorous analysis approach. It has been abstracted to a series of categories that are related together, to form a coherent conceptual framework that could be applied in other contexts. The framework conceptualises a collaborative process which whilst not prescriptive, could be used flexibly by module teams, to guide them in their own problem identification and problem solving activities.
7.	Has the project enhanced mutual stakeholder understanding?	Guidance: understanding among students, tutors, learning designers, IT support; for example, their skills, challenges, requirements; a community that SoTL creates and moving outside traditional silos.
		The integration of the tutor, student and module team voices has led to collaborative learning about the complex, interrelated and somewhat intractable issues which the module team and faculty management had been facing. Signposting outcomes have informed possible interventions in the precursor module S112.
8.	Has the project facilitated the personal and professional development of project team and associated stakeholders?	Guidance: improved practice or personal knowledge; developing an analytical mind-set; collaborative or team-working skills; reflective skills; becoming a mentor to others; becoming a champion for SoTL; continuity in SoTL activity by individual educators; students gain skills/expertise (e.g. research, team-working, dissemination) when involved as partners in SoTL.
		Collaborative and equitable team working was a fundamental aim of this research and scholarship project. Joint reflections show that the project has facilitated significant development and growth for the project team members and participants, and development of the module as a whole. Tutors have been empowered to use their teaching experience, provide insights and contribute towards the development of solutions.

9.	Has the project led to the recognition of project team members and other stakeholders?	Guidance: career trajectory that can be attributed to SoTL such as promotions; fellowships or memberships of professional associations nationally and internationally (e.g. Advance HE fellowships); invited speaker to events/conferences internally and externally; public recognition through publications, conference presentations; leadership roles related to teaching and membership of strategic committees; external examiner and membership of external bodies. *Not as yet.*
10.	Has the project helped to foster SoTL culture?	Guidance: stimulating interest in SoTL; inspiring others to conduct SoTL; increased involvement of students in SoTL projects; a stronger overall faculty that values teaching and student learning; renewing/raising faculty excitement about teaching and making them more aware of how they teach; a move towards staff-student collaboration in curriculum design, development and evaluation; recognition of SoTL at par with disciplinary research. *The combination of successive action research cycles of constructing issues, planning action, taking action and evaluating action combined with rigorous qualitative analysis provides structure to the unfolding path towards achieving impact. This may take some time – and could be several cycles over several successive years. The ULTIMATE framework and its associated qualitative codes could be used to provide confidence to module teams starting out in this venture, and to give them a series of steps to follow. The proposed practical guidelines associated with the PhD research will provide implementation tips and guidance for facilitating a collaborative inquiry process with no specialist research methodology expertise.*
11.	Has the project had any financial implications?	Guidance: opportunities for income diversification; effect on costs of modules or programmes. *Not as yet*.
12.	Has the project led to funding opportunities?	Guidance: internal or external funding (source and amount) for follow-on/new projects based on the SoTL project's success. *Not as yet.*

Table 8. Evaluation of impact using the Impact Evaluation Framework (Minocha, 2021)

9. Dissemination

A list of dissemination activities for the project is shown in Appendix D.

10. List of deliverables

- *ULTIMATE framework, available as an Excel spreadsheet file on the eSTEeM project page*
- *Practical guidance to accompany the framework (forthcoming by request)*
- *eSTEeM project page with further list of dissemination resources*
- *The PhD thesis associated with this project was submitted on 29th October 2021, and due to be examined in early 2022. Future publications from the project are planned.*

11. Key References

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https://www.open.edu/openlearn/education-development/learning/teaching-and-learning-tricky-topics/content-section-0?active-tab=description-tab (Accessed 24 September 2021).

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12. University approval processes

- Ethical review – An ethical review was obtained according to the Open University's code of practice and procedures before embarking on this project. Reference number HREC/2017/2480.

- SRPP/SSPP – Approval from the Student Research Project Panel/Staff Survey Project Panel was obtained according to the Open University's code of practice and procedures for the Real Time Student Feedback (RTSF) questionnaires. Application numbers 2019/053, 2019/141, 2020/034.

