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RESEARCH NOTE

REVISED Trialling the use of Google Apps together with online marking to enhance collaborative learning and provide effective feedback [version 2; peer review: 2 approved with reservations]

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Abstract

This paper describes a new approach to an ecology practical in which 76 Level 4 students were divided into four groups (n = 20 +/-2) to collect data. Each group studied a different habitat and was further divided into seven subgroups (n = 2 or 3) to collect field data. Each of the four groups collaborated through Google Drive on descriptions and images of the habitat site, and also collaborated at the subgroup level on their own habitat data. The four groups then shared habitat descriptions with the aim to provide enough information to enable everyone to understand the entire data set.

The three-stage assignment was assessed and feedback issued at group and individual level via the University's online submission service (FASER), with some additional feedback given via Moodle, the University's Virtual Learning Environment. Two separate submissions were made to FASER, the first was the group and subgroup work (stage 1), and the second included the peer assessment task (stage 2) and the individual evaluation of the habitats (stage 3). Feedback was given after the second submission had been uploaded to FASER and again when the assessment for the second submission was complete. The group and subgroup data sets were provided to all students via Moodle, so that individuals could carry out their own analysis of all four habitats. The use of Google Drive and Google Apps helped to improve the digital literacy of the staff and students involved.

All three stages of the assignment were successful; over 85% of students passed the first two stages, and 82.9% passed stage 3. The collaborative work enabled students to produce high quality descriptive ecology documents valuable for the subsequent stages of the assignment. The peer assessment encouraged students to gain

Open Peer Review

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Any reports and responses or comments on the article can be found at the end of the article.

information on expected Undergraduate Minimum Standards, and gave students the opportunity to study multiple habitats. The final stage was open ended and challenged students to make sense of large ecological data sets. There was a positive correlation between levels of success at stages 1 and 3 for students who achieved less than 65% for the independent work, i.e. they benefited from carrying out group work.

This collaborative, three-stage approach is recommended especially as it helps lower ability students gain subject knowledge and improve their presentation skills. However, some modifications are recommended: 1) simplifying the sample and data collection, and 2) providing more guidance for the peer assessment task and individual analysis. Learner autonomy enabled self-directed learning to take place and enriched large scale teaching as it encouraged student-student interaction. Significant differences between gender and ability are discussed.

Keywords

Collaboration, Digital Literacy, Ecology, Fieldwork, Google Docs, Google Drive, Peer assessment, Self-Directed.

This article is included in the **Teaching and communicating science in a digital age** collection.

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REVISED Amendments from Version 1

The new version contains some more information on degree programmes studied by the students, information on gender ratio and some background information about the lecturer. In addition numerical data and statistical analysis, together with definitions about success criteria, has been added to improve the clarity. The hyperlinks have been updated to make them accessible. There is also more specific information about the ecological sampling and a fuller example of the group work is included in the [Supplementary material](#). The accompanying data set has been updated and uses the last available marks obtained by the students. The data sets are now available as csv sheets rather than excel workbook.

See referee reports

Introduction

This article is aimed at university lecturers and outlines a method that enables students to enhance their knowledge and understanding of ecology by working in the field, in the lab, and online as members of a small group. The method makes use of free online tools—provided by Google—to facilitate collaborative activities that can be easily monitored by a lecturer; these activities also aim to increase the digital literacy of both the staff and students involved.

This report demonstrates that an academic with limited technological ability, but with an open mind and a small amount of support from a learning technologist, can create and manage an online assignment method that enables students to collaborate within a framework that is both defined and monitored. The approach also meets the “[Challenger Philosophy](#)” that is a key driving force at the University of Essex.

The rationale for trying new methods came from a [Society for Experimental Biology \(SEB\) “Researchers – Teachers – Learners” conference \(2012\)](#). Other influences included the concept of learner autonomy to encourage student engagement ([Scott, 2012](#)), [Voelkel’s work \(2012\)](#) on staged assignment to engage students, and the use of technology to promote student engagement and self-directed learning ([Mello, 2012](#)). The approach was also developed as part of a process to enrich large-scale teaching ([Biggs, 2003](#)) and to encourage student-student interaction, as well as student-led group work to enhance cognitive understanding.

The approach taken involved a new cohort of Level 4 students (first-year undergraduates) taking part in a three-stage assignment designed to give individuals an opportunity to gain practical experience in ecology, both in the field and in the lab, and to increase their knowledge of their local surroundings. This combined field and lab work represented 50% of the practical work associated with their Level 4 ecology module (BS111).

The students enrolled onto the ecology module were following biological sciences ($n = 56$) or marine biology degree courses ($n = 19$). There were two additional students studying complex variants, e.g. study abroad. The gender ratio for the cohort was: 1.3 males to every female (see [Supplementary material, Dataset 1.1](#)).

The academic involved in developing the new practical (N Slee) is a Fellow of the Higher Education Academy (HEA) and is an experienced part-time lecturer who has used technology to enhance the student learning experience since 2005. For 10 years she has taught a range of subjects to small groups ($< n = 55$) including general biology with an emphasis on molecular biology, biochemistry, plant science, environmental science and key skills (all at Level 3). More recently she has developed innovative school-based research projects for third years (Level 6 students) and in 2014 she took over the ecology module. Previously, the ecology module had been run by other academics, but they were assigned new roles. For the academic year, 2014–15, both the module supervisor and lecturer for BS111 lacked an animal licence, which was required for one of the existing practical sessions. The practical sessions also needed to be simplified due to the larger number of students involved. The new approach required two practical sessions and was developed to reflect the lecturer’s academic interests. It was decided that the assessment would be open-ended, and would incorporate both group and individual work to develop and broaden the academic skills of the students.

Research has found that students have different interests and thus giving them the control over their learning environment enhances their learning experience as they will be motivated and be actively involved in the process. In student centred learning the instructor becomes a facilitator and the main focus is on the process of student learning ([Blumberg, 2008](#)); in this situation “students with control” will build on their own knowledge and reflect on what they have learnt. In addition, the student will determine what is important, take responsibility and be more motivated than if they are told what to do. This aligns with the Berlo’s model of communication and the transactional or dialogue model developed by [Bowater & Yeoman \(2013\)](#); [Wood \(2003\)](#); [Springer et al. \(1999\)](#) reported that small group learning tended to create a collaborative environment where final outcomes were negotiated by the participants; it removed the competitive nature and was shown to be the most effective at enhancing a wide range of attributes in the individuals involved e.g. increased self-esteem and knowledge. These approaches link with the 3E Framework ([Smyth et al., 2011](#)) (Enhance-Extend-Empower continuum) which is a structure that gives students responsibility and power to develop skills that incorporate the use of technology that can be transferred to their future profession. In the present study the lecturer is interested in giving student the opportunity to lead their learning in a small group environment to help them feel part of their new community and develop a suitable learning environment for their future.

The aim of the practical was for student to gain first-hand knowledge of one field site. This, together with the group work, would give individuals the confidence to analyse data from other unfamiliar habitats; [Scott et al. \(2012\)](#) concluded that first-hand exposure to field work enhanced pupils’ knowledge in ecology, and thus made them capable of engaging in self-directed learning. It was hoped that the practical work would give students a feeling of ownership over the data collected, and hence make it possible for them to take part in self-directed tasks connected with their data, as well as associated unrelated data (which the students would be able to contextualise through their hands-on experience of collecting data at one of the other four habitats).

The ecological aim of the project was for the students to become aware that distinctive habitats arise due to the constant interaction of organisms with biotic and abiotic features of their environment. There are distinctive grassland habitats within the Wivenhoe campus, four of which were investigated; students were asked to identify any differences, patterns or correlations between them.

It was also hoped that this new approach would help the students—new to university life—make the transition from the small group session format popular at most colleges, to the large group teaching scenarios that are commonplace within a university setting. The divided practical work aimed to create a small, friendly atmosphere which would enable students to ask each other questions, and encourage them to engage in discussion with the Graduate Lab Assistant or academic leading the group.

Students regularly work in pairs for practical tasks (School of Biological Sciences, University of Essex), but generally write up reports independently. However, scientific research papers are frequently written by multiple authors. Therefore, another aim of the assignment was to teach students to work collaboratively, using digital tools and self-directed methods, to produce work that met with Minimum Undergraduate Standards. For full details of these standards, please see an extract from the School of Biological Sciences UG Handbook ([Supplementary materials 1a](#)).

Ecology scientists frequently handle large datasets and use a variety of statistical methods to identify trends or patterns. Therefore, this work challenged students to use datasets that would not have a pre-determined outcome. Hence, individuals were given open-ended templates to enable creativity within the parameters of the standards required. This fulfils the educator's task to create an environment with a high level of control where student learning is possible ([Brown, 2004](#)). Brown states that a series of tasks are needed to enable successful learning, and that students should start with simple tasks, but later be challenged to complete more complex work. With this in mind, students were first asked to produce group documents; these documents were then used by the whole cohort for peer assessment, and then by the lecturer as a means to accurately assess each student's contribution to the task as a whole.

The Google Apps service was selected to support the assignment process because Google is a familiar brand and is responsible for running the world's most popular search engine; it was understood that this familiarity would make engagement more likely. Ease of access and versatility were also important deciding factors when selecting technology to support the assignment. Office 365 and wiki tools were also considered when deciding what technology to use, as they can both be used for online collaborative tasks ([Doolan, 2007](#)). However, the Google Apps service has a stronger emphasis on real-time collaboration. Also, the various apps use concepts that students are already familiar with (borrowing several features from traditional office software packages). Google Docs has also been used for effective collaborative English Language Learning ([Hosseini, 2014](#)) and has been used by business schools in a similar manner (see [unpublished paper by Schneckenberg](#)). The apps enable multiple users to work on a single document via a web

browser. The document owner can also retrieve an earlier version if necessary. Knowledge can be created, edited and exchanged ([Doolan, 2007](#)) which empowers learners to develop team skills. By using a platform not controlled by the University, students were given greater ownership of the learning environment, which helped with engagement and motivation.

