Final Report for the eSTEeM project entitled The impact of technology on the teaching and assessment of 'systems diagrams'

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Summary

Diagramming is a creative process where the context and tools used to create the diagram may hinder or help students in learning both how to create diagrams that represent a situation and how to learn about diagramming and the situation. These tools equally provide opportunities and challenges to tutors in teaching about and assessing these diagrams and providing feedback, particularly for students studying at a distance.

There is a long history of teaching systems diagramming as a 'thinking and doing' technique at the Open University and of evaluating the mediating effect of technologies on this technique. A recent manifestation of teaching systems diagramming has been in two mainly online undergraduate modules, T219 Environmental management 1 and T319 Environmental management 2, where students share diagrams with other students throughout the duration of the module, have to work collaboratively on diagrams in small groups for one part of the module and include diagrams in all assignments. This report describes the rationale for this study, the means by which data was collected and how it was analysed. It looked at student postings in online forums; samples of assignments with specific questions about diagramming as a practice; an online survey of students who studied one or both of the modules; and telephone interviews with a small sample of students and tutors.

The study focused on students' experiences of using diagrams before, during and outside their study of both modules to better understand the main factors that influence their educational value, in particular the part that familiarity, experience and confidence in the technique and the technology played in supporting learning and whether the act of sharing helped or hinders that learning.

It was found that few students seriously used diagrams before their study of the modules; that they were either enthusiastic or sceptical about their value although most said they would use them in future; that the number of diagrams and the technologies used to create and share them were often burdensome in the two modules investigated; and that the group work could provide a better experience for using diagrams but that this too could be blighted by timing and technical issues. In addition many students disliked the mainly online delivery of the two modules, wanting printed books, and would like to have seen face to face tutorials where diagrams could be created and discussed. Open Design Studio has not proved helpful as a sharing technology compared to other modules and more work is needed to understand this and to find a technological solution that does suit students and ALs alike to compensate for the lack of face to face events.

Introduction

There are some disciplines where diagrams can be important for sense-making, evaluation and communication, such that they form a significant part of some programmes of study that students have to learn about and use. Systems thinking and practice is one such discipline where diagramming as a form of representing peoples' perspectives on particular situations is considered important; and equally it

is a discipline that has mostly been applied to managing complex or messy situations in which people are trying to take action (Checkland, 1999; Reynolds and Holwell, 2010) and unsurprisingly has been extensively applied to managing complex environmental situations with many actors and stakeholders (e.g. Seiffert and Loch, 2005; Ison, 2010).

There is a long history at the Open University (OU) of teaching (and researching) systems thinking in practice (Lane, 1999; 2013) and of applying it to environmental situations and sustainability (Blackmore et al, 2015) although it is by no means unique in doing so (Karlson et al). However it is more unique in that it has largely been doing so through distance teaching and learning. Distance teaching and learning of practical subjects and skills is challenging in many ways. Firstly, there may be issues of access to necessary technical equipment and secondly of sharing and collaborating on particular activities. Secondly, in a classroom setting it is possible to use very low-tech means (pens and paper) for individual students or group of students to collectively (and synchronously) create, share and discuss diagrammatic representations of complex or messy situations under supervision or guidance of a teacher or instructor. Thirdly, for distance learners distributed through time (zones) and (geographical) spaces around the world similar activities more often rely on the appropriate use of (asynchronous) information and communication technologies. Equally, whereas a classroom based cohort in a traditional university largely involves interactions between a single teacher and a relatively small group of full time students taking one, possibly two, related degrees, a distance learning module at the OU often has a large population in the hundreds, with students taking the module part time as one component of several different qualifications, and with groups of 20-25 students allocated to a tutor.

In the past the OU relied on the postal system for students to submit their assignments, including hand drawn diagrams relevant to that assignment. Some students were also able to practice drawing diagrams individually and collectively in optional face to face tutorials (the geographical and temporal availability and accessibility of such tutorials has diminished in recent years). All students on some modules could also attend a one week discipline based residential school (originally the Systems Summer School from 1972 to 2000; later on the residential school module TXR248 from 2000 to 2007) where they could have extensive involvement in creating, sharing and debating diagrams. However no face to face tutorials or residential school modules are now run alongside such modules as costs of running them and demands on students' time, many of whom were in full time work and faced difficulties in attending, made them unviable parts of the curriculum except for subjects requiring the use of specialist scientific or technical equipment in laboratories or workshops.

From the 1990s onwards the widespread adoption of personal computers and the emergence of the internet (in particular the World Wide Web) began changing the ways in which distance learners could create and share their diagrams. Firstly in the 1990s they could use graphical packages to produce diagrams to include in assignments. Second, the teaching and learning of diagramming as a skill that had been principally done through static text based material (sometimes with audio or video elements) could be supplemented and strengthened by being presented in dynamic interactive media in the 2000s (Lane and Morris, 2001; Lane, 2013). A version of the interactive media resource used in the 2000s can be found at http://systems.open.ac.uk/materials/T552/.

Previous research at the OU has shown that:

> *'students on a distance taught systems module preferred to learn diagramming in face to face situations as part of a group even though that was the least used mode. However, learning diagramming by themselves through a mix of technology mediated modes was not seen as substantially less valuable. Both print and web based teaching modes were the most popular in terms of use by the students. This indicated that the mediating technologies available at the time could successfully substitute for face to face learning of diagramming skills in the view of the learners themselves. However, the nature and capabilities of the technologies have developed since then to include videoconferencing or other virtual collaboration tools which can replicate some of the features of a group based face to face teaching model. New studies are needed which both broaden and deepen our understanding of diagramming in systems practice and how technologies have supported the teaching and learning of diagramming for systems thinking in practice.' (Lane, 2013 p 328).*

This report details a recent study conducted in 2015 on two new, almost wholly online, modules on environmental management, where systems thinking and practices, particularly diagramming, are a defining feature. As well as nearly all the teaching materials being online, all interactions between students and tutors were online, and students had to undertake a significant group task online.

The modules

The focus of this study was mainly on the experiences and perspectives of students, supplemented by those of tutors, within two related modules, namely T219 *Environmental management 1* and T319 *Environmental management 2*. These two 30 credit modules are core components of B/Q72 BSc in Environmental management and technology; but they are also optional modules within B/Q19 BA in Environmental Studies, the BEng (B/Q65), and also the Open degree (BD/QD)(see also Annex 3 for some key data on the modules).

The two modules have a similar structure and philosophy as well as approaches to teaching, learning and assessment. The module is broken down into three equal blocks of about 100 hours. The first block looks at issues related to environmental management at the domestic or household context; the second deals with environmental management within organisations; and the third block covers environmental management within community settings.

Each module uses systems thinking and practice, including the use of diagramming, as a key toolset alongside an action learning model. Throughout each block there are a number of online activities, many of which include producing diagrams and sharing them with their tutor group or the whole module cohort through a version of Open Design Studio called the Display Wall, and at the end of each block there is a tutor marked assignment (TMA), again which requires the inclusion of diagrams as part of the assignment. The third block requires smaller groups within each tutor group to spend 6-8 weeks on a group activity that informs the third TMA (while the activity is done in groups, students produce individual TMAs but have to reflect on the group process). Finally, students have to produce an end of module assignment (EMA) which once again requires the inclusion of a number of diagrams.