- Data Protection Impact Assessment/Compliance Check – A Data Protection Impact Assessment/Compliance Check was obtained according to the Open University's code of practice and procedures before embarking on this project. Data Protection registration number – Notification by email at commencement of research project.

13. Appendices

Appendix A: Metrics for the project

Project staff	
Number of academic, academic-related staff who contributed to the project	5 academic and academic-related in STEM 1 PhD researcher in IET 1 data wrangler in IET
Number of days spent working on the project for all staff involved, including the project lead(s)	Not separately identified. Work evolved over three presentations (annual deliveries) of the module.
Number of ALs and number of days contribution to the project	7
Number of students involved as co-researchers/co-collaborators on the project and any student incentives provided	4 students participated in the online Student Feedback Follow Up session. One student couldn't attend but supplied written feedback afterwards. They were provided with an Amazon voucher of £25 each.
Student survey data (if applicable)	
Number of students surveyed (RTSF)	Approx 160 in each of 18J and 19J
Number of student respondents	18 for 18J RTSF in last two weeks of module 39 in 19J single question RTSF before Block 8
Student interview data (if applicable)	
Number of students interviewed	
Student focus group data (if applicable)	
Number of students involved either as interviewers or interviewees	4 students participated in the online Student Feedback Follow Up session
AL survey data (if applicable)	
Number of ALs surveyed	
Number of AL respondents	
AL interview data (if applicable)	
Number of ALs interviewed	
AL focus group data	
Number of ALs involved either as interviewers or interviewees	7 ALs participated in the learning network discussion and the online workshop, out of a total of 11.

Appendix B: Learning design analytics visualisations

The three visualisations were as follows:

1. **Expected Student Activity against Activity Type**

    Figure B1 shows the Activity Types Classification Framework (Conole, 2012) which has been adopted by the OU in order to improve design and evaluation practice in teaching and learning. Modules can be 'mapped' or 'coded' using this framework, and the time a student is expected (using the OU student workload guidance norms) to spend engaged in each of the Activity Types.
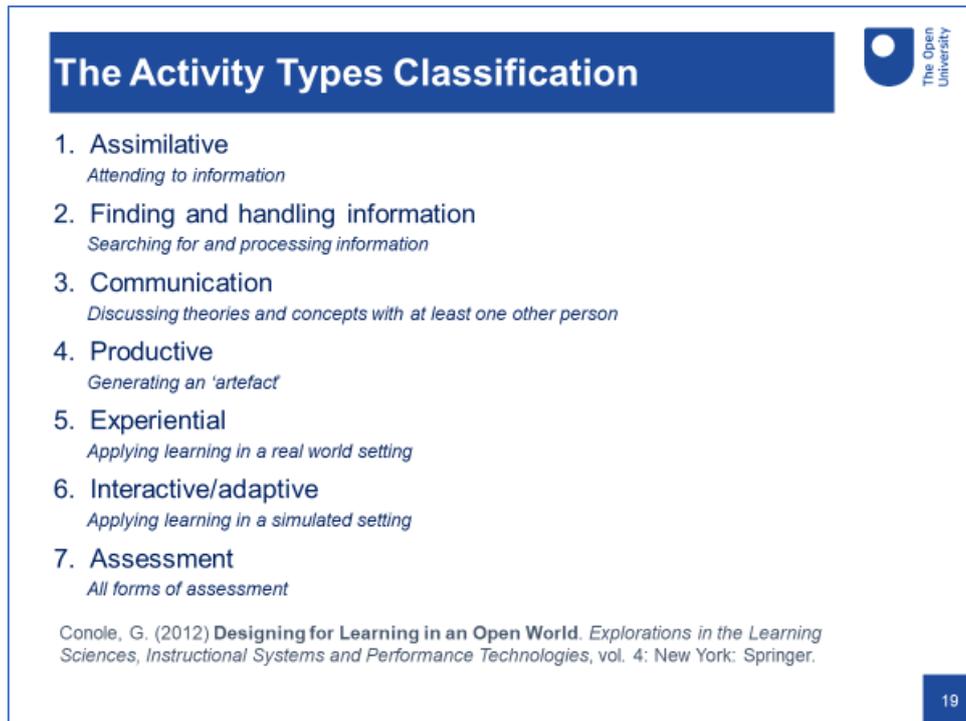
Figure B1. The OU Activity Types Classification Framework (Conole, 2012).