The rationale for a three-stage process was to encourage students to engage in tasks outside of their comfort zone, and to enhance deep rather than surface learning ([Biggs, 2003](#); [Rust, 2008](#)). The assignment was also designed to promote student engagement at each stage ([Brown, 2004](#); [Voelkel, 2012](#)).

A summative assignment was used to improve student engagement in the task. A peer assessment element was also included to promote a deep learning strategy ([Biggs, 2003](#)). The quality of the peer assessment activity was also a key component of the summative assignment. The learning outcome of the peer assessment task was twofold: the students were exposed to other habitats they did not visit, which helped them with their independent work, and, secondly, forced students to understand task requirements and, as a result, involved them in a deeper learning experience ([Biggs, 2003](#)).

Methods

A new cohort of students ($n = 76$), from the School of Biological Sciences, taking a Level 4 module in ecology (BS111) were involved in the assignment. Two practical sessions were used to carry out fieldwork, followed up by subsequent analysis of samples in the laboratory. The cohort was divided into four groups of 20, which, in turn, were split into 7 subgroups. The assignment was split into three stages:

1. **Collaborative work** – Each of the four groups worked on their own set of shared files (see [Supplementary material 1b](#), [Supplementary material 2](#)). The seven subgroups also used a separate shared data file to record their datasets (see [Supplementary material 3](#)).
2. **Peer assessment** – Students produced an individual report on the entire cohort's group work (see [Supplementary material 4](#)).
3. **Independent work** – Documents were created and submitted for individual assessment (see instructions in [Supplementary material 5](#)).

Stage 1 of assignment: collaborative work

Due to the early scheduling of the practical session in the autumn term, a preparatory lecture for the practical sessions was not possible. Therefore, information was disseminated via Moodle (see [Supplementary material 6a–Supplementary material 6e](#)).

Documents available on Moodle included: Notifications via News forum, a Guide on how to set up Google Drive, Group lists and the practical handbook, which contained all the relevant information needed for successful completion of the practical sessions and the assignment. During the practical sessions, a presentation was given to guide the students; this was then available from the BS111

Moodle page (see [Supplementary material 6c–Supplementary material 6d](#)).

Each group (W,X,Y and Z) went to a different habitat on campus. The habitats used were as follows:

- Group W - Benton's Top Heath and Hay Meadows (Site Number 16).
- Group X - Bluebell Wood (Site Number 15).
- Group Y - Kingfisher Lake (Site Number 14).
- Group Z - Campus farm and pond (Site Number 13).

(For more information about these habitats and site numbers, visit the University's [biodiversity web page](#).)

For the field and laboratory work the Cohort was randomly divided into four equal groups ($n = 20 \pm 2$); each was allocated a grassland habitat on the Wivenhoe campus. The groups were further divided into 7 subgroups at the beginning of the practical, then equipment and data recording sheets were collected and graduate lab assistants took them to the correct location. The site was overviewed to assess different plant species, whether monocot or dicot (each group used a unique set of plant codes, which enabled standardization for the group data collection exercise).

A simple guide was used to help student determine if the plant was a monocot or dicot. The group took a sample of the different plants; labelling it using the unique code, which was attached to the stem. The sample was photographed then put in large plastic bag. A data sheet was filled in with the sample code, name (if known) together with any distinguishing features.

Each subgroup collected data from two randomly-thrown square quadrats (0.5 m^2). Samples of soil, plants and invertebrates were taken for further analysis. The following information was collected directly from the quadrats: the number of different types of plant, the percentage cover of these plants, and the percentage of bare ground. A point quadrat was placed over the square quadrat (so it was parallel to the sides and went through the centre of the quadrat). The point quadrat was used to assess the height of the vegetation at 10 cm intervals across the quadrat, and also to determine the number of hits, e.g. the number of leaves contacted before the pin hits the ground when following a vertical path.

Temperature of air, plant (IR temperature gun) and soil (temperature probe) were also recorded. Soil was assessed in the field using feel for dampness, odour to determine type of respiration, and colour noted. A sample was taken from the centre of the quadrat using a trowel to a depth of 10 cm. The shoots (vegetation above ground level) were put in one labelled sample bag and the soil with roots in a second. In the lab, fresh and dry weight measurements were determined for the vegetation (roots had to be separated from the soil sample). A subsample of the mixed soil core was also taken for fresh and dry weight analysis. Fresh weight samples were dried in an oven for over 48 hours.

In the second practical session dry weights of plants and soils were recorded on data sheets or in lab book. Soil samples were analysed for pH using the method described in the soil test kits ([Palintest, 1997](#)); texture was determined from feeling wet and dry samples and comparing to descriptions of different soil textures. Soil samples were mixed with water and then allowed to settle to determine sedimentation profiles. A standardised amount of soil was placed in a funnel and standard volume of water was poured through and timed to determine soil porosity. Plant samples collected at the group level were identified within the laboratory using laminated identification sheets and a range of plant guides. Further analysis was carried out independently using the photographs taken *in situ*. The range and type of invertebrates found in the bagged soil samples were recorded, no special method was used to select for invertebrates.

Instructions were given via Moodle and verbally during the practical sessions, so that each student could create a personal Google Account. In addition, a handwritten record of their account details was collected during the practical sessions. Students were instructed to navigate to <https://drive.google.com/> to access the Google Apps service.

The lecturer created a folder for the module (BS111) containing four group folders (labelled W, X, Y and Z). Within each group folder there was one folder that was shared at the group level and seven subfolders, each shared only with the relevant subgroup. The Google Drive desktop application was used to duplicate a template folder/file structure, as this proved to be much more efficient than creating all the folders and files through the web interface (see [this support article](#) for more details about the desktop application and how it works).

Each group folder (X to Z) contained two template documents: a Google Docs file called "BS111 Practical 1 Description of Habitat" (see [Supplementary materials 1b](#)) and a Google Slides file named "BS111 Photo Submission for Group Work" (see [Supplementary materials 2](#)). The group folder was shared with all students in the group, who were granted full editing rights over the content of the folder. The seven separate sub-folders contained the Google Sheets document for the data collection task, and were only shared with members of the subgroup. The Google Sheets included pre-formatted tables, with some of the column headers already containing units. The documents at the group and subgroup level also contained inline instructions for the collaborative work (see [Supplementary materials 3](#) for example).

Students worked collaboratively at the subgroup and group level; each student downloaded a copy of the Slides and Docs file that was then uploaded to the University's online coursework submission service (FASER). The group Slides and Docs files were exported as PDF files and the data collection sheets were exported in Excel format (to make further manipulation possible).

Once this point was reached, the lecturer removed the editing rights of the students in Google Drive, so that further editing was not possible, effectively making all of the collaborative documents "read only". The documents were then uploaded to Moodle and

students used these copies for stages 2 and 3 of the assignment. The lecturer also established a discussion forum site on Moodle to facilitate student discussion of the fieldwork.

Stage 2 of assignment: Peer assessment

Instructions and a *pro forma* for peer assessment was issued to the students (see [Supplementary materials 4](#)). Each student peer assessed the other group work (including the subgroup data collection sheet). This was worth 10% of the overall assignment mark.

The lecturer assessed two aspects of the student peer assessment process:

1. Evidence of engagement in peer assessment, which required students to review information produced by the other groups and subgroups for the other three habitats.
2. Evidence of engagement/research into definition of “question terms” used and correct application of Minimum Undergraduate Standards.

Stage 3 of assignment: Independent work

Printed instructions, also available in Moodle, were issued. The final part of the assignment was individual analysis of the four habitats for patterns, correlations, and variability. This was an open-ended task (see [Supplementary materials 5](#)), facilitated by an Excel guidance file, which was provided on Moodle for download. Students requested further help and support, which was subsequently given.

The assignment files were uploaded to FASER by every individual. Electronic marks and feedback was returned to each student. Group level feedback for Stage 1 was given after the second submission (stages 2 and 3) had been uploaded to FASER. This feedback included information on learning outcomes achieved, advice on areas that needed improvement, and more detailed information on calculations (see [Supplementary information 7](#)). Individual annotated feedback was also provided along with the standard feedback sheet for level 4 students (see [Supplementary information 5](#)).

Students were given access to the group and sub-group datasets via Moodle after the deadline for the first submission, so that Stages 2 and 3 could be completed.

Analysis of student performance

Performance of students at stage 1 was used as a measure of their engagement. Stage 1 included practical and group work. Students achieving a mark higher than the mean mark (65%) were defined as having a good level of engagement (or good performance) in the practical work and group interaction. Students obtaining marks below the average (65%) were defined as having a poorer level of engagement (or below average performance). This threshold (65%) was used at all stages of the assignment, and was used as an indicator of an individual's level of ecological knowledge and understanding.

Data was ranked according to the University's degree classmark divisions; students who passed the assignment obtained 40% or greater. Non-engagement is defined as any situation in which a student did not submit work for assessment.

The three stages of the assignment were analysed for student success and for their level of engagement/performance. Pearson's correlation analysis was used to establish whether there was any link between the marks achieved at different stages of the assignment, and whether group membership or gender had an effect on performance. Analysis of variance was carried out on marks obtained at each stage, comparing groups and degree schemes (Excel vs 2010). Detailed information for this section is available in Supplementary material, [Dataset 1.1 – Dataset 1.6](#).