There is a consistent set of 'systems diagrams' taught within each module and which students have to both learn and apply. Some they might have met before in their studies or even in their working lives but for most students mastering the purpose, value and technicalities of this set of diagrams represents a significant outcome of the modules. The core set of 'systems diagrams' is:

- Spray diagrams
- Systems maps
- Influence diagrams
- Causal loop diagrams
- Rich pictures

In calling these 'systems' diagrams the module teams were not claiming that these diagrams necessarily originated with the discipline of system thinking itself, nor that they are unique to that discipline. They are being called 'systems' diagrams because they are diagrams that are regularly used as ways of thinking about and representing aspects of complex systems and are key features of systems approaches to managing complexity where situations are looked at as if they were a system from the perspective of those people creating the diagrams (Armson, 2011; Checkland, 1999). The teaching of diagramming as a technique within both modules is covered statically in a printed Resource Book[1] and dynamically in an online Resource Bank[2] while all the remaining online teaching materials themselves include many examples of the diagrams as applied to environmental management situations. Lastly, students are also pointed at a free interactive Guide to Diagrams on OpenLearn.

Finally, T219 was first presented in 2013J[3] and T319 in 2014J. This study primarily relates to students taking the 2014J presentations of both modules, although some references will be made to other presentations where appropriate. There were 277 and 135 students who started T219 and T319 respectively and 171 and 94 who completed the module (the many reasons for non-completion are not the focus of this study, including the 29 and 5 student respectively who deferred their studies during this presentation to a subsequent presentation [see annex 3], but it is important to note that the surveys only involve students who have completed the modules). Of the 135 students on T319 2014J 44 had taken the first presentation of T219 in October 2013 while seven students started both modules concurrently in October 2014.

Methods

The project was approved by eSTEeM in March 2015 and the budget and final timetable agreed in April 2015.

During June/July 2015, I sought and obtained a favourable opinion by the Open University Human Research Ethics Committee by Chair's action (HREC/2015/2070/Lane/1); alongside successful applications to the Student Research Project Panel (SRPP application 2015/064) and to the Data Protection Coordinator. The SRPP approval was particularly useful as it meant that the Student Statistics and Survey Team would help me with administering the online survey and selecting the sample of students.

A number of different means were used to collect mostly qualitative data on the experiences and perspectives of students (and tutors) with 'systems diagrams' in these two modules in the four months after the module had finished (July to October 2015). It was decided to do this post hoc data collection rather than during the presentations so as not to have any impact on their studies, although it is recognised

[1] Available as an ebook at https://learn2.open.ac.uk/pluginfile.php/1206755/mod_resource/content/4/Resource%20book.pdf
[2] See https://learn2.open.ac.uk/mod/oucontent/view.php?id=490160
[3] This J indicates an October start date

that perspectives and recall may change over time. It was also decided not to collect or use any personal data on the students within the analyses beyond knowing which module(s) they had studied as the prime aim was to thematically analyse the data for its qualitative aspects and not its quantitative aspects and to build up a representative picture by triangulating the analyses of the different data sources.

First, both modules' online forums were examined in August 2015 to see if there were any conversation threads that involved diagramming and later analysed to see what the substance of those conversations was. Each module has 5 distinct forums: a café forum; one for each of the 3 blocks and an EMA forum). T219's 13J and 14J presentations and the T319 14J presentation were examined.

Second, the EMA for T219 14J had a part of one question that asked: '*Write a short commentary on your experiences (both positive and negative) of using systems diagrams in making sense of environmental management situations'*. A semi-random sample of 58 of these EMA answers was taken in August 2015 for later examination and analysis.

Third, a short online survey of 233 students who had studied T219 and/or T319 in 14J and who had not been involved in another special survey that year was administered by the OU's Student Statistics and Survey Team (some T319 students may have taken T219 in 13J but this was not part of the selection criteria). This questionnaire involved 9 questions of which 8 mainly asked for free text responses (see Annex 1). A link to the survey was sent to 233 students on 17th August 2015 and a reminder email was sent to 212 students on 1st September and the survey remained open until 15th September. 42 responses were received, 30 where all answers were completed and 12 incomplete responses, giving an overall response rate of 18.0%. The Survey Team then provided a spreadsheet containing all the raw data from the respondents as well as a pdf copy to enable analysis.

Fourth, a sample of six students from the 12 who had agreed to do a follow up interview within the online survey were contacted and interviewed by a freelance educational researcher in October 2015. The students were asked six questions (see Annex 2) by telephone, their responses being recorded and then transcribed before being thematically analysed.

Fifth, three tutors from T219 and T319 nominated by the respective module team chairs, were also interviewed by telephone in October 2015. They were asked a separate set of six questions (see Annex 2) with their responses being recorded and then transcribed before being thematically analysed.

Results

Module forums

Diagrams and diagramming was not a significant topic in any of the forums in any of the presentations. It was the subject of only 11 discussion threads out of a total of 136 on T219 13J; 5 of 97 on T219 14J; and 11 of 291 on T319 14J. No single thread involved more than 10 postings and most were under six postings. Almost all the threads on diagrams fell into one of three fairly equal categories:

1) Queries from students about the 'rules' around drawing diagrams in the modules and for assignments:

> *I have been experimenting with rich pictures and enjoy drawing them. However, I have tried doing one using cartoons and images off the internet and really enjoyed the approach. Can I use this approach in TMA's? and if so are there any conventions I need to follow ?* T219 13J

2) Queries from students about the technical aspects of creating digital versions of diagrams for including in assignments or posting to the Display Wall:

> *I find drawing and writing difficult due to problems with my hands so I've been using software to help. My tutor suggested I mention it in case it could be of help to anyone else.*
>
> *For drawing rich pictures I've been able to borrow my daughter's iPad (very occasionally!) and I used an app called Penultimate.*
>
> *For all the other diagrams I've used a free trial of Inspiration (free for 30 days). It makes it really easy to draw and link the components within the diagram. I was also told about Microsoft Visio but in true Microsoft fashion it's a nightmare to use and nowhere near as good as Inspiration though that is just my opinion! I did follow the tutorial in Inspiration so maybe I should try the same for Visio! Previously I was using Power Point and taking a screen shot but Inspiration is much faster and easier.*); T219 14J

3) Sharing of found or self-generated diagrams on environmental topics by students and AL moderators, often but not always in the styles used in the module:

> *[AL] Another diagram that aligns more with Block 1 themes- climate change, and the role of the individual.*
>
> *This blend of spray and rich picture diagramming below was created by Sharon Genovese, founder of an anti–global warming group called "Live the Solution". A lot of the words and symbols seem to be associated with the DOING stage of the T219 cycle.*
>
> *The mind map, as well as several others, are featured in her free e-book Global Warming: A Mind Mapper's Guide to the Science and Solutions (PDF, 5 MB / 103 pages). http://live-the-solution.com/mindmaps/.* T219 13J

Of the five main diagramming types used in the modules rich pictures dominated all 3 categories.