An extract of the learning design mapping data for the initial weeks of S215 is shown in Figure B2. The horizontal bars in the last column represent total study hours, mapped from all the different activity types designed for that week. If this horizontal bar exceeds 20 hours, it will appear in red, which indicates an 'overloading' of that particular week.

All the visualisations underscored the qualitative feedback from tutors that several blocks contained more student workload than was appropriate and exceeded current OU guidelines, especially in the second half of the module. The data was underscoring the qualitative feedback from tutors that the pace and volume of study material was an important issue for students. Thus the learning design mapping was an important artefact to share with the tutors.
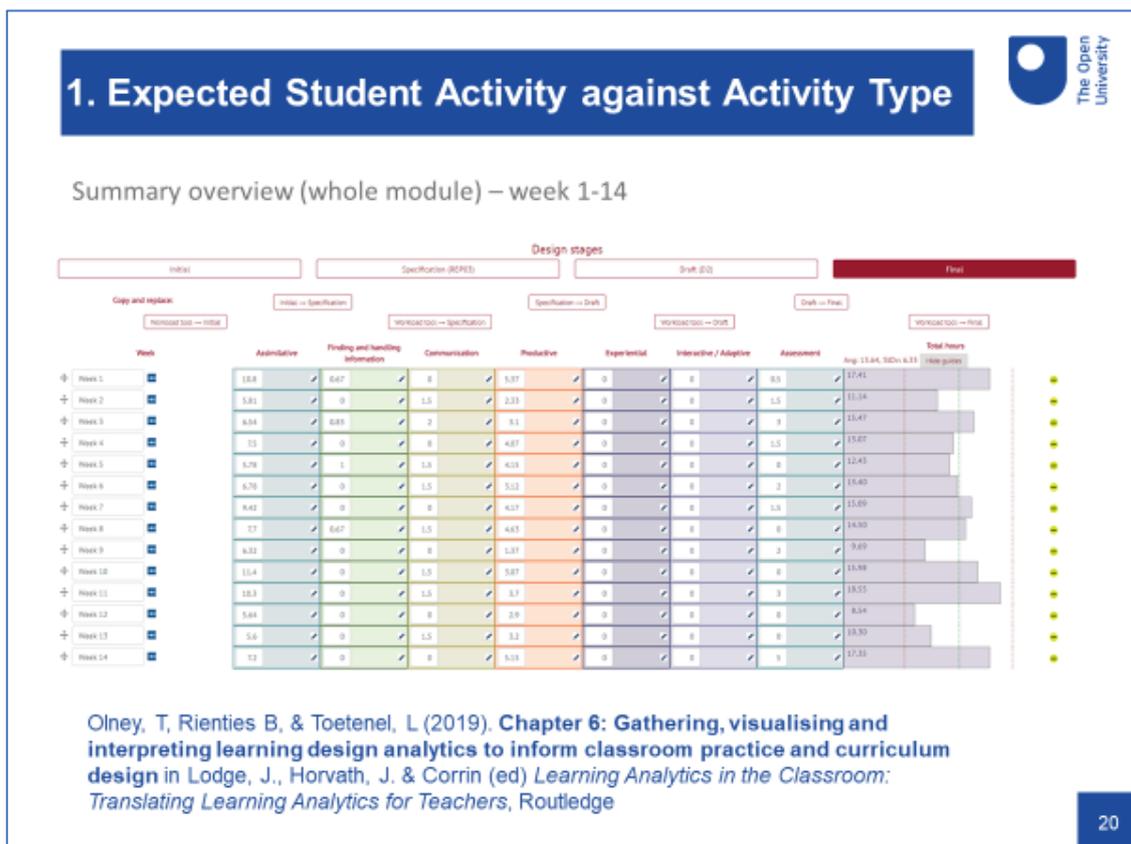

Figure B2. Extract from the Expected Student Activity against Activity Type visualisation

(Learning Design 'mapping')