Results

Stage 1 of assignment: Collaborative work

Three groups successfully collected all of the expected field data; the fourth group collected half the expected amount, i.e. from single quadrats rather than two. The considerable amount of data collected within the two three-hour practical sessions involved a lot of collaboration in the field, as well as in the lab, to ensure data sampling and recording was accurate.

In order to engage in the online group work, students had to create Gmail Accounts and make a handwritten record during the practical sessions (81.6% of students succeeded in doing this). Lists for two of the four groups were almost complete; the other two groups emailed the missing account details to the lecturer.

There was a good level of online collaboration, 92.1% of students were active on Google Drive ([Dataset 1.4](#)). Five students (6.5% of the cohort), who were all absent from one of the practical sessions, failed Stage 1 and one of them did not submit any work at all. Qualitative analysis of Google Drive activity, together with the quality of the group work produced (see [Figure 1 – Figure 3](#)) provides strong evidence that students successfully engaged in the group work component of the assignment.

Interesting group dynamics were evident from monitoring the Google Drive activity. Members of one group engaged in the process very actively, and some members became natural leaders. These leaders then became a little too controlling and removed the other group members' editing permissions. The lecturer intervened by sending an email out via Moodle to let them know this was not acceptable behaviour, and permissions were reinstated for all group members. The students also engaged in group discussions using a forum in Moodle and the Google Apps comments feature. The latter was particularly useful when students were refining their documents; the comments stream acted as a private, student-led forum for discussion.

Students successfully accessed the documents on Google Drive to create a written description of the habitat. All groups also managed to curate photographs of the habitat site and plant species found using Google Slides. Self-directed learning clearly took place during the creation of the group documents, which surpassed the expectations of the lecturer in terms of overall quality and attention to detail. The descriptions and figures for the submissions were of a very high standard, especially considering the students had no formal training on expected undergraduate academic standards.

An example of the type of work completed from one group (X) can be seen in [Figure 1](#); it shows the habitat site ‘The Bluebell Wood’

and one of the plants identified, *Plantago major* (Figure 2); feedback should have been added that this was not a Monocotyledon. This data demonstrates that students did research the Minimum Undergraduate Standards required, as evidenced by the correct use of binomial names and the use and position of figure legends. The students managed to produce group work that met expected standards, all within six weeks of arriving at the University. The task instructions were purposely brief to enable students to make their own contribution. Figure 1 and Figure 2 show that some students used this opportunity to deepen their learning and understanding; the inclusion of additional notes demonstrates that several groups were engaging in high quality research, and managed to identify

plants at the species level (Figure 3a) and produced a list of specific plant species present at the site. This also shows an awareness of ecological knowledge.

The group work documents demonstrated that students were more aware of the campus grounds. Each group submitted 10 – 12 photos of habitats/plants and a habitat description (Supplementary materials 8). Group work submissions and individual analysis of the four grassland habitats on the Colchester campus were used as evidence of an increased understanding of ecology (Figure 1–Figure 3). Figure 3 demonstrates that the students in group X gave a good general description of habitat sample and detailed features of

Figure 13: The Edge of the Bluebell Wood

Notes:

The Bluebell Wood is located at the shelter belt alongside the main road from the lake to the middle lodge. It is the woodland along Clinghoe Hill Road.

Figure 1. Example of student generated Google Slide of habitat from Stage 1 of assignment.

Figure 2 : Greater Plantain (*Plantago major*)

Notes :

The Greater Plantain (*Plantago major*) commonly known as rat tails, is identified as a ~~monocotyledon~~ from it's distinct fibrous root and parallel veins. It is a perennial plant that is pollinated by wind distribution of seeds and can produce as many as 1,500 seeds per individual. The dark green leaves lie close to the ground and form a rosette at the base. There are few veins present on the leaves, and the flowers are borne on a long narrow spike that gives the plant its nickname (rat tail). The leaves and spikes themselves are very resistant to trampling by feet, and can sometimes even harm the thing that trampled on it, giving a small bruise or cut. Consequently, this plant can also be used to treat ulcers and sores, as it has been used in Britain. It is very widespread in the area and has even been used to create bread (way-bread).

Figure 2. Example of student generated Google Slide of plant from Stage 1 of assignment.

a

Group Number/Code: 15 / X	Habitat Site: Bluebell Wood
---------------------------	-----------------------------

Description:

The habitat that we sampled in was located at the edge of Bluebell Wood. The samples were collected along the treeline. Vegetation was scattered around in small patches within the area and they were cut short along with the grass. We sampled the vegetation growing above the cut line. There were also leaves scattered around the roots of the trees from the tree itself, but not a large amount giving the impression that leaves are raked to keep the area clear. This allowed us to make the assumption that the area is managed in a specific way, and most likely managed quite often to prevent the grass growing too high. This could possibly limit various plant species growth in the area, possibly weeds if the maintenance of the area includes weeding, especially around roots of the trees.

The grass in the sampling area was moist and the subsequent patches (the exposed soil with little or no vegetation) was muddy. Near to the sampling area, between the parallel row of trees that are planted on the walk to the treelines that grow parallel to each other, with the trees providing a moderate amount of shade for species of plants growing beneath them. One of the most important factors that had impact on our results were habitat conditions.

Many species of plants were identified scattered around the trees and in the field, such as Creeping Thistle (*Cirsium arvense*), Plantain (*Plantago*), Creeping Buttercup (*Ranunculus repens*), Chickweed (*Stellaria media*), Broad Leaf Dock (*Rumex obtusifolius*), Agrimonia (*Agrimonia eupatoria*), Ragwort (*Senecio jacobaea*), Yarrow (*Achillea millefolium*) and two different species of Grass that could not otherwise be specifically identified. There were some other species present but they could not be accurately identified as we did not have enough information for proper identification.

These habitat conditions differed in the two general areas that we took our samples from. One area was mainly sunny, but had some shade in smaller patches. Medium sized grass was observed growing on small mounds. Air temperature was generally around 13 degrees Celsius, but in the areas exposed to the sun, the temperature did reach the high teens. The soil had a damp texture due to heavy rainfall the day before. The grass was shorter in this area than further into the forest due to groundskeepers periodically cutting it, limiting its height and potentially damaging it. The sampled area had a uniform covering of plant life with no bare earth visible. The other sampled area was in the shade of a few trees so the ground was exposed to less sunlight and rainfall, the effect of which could be seen in the fact that plants were scattered in small patches and there was a presence of more bare patches. The earth was more dry and crumbly in this location and there were small stones.

b

Comments List (7)

Find

nicola ▾ +
Page 1 13/11/2014 11:15:46
Good to start with habitat, add more details about location, Colchester campus

nicola ▾ +
Page 1 13/11/2014 11:16:17
Avoid we as this is a personal style.

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Page 1 13/11/2014 11:18:14
This is a reason, do not include for descriptions. Many examples in this paragraph were your opinions are expressed. You include these if you were asked to explain.

T nicola ▾ +
Page 1 13/11/2014 11:16:38

nicola ▾ +
Page 2 13/11/2014 11:18:50
Good details of plants, including common and binomial names, using correct conventions

nicola ▾ +
Page 2 13/11/2014 11:19:37
Repetition of comments already made about weather.

nicola ▾ +
Page 2 13/11/2014 11:20:06
Good

Figure 3. (a) Example of feedback comments on descriptive task of stage 1 of assignment. **(b)** Lecturer comments added to student descriptive task in Figure 3a.

habitat boundary; characteristics of different plant forms and presence of different patches within the habitat, and information on weather and soil characteristics.

The Google Sheets data, collected during the subgroup task, highlighted a greater range of student ability and was less successful overall. Raw and calculated data were expected; the submitted information ranged from no data, incomplete data sets, to data sets complying with Minimum Undergraduate Standards. The approach required students to be responsible for keeping data safe until it was inputted online, and to understand the Minimum Undergraduate Standards for tables. Evidence suggests that many students were unaware of these expectations, as more than one of the data sheets had no data submitted. Many others contained data with the units in the body of the table.

The small size of the subgroups meant that there was greater variation in the standard of work. (This is to be expected for normal distribution of data.) This demonstrates that the subgroups were working within the team that they were assigned to. The large number of data sheets generated (28) meant it was difficult

to quickly achieve a single, combined dataset in a format that was suitable for the students to access for the latter parts of the assignment. The deadline for the assignment was adjusted to take account of the time needed to collate and disseminate the data to the cohort.

Stage 2 of assignment: Peer assessment

The second part of the assignment was designed to make students aware of the marking process and give them an opportunity to become familiar with the habitats they had not visited. A student who did not take part in the practical sessions (due to a change in degree course) was able to do this and successfully complete the assignment (with a final mark of over 90%).