T219 EMA answers

The 58 answers sampled were copied and pasted into a word document and coded A, B, C through to Z, then AA through to ZZ, and finally AAA through to GGG. They were then examined and categorised for two aspects. The first was the predominant narrative approach used; the second was for particular issues to do with the process of diagramming.

The question was designed to get a personal reflection on the students' experiences of diagramming, both good and bad, and yet the narratives used in the answers was surprisingly varied. Six sets of narratives were identified, five of which provide a spectrum from the very positive to the very negative responses. These are described below.

At one extreme is the ***sceptic*** (n=2; 3.4%) where the students did not find the diagramming at all useful:

> *My overall experience of systems diagrams has not been a positive. Systems diagrams do not allow me to be or feel natural in communicating my thinking effectively as I should be and therefore I struggle when trying to fulfil my sense making of environmental management situations. Systems diagrams feel like a forced and channelled method of expressing this, hampering/suppressing my creative and freethinking flow*. (Answer VV)

> *Systems diagrams are a difficult process for me, I do not use them as part of my learning process and have had a long history of disregarding their usefulness. I prefer to read and write with simple lists of information.* (Answer II)

The fact there are so few sceptics could be influenced by few wanting to take such a negative line in an EMA on a module which promotes diagramming plus it could be that there were fewer sceptics amongst completers because they were more likely to have withdrawn from the module because of their views on, and difficulties with, diagramming as a thinking and communicating technique.

Next are the ***sceptical converts*** (n=15; 25.9%) who initially expressed being wary of or unconvinced of the value of diagrams but who recognised their usefulness by the end of the module and were now generally positive:

> *I have found the process of using system diagrams quite challenging to learn as a process due to the fact that this style and form of presenting data was an alien way of working for me. I have however found the experience very valuable and the skills that have been learnt will be put into practice and used going into the future with in my present line of work*. (Answer M)

> *At the start of the course I found systems diagrams extremely pointless and time consuming. I felt I could produce exactly the same ideas by drawing a bullet point list and taking a tenth of the time to do so. However at this point of the course I am beginning to see they have some benefit.* (Answer N)

> *I found drawing multiple diagrams to be tedious, particularly as I had to learn how to use new software to enable me to draw them. I persevered and gradually they started to make sense, showing me why they are valuable in analysing and interpreting an environmental management situation. They help to focus on the issue and help to highlight potential problems*. (Answer AA)

> *I began this module having never encountered the term systems diagram; and not regarding myself as a visual learner, the first negative experience was realising that I had to produce these diagrams throughout this module.*
>
> *However, whilst I have found the module challenging and equally interesting, I have not really had the negative experiences regarding systems diagrams that I first envisaged.* (Answer DD)

Close to the sceptical converts are those with ***mixed responses*** (n=14; 24.1%). These students detailed what they liked and did not like (as might be expected from the question) but did not portray such a strong negative attitude from the outset nor be as strongly positive at the end:

> *The use of the systems diagrams for me was varied* (Answer E)

> *I found certain diagrams helped at different stages* (Answer K)

> *My experiences of using systems diagrams has been varied but most importantly I have come to understand the importance of them when making sense of E.M situations especially when working with people* (Answer KK)

> *The use of systems diagrams was a new experience for me, prior to studying T219 I had not used them. My experience and feelings are now mixed*. Answer QQ)

> *I can't say that I have found using diagrams easy and at times immensely frustrating, although some made more sense than others*. (Answer UU)

At the other end of the spectrum were the ***enthusiasts*** (n=16; 27.6%), who provided an overall positive account of their experiences with diagrams and any doubts were over the time needed to create them or technical issues with creating them:

> *I enjoyed using systems diagrams to make sense of environmental situations.* (Answer L)
>
> *I generally had a positive approach to systems diagrams; I found they clarified situations in my mind; they helped me understand case studies better for example. I like how they can break things down into component parts; and can link seemingly unrelated issues to a common factor.* (Answer S)
>
> *My experience of using system diagrams was great and I enjoyed personally in using them during the tasks given. I think I understood well the reasons and direction of the different diagrams used during the study which helps me in mind to accept the explained topic*. (Answer U)
>
> *I have enjoyed using system diagrams as a method of working. I think they are a good way to get your thoughts on to paper to interoperate ideas and processes*. (Answer NN)
>
> *The use of systems diagrams in the course has been highly beneficial to my personal understanding of both particular case studies and course content as a whole.* (Answer CCC)

The fifth narrative set, ***the party line*** (n=11; 19.0%) are largely sub sets of both the enthusiasts and mixed responses in that they exhibit features of those narratives but are written in a more abstract and impersonal way, in effect repeating what was said in the module material rather than providing a personal reflection:

> *The systems diagrams used in course T219 have offered a means to organise thought processes and display information. Influence diagrams, scatter diagrams and casual loop diagrams offer the means to display flows of complex connections to an area under investigation. The course offered different diagrams that could be more suitable to different mind sets and audiences*. (Answer F)
>
> *Systems diagrams help to focus on the specifics of environmental management situations such as the specific systems they affect and what lies within those systems. However this can also be a negative as the system boundary and the context has to be broken down into smaller subsystems to identify these.* (Answer H)
>
> *Systems diagrams are invaluable tools in understanding environmental situations. They help to make sense of situations by capturing them all in one diagram. They are also extremely flexible because they can be applied to any situation.* (Answer R)
>
> *Systems diagrams provide a graphic format to explore the components, interconnectivity and complexity of any system of interest.* (Answer BBB)

Finally, there was a small number who ***answered a different question*** (n=2; 3.4%) in that they focussed on systems thinking more than diagramming:

> *Systems thinking was more difficult for me than environmental management. I found the diagrams straightforward to draw, and I understood what they represented. But what took time and effort to master was applying the module's systems thinking approach to environmental management*. (Answer I)

> *However the t219 module has gives an insight into concept of system thinking, a new experience of viewing the situation as a system which can be divided into individual components.* (Answer DDD)

As well as these narratives there were three other issues which were each present in around ten of the students' answers. The first of these was students professing an ***inability or lack of confidence in drawing***:

> *However, initially using diagrams was difficult. I was not confident with my drawing skills. This meant I restricted ideas to those I could draw. I learnt to not rely on my first attempt and to redo drawings. My drawing skills improved with practice and that made things easier.* (Answer K)

> *As someone who doesn't draw or have any past experience of using diagramming I initially found the use of systems diagrams to be a challenge*. (Answer V)

> *As I am not good in drawing pictures or symbols I prefer not to use rich pictures when need to represent a particular situation or issue. It is quicker and easier to write down the elements of a situation in the form of words and blobs using a systems map.* (Answer W)

> *Initially I found it hard to use diagrams as I was never really a visual learner, I liked to just write down bullet points.* (Answer RR)

> *Certain ones I didn't engage with as much such as rich pictures. This is possibly due to my own embarrassment of how bad my drawing is, or just that I felt it didn't create a picture of the situation as clearly as others did.* (Answer YY)

The second issue was about how ***time consuming*** drawing diagrams could be:

> *I found working with systems maps problematic due to difficulties in making decisions about what to/to not include within the system boundaries. This became time consuming as having to often change boundaries but the end result was a more accurate reflection of the situation.* (Answer L)