2. **Expected Student Workload against Advised Student Workload**

Module teams are required to advise students (in the study planner on the VLE) of the amount of time they expect students to spend on different activities within the module. The second visualisation takes the mapped workload and compares it against this advice. This visualisation forms a comparator between the hours that are actually designed in the module, and the advice given to students. It is illustrated in Figure B3.
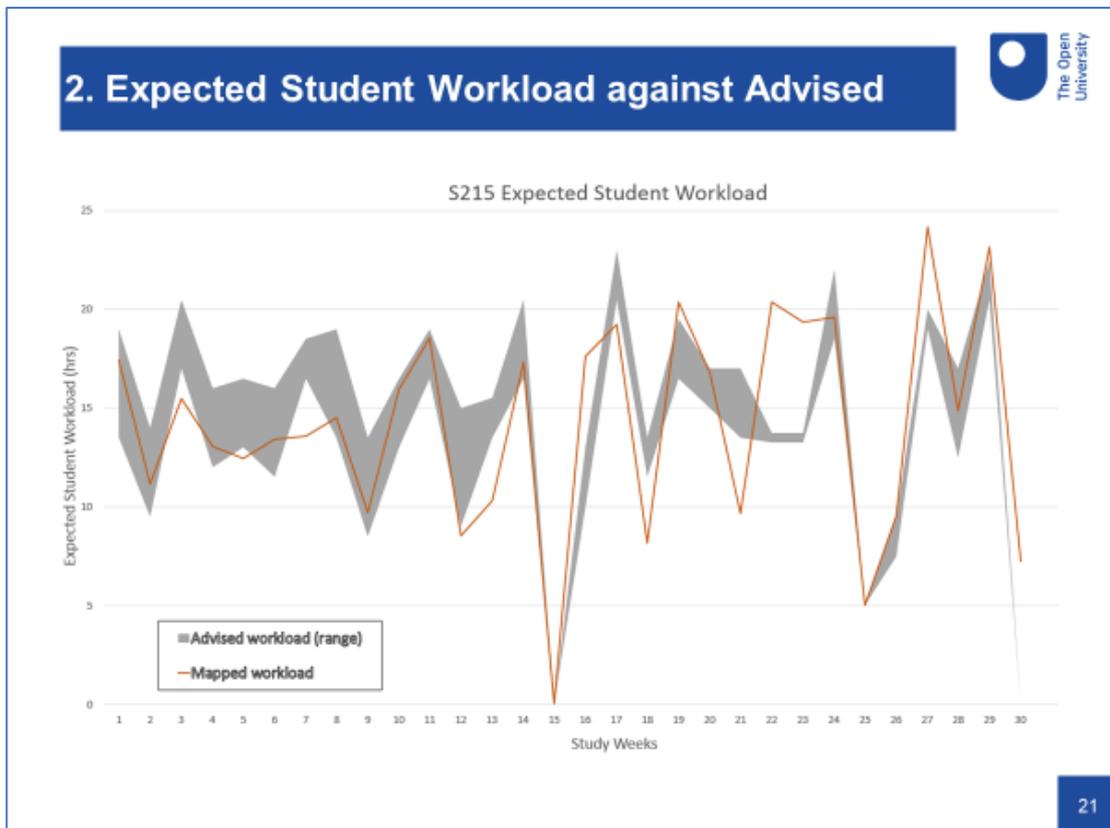

Figure B3. Expected Student Workload against Advised Student Workload

For S215, this visualisation illustrates that for the first half of the module the mapped student workload falls mostly within the advice given to students (despite it being unevenly distributed). However, in the second half of the module there is a clear disconnect between the mapped and advised workload and the uneven distribution between weeks is increased. Several weeks of the module contained more student workload than was appropriate and exceeded current OU guidelines (in excess of 20 hours).