The peer assessment required students to look at the eight group documents, descriptions and figures of the four habitats, as well as the 28 data sheets. A high proportion of students demonstrated a good level of engagement with the assignment; 78.9% of the cohort obtained over 65% for stage 2. This proves these students reviewed the minimum standards and used their observations to successfully peer assess the work of others (see Figure 4 for an example). Fifty percent of students who obtained a first class mark for the

BS111 Practical 2& 3 Correlation of species richness to soil properties

Student Name: XXXXXXXXXX

Group: Z

Date 04/11/14

Peer Assessment form for other groups: W, X and Y

Element	Requirements	Score Group W	Score Group X	Score Group Y
1. Written description of the habitat	Minimum Standards : Sentences, with descriptive words , no explanation, good grammar, no/few spelling mistakes	3/5 Grammar good, but mistake regarding tense. Describe is factual recall, but included interpretation of factors.	4/5 Sentence structure and wording concise. However different font sizes were used within the text	3/5 Slight grammar mistakes including missing full stop. Simple descriptive words
2. Provide Photos of site & some of the species	Range of photos of habitat and close up of species (12 – 20 photos) Fig number and title below photo (labeling if appropriate)	4/5 Included species and habitat photographs. Some photos out of focus (e.g. fig.11). The photos of species were zoomed out, perhaps not the appropriate level of detail.	4/5 Effective use of notes to give further species description of species. Clear photos of species, including plain background. A few photos of poor quality (e.g. fig. 14 &16)	3/5 Lots of general habitat photos and not enough of species. Didn't include any specifically named species identification. Fig. 15 was a repeat of fig. 14.
3. Provide data obtained from quadrat analysis and subsequent lab work	Tabulated data applying Minimum standards.	2/5 Lots of data missing. Units were included in the table rather than the heading. Some data from the same grouping was not to the same number of decimal places	4/5 One of the sub groups had data missing. Units included in the table. Come cases where the number of decimal places were not uniform.	4/5 Missing data for a few entries. Cases where the same number of decimal places not uniform. Few sub groups included units in their tables.
Overall comment:				
Best aspect with reasons why	Group X's species photographs because the photos were clear, showed close ups and the use of annotation included further detail on species.			
Area that needs most improvement and why	Consistent data collection, because there was data missing throughout tables and this data was not always uniform e.g. to the same number of decimal places.			

Comment [njds1]: Good analysis, and understanding of requirements needed for assessment and areas that needs to be improved most.

Figure 4. Example of a good individual student peer assessment task, stage 2 of assignment.

peer assessment also got a first class mark for their independent work. Some students (2.6%) submitted work but had a second class mark for this stage. In these cases the peer assessment had arbitrary marking patterns and over-inflated scores, e.g. 5/5 for everything, and comments were very brief or absent. This demonstrated that they had limited knowledge of expected requirements and types of answers. A larger sub-set of students (14.5%) did not engage in the peer assessment at all (see [Dataset 1.2](#) & [Dataset 1.3](#)).

Stage 3 of assignment: Independent work

The independent work was an open-ended task. The endpoint of the entire assignment was to carry out correlations to establish if there were any discernible patterns in the data from the different habitats. Students found that the data sheets were not in a suitable format to enable correlation, and had to make difficult decisions on what data to include/exclude and how to standardise the results. As a consequence, the students asked for guidance on sorting and

analysing the data. Some individuals became stressed, evidenced by emails sent to the lecturer. An extra tutorial was run in a computer lab to support these students. During the tutorial, the majority of the attendees felt anxious because they had not achieved the ultimate endpoint of the assignment. As a result, the task was modified to include a simpler outcome that they could achieve. Students had put a huge amount of time into the activity; the lecturer feedback indicated that they had done well and listed achievements for figures and descriptions, and highlighted the fact that most had created tables and figures that mainly complied with expected academic standards.

However some students had overcome these issues by that stage, e.g. they had produced correlation tables and figures which they submitted in their individual assignment (see [Figure 5](#) and [Figure 6](#)). By the end of this process, 47.4% of students were capable of handling, analysing and interpreting ecological data, enabling them to achieve a first class mark.

Table 2: The recorded invertebrate data found from each habitat; W, X, Y and Z

Invertebrate type	Habitat W	Habitat X	Habitat Y	Habitat Z
Spider	yes	yes	no	no
Beetle Larva	yes	no	no	no
Centipede	yes	yes	yes	yes
Millipede	yes	yes	no	yes
Worm	yes	yes	yes	yes
Nematode	yes	no	no	no
Wood louse	no	yes	no	yes
Beetle	no	yes	no	no
Fly	no	yes	no	no
Caterpillar	no	yes	no	no
Ants	no	yes	yes	yes
Weevil	no	no	yes	no
Mite	no	no	no	yes
Geophilomorpha	no	yes	no	no
Insect larvae	no	no	yes	yes

Figure 1: The number of different invertebrate species found in each of the habitats; W, X, Y and Z

Table 3: The recorded plant identification data from each habitat; W, X, Y and Z

Plant Type	Habitat W	Habitat X	Habitat Y	Habitat Z
Creeping Thistle	yes	yes	no	no
Plantain	yes	yes	yes	yes
Speedwell	yes	no	no	yes
Buttercup	yes	no	no	no
Grass	yes	yes	yes	yes
Ragwort	yes	yes	no	yes
Chickweed	yes	yes	no	no
Creeping Buttercup	no	yes	no	no
Yarrow	no	yes	no	yes
Agrimonia	no	yes	no	no
Broad leaf Dock	no	yes	no	no
Clover	no	no	yes	yes
Dandelion	no	no	yes	yes
Small Thistle	no	no	yes	no
Moss	no	no	yes	yes
Daisy	no	no	no	yes

Figure 2: The number of different plant species found at each of the different habitats; W, X, Y and Z

Comment [N1]: Add habitat locations as well as codes; add binomial names for plants.

Figure 5. Demonstrating how a capable student sorted the class data for stage 3.

Table 9: the correlation between the number of Dicot species and the soil pH

	No. of Dicot species.	soil pH
No. of Dicot species.	1	
soil pH	0.568810261	1

Figure 3: The positive correlation between the number of dicot species and the soil pH at each of the habitats; W, X, Y and Z**Figure 6.** Demonstrating how a capable student sorted the class data to produce correlation figure (stage 3).

Overall analysis of the three stages

Over 82% of students were successful in completing all three stages of the assessment; with 85.5 % of students passing stage 1 and 86.8% passing stage 2 (see [Dataset 1.5a](#)). A small number (5.3%) did not submit any work in any of the three stages. The peer assessment component (stage 2) had the highest level of non-submission (14.5%), followed by the stage 1 group work (9.2%).

Considering the whole class dataset, 59% of students had a good performance (marks greater than 65%) for the group work, 78.9% for peer assessment and 51.3% for the individual work. For the whole class, there was a positive correlation between the mark obtained by students during group work and the later independent work (stage 2 $r = 0.334$ $p < 0.01$, stage 3 $r = 0.516$, $n = 76$, $p < 0.001$). There was a weaker correlation between the mark obtained in peer assessment and the mark obtained for independent work ($r = 0.293$, $n = 76$ $p < 0.05 - 0.001$).

For the set of students with a mark over 65% for the independent work (stages 2 and 3), there was no significant correlation between the marks they obtained in group work and marks achieved at the other two stages of independent work ($n = 41$, $p > 0.05$).

However, for students who underperformed, with a final mark less than 65%, there was a significant positive correlation between the mark obtained in the group work and the mark obtained during the stage 3 independent work ($r = 0.597$, $n = 35$ $p < 0.001$). (See [Dataset 1.6](#))

Analysis based on gender indicates female students had a significantly higher mean mark (73.3%) than males (57.8%) for stage 1 (ANOVA: $F_{1,74} = 6.45$, $p < 0.05$). For stage 3, the female mean mark was also higher at 76.2% compared to a male mean mark of 47.9%; demonstrating a significant difference between male and female performance (ANOVA: $F_{1,74} = 22.031$, $p < 0.0001$). There was no significant difference between the mean marks for male and female students during the stage 2 peer assessment ($p > 0.05$). For female students there was also a positive correlation between the marks obtained in stage 1 and stage 3 ($r = 0.518$, $n = 34$ $p < 0.01$), but no correlation between stages 2 and stages 3 ($r = -0.013$ $p > 0.05$). (See [Dataset 1.6 & 1.7](#)).

For males students, there was a positive correlation between all three stages ($r = 0.477$, $r = 0.430$ respectively, $n = 42$ $p < 0.01$). However, in contrast to the female students, there was a weak

positive correlation between peer assessment marks for males at stage 2, and the marks obtained for independent analysis during stage 3 ($r = 0.349$, $n = 42$ $p < 0.005$).

There were no significant differences in the mean marks of students allocated to the different groups (W, X, Y, Z), or for students studying on different degree schemes ($p > 0.05$).

There were a number of student absences from practical sessions (1.31% of the non-submission data is accounted for by one student, who did not attend either practical session nor submit work during stage 1.) Seven students (9.2% of cohort) did not attend practical 2 resulting in a low level of submission for stage 1 (only 2.62% passed this stage), but these students performed well at stages 2 (with marks over 80%) and two students (2.62% of cohort) also performed well at stage 3 (with marks over 90%) (See [Dataset 1.8](#)).

Dataset 1. Raw data for 'Trialling the use of Google Apps together with online marking to enhance collaborative learning and provide effective feedback'

<http://dx.doi.org/10.5256/f1000research.6520.d146293>

Dataset 1.1 (BS111 2014NSMJ): Degree options and gender ratios

Dataset 1.2 (BS111 2014NSMJ): Updated mark BS111 students for stages 1 – 3

Dataset 1.3 (BS111 2014NSMJ): Descriptive statistics on marks

Dataset 1.4 (BS111 2014NSMJ): Student data on making and using Google account/drive

Dataset 1.5 (BS111 2014NSMJ): Analysis of student success for the three stage assignment

Dataset 1.6 (BS111 2014NSMJ): Correlation analysis of marks

Dataset 1.7 (BS111 2014NSMJ): Analysis of variance data

Dataset 1.8 (BS111 2014NSMJ): Absentee data and student marks

Discussion/Conclusions

The three-stage assignment was a successful learning experience for most of the students involved, who had no prior knowledge of the collaborative learning tools used. The lecturer embraced the University ethos which involves being tenacious, bold and challenging. The collaborative activity stretched the lecturer as well as the students; both learnt how to use these new technologies together.