> *My negative experience of systems diagrams regards the time they can take to produce.* (Answer S)

> *In block 1 the early rich pictures I drew took a considerable length of time and I found it frustrating thinking I could have typed up a list to convey the same points in less time.* (Answer V)

> *Initially systems diagrams appeared cumbersome and time consuming to draw, I wondered why that if all the information was presented to you, why did you have to put it into diagrams? However, using the different types of diagrams throughout the course I began to understand their value – especially when it came to a complex and messy environmental management issue like fracking.* (Answer LL)

The third issue revolved around ***group working***. In most cases the students said how much better they found doing diagrams in groups rather than individually:

> *I enjoyed the group work as I felt it simulated as closely as possible diagraming in a real situation. I didn't appreciate until the 'water stories' how diagramming can convey information to a wide group of people, enabling them to work together.* (Answer G)

> *Systems diagrams were a helpful tool most of the time. However, it felt that they are best used when working in a group, so they reflect understanding of multiple stakeholders, otherwise diagrams can sometimes be just an affirmation of their creator's views and can be biased.* (Answer J)
>
> *I have found systems diagrams useful in understanding and making sense of environmental situations, although, their level of usefulness has depended on the situation and method of working. For example, during the collaborative Maltese work, the drawing of a group rich picture helped to galvanise the group and create a reference piece which the group referred to and ensured the outcomes related to the issues and tasks identified*. (Answer P)
>
> *However by the time we got to the group activity I could really appreciate the benefits of rich pictures as a way of making sense of an environmental management situation. The way we pulled our individual rich pictures to produce one collective vision was invaluable throughout the task.* (Answer V)

Nevertheless, one or two students' answers noted downsides to group work:

> *In this module the only downside I found was reluctance of some students to share their diagrams with the group.* (Answer D)
>
> *Systems diagrams take time to create and not all team participants see the benefit.* (Answer Y)

Overall, these findings indicate that the value of systems diagrams in environmental management can be successfully taught online but not everyone takes to this form of representation whether through inclination or ability, that learning about diagrams and diagramming is a challenging and time consuming process and that collective approaches (i.e. diagramming in groups) may be beneficial. None of this is surprising and most fits in with previous research in this area. The one question that does arise is whether the actual student workload related to diagramming is much greater for most students than expected and planned for by the module teams.

T219/T319 online survey

Of the 42 respondents to the online survey questions (see Annex 1) 73.8% had taken T219 and 38.1% T319 (with 11.9% having taken both; hence total greater than 100%).

Similarly, 40.5% had used systems diagrams before studying the modules (and 59.5% had not).

Prior use of diagrams

Of those that had used diagrams before studying the module(s) 8 out of 17 (47.1%) had done so when studying other modules or courses and 7 (41.2%) had done so through their work. For some it was not clear whether it was through studies or work as they mentioned a topic only e.g. *used mind maps, so similar for design*.

Reactions to having to use diagrams

The reactions of those who had not used systems diagrams before can largely be grouped into the four main categories found in the T219 EMA answers: enthusiasts, sceptics, sceptical converts and mixed responders.

There were five enthusiasts among the 25 responses (25.0%):

> *Intrigued and interested*

I found the study materials clearly explained the function of and how to create the various systems diagrams. Coupled with feedback from the tutor and also with discussions raised on the various student forums and further research by myself I was happy to learn about systems diagrams.

I was quietly pleased.

There were also three sceptics (12.0%)

time consuming and not worthwhile

Wasn't too interested in this aspect of the course - it felt like forcing ideas to conform to a certain scheme/format. While it helped with exploring some new ideas in the diagram, for myself at least the overall time and effort did not seem to be worth the end results.

The majority (ten) were sceptical converts (40.0%):

Curiosity followed by confusion and frustration as to how to draw in an electronic format. A little angst as to the time required to complete a diagram followed by a lingering doubt of "am I happy with it?". However, the process of constructing the diagram, including multiple re-draws, gave clarification to my own ideas and was quite enlightening. I now use them for all sorts of everyday applications and find them especially useful when trying to explain complicated situations.

I was surprised that systems diagrams form such an important part in environmental management and was initially sceptical about their value.

I was concerned of my ability to do diagramming especially with rich pictures as I'm a terrible drawer. The guidelines however were clear and once started I really enjoyed and with times for each TMA it came more and more natural.

Initially I was uncertain and fairly anxious about it particularly as those more artistic did produce better looking diagrams but became intrigued by the aid they gave to analysis and thought processes.

A further four gave more mixed responses (16.0%):

At first I was intrigued and thought that it would be easy. It was not. I found them difficult to understand, not helpful and too heavily focused on.

Reactions included: knowing that had lack of drawing skills; understanding whether the actual systems diagrams would be beneficial long term for employment purposes or if it was just a necessity to understand for this module only; ability or not to be able to upload hand drawn diagrams for online requirements.

Horror at drawing and presenting what I drew to others. I have never done drawing apart from technical drawing so trying to be an artist was a nightmare. The by hand only rich picture (not knocking the idea but my drawing standard is bad) was a challenge and very time consuming the way it was explained to do.

It is clear that relevance, confidence in drawing ability and role of technology are consistent themes in these comments.

Most and least useful diagrams

Of the 30 completed responses to this question two students (6.7%) declared that none of them were useful (e.g. *None of those required on the course were of any use*

and were a distraction from the subject matter) and four (13.3%) that all were useful (e.g. *I found them all to be useful in different circumstances*). The rest showed differing degrees of enthusiasm for different diagram types with all featuring in the most and least columns except for spray diagrams which only featured in the most useful column. Influence diagrams got the lowest number of mentions (three liking; two disliking) and rich pictures the most number of mentions (ten liking; 6 disliking). The only type with more dislikes than likes were causal loop/multiple cause diagrams.

The reasons why students liked diagrams were because they helped explore situations, providing overviews, and defining relationships and structure

> *I found Systems Maps, Influence, Multiple Cause and sign graphs the most useful as they enabled me to visualise the structure of the environmental system and the interrelationships between stakeholders most clearly*
>
> *I found mind maps most helpful for capturing my personal understanding of a system, illustrating the nature of connections between factors and helping me remember the situation as a whole*).

The reasons for not liking certain diagrams were they were time consuming to draw, ended up being too detailed or messy and provided little or no learning benefit:

> *Generally I preferred diagrams which highlighted interrelationships e.g. causal loops and found 'brain dump' approaches such as rich pictures less useful, as well as time consuming and tedious to produce* and *I personally didn't do well with multiple cause diagrams. It is perhaps due to my own thinking style/learning style, but I found these diagrams a bit messy, and therefore not very helpful*.