3. **Expected Student Workload by Activity Type against VLE Engagement**

The third visualisation was produced in the course of research carried out by Nguyen, Rienties, Toetenel, Ferguson, and Whitelock (2017). It is illustrated in Figure B4.
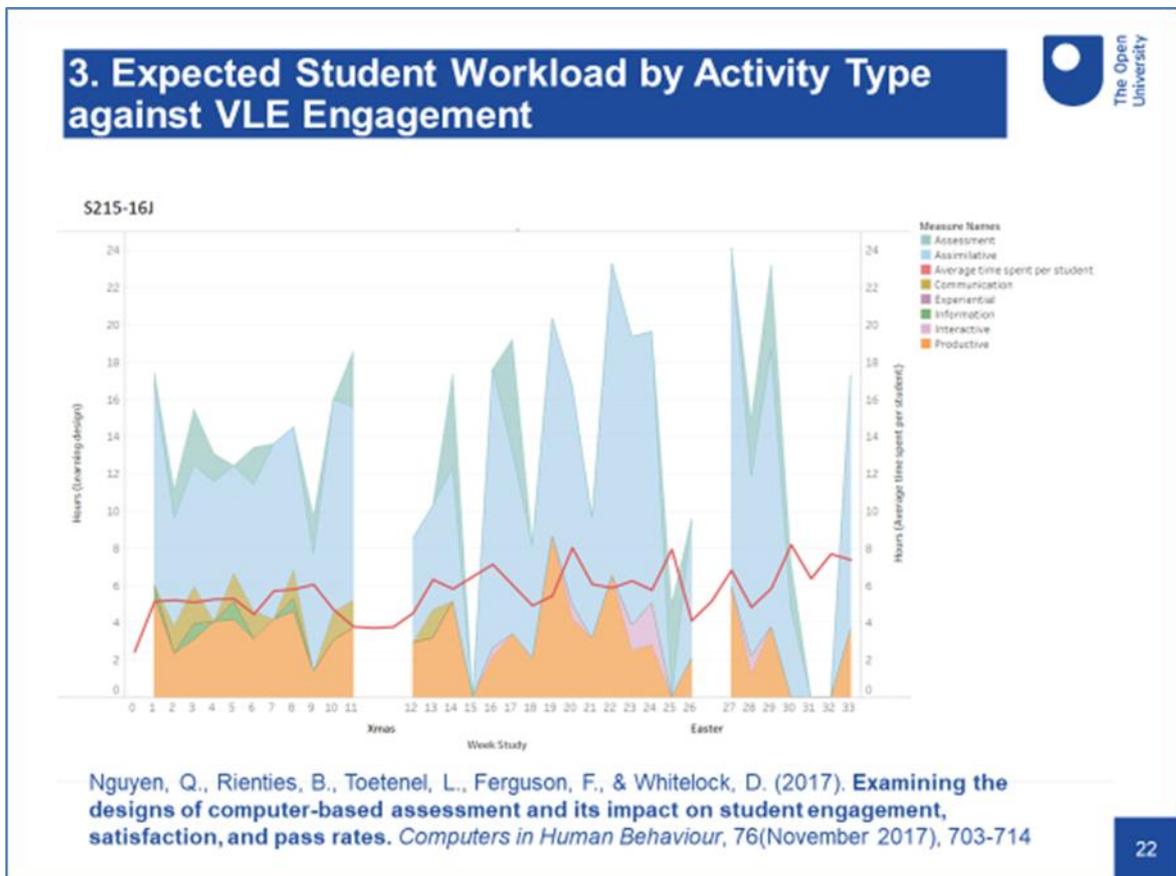

Figure B4. Expected Student Workload by Activity Type against VLE Engagement

In this visualisation , the expected student workload by activity type from figure B2 has been plotted in a stacked graph formation, for each week of study. The red line represents average hours of VLE engagement per student. The plot indicated that average VLE engagement was significantly below the expected student workload, and did not exceed 8 hours in any one week. The visualisation enabled a discussion to be had about the relationship between VLE activity, expected student workload and student study behaviour. As S215 has been designed as a fully online module with no printed study materials provided, the expectation was that VLE engagement would be much higher and more closely correlated with expected workload. Several tutors suggested students were choosing to download and print resources.

Appendix C: Tutor and project leader (MTC) evaluation and future directions for S215 eSTEeM project

The evaluation questions were based on personal reflections, reflections for S215, and reflections on wider transferability. Extracts are shown below.