Stage 1 of assignment: Collaborative work

The division of the cohort into four smaller learning groups and seven subgroups created an effective and friendly environment for practical work, which provided a good situation to meet the challenge of online collaborative work. The approach of creating small friendly groups and subgroups was a success, in terms of collaboration and passing stage 1 of the assignment. The majority of students succeeded in setting up Google Accounts (92.1%) and were active within Google Drive, which was a major achievement one week into the academic year. Group work

also appeared to enhance the performance of underperforming individuals.

It was evident from the practicals and data collection stage that there was too much data to collect and analyse; this should be simplified in the future, e.g. reduce sample collection to one quadrat per sub group. Also, improved management during practical 2, e.g. rotating the groups around the laboratory-based activities, would increase the efficiency and reduce the pressure on the limited equipment available in the laboratory. The class data from this year's survey will be reviewed to reduce the range of data to collect. This would decrease the time pressure for staff and students during the practical sessions, and would also simplify the class data set.

A better system is needed for subgroup data collection; the method used was cumbersome and not as effective as alternative methods. It hindered the process of looking at the data for ecological analysis. Other options include the use of a single document at the group level; use of electronic voting devices (clickers) to collect data, or the use of an online form to collect class data in a standard format (Google have a tool to facilitate this). This would help team leaders provide class data quickly in a usable form. These alternative approaches would make it easier for students to collect and use the data.

Students collaborated within Google Drive and managed to produce high quality documents ([Figure 1](#) to [Figure 3](#)) and there was evidence that they had carried out student-directed learning. They had applied the expected minimum undergraduate standards and carried out descriptive and statistical analysis on their data. This was before formal training had been delivered at Level 4 via a Key Skills Module (BS141). There was a noticeable variation of style between the four groups' description and slides. This indicates that students worked within their own group and were not using other mechanisms to exchange information with other students outside of their allocated group. Therefore this part of the assignment met its intended learning outcomes.

The group work, together with the use of comments within Google Docs, demonstrates that students engaged in self-directed learning. The open-ended nature of the assignments allowed the students to deepen their learning, which is evident from research notes added to [Figure 1](#) and [Figure 2](#). Students demonstrated emergent behaviour, which included self-discovery of features in Google Apps, e.g. the discussion stream and document permission settings, which suggests student-student learning took place. Therefore, this met the intended outcome of this new approach.

During the group work, it emerged that students were using three methods of electronic communication, i.e. discussing and using comments and emails in Google Drive; using the Moodle forum, and also emailing each other directly via Outlook. The communication tools within Google Drive were most advantageous, as they acted as a private forum for student discussion within their group. The disadvantage of the Moodle forum was that it was accessible to the whole cohort and also, more importantly, all lecturers teaching Level 4 modules in the School of Biological Sciences. Having access to these conversations might colour a lecturer's view of a particular student when setting and marking their future

work. Therefore, it would be wise if the lecturer directed the students to a single method (most likely within the Google ecosystem) as this would avoid such problems.

The success of the three stage assignment required the rapid creation and collection of Google Account details from students. Overall this worked well, but students who didn't have accounts could not create any evidence of collaboration, hence did not pass stage 1. Reasons for lack of student engagement were varied: Some individuals were reluctant to try something new, others distrusted the online services, and a few didn't want to put their data in the "Google cloud". Another probable reason for this poor engagement is the timing of the task; it took place early in the term, so students had to contend with many new things, such as some subgroup members changing degree schemes. Student absences from the practical sessions resulted in 6.5% of them failing Stage 1. Therefore, it appears that the face-to-face interaction with fellow students, and members of staff, is crucial for the success of online collaboration and submission of coursework.

In the future, it would be advantageous to use Google Apps for Education or the Microsoft Office 365 suite of tools, as all members of the University have access to both of these services now. (However, Office 365 would only be used if the collaboration features are as good as those found in Google Drive). Using Google Apps for Education would give the lecturer greater control, e.g. the ability to establish student accounts for Google Drive before the start of the practical session and would make it easier for all students to take part. Google takes the education arm of its business very seriously, which should reassure students that their data is safe. Showing the students a short video revealing the security measures that Google enforces at its data centres would perhaps ease any concern, e.g. [Inside a Google data center](#). Getting students to look at the [Google Drive privacy policies and terms of service](#) would also be helpful.

Using Google Drive/Apps did make it a little difficult to see which students had done what, as the activity updates are presented as one continuous stream of information. Using Google Apps for Education could also help improve this situation. It would be possible to provide formative feedback for the stage 1 work rather than wait for formal feedback. This environment is good for self-directed learning, experimentation, and for encouraging informal communication (which will help students engage at a deeper level and gain a more comprehensive understanding of the subject).

Stage 2 of assignment: Peer assessment

The peer assessment provided the link between the group and individual work. It also ensured that the students engaged in data that they were not involved in creating.

Stage 2 enabled students to regain entry into the assignment process if they had failed to complete stage 1, which is a key feature of this multiple-stage process. A student who came onto the course after the practical sessions entered late in stage 1, participated in stage 2 and successfully completed the whole assignment. By engaging students at this stage of the assignment, it was hoped that they would become familiar with the habitats they had not visited and

not just rely on the site they sampled. Students did analyse all of the data sets, so the peer assessment activity met its intended aim. However this was the stage that had most non-submissions and also included three students who did not submit any work. It is possible that students were tactical as a larger amount of work was required for a low proportion of marks. Also some students may have found it hard to make judgements.

Stage 3 of assignment: Independent work

For the third stage of the assignment, some students used the tutorial and managed to achieve all of the expected outcomes, i.e. correlation figures and identified plants to the species level through their own endeavours ([Figure 5](#) and [Figure 6](#)). It is important to let students know that there is no correct answer expected, and that the assignment is designed to force them to work outside of their comfort zone. This would be made clearer in future.

The initial tasks (e.g. finding averages) should have been accessible to all students. Stage 3 assumed that stages 1 and 2 had been achieved to a high standard. However, the data sheets between subgroups were not consistent—one group had a complete data set missing and other groups had sheets with incomplete data.

The fact that there were three stages to the assignment allowed any student not succeeding at a particular stage to be successful at a later stage. Analysis of gender showed that there was no correlation between stages 2 and 3 marks for females, but a weak positive correlation for male students. This is worth reviewing again in future years. A benefit of this staggered approach was that it required a variety of skills for completion, thus enabling a diverse range of learners to succeed at one or more parts of the assignment.

The overall assignment demanded a high level of engagement, so students who succeeded were clearly involved in a deep learning experience. Many students met this challenge, but some became stressed as they had other assignments to carry out in the same time frame; there was a definite cost versus benefit relationship between the stress created and the learning achieved. For a healthier balance, a simpler data set together with a more directed final assignment (with some scope for an open-ended approach) will be used in the future. A student evaluation of the assignment and self-reflection on skills gained would also be a useful addition.

Data availability

F1000Research: Dataset 1. Raw data for 'Trialling the use of Google Apps together with online marking to enhance collaborative learning and provide effective feedback', [10.5256/f1000research.6520.d146293](#) (Slee & Jacobs, 2016).

Consent

Consent has been obtained from BS111 students using an electronic voting system and only students giving consent had data used.

Author contributions

Nicola Slee (NS) and Marty Jacobs (MJ) conceived the study. NS designed the experiments. MJ carried out the research and training

of Google Drive collaborative tools and integration with FASER. MJ provided support to NS and BS111 students. NS contributed to the design of experiments and assignments. NS and MJ prepared the first draft of the manuscript and preparation of the manuscript. All authors were involved in the revision of the draft manuscript and have agreed to the final content.

Competing interests

The authors declared no competing interests.

Grant information

The author(s) declared that no grants were involved in supporting this work.

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Supplementary materials

Supplementary materials 1a: Undergraduate Standards of Presentation 2014–15

Minimum Undergraduate Standards as detailed in Biological Sciences UG Handbook 2014 15

Guidelines on writing assignments

- a) Latin binomials (species names) must be in italics when word processed (e.g. *Aphis fabae*) or underlined when handwritten (e.g. Aphis fabae)
- b) Figures (this term refers to all non-tabulated data: diagrams, graphs, drawings etc)
 - i. must be numbered and referred to in the text by number e.g. **Figure 1**, **Figure 2** etc
 - ii. must have a descriptive title (and legend if necessary) so that they can be understood without reference to the text
 - iii. must have a key to any symbols used
 - iv. must be produced using appropriate software to generate graphs and diagrams (except for some year 1 worksheets as specified by the lecturer)
 - v. graphs must have labelled axes with units and may have only sparing and selective use of colour, where appropriate to improve clarity
 - vi. hand-drawings must be made with single clear lines using a hard (2H) pencil and must not use artistic shading (cross hatching to differentiate between tissue types may be appropriate)
 - vii. as appropriate, drawings must have a scale and be labelled, using ruled pencil lines (without arrowheads or other end markers) as pointers
- c) Tables
 - i. must be drawn with a ruler or using appropriate software.
 - ii. must have a descriptive title and column headings so that they are comprehensible without reference to the text.
 - iii. must be numbered and referred to in the text by number e.g. Table 1, Table 2 etc.
- d) Numbers
 - i. must have units where appropriate (leave a space between the number and the unit) and should be rounded off appropriately.
 - ii. numbers from one to ten should generally be written as words in the text. Numbers greater than ten should generally be written as Arabic numerals (i.e. 11, 126 etc.). When making reference to figures or tables use Arabic numerals.
- e) All references
 - i. must be cited correctly in text (see section on Referencing)
 - ii. must be listed in a reference list in the appropriate way
 - iii. cited in text must be in reference list
 - iv. in reference list must have been cited in text.
- f) Font
 - i. must be 11 point Arial

Referencing

The most important independent measure of the research a scientist has produced is their research publication list, so writing scientific papers is central to a career in science. All scientific papers have to include references in the research journal style, so it is a key scientific skill to be able to follow the details of reference style guidelines and apply these precisely to your work. An important principle in all forms of research and scholarship is that you must fully reference the sources of all ideas and results that you are quoting or using. In the context of your learning, references also show the reader or examiner that you have read and can integrate information from different sources. It also helps you to avoid plagiarism.