Use of technology

Most of the 30 responses focused on the use of technology to create and submit diagrams but a small number (six; 20.0%) focussed on broader issues:

> *This course was made difficult by the over use of the diagrams. If I wanted to learn about diagrams I would look for a course on the subject*
>
> *As the entirety of T219 was presented online there is little distinction between use of technology for studying and assignments. The gallery where we were supposed to upload our diagrams was ineffective as a collaborative learnign tool as no-one commented on posts, despite requests for feedback. We were encouraged to draw diagrams freehand rather than to use clipart for rich pictures but this was ignored in our group rich picture task. I woudl scan freehand drawn systems maps and pictures for upload into assignments. Freehand allowed me to obseve my personal interpretation more clearly. Mostly my experinece of technology within this course was negative and reduced the enjoyment and effectiveness of the learning. All course reading was online which drastically reduces capacity to interact with the text. It also reduced my capacity to refer back to find and check information. It neither had my notes and marks as guides or any physical sense of how far along in the course a particualr page had appeared.*

Of the remaining 25 the biggest number (eleven; 44.0%) hand drew and then scanned their diagrams, often following advice:

> *I hand drew the diagrams as I found this fastest and easiest. It was trial and error related to how effective the diagrams were in relation to the situation*

being assessed. Lots of drafts sometimes. Didn't have the time or patience for fiddling around with software that I had to hunt around for myself);

While another two (8.0%) hand drew their diagrams and then photographed them through a lack of a scanner, and which was troublesome:

> *As not au fait with drawing diagrams using the computer, this meant that all diagrams had to be hand drawn. Then the complication was how to upload the diagrams into the assignments and online. I had to use the phone on my camera to be able to take the photo, then email it to myself and then download - no ability to scan the diagram. Tutor expected hand drawn diagrams to be scanned - this was not possible as did not have a multi function printer. This meant that marks were probably deducted for "poor quality" images. From the outset it should have been explained the requirements and how to get the best drawings from what you had ie outline in pen the diagrams to make them stand out. It should also have been explained in the course description. Overall this meant that the learning process was lengthened and created a frustration, The theory was fine, but the practicalities were a pain*

A further eight (32.0%) only used their computer to create their diagrams, although sometimes with difficulties:

> *I hated the process of drawing electronically. I struggled to find a piece of software that I could draw effectively and quickly. I'm also a bit of a luddite with technology and found this aspect frustrating. A little more tuition in this area would have assisted me greatly*.

Four students (16.0%) did a mix of both hand drawn and computer drawn diagrams although 3 of those 4 switched from hand drawn to computer drawn:

> *It changed with time initially I took a lot of care to create neat diagrams - later with lack of time I sometimes used hand drawn diagrams more as a means rather than and end in themselves. Finding a quick and easily editable technology was not easy - I do have access to professional software which is rather too complex and have found on or two freeware tools but it would be very useful to have more support with these as it is time consuming.*

The use of technology was particularly a problem for students with disabilities:

> *As I said, I had to use assistive technology and software to enable me to draw the diagrams as I find holding a pen for writing quite difficult. Once I learnt how to use the software drawing the diagrams was fairly easy. I would've preferred to use a pen though as it's more natural and your thoughts flow more easily when you're writing. I started off trying to use the iPad with an app my tutor recommended but it was quite frustrating having to email everything to myself and working from a smaller screen*.

The overall picture is one of technology enabling learning but not necessarily of enhancing learning due to many factors.

Sharing diagrams

The responses (n=30) to the question - *What did you feel about sharing diagrams with fellow students and did that help your studies?* - fell into four groups: those with only positive reactions, those with only negative reactions, those with mixed reactions and finally those who were initially negative ant became positive (and could be seen as a subset of the mixed reactions).

Those with positive reactions (n=10; 33.3%) tended to give short, sharp responses:

> *I enjoyed looking at others work to get ideas to aid my own diagrams, and I was happy for people to look at mine and gain the same insight*
>
> *Extremely helpful*
>
> *I found this very beneficial often alleviating any doubt relating to my understanding of the course requirements. More importantly during group work provided discussion opportunities and was essential in reaching any consensus.*

Those with negative reactions (n=6; 20.0%) could be equally blunt (*Did not gain anything from sharing*) but most spoke about technical problems or poorly functioning groups:

> *sorry, but really didn't enjoy the student interaction aspect of this module. I think we were unlucky as a group for Block 3 and some of us found that it actively hindered our studies and actually put the outcome of TMA 3 and the EMA at risk due to either the late submissions or lack of submissions from other students. I could see that it would be good if it worked though re: different insights but unfortunately, for me, it just didn't*.
>
> *The gallery where we were supposed to upload our diagrams was ineffective as a collaborative learnign tool as no-one commented on posts, despite requests for feedback. This site also became an obstuction to learning when working on the collaborative task as students posted their diagrams here while ohers posted them as attachments to converstaion threads. Posting diagrams here did not contribute to my learning about the course content. I ceased to use it eventually as it provided no additional benefits. The navigation was clunky and the smiley/sad face indicator useless.*

Those with mixed reactions (n=10; 33.3%) generally could see value in sharing but technical or group issues spoiled their experiences:

> *It was nice to share my diagrams with other students. Looking at other diagrams from students was useful at times. The Tutor mentioned that we must be helping each other with our diagrams, yet I found that people were not commenting on diagrams much. Hence I don't believe sharing diagrams really help students as you dont get feedback and at times the tutor does not comment on them either*
>
> *The sharing diagrams with fellow students is a very good idea, but of course is only as good as the students that take part. I cannot say that this vehicle assisted my studies particularly, because really I didn't receive much feedback during the module from other students. If I'm honest I would say that my sharing of diagrams tailed off during the module, due largely to lack of any feedback. So yes it's a great idea, if we can get students to participate more fully*
>
> *I can see the point of sharing diagrams with the students as a means of exchanging thoughts and ideas and in order to give one confidence that you are on generally the right track. I do not like the use of smiling/unhappy faces to signal progress towards completion of the required number of images, I think people with busy lives could easily be put off by this.*

And as noted above there were 3 students (10.0%) who were initially sceptical but changed their minds as their studies progressed and their confidence grew:

I was a little reluctant at first as I thought my diagrams were a little inferior but once I gained confident in creating the diagrams I was happy to share. Seeing other students diagrams also helped at times to see that I was heading in the right direction.

Tuition and feedback

The final area explored around their study of the two modules was their views on tuition and feedback about their diagrams from their tutor (n=30). Seven (23.3%) were very positive about their experiences:

Brilliant. Enthusiastic, supportive and systemic

Both were excellent. The feedback helped me to improve and was very useful during the EMA. The tuition was helpful and often having someone to bounce your ideas off was useful and enabled you to work through to your own answer.)

14 (46.7%) were very negative about their experiences:

I didn't feel I had any meaningful feedback from my tutor and that tutor interactions, most specifically in Block 3 when we really could have done with guidance was non existent

There was little feedback during tuition and the TMAs

Poor to none existent

While one or two noted that their response was influenced by their tutor's personal circumstances the majority were not happy with the nature and type of feedback. This is also seen in the fact that the remaining seven (23.3%) students had more mixed views:

The tuition could have been better with live examples during tutorials and the feedback on the display wall examples from memory was very little. TMA feedback was better but with only three TMAs, learning by doing and getting feedback doesn't work well. Face to face tutorials would have been much better.

I think half the problem with systems diagrams are they are not clearly defined. There is no right or wrong answer. Therefore, feedback from my tutor never said "yes, that is the type of diagram we require" or "no, you are way off the mark". I found this the most frustrating part of this module. The three previous modules I studied were more fact based so the answers were right or wrong, no middle ground.