1. **Personal reflections**
   What has been your experience of this S215 eSTEeM project? If you participated, how did you find it? Is there anything you would like to highlight to us, positive or negative?
   Did you learn more about S215, or did it help you build up a better picture about it?
   Please feel free to answer whether or not you participated in the discussions and workshops.

   Tutor: *'Yes, I participated in the Tricky Topics Workshop and discussions. I found the workshop and discussion a helpful reflective process and an insight into S215 as a whole (from the Module Team, combined AL and analytics perspective), I also found the process collaborative and felt supported in terms of being listened to as an individual and part of the AL team and with the AL suggestions being actioned'.*

   Tutor: *'I thought that the online workshops were good - much better than I anticipated. The use of the forums before/after helped direct thoughts. It was good to have time to reflect on the 'educational' dimension of S215 instead of the chemistry. On the negative side, I thought that we could have done more [I know that resources were limited]'.*

   Tutor: *'I was on LOA when this first started but have appreciated being involved and being asked for tutor feedback to the module team. The data on student participation and the work overload at certain points was interesting and I appreciated being kept informed. I have been pleased to write the signposting material (more to come) which seems to be a help to some students. It seems to be that the problem of helping the "struggling" students by targeting them is going to be an on-going problem. I have used the tricky topics videos as references in my feedback to students who get these relatively basic ideas wrong so these have been very helpful to me as a tutor. I have also encouraged students who have fallen behind to use the signposting material. But overall I have not advertised the signposts to all my students mostly as I do not want to encourage students who are progressing successfully to miss out parts'.*

   Project leader/MTC: *I was involved in both this and the previous Tricky Topics project. I found the opportunity to work closely in a directed and focussed manner with AL colleagues– who were able to bring to the project many years' experience of teaching chemistry across HE and beyond - invaluable in identifying shortcomings with the module. Furthermore the opportunity to produce something concrete to support our students based on this process was very rewarding. Equally important the detailed and considered feedback from students (via forums and online workshops) both to the signposting material and the module as a whole, and the evaluation of their study patterns will undoubtedly inform modification to the existing module and inform the future re-write. The opportunity to work with colleagues outside of STEM broadened my own perspective away from a purely subject focus, towards trying to understand our student's experience and success based on established pedagogical reasoning and research practices.*

2. **Module reflections**
   Do you think this project was beneficial to S215? Please explain further if you wish.
   Do you have any comments or feedback about the signposting interventions?

   Tutor: *'Yes, I feel the project has been beneficial to all involved in S215 (students, ALs and Module Team); reflection from ALs and Module Team was listened to, the process was a collaborative and, significantly, key improvements were made, for students, based directly on the project reflection and solutions put forward'.*

   Tutor: *'The signposting through some Block were a great idea and it was helpful to be able to direct students to the videos. I know that both of these interventions were used by my students'.*

   Tutor: *'The removal of some assessments etc was beneficial to the students. I thought that it was good to explore the pinch-points in the course - and the use of the online OU Analyse was excellent'.*

Tutor: *'Overall I think that it will have helped in the development of S215 and the forward planning for the course'.*

Tutor: *'Yes, tricky topics and signposts are a useful addition to S215'.*

Project leader/MTC*: The implementation of signposting material and better understanding of pinch points and study behaviour are all helpful contributions and (although difficult to demonstrate cause and effect) should positively effect retention moving forward.*

3. **Reflections on wider transferability**

In the OU, it often reported that there is a perennial need to close a feedback loop between module tutors and campus- based teams, to develop a joint understanding of teaching and learning design challenges, and to put tutors as close as possible to the development of solutions.
Could you please reflect on whether this project facilitated your contribution in a collaborative and equitable way, to try to achieve the above?