The point of the referencing system is to make it clear who came up with an observation or idea and make it possible for readers to track that material down. There are general conventions for referencing sources, both how they are referred to in the text, and how the reference is given in the reference list. Different disciplines and publications do use slightly different formats, but for consistency we have adopted one standard across the school.

Referencing in text ('citation'):

References in the text are cited using only AUTHOR (surname only) and DATE (year only):

"Smith (1989) reported that..." or "X was discovered by Smith and Jones (1989)" or "there have been reports in support of this mechanism in other species (Smith and Jones, 2002; Smith *et al.*, 2008)"

One author: (Smith, 2004)

Two authors: (Smith and Jones, 2002)

More than two authors: (Smith *et al.*, 2008)

Two or more papers: (Smith and Jones, 2002; Smith *et al.*, 2008) *oldest first*

Two or more papers by the same authors in the same year (Smith *et al.*, 2002a and b)

Where an author cannot be identified (for example some internet sources) use the name of the organization, such as BBC or Online Mendelian Inheritance in Man. Do **not** insert the URL in the text. The data used should be the last time the information was updated.

Reference lists: must be in alphabetical order at the end of the work. **Do not number your references. This is the complete information that identifies the source and includes (in this order):**

Surname(s), initial(s), year, title of paper, journal, volume (in bold) and first and last page number.

Sometimes you will have to put your information into this format, for example abbreviating first names to initials only. The issue number (sometimes in brackets, after the volume) is not required.

For journals:

Jones, A., Black, C and Zebidee, A. (2005) Recruitment of DNA methylases to DNA strand breaks. *Nature*, **248**, 771–777.

Smith, J.C. (2001) Effect of inhibition of PARP-1. *Journal of Cell Sciences*, **47**, 123–132.

For internet sources:

Mahillon, J. (2003) IS Finder: <http://www-is.biotoul.fr/is.html> Last accessed 28 May 2008

National electronic Library for Health. 2003. Can walking make you slimmer and healthier? (Hitting the headlines article). Updated 16 January 2005 <http://www.nhs.uk.hth.walking>. Last accessed 10 April 2008

i.e. Surname(s), initial(s)(if possible), year, name/title of site, full URL, date of last access.

For books:

Chrispeels, M.J. and Sadava, D.E. (1994). *Plants, Genes and Agriculture*. 2nd edn., Boston: Jones and Bartlett, pp 162–186.

Dame, J.J. (1998). Formulation of cloning strategies. In *Recombinant DNA: Principles and methodologies*. J.J. Greene and V.B. Rao (Eds). New York: Marcel Dekker, pp. 193–267.

i.e. Surname(s), initial(s) (of author of chapter) year, title of chapter, title of book, editors, page numbers, place of publication, publisher.

Secondary sources:

If the information you are using was quoted by a source such as a textbook or a review as originating from somewhere else, this is then a secondary source. Cite this in the text as: “Bloggs (1985, cited in Smith, 1992) showed that ...” or “It has been shown that ... (Bloggs, 1985, cited in Smith, 1992)”. In the reference list you only give the details of the source you read: Smith (1992).

Please refer to the section on academic offences in Section 4 of this handbook for further information on referencing and where to seek advice.

Supplementary materials 1b: Google Docs document instructions for group task

BS111 Practical 1 Description of Habitat

Aim to apply minimum Undergraduate Standards of Presentation. See Undergraduate Handbook for Guidance: http://www.essex.ac.uk/bs/current_students/default.aspx (see page 27–32) (see **Supplementary materials 1a**)

Provide a written description of the habitat you visited and sampled including details of its location. Apply Minimum Undergraduate Standards of Presentation and appropriate details for term “Describe” (see Undergraduate Handbook for guidance). Ideal word count 500–750 words

[10% of overall mark Practical 2 and 3.]

Supplementary materials 2: Google Slides document instructions

BS111 Photo Submission for Group Work

Provide photos of site and some of the species found. Apply standards required for figures (See guidance in Undergraduate Handbook, section on Minimum Standards of Presentation Diagram/Figures) (see **Supplementary materials 1a**). Ideal number of Figures: 12–20.

[10% of overall mark Practical 2 and 3.]

Supplementary materials 3: Google Sheets document instructions

BS111 Ecology Practical 2 and 3 Part A Subgroup Data Sheet Instructions

It is important that you all access your own version of this via your Google Drive. Divide the tasks up, e.g. for your subgroup one member can put in raw data information from data sheets, one member can work on calculation needed, other members to check.

One member to check requirements of Minimum Undergraduate Standards for tables, and apply them.

One member can cross-check with descriptions and photos for details on species identification.

Final version to be downloaded as an Excel document from Google Drive. The final version will be uploaded to the BS111 Moodle page after the Part A deadline to be used for Part B (evaluation and analysis).

This will be worth 10% of your assignment

Add units, etc, to comply with Minimum Undergraduate Standards.

Supplementary materials 4: Peer assessment Instructions and Pro forma

Worksheet Instructions for BS111 Practicals 2 & 3 Part B: Individual submission:

Aim to apply minimum Undergraduate Standards of Presentation. See Undergraduate Handbook for Guidance) http://www.essex.ac.uk/bs/current_students/default.aspx (see page 27–32, **Supplementary Material 1b**)

Using all the group data that is accessible on Moodle BS111 i.e.

The written description of the 4 different habitats; photos of habitats and plant species of the four sites and group data from quadrats, cores that included vegetation, soil, invertebrate analysis carry out the following for this worksheet.

Part B submission: (Stage 2 & 3)

Work to be assessed (see Practical 2 & 3 Part B):

1. Peer assessment & submitted with Part B. Use the Peer assessment form from the BS111 Practical 2 & 3 handbook to assess the other groups information on

[10% of overall mark Pract 2 & 3]

Instructions:

1. Access the group data which will be uploaded to Moodle in section for BS111 Practical 2 & 3. Using Peer assessment form peer assess the following:
 - a. Group descriptions for each habitat (excluding own group)
 - b. Figures of the site and species (excluding own group).
 - c. Group data sheets (excluding own group)

Use the FEEDBACK Checklist of Expectations and Common Errors to guide you in your peer assessment & Minimum Undergraduate Standards (p27–32 of Undergraduate Handbook).

Use Guidance given in instructions and example excel workbook.

Worksheet for BS111 Practical 2 & 3 Part B: (Pro forma for Peer Assessment)

Individual work submission:

1. BS111 Practical 2 & 3 Peer Assessment form.

[10% of overall mark Pract 2 & 3, part of Part B mark.]

Student Name: Group: Date:

Peer Assessment form for other groups: W, X, Y, Z (delete as appropriate)

Element	Requirements	Score Group W (/5)	Score Group X (/5)	Score Group Y (/5)	Score Group Z (/5)
1. Written description of the habitat	Minimum Standards : Sentences, with descriptive words, no explanation, good grammar, no/few spelling mistakes				
2. Provide Photos of site & some of the species	Range of photos of habitat and close up of species (12 – 20 photos) Figure number and title below photo (labeling if appropriate)				
3. Provide data obtained from quadrat analysis and subsequent lab work	Tabulated data applying Minimum standards.				
Overall comment: (exclude your group which is -----)					

Supplementary materials 5: Individual: Instructions and Generic Feedback sheet for individual work (Stage 3)

Stage 3: Final Instructions for Individual Work to be assessed (see Practical 2 & 3 Part B):

Questions

1. Individual evaluation of class data on the 4 habitats. Details

You will have access to 3 excel documents that will provide you with

1. Information and examples of the types of analysis to carry out.
2. Class data for the four habitat sites in one workbook where each habitat will have a separate page in the excel workbook. There is also the original downloaded sub-group data in another excel workbook
3. In the class data workbook, save with your surname BS111 2 & 3 Part B then **Analyse to determine habitats species richness and variability in habitats following quadrat sampling & further laboratory analysis: Some guidelines of potential analysis.**
 - a. For each habitat calculate the average, standard deviation and standard error for each parameters (numerical data), just a few are shown in the example document.
 - b. Tabulate the average data into a new table (must comply with Minimum Undergraduate Standards).
 - c. Decide how many dp are appropriate for numbers.
 - d. Past Table(s) & if appropriate Figures into word document, reformat as necessary to comply with expected standards.
 - e. **Analysis of data to find out if there are patterns and correlations in the habitats investigated.** See information at the end of worksheet on how to carry out analysis.
 - f. Your aim is to create a correlation table of the different parameter,
 - g. Work out if there is a significant correlation between the different factors
 - h. For two significant correlations produce figures of the scatter plots of the data but add a different symbol or colour for the different habitat sites. (See examples on example sheet)
 - i. Past relevant tables and Figures in this document of correlation data.

Steps e to i became a bonus section

- j. Write your interpretation of the determine habitats species richness and variability in habitats results in text box (ideal word count <750 words)

[Click here to access the data](#)

Generic Feedback sheet used by students to complete Peer assessment task (Stage 2) and used by lecturer for Stage 3 assessment.