The impression is that many students were struggling with these unfamiliar modes of presenting their work and that neither the teaching materials nor the tutor feedback were helpful:

Tuition was negligable and feedback almost useless, being generic and often took the form of 'see my notes' which were a list of hyperlinks back to the course pages and these hyperlinks didnt work. If i have failed to apprehend a point of learning from my first reading, providing the page for me to read again is likely to be ineffective then too.

The future

The responses generally paint a picture of most being happy with diagrams and diagramming but with a significant minority not at all happy with both, although even the happy had complaints about some aspects – the time consuming effects, the

problems with technology and sharing, and inadequate levels of tuition and feedback. It was therefore surprising to find that 86.7% (26 out of 30) said they would use systems diagrams in future:

> *I now use systems and spray diagrams along with rich pictures in my day to day work. I run continuous improvement workshops and fins these methods well accpeted by the attendees.*
>
> *Assessment of nuclear waste management options - some of the diagramming tools are really quite powerful. I don't enjoy the diagram process but understand it's worth*
>
> *I use rich pictures to analyse complex managerial situations, systems maps for organising, spray diagrams for an overview of connections within a project before getting deeper understanding via influence diagrams and causal loops. Stocks and flows are useful for specific aspects of process. Presently I am involved with an innovative company developing a new renewable energy concept and the diagrams are proving invaluable, both in developing the idea and also the business model.*
>
> *I am already using them. I am involved in several local projects including bringing BB to rural areas and encouraging local use of renewables. System diagrams have helped both to inform and motivate.*

The four (13.3%) who said they would not use them again were inevitably sceptical of their value:

> *Can't see a useful reason to use them*
>
> *because i don't understand them, didn't find them helpful or useful, found them complicated and time consuming and i don't see a place in my future studies or career for them*

Last words

The final question in the survey asked the students if there was anything else they would like to say about their experience of using diagrams in the module(s). There were 29 responses and most were reiterations of previous responses either saying how much they enjoyed/hated them. The only relatively new point to come out was the relevance of diagramming to environmental management as a profession:

> *Diagrams are useful in terms of thinking out a scenario but the techniques were overshadowed by a lot of course waffle. I often ran out of time and had to take short cuts which was invariably skipping the diagrams. This frustrated me and I lost interest fast. In fact, I couldn't stand the module by the end of Block 1 and by the end of Block 3 was beside myself. The Renewables module I took alongside this one was far more professional in it's approach re: lack of airy fairyness, good clarity and robust technical learning. I passed both modules with good grades but felt that this one could easily have been taught in 1/2 the time with 1/4 of the words. Working in Env. Man. within the nuclear industry I can't stand "tree hugging" attitudes as it puts other disciplines off when trying to reach a solution and contributes to the general lack of respect for env. as a whole. This module was hugely disappointing in this respect with only Block 2 taking a well rounded and approach to env. man*.
>
> *I think its important to stress to students that diagramming might require significant time investment and iteration but that students should not be put*

off by this as the end result will be a much better understanding of cause and effect in environmental management.

only that i found them too much of a focus of the course. i felt that all i was being taught about was systems diagrams and not about environmental management and in the end i felt i learnt very little about either. to be honest i felt they ruined the course for me and i would not recommend the course because of this focus. i think the course is very misleading and do not feel that group work or systems diagram reflect the work of environmental management.

Student telephone interviews

The responses of these students largely reflect the many issues and aspects noted above but do provide a little more detail on some key areas.

First, there was an outright sceptic among the six:

[…] I would have liked it to have been more factual and I guess it was a lot about methods but it was aimed at ten year olds so I probably would have liked a more grown up way of teaching.

[…]

It was so disappointing. It was the only course that I have done from the OU that… I mean if that was the first course that I did I would never do another OU course. I don't understand why, I just don't understand how you can put it on and I can't believe that everybody else's feedback isn't the same but I understand that it isn't. Weird.

The others were more positive but one did highlight a related issue of perceived identity for the module(s):

I found it quite difficult at times to know what the course wanted. I thought at times the course didn't know itself what it wanted, whether it wanted to be sort of technical in terms of the environmental action plans and LCAs and what have you, and the technical side of the various systems diagrams or whether it wanted more of the what I call the flowery waffle language in terms of thinking about thinking and putting honest philosophical viewpoints across.

In addition to this potential issue of confusion as to the nature of the module content it looks as if other factors may have contributed to difficulties that some (many) students faced. It has already been noted that the modules were seen as time consuming and two students amplified that view:

One of the things that…. Don't get me wrong, I think there is a lot of very good content in this course but the first thing I would say is that for a 30 credit module I actually think there is too much material to get through and one of the reasons that I think there is too much material is because there is a lot of repetition in the module material. For example points are made repeatedly, the same points are made repeatedly by the different authors. In the particular area that I noticed that in was in the water stories work, so I think without being completely ruthless you could actually cut the amount of text in that section of the course by 50% and you wouldn't actually adversely affect it.

And:

Also the other thing I found in the course generally; the amount of reading material, the material that you actually read through was, compared to other courses that I have done, excessive I thought. It was just difficult to get to...

> *you had to get all the reading done that you needed to and cover all the various exercises and that that you were doing as you went along so the course became very very intensive and I know from comments on the forums during the course, from other students, they also found the same thing; the course content was rather heavy. I think the general comment was that there was as much work, and in fact there was, in my opinion anyway, as much work in this 30 credit course as there would normally be in a 60 credit.*

The first of these students also queried the intellectual level of the module:

> *I enjoyed this course although it was a challenge for me and that is probably a reflection on my level of intellect but I actually think the course is aimed as a Level 2 course I don't think it is a Level 2 course compared with other modules I have done. I would say this is a Level 3 module and people I think need to be aware of that before they start studying this.*

The online delivery of the modules added to this sense of heavy workload and difficulty in keeping up with the work as noted in these two quotes:

> *This is a course, whilst it is very satisfying and very very informative; I think you need to approach this module with a great deal of care. It is not the kind of module where you can take a break from it during the module and then say 'in a couple of weeks time I will have more time I will get on with this', this is very much a module where you have to be bang up to date with it virtually every week a) because of the amount of material in it and secondly because of the amount of group work, which when you get to the group work stage you need to do, the time tabling of the group work is very very tight and our tutor acknowledge that, which I think was a good point to make right at the outset, that you haven't go much time to do this and when you are doing it by distance learning that makes it even more difficult so I think that from students point of view this is a course that you really do need stay on top of it every single week otherwise you will quickly lose, I think you could end up being in a non-recoverable position quite quickly, not able to catch up with it.*

And:

> […] *what I found was going through the course, that there was a lot of... on any particular part of the course there was a lot of sidelines that you had you click on to and then read. What I found was that doing that you started to get slightly disjointed and in particular, later on when you are looking at doing the EMA and that, was trying to backtrack and find out where this information was. It wasn't on the main text but on a subtext and this made it very very difficult to collate.*

Looking more specifically at diagramming the general dislike of online delivery (and love of the one printed item) was not just confined to the main teaching material. Students were not generally happy with online tutorials (particularly in comparison to face to face tutorials), while the means of sharing and commenting on diagrams did not work well:

> *I would certainly like a face to face tutorial although it is not always possible […] also in addition to that it is the display wall. I think unfortunately it is perhaps under utilised by students. I would like to have perhaps slightly less diagrams required to put up there but a much greater level of participation with students in terms of feedback*.
>
> […]

It was… the resource book was excellent, I really can't fault that at all. I really think that is very well written, simple and easy to understand and concise. I liked that a lot. Apart from that, as I said it again reflects back to the comments about the display wall, I don't think there was enough positive, sorry wrong word, specific feedback from perhaps tutors or staff on the display wall. I didn't feel that came through quite well enough from everybody, students as well.