Tutor: *'Yes, see my comments above. In addition, I felt ALs, the face of tuition for students, were listened to and involved in the problem-identification and problem-solving process during the Tricky Topics workshop and discussion - a welcome collaborative process that is perhaps missing on other modules. I must add that I feel, as an AL on S215 (and [additional module]), I already felt/feel listened to by the respective Module Teams'.*

Tutor: *'I was pleased to be involved and felt part of the 'course team' even though that is not strictly true! The approach taken was inclusive and 'open minded'.*

Tutor: *'Yes, I appreciated being part of this project and so closer to the module team and changes being considered'.*

Project leader/MTC: *'I see no reason why the process adopted here should be exclusive to S215. Other modules will experience similar issues to at least some degree. The enthusiasm of our tutors in engaging with the process (particularly since tangible outcomes were forthcoming), the receptiveness of the module team to tutor input and the involvement of colleagues outside of the module team (and Faculty) engendered a collegiate feel to the whole process and suggests there is an appetite amongst ALs to work closely with a wide range of OU staff in this way'.*

4. **Any other comments?**

Is there anything else you would like to comment on that would help us to implement or improve projects like this in the future? Or any further questions you would like to ask?

Tutor: *'A good project that I found beneficial to participate in, and perhaps more significantly, found being kept up to date with the project and seeing discussions during the workshop implemented and of use to students, welcome'.*

Tutor: *'I think that it was a worthwhile exercise - it stopped a little early - more could have been done. We added support for students and aided ALs with their teaching. However although we added more support material we didn't subtract any written material so 'overload' of content could still be a problem. We didn't really look at how the support material is structured/ordered on the module web site - is there too much, too hard to find etc?'*

Tutor: *'I was thinking about how I could contribute to this – it is quite tricky as I haven't been a tutor on the module since 17J, so haven't seen the changes in operation such as the signposting. I would say that the LDS input was probably the most interesting to me, in particular the workshop (and the talk at the Teaching Conference that Rob and Tom did). It is useful to compare student behaviour on this module with other modules (in particular S112 for me).*

Tutor: *I think the signposting materials could be useful in future module production as well – and is something I am looking to bring into S112. So with that in mind, I would say that your project has helped to inform changes I want to make in S112 for 21J'.*

Tutor: *'Well done Rob, Lesley, Tom and Christine'.*

Tutor: *'As I write this I wonder if we should have an overall signposting document for tutors, I am more stringent in my comments to students who are behind now than I used to be, with the aim of keeping them going and aiming to pass. I still think the individual student positions are the most important consideration but, I do now try to move students on in some places and not in others. For example, I would advise starting Blocks 2 and 5 on-time. If students have not done the Block 5 experiment by the debrief tutorials then they should miss out the experiment but still attempt the write-up for the TMA03 question. This might be useful for new tutors but would have to have the agreement of all tutors and module team as we may differ on what is the most important'.*

Appendix D: List of dissemination activities

- OU Professional and Digital Learning (PDL) Research Group, July 2021. Lesley Boyd: presentation on completion of the PhD research

- OU eSTEeM conferences 2021. Lesley Boyd: presentation on project completion

- OU WELS PGR Conference, March 2021. Lesley Boyd: presentation on the PhD research and project progress

- OU STEM Teaching Conference, Feb 2020. Tom Olney and Rob Janes: Project update focussing on analytics

- OU Module Team Chair events, March 2019 and 2020. Rob Janes: presentation on project from MTC perspective 'Working collaboratively in teams at the OU'

- Learning Design Cross Institutional Network (LD-CIN) Dec 2019. Lesley Boyd and Tom Olney: presentation on the PhD research and eSTEeM project, with learning design analytics workshop

- Work-in-progress published paper:
  Boyd, L. (2019) Using Technology-Enabled Learning Networks to Drive Module Improvements in the UK Open University. Journal of Interactive Media in Education, 2019(1), p.16. DOI: http://doi.org/10.5334/jime.529

- University Forum for Human Resource Development (UFHRD) 20th Anniversary Conference, Nottingham June 2019. Lesley Boyd: presentation on 'Using technology-enabled learning networks to drive module improvements in the UK Open University'

- Horizons in STEM Conference, Kingston University, July 2019. Lesley Boyd and Christine Leach: presentation on 'The search for collaborative improvements: using learning networks and learning analytics to drive module improvements in STEM at the Open University'

- OU eSTEeM conferences 2019. Lesley Boyd, Rob Janes and Tom Olney: presentation on project progress

- OU Open TEL Show and TEL conferences 2018-2020. Lesley Boyd: presentations on research and project progress

- OU CALRG (Computers and Learning Research Group) conferences 2016-2020. Lesley Boyd: presentations on research and project progress.