Student Name: _____

FEEDBACK SHEET FOR YEAR 1 FOR BS111.2 & 3 Part B:

COMMENTS: (Good points/areas for improvement)

Text (written answers)

GOOD POINTS	BAD POINTS	COMMENT
Neat presentation	Careless, untidy presentation	
Clear answers	Points not made clearly	
Concise writing style	Waffle and irrelevant material	
Legible	Difficult to read writing	
No/few spelling mistakes	Many spelling mistakes	
Good grammar	Poor grammar	
Correct units always included	Units missing/wrong/poor choice (e.g. 1.2 ml, not 1200 µl)	
Correct number of d.p.	Excessive d.p. used	

Figures

GOOD POINTS	BAD POINTS	COMMENT
Numbered consecutively	Not always given a number	
Number and title together BELOW	Titles sometimes above or beside figure	
Title concise and contains all key information	Title too brief/long or missing important details	
Figure fully and neatly labelled	Untidy/inappropriate labels	
Sharp hard pencil used for drawing, scale included where appropriate	No scale Blunt soft pencil	
Axes always labelled on graphs, units included	Poor/un-labelled/units missing	
Good choice of graph type: line or bar chart (continuous or discontinuous data)	Inappropriate format selected	
Grouped data presented	Raw/individual data presented	

Tables

GOOD POINTS	BAD POINTS	COMMENT
Numbered consecutively	Not always a number	
Number and title together ABOVE the table	Titles sometimes below table	
Title concise and contains all key information	Title too brief/long or missing important details	
Neat layout	Gridlines not drawn with a ruler or untidy	
Appropriate headings	Headings missing/unclear	

Part 3: Mark out of 60

[Supplementary materials 6: Preparatory Information on BS111 Moodle:](#)
[Supplementary materials 6a Moodle News Forum](#)

Preparation for Ecology Practical Sessions (2 & 3, 2014) for Students

BS111 Practicals 2 & 3

by Nicola Slee - Friday, 3 October 2014, 4:28 PM (News Forum)

Dear All,

It was good to meet a number of you this morning for the tour of campus and surrounding area. You will be doing a couple of practical sessions before you start your lecture course for Ecology (BS111). Dr. Alex Dumbrell will be running the first practical on Tuesday (9.00 – 12.00) and I will be doing the second practical session (Thursday 10.00 – 13.00).

I have made various documents available on Moodle BS111 for you to start looking at for practicals 2 & 3. These include your practical handbook and some instructions to set up a Google account for your collaborative team work.

Read through your practical handbook and also have a go at creating this account before the practical. I may add other documents during the week

Remember to bring wellies, waterproof coat, lab coat, pens/pencils and a device to take photos.

Alex is planning to send you details about his practical on Monday.

With best wishes

Nicky

BS 111 Practical 2 & 3

For practicals 2 & 3 you will be assigned into a specific group. It is important that you know which group you are in and remain in that group.

These two practicals will be developing practical skills in the field and in the lab for collecting & analysing data on species richness.

It is also developing team work and collaborative work which is a key feature of many ecological research and workplace situations.

Julie Snell has emailed you with details of which group you will be in for Thursday 9th October and Monday 13th October.

Documents to access: information on how to set up Google drive that was needed for team work; group allocation for teams (W, X, Y & Z); Practical Handbook which contained timetable and requirements for the practical, learning outcomes Safety, Introduction, methods for teamwork, field work, lab work, assessment coversheets, feedback sheet for Year 1, link to Undergraduate standards, worksheet questions for for part A (group work & sub-group work), part B (peer assessment and individual evaluation, assessment weighting of the different stages of the assignment).

Supplementary materials 6b: Google Drive instruction set up for team work for BS111 Practical 2 & 3

Team work:

You will have been allocated to a group before you come to the first practical session. Go to that group in the teaching lab; Find two other people in that group to form a sub-group. Sign the register and on a separate sheet note the members of the sub-group and allocated code.

Before the end of the first practical you will need to enter your Google account details onto the group register list (In the practical).

Google Drive instruction set up to enable your teamwork (collaboration) during/after the first practical session.

You will be carrying out your collaborative work in Google Drive.

In Google: Search for Google Docs

<https://drive.google.com/>

If you can have a go at setting this up before the practical next Thursday you will a step ahead.

Supplementary materials 6c – d: PowerPoint Instructions and Guidance

[Click here to access the data](#)

[Click here to access the data](#)

Supplementary materials 6e: BS111 Ecology Practical Data Collection Forms

BS111 Ecology Practical 2 & 3 Part A Date: 9th October 2014

Group Data.

Group No. (W, X, Y Z)	
Habitat Number Name & Location on Wivenhoe Campus (Figure 1)	

General Description of Area/habitat:

Photos taken of habitat:

Identification of plants in habitat:

Do this as a group activity before collecting quadrat data so that each group uses the same code.

Different Plant Species identified in the two quadrats	Monocot/Dicot (M/D)	Further ID. (in lab)	Sample taken, labelled & put in plastic bag.	Photo taken (y/n)
Bare ground.				
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				
T				

Sub-Group Data: Group No. (W, X, Y Z) (Circle appropriate letter for group) Sub Gp No: ____

Student Names in trio (sub-group): 1 _____

2 _____ 3 _____

Different Plant Species identified in the two quadrats	Monocot/Dicot (M/D)	further ID.	Quadrat 1 (% cover)	Quadrat 2 (% cover)
Bare ground.				
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				
N				
O				
P				
Q				
R				
S				
T				

Quadrat Data	Quadrat 1	Quadrat 2
No of different plants species in quadrat		
No of monocot species		
No. of Dicot species.		
Air Temperature (°C)		
plant temperature (°C)		
Soil temperature (°C)		
Plant samples taken		
soil water content based on feel		
soil respiration based on smell		
soil colour		

Group : W, X, Y or Z (circle)

Sub-group code: _____

Student Names:

Point Quadrat	Quadrat 1		
Point	No of hits on bare ground	Height of tallest vegetation above ground.	No of hits on plants
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
TOTAL COUNT			

Point Quadrat	Quadrat 2		
Point	No of hits on bare ground	Height of tallest vegetation above ground.	No of hits on plants
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
TOTAL COUNT			

Label 2 bags per quadrat – one for the vegetation and the other for the soil sample; include group and subgroup code and date.

- For one of the quadrat samples put soil of quadrat in one of the labeled bags and the vegetation and roots in the other.
- Core Samples are taken from central areas of the quadrats

Gather as a group and return to the lab (6.04)

Data collection in Lab

Make notes in your lab book. This data will be collected over the two practical sessions. Steps essential to be done on the first day are in bold.

Parameter	Core 1	Core 2
Gmail details on group data sheet.	n/a	n/a
Fresh weight (F.W.) of total soil core (in bag)		
Fresh weight plant material		
Fresh weight of shoot		
Dry weight of root		
5g f.w. soil sample		
dry weight of 5g soil sample		
soil texture (dry) descriptive observations and deductions		
soil texture (wet) descriptive observations and deductions		
Porosity of soil rate ()		
soil pH		
Identification of plant samples from habitat site (Plant ID)		
Number of worms in core		
Number of different invertebrate types		
List types of different invertebrates found		
Info on sedimentation profile (% sand, silt & clay particles)		

Other information that may be collected:

soil potassium mg/l K		
potassium levels (520nm)	Cloudy solution: presence	Clear solution: absence

This information will form part of your Part A submission. You will input the data into documents available on your Google Drive which you can access after your gmail account has been received. Each student needs to access their own Google Drive and demonstrate they have taken part in the team work.

The data you submit for Part A will be used to create the class data that you need for part B.

Your first task will be to submit the data onto the files available on Google Drive.

For Part B: you will be analyzing the data from the different habitats i.e. you will use all the class data so it is important you take care over collecting your group & sub-group data.

Supplementary materials 7: Generic Feedback

Feedback for MODULE NUMBER: BS111 Pracs 2 & 3 Part A

For Correlation of species richness to soil properties from different habitats

OBJECTIVES ASSESSED

- 1) Team work
- 2) Familiar with quadrat sampling in vegetation.
- 3) Description of habitats using variety of formats
- 4) Provision of quantitative data obtained from with quadrat sampling in vegetation
- 5) Information suitable for other scientists to use for statistical analysis and evaluation.

Feedback on Objectives tests:

1. Many of you have demonstrated excellent teamwork, during the practical session, creating gmail accounts and setting up Google drive to work collaboratively on providing description and figures of the different habitats. In sub-groups you also collected data based on your quadrat sampling that other scientists were able to use for evaluation.

2. It is evident from the data sheets that you are now familiar with quadrat sampling and obtained quantitative data from the quadrat analysis.

3. You have provided excellent written descriptions of the 4 different habitats & figures (photos) of habitats and plant species of the four sites. Generally excellent identification of species included in both written work and figures, and use of genus and species name. You have demonstrated, especially with the descriptions and Figures that you have provided data that is suitable for other scientists to understand about the different habitats.

You understand and applying Minimum Undergraduate Standards to Figures i.e. Figure number and descriptive title below text, using italicized binomial names. You have provided a good resource for members of the other groups to know the general features of a particular habitat sampled.

The Sub - group data from quadrats, cores that included vegetation, soil, invertebrate analysis was variable, ranging from excellent to absent.

Areas to develop:

a. Figures: add labeling lines and label to side of photos. Add scales.

b. For descriptive text refer to the figures in the text. Avoid explanation, reasons, opinions for 'Describe' or 'Description' gave good gain excellent information about the

c. Sub - group data from quadrats, Area to Improve: How you record you data to enable other scientist to access the information. Put units in headings not in body of the tables; some of the data was difficult to access because you put the units in the body of the table rather than in the headings.