And:

I think course actually needs, you need to have written text books. I appreciate the environmental aspects of printing all this stuff and the fact that it all becomes out of date, which will solve that by having it online, taught on line, but it is a very complicated course and I think you need to have a paper in front of you to understand it.

[…]

I actually thought the resource book was probably the thing that helped me the most because it was fairly succinct and it had got lots of examples in it of how systems diagrams… first of all how systems thinking works and why it is important and second how systems diagrams need to be put together.

Associate Lecturer telephone interviews

Finally, this section triangulates the key themes from the interviews with ALs with those above for students.

Teaching diagramming

These three ALs had varying prior experience of diagramming before being appointed to these modules but all are very keen on their use in environmental management. However, their views on how systems diagrams are taught in the modules spans all the mixed bag of issues already covered above, from the technical to the conceptual:

I think they are extremely difficult to teach online, distance learning wise because all we can do is show them direct routes to videos or diagrams or the books, the literature of you like, to show them how to create diagrams but it is not quite the same as actually watching somebody do the work, map it out and discuss it in real time and I think students really struggle with that. The other things I have noticed as well is that they struggle with actually constructing them. Again because we can't show them physically where you would start on a piece of paper or we can't talk them through the software that we might use or the programmes we might use. I can direct them to online programmes which you could use to create certain diagrams but with mixed results.

[…]

Some of them are happy with it; they seem to think in that way, they have that kind of disposition if you like. They like to use diagrams, the like to draw, they like to explore. They are the students that do well. Then we have others who are completely the opposite, they just drift when you are trying to direct them to do these pictures they don't allow themselves to be creative, they tend to be more restrictive and it affects their marks because you can see that although they are really trying, they are scared to go with it, to use it as a tool. So yes it is very mixed, they either love it or hate it, like marmite. [A]

> I think that there seems to be, broadly speaking, two groups of students. So those that get it straight away, I don't know why but there are those who seem to get it straight away and they seem quite comfortable towards the idea of using the diagrams and that includes everything from the rich picture through *to say the cause and effect diagrams. Then there is a group of students who struggle and again I don't quite know why they struggle with it but some of them overcome whatever problems they have with using the diagrams and some of them don't. The ones that are in the kind of struggling group it is possibly two factors coming together. One is the concept of using diagrams and the particular diagrams that we introduce them to, including the rich pictures, and I think for some of them it is actually the issue of producing the diagrams, so the actual process of putting something down on paper so to speak.* [R]
>
> *So I think the material itself is, as I say, it is very instructive, directive and mechanical for some students, systematic in the possibilities of how you might start. I know a lot of students have never done diagramming before so it provides, I guess, a very basic level, step by step entry point into diagramming, but I am not sure if it invites possibilities because, as I said, it is mechanical stepwise.... it appears that it is mechanical in the way that the instructions are outlined but in terms of how you… because there is so much resistance... a lot of the students start off diagramming with resistance. I have noticed that mentality on making the shift with no instructions on how you make that shift, so it is more the functionality of how you do a diagram. If you like the emotionality of the process that you go through of trying to make the transition, especially if you have never done diagramming before. That part, that kind of guidance is not there for the students*.
>
> […]
>
> *We have a display wall which doesn't, in my opinion, work for sharing. I am not really sure why but I do think there is some awkward mechanism within it but that seems to prevent understanding between everyone and if I recall when we did use the display wall willingly I had to step outside of it first because on the tutor group forum they had discuss a mechanical way to work out how they could get together on the display wall and maintain a transparency with each other but other students, they did do it but it was difficult. It was more solitary solo passageway through the display wall rather than one where there was responsiveness between each other* [S]

These ALs all thought there needed to be more or better ways to teach diagramming, whether that is by having more teaching material on this;

> *[…] we should have a better bank of resources to show them how to do diagramming* [A]).

Or by offering up their own examples;

> *Sometimes I respond myself and draw a diagram rather than write something. I will respond or intervene with my own visual interpretation or say, thoughts. So it is continuously keeping alive the exercising of diagramming* [S]).

Or by lamenting that fact it is hard to find some examples out in the wider literature

> *It would be quite nice to be able to find published examples where the authors say 'we have taking on this, we have examined this environmental issue and in doing so we have found that getting a community or getting a school or a*

group of business people, whatever it might be, together and using some of the examples such as rich pictures and this is how it worked for us [R]).

The three ALs also talk about how doing everything online is more limiting than it would be face to face, particularly around diagramming, but that this does not in itself overcome some student views on the primary value of using diagrams in environmental management:

> *At the same time I teach environmental management at another university and, at Level 3, and I have taken some of my experiences from T219 into there, into that situation and those Level 3 students look at me a bit gone out when I say 'one of the easy of exploring this in given situations is by using rich pictures' and they end up encountering similar kinds of conceptual and theoretical challenges to the ones I have had on my T219 presentations so it is not unique to it being on line by any means. It is not unique to the OU and it is not unique to any of the materials presented in T219*. [R]

But equally some students are seen to 'get it':

> *Overall, as I say, I am really positive about diagramming in these courses. I think overall I have seen a lot of students really change and transform their understanding of environmental management. As I have said to the point that now certain students have finished the module but they are still inventing and still responding and coming back for more so I think there is a lot of opportunities for carrying forward this in a more of a creative way so if we can develop more spaces, labs, clinics and more inventive ways to share with each with each other I think something exciting could happen*. [S]

Assessing diagramming

ALs are faced with marking and giving feedback on diagrams used in assignments. Technological limitations were evident in their responses to how they fared in assessing them:

> *Difficult, with some mistakes. They would take all different forms. So you get ones that are beautifully hand drawn, you get ones that used clip art, you get ones that had used drawings off the internet, cut and pasted in. So it was quite difficult really to kind of compare or to be consistent in the marking so you would have to really try to look for the … not be too hard on them for the execution and look for the actual content. A lot of them really struggle because of the size restriction of the TMAs when uploading via the Open University assignment handler. So they would do these really nice pictures, take a photo of them for instance put them in there and then it would be way over the size that they could use so often then they have to reduce the photo down and then t I get a picture which when I try to scale it up on my computer to interrogate it, it is too fuzzy or I can't read there writing so that was very difficult. So sometimes I would have to go back to them and ask them to resend me these pictured by email*. [A]

But more important was how they approached diagrams within the context of the marking guides:

> *I think I had to learn in the first presentation to not expect too much and to learn to kind of be less critical of them and go with the flow sort of thing, and to look for bits in their diagrams in terms of the process they have used and even some of the specific outputs', and to look for the positives rather an look for the negatives; this diagram doesn't work, say why it doesn't work and*

actually step back and say why it does work or why parts of it work so that the student can then build their confidence because they are going to be doing that diagram again almost certainly, to feel confident that they can actually use it to explore the next path through the T219 cycle in another context. [R]

Well I actually find it enjoyable with a multi-dimensional set of criteria. So I think that really helps the students because I might look at, if we are looking at a rich picture for example, I will dissect it from different angles using a range of visual metaphors; the size, the colour, the symbolisms and then I will bring in the... and then I will assess it from social, economic and ecological issue based angles. So the students feel that whatever they are doing, that it is real, it is feeding back out messages into the real world. [S]

Conclusions

The findings of this report cover a lot of contextual material as well as that directed specifically at the use of technology in teaching diagramming. This has been deemed necessary in order to tease out the complex interactions between different elements of the two modules, of which diagramming is but one part; and other matters which might influence the students' disposition towards diagramming.