Generic Feedback for Part A.

Best aspect with reasons why: Depth of knowledge presented, much greater than I anticipated. The group work enables the whole class to see standard expected.

Area that needs most improvement and why

To make sure describe/descriptions have no explanations.

Units present, using SI conventions but in body of table rather than within heading section

Feedback for calculations:

Root to shoot ratio (F.W.)

= ratio of root (1) to shoot = 2.77 (fresh weight of shoot) $\div$ (fresh weight of root) $(6.03) = 0.45$ g shoot to 1 gram of root on a fresh weight basis.)

If you have done it the other way: fresh weight of root $(6.03) \div$ fresh weight of shoot = 2.17 g root to 1 gram of root

Root to shoot ratio (D.W) use the same principle but with dry weights.

Dry weight of whole soil sample (give details of calculation elsewhere on sheet 1)

= fresh weight of soil $\div$ fresh weight of sub sample $\times$ dry weight of sub sample

Fresh weight of soil e.g. 269.56g

Fresh weight sample = 5g

Dry weight of 5 g sample = 4.35

i.e. $(269.56 \div 5) \times 4.35 = 234.51$ g dry weight soil for total sample

Porosity of soil (give details of calculation elsewhere on sheet 1)

Porosity = volume of water to pass through soil (cm^3) $\div$ time taken (min) =(rate $\text{cm}^3 \text{ min}^{-1}$)

End of generic feedback.

Supplementary materials 8

PDF of Google slides produced by one of the groups.

[Click here to access the data.](#)

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Open Peer Review

Current Peer Review Status: ? ?

Version 1

Reviewer Report 20 July 2015

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Melanie Link-Perez

Department of Biology, Armstrong State University, Savannah, GA, USA

This article describes a multiple-week ecological exercise that has both field and laboratory components and combines opportunities for collaborative learning, peer assessment, and individual work, with instructor feedback included at several stages. An important component of the three-stage assignment is the pivotal role of technology, in the form of free Google online tools, in order to facilitate the collaboration between students and the delivery of feedback from the instructor. The introduction does a nice job of providing context and articulating the rationale behind the design of the method described. The assignment is well-conceived, and there is a natural progression from group work and collaboration toward individual demonstration of learning outcomes. Especially valuable is the opportunity for the students to engage in assessment of their peers, a high-impact activity that the authors noted led to higher achievement in the final stage of the assignment for those students who fully participated in the peer-review. This method should be easy to implement for instructors willing to do so.

General comments to consider during revision:

- Change “peer assignment” to “peer assessment”; better reflects the nature of the activity, less confusing.
- Make the abstract a bit more explicit; for example, in the third paragraph it states that the assignment “was a success.” Based on? How so? The answers are there, but the reader has to wait for them and is not certain if she has correctly identified them. Go all the way when making a statement; don’t lead the reader part of the way there, and expect him to complete the thought the way you intended. Be explicit. This comment goes for the article in general.
- In the introduction, the authors refer to the “Challenger Philosophy”; the hyperlink requires additional log-in information and is not generally accessible. Please summarize the key points and remove the hyperlink.
- The authors repeatedly reference the “Minimum Undergraduate Standards,” which appear

on pages 27-32 of a 79-page PDF that is hosted elsewhere online. These standards should at a minimum be summarized (so that the reader doesn't have to find them in the aforementioned document in order to know what type of criteria are included). Since the PDF that contains them is likely to be updated regularly the by School of Biological Sciences at University of Essex, therefore causing the page reference to change, the authors may wish to create a static, free-standing document containing this information.

- Under Methods, Stage 1: What kind of information was disseminated via Moodle to prepare students for the habitat visits? What background information did the students have? I was often distracted by the lack of information provided about the field and laboratory portion of this assignment (although I could clearly follow the collaborative and individual written work). What size quadrats did the students use? How did they go about species identification? When the soil samples were collected, the authors state that "the vegetation was put in one labeled sample bag and the soil in a second." Was that the upper, vegetative layer of the soil sample, and for what purpose? How were the insects collected? By Berlese funnel from the soil samples? Were they just the invertebrates that were observed while the students were in the field?
- Add more information about Instructor Feedback in the Methods section; what kind of feedback was provided at each stage? Were students assessed primarily based upon the presentation criteria (following guidelines regarding Tables and Figures, etc.) or were they also assessed to some degree on accuracy/correctness of information presented (for example, in Figure 2, the student notes state that *Plantago major* is a monocotyledon, which is erroneous; it is a Eudicot)? Based on the article title, a reader will expect more information about this aspect of the research.
- I like the examples of student generated work. It might be nice to include a few more examples under "Supplemental Materials" for those who would like to view them.
- I was a bit surprised by the amount of students who didn't participate in stage 2 (26%). Any suggestions for how to resolve this issue? Why the low "buy in" by these students?
- I think it would be nice to include a little more information about the lecturer's experience. Could some of this be added to the Results and/or Discussion?
- The final paragraph of the paper ends oddly. It seems to reference a future event (having students use Google Apps for their third year project) but talks about it in the past tense ("but this time they took ownership"); consider revising. It is not a good idea to end an article with a parenthetical comment (weakens it).

Quick fixes:

- Data are plural (see 5th paragraph under Results)
- Second to last paragraph under Results, Stage 1: "The large number of data sheets generated (21) meant..." I think the number in parentheses should be 28.

Overall, a nice teaching module that I would encourage instructors to try; I can envision several standard laboratory or field exercises that could be modified and expanded to include the collaborative group work, peer assessment, and individual analyses presented here. It is a really nice model. The article itself can be strengthened by providing more details, where relevant, and

by being more explicit.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 17 Aug 2015

Nicky Slee, University of Essex, Essex, UK

We thank the reviewer for her helpful comments. We will address these, along with others, in a revision of our paper once the other reviews have come in.
Nicky Slee

Competing Interests: N/A

Author Response 25 Nov 2016

Nicky Slee, University of Essex, Essex, UK

The authors would like to thank Melanie Link-Perez for her review and helpful comments to improve the paper. We have addressed the comments raised and incorporated them into the updated version of the paper e.g. terminology has been changed from peer assignment to peer assessment. The hyperlinks have been updated (Challenger Philosophy) or changed e.g. Minimum Undergraduate Standards is now in Supplementary Materials. Information has been added about the Lecturer's background and experience. The methods section has been expanded to give more details about the ecological sampling. Information on feedback has been included. The new version Numerical data been added to make information more explicit together with definitions about success criteria (performance related to average for stage 1 and success related to degree class marks). Abstract and paper has been updated to include specific details on success at each stage, looking at different success criteria that have been defined; statistical analysis has been carried out and reported; results are the final results assigned to the students for this work. An example of one student's group work, Google slide document, is added in the supplementary materials.

Competing Interests: None.

Reviewer Report 10 July 2015

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Kay Yeoman

School of Biological Sciences, University of East Anglia, Norwich, UK

This is an interesting paper which gives a lecturer who is new to learning technology an opportunity to try a relatively straight forward intervention. The paper describes the use of Google Web 2.0 technology tools, namely Google Docs and Google Slides to help with the ecology field work of first year students. I think it would be good to alter the use of the terminology, and refer to first year students as 'Level 4'. I would also like to know the range of degree programmes which these students are enrolled on, and what the gender ratio is. The first link in the introduction 'Challenger Philosophy' requires the use of a password to enter the content. I think it would be good in the introduction to say something about what the challenger philosophy is, as readers will not be able to access this information via the link. In the development of this idea, it would be good to know what had been done in previous years, and what promoted the change to this new approach, or was this a new module? The introduction gives a good rationale for this choice of technology intervention, e.g. enhanced group work, opportunity for peer assessment, and a greater opportunity for cohorts to get to know each other and to discuss data generated. Other educational literature is cited to support the rationale. In the results, the authors stated that the students 'mainly succeeded' in setting up Google Accounts. This suggests that some did not? If they did not, what were the barriers? (This was actually subsequently looked at in the discussion). The authors indicate that after the group work the students showed a greater awareness of ecology techniques and the campus, how was this information gathered? Was it through informal discussion, or was it through comparison to previous experiences of work produced in this module? This needs some clarification. There were interesting reflective comments from the authors, but I would like to see some information on the student evaluation, it would be particularly interesting to see if any themes were emerging from student free text comments on the skills which they considered they had developed. If this module has run before, without this technology intervention, is there a difference in the marks obtained for the module? The authors mentioned 'ownership' of the information several times during the paper. I think some referral to the wealth of literature surrounding research-led teaching where ownership is a key outcome of this type of learning, would enhance the paper.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 17 Aug 2015

Nicky Slee, University of Essex, Essex, UK

We thank the reviewer for her helpful comments. We will address these, along with others, in a revision of our paper once the other reviews have come in.
Nicky Slee

Competing Interests: N/A.

Author Response 25 Nov 2016

Nicky Slee, University of Essex, Essex, UK

The authors would like to thank Kay Yeoman for reviewing the paper and giving comments to improve it. We have addressed the comments raised and incorporated them into the updated version of the paper.

The terminology has been updated, first year students are referred to as Level 4 students. Details have been added about the degree programmes studies and gender ratio. An updated link has been provided for the Challenger Philosophy which provides information needed. The rationale for the new approach and reasons for changing the previous practical have been given and information about the lecturer's experience has been added. Greater awareness of ecology and campus was based on work submitted rather than from informal discussions with students or comparison to other years. Literature has been added about student centered learning and proposed benefits of the approach. Student evaluation was not included in this work but would be an important addition in the future.

Competing Interests: None.

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