In terms of **learning about the necessity and mechanics** of diagramming students seem to very much like the printed resource book over the online materials. The mainly online delivery does not, it seems, provide a useful context for learning about diagramming. Many would have like to see face to face tutorials as well as printed books.

The problems with the Display Wall, difficulties with creating digital copies of diagrams, the limitation of sharing and discussing diagrams in online tutorials and within the group work, also appear to hinder first order and particularly second order learning about the **value and relevance of diagramming** for improving their own learning in general and for use in environmental management in particular.

While many did gain value from, and see relevance in diagramming, it looks as if the number of diagrams to learn about and the number of diagrams that needed to be produced throughout study of the modules, contributed to a **significant intellectual and time burden** that may have contributed to the more negative view expressed.

Those students who were or became enthusiasts for diagramming were very likely to continue using them in their studies and possibly in their work. For others diagramming was seen as a waste of time anyway and the technological issues just seem to have compounded this negative view.

Therefore it seems that these two modules have shown that while mediating technologies can be used to successfully teach diagramming that this success is very much conditioned by the disposition of the students towards a more constructivist (skills and value based) versus a more instructivist (knowledge and fact based) teaching strategy; by the need to interact more directly with other students in group work; and by the limitations of the technologies for creating and sharing diagrams. Most notably the Display wall (based on Open Design Studio) has been successfully used on several other modules but not so on these. More work is needed to understand why that has been so.

In terms of **the two modules themselves** it looks as if they need to address the following issues to improve students' satisfaction with diagramming:

1. Provide more examples of diagrams being used in practice and how they are developed over time
2. Reduce the intellectual and time burden of diagramming by reducing the number and types that are necessary for covering the learning outcomes
3. Test and introduce new guidance/systems for the creation and sharing of diagrams using mediating technologies
4. Explore whether face to face events could be used to reduce the fear and scepticism that many students show towards these techniques.

Next Steps

This final report will be shared with the two Module Team Chairs as part of deliberations over the future development of the two modules to improve retention and completion.

An article based on this work will be submitted to the Special Issue of Open Learning being edited by Clem Herman and Nick Braithwaite.

The work will also inform two other articles being written about T219 and T319 relating to (a) their conception of environmental management and (b) to the use of online group work.

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Annex 1 System diagramming student online survey questions

The aim of this survey/interview is to get you, from your own perspective as student who has recently completed T219/T319, to indicate what were your experience of, and views, on 'systems diagramming' as taught in the module:

(1) before you began studying the module;

(2) as you studied the module; and

(3) now that you have completed the module.

This covers the reasons for using diagrams, the techniques of drawing diagrams, the technology used to help with the diagramming process, the sharing of diagrams with others and the learning you gained from them.

Ethics

This survey/interview forms part of a wider research project and as such I will want to keep a record of responses you make as they will collectively provide the data which I will subsequently analyse and write about. By continuing to participate in this survey/interview you will have consented to me using this data for this purpose. However, I will not be collecting any personal data about yourself nor identify you within any publications. You are free to leave the survey/interview at any time and/or indicate at that time that you do not want your contributions to the activities to be included in any analysis and publications. Any publications arising from this research will either be published under a CC licence or in an open access journal as appropriate.

Questionnaire

Q1 Please indicate which of the following modules you have studied:

(Please select all that apply)

T219

T319

Q2 Had you used systems diagrams before studying T219/T319?

Yes

No

Q2a [If yes] Please explain in what situations you had previously used systems diagrams?

[Free text]

Q2b [If no] Please explain what were your reactions to having to learn about and draw systems diagrams?

[Free text]

Q3 Please explain which diagram types taught in the module(s) you found most useful in your studies and which you found least useful and then give reasons for those choices

[Free text]

Q4 How did your use of technology for both studying and doing assignments influence how you learned about and drew diagrams within the module? Please explain

[Free text]

Q5 What did you feel about sharing diagrams with fellow students and did that help your studies? Please explain

[Free text]

Q6 What did you think of the tuition and feedback about your diagrams given by your tutor? Please explain

[Free text]

Q7 Would you use systems diagrams in the future and why?

Yes

No

Q7a If yes please explain how you would use system diagrams in the future

[Free text}

Q7b If no please explain why you would not use systems diagrams

[Free text]

Q8 Is there anything else you would like to say about your experience of using diagrams in the module(s)?

[Free text]

Q9 Would you be interested in taking part in a follow up telephone interview?

Yes

No

Annex 2 Telephone interview questions

Students

How would you describe the key features of T219/T319 to another student thinking of taking the module(s)?

What was the most enjoyable aspect of T219/T319 for you and why?

What was the least enjoyable aspect for you and why?

What would you liked to have seen changed in what is taught on T219/T319?

What would like to have seen changed about the way things are taught in T219/T319?

Who or what helped you the most in understanding and drawing diagrams for T219/T319 and why?

Associate Lecturers

What were your own experiences of systems diagrams before being an AL on T219/T319?

What are your own views on how systems diagrams are taught in T219/T319?

How have your students responded to learning about diagramming in the module?

How have your students coped with drawing and sharing diagrams throughout the module and in the assignments?

What were you experiences of assessing the diagrams that students included in their assignments?

Is there anything you would you like to see changed around how diagramming is taught and assessed in T219/T319?

Annex 3 Selected student characteristics for the T219 and T319 14J presentations using the Reg25 fee liability point data (source: IET Module profile)

	T219 - 277 students	T319 – 135 students
Student type		
Continuing from 2012I	83	22
Continuing pre 2012I	181	108
New	13	5
Module results		
Distinction	24	12
Grade 2 pass	28	40
Grade 3 pass	45	33
Grade 4 pass	20	5
Fail – submitted EMA	4	4
Fail – did not submit EMA	33	10
Withdrew	44	26
Assessment banked	28	5
Deferral	1	0
Qualification registration (>10)		
Q72	66	11
B19	51	29
BD	51	28
B72	36	16
QD	25	12
Q19	12	3
B65	8	19
Gender		
Female	110	45
Male	167	90
Ethnic origin		
White	91	94
BME	8	4
Previous qualifications		
PG	7	3
HE	83	56
A level	112	49
Lower that A Level	69	24
No formal qualifications	6	3
Concurrency		
Other modules at 14J	197	95
Other modules after 14J	19	24