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The Journal of Learning and Teaching in Higher Education

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Editorial

Welcome to Volume 1, Issue 1 of the Journal of Learning and Teaching in Higher Education (JLTHE).

At first glance, this journal follows the conventions of many other open access journals – PDF files organised into a table of contents, abstracts, references, all freely shared on the web. However, for the editorial team and for the authors, the journal already represents something unique. As a group of staff and students, we have collaborated over the past year, persistent in our initial undertaking to provide an accessible journal for staff and students to publish their research, case studies and thought-pieces. We have achieved this by taking care to provide an appealing and strongly visual design, offered supportive peer reviewing and editing, included work from within and outside the host University, and established an editorial board which comprises higher education staff and students. Student journals have been a feature of the landscape for some time now, reflecting the students-as-researcher pedagogy (Walkington, 2015, **Hurkett,** this volume) but publications are now emerging which negotiate a shared space between staff and students, and they are charting new territory. It is not a straightforward journey, as one such journal puts it: "We have cycled through the excitement and the uncertainty that come with collaboration through partnership as we strive to translate those words into authentic practices." (Cliffe et al, 2017).

Our original conception of the journal was for it to "encourage teaching-focused staff, other academic staff, students and others who support learning to contribute to higher education debate through the medium of an online publication." This initial idea attracted interest from students and staff alike and at our first journal planning workshop we were faced with great enthusiasm and a range of ideas of what this journal might potentially yield. As a collaborative venture, it was important to ensure that all contributors benefit from being involved, have a voice and work on developing shared values for the journal. The diversity of opinions has been worked through and is evident in this, our first issue. The articles cover the full range of sections in the journal, with creative writing and reviews of software, thought-pieces, case studies and research papers. We have also adopted a mechanism of 'reinterpretation' whereby the ideas from an article are amplified through reworking them for another audience, and in another medium. The nature of reinterpreting others' work unfolded as we progressed our thinking, as described in the thoughtpiece by **Cork et al**, who were mindful of the 'ethic of reciprocity' (Cook-Sather and Felten, 2017) in the process of realising the journal's vision of reinterpretation.

As an online, open access journal, we embrace the capabilities of digital media, and we are pleased to include both a podcast and a movie in this first issue. Both are student-led reinterpretation pieces. In their evocative movie, **Abdelkarim, Alkhayer and Watson** use words and imagery to trace the ideas running through a research report on complex learning spaces by **Wood and Walker**, creating a commentary on the spaces they encounter as students at the University of Leicester. In developing their podcast, **Blacklaws and Mohamed** work in an interdisciplinary partnership (a third-year undergraduate Neuroscience student and a PhD student from History) to debate the topic of staff:student collaboration, in a conversation between themselves, two members of staff and the Education officer of the Students' Union.

Diversity in the population of our higher education institutions is a given. How we understand it and respond to it, is something we need to keep working at. Our one creative writing submission, by **Coombes**, takes us into a flow of consciousness about dyslexia from a lecturer's perspective. For students starting out at university, there are numerous sources of information available, but as **Edirisingha et al**'s research shows, only some of that will be effectively conveyed. Here we might look to the semi-formal nature of student-generated podcasts as a means to support student transition into higher education. This is one example of the kind of embedded digital practice that **Walker and Patel** advocate in their paper on the development of digital literacies as a driver for cultural and social change, and their impact on learner identity.

Bannister sets out in great detail how complex learning can be facilitated through simulations with appropriate guidance and support. Similarly, in her report from a national workshop on games in higher education, **Harvey** balances the excitement of games to support learning with the practical challenges of designing and implementing them effectively. As ever, the key to success depends on careful planning, good direction and fitness for purpose. **Hurkett et al** specify seven success criteria for their own transatlantic inter-institutional, inter-programme activities and invite the reader to consider the benefits were they to develop their own similar activities.

We are grateful to the University of Leicester's Teaching Enhancement Project Fund who provided the institutional backing for the Journal to get off the ground.

In producing the first issue, we have laid the groundwork for future creative and collaborative working where we have seek to 'reimagine' a journal about and for those situated in higher education, so we hope that you will be pleasantly surprised by a closer reading of its contents.

Frances Deepwell,

Editor, Journal of Learning and Teaching in Higher Education

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JOURNAL OF LEARNING AND TEACHING IN HIGHER EDUCATION

Coombes, M. J. (2018). Reading Between the Lines. *Journal of Learning and Teaching in Higher Education*, *1* (1)

Creative writing

Reading between the lines

Matthew J. Coombes[1]

[1] matt@contradictorydesign.com, Faculty of Arts, Science and Technology, University of Northampton

Abstract

The non-normative structural possibilities of poetry, with its focus on emotion, imagery and sound, makes it a useful way to portray inner experiences that are difficult to express through traditionally descriptive, more prosaic language. As a lecturer, artistic designer and researcher with dyslexia I have often had to use alternative paths to succeed professionally. Both professionally and privately I share arising complexities of my inner intellectual and felt life through poetry. This is a flow of consciousness about my dyslexia.

Keywords: Poetry, learning, disability, dyslexia, education, personal experience

Introduction

At a time when teaching methods and learning support have come a long way in understanding and embracing differences, it has become easier for people with particular needs to engage in and successfully complete higher education studies. Educators and students alike now have the means to adapt and find methods and strategies allowing both a class to progress while individuals can still be supported. However, this often means meeting half way for all parties involved in the learning process. As a lecturer, artistic designer and researcher with dyslexia I have often used alternative paths to succeed professionally. As part of my own dyslexia, I have 'slow processing' and short–term memory issues. In particular, making sense of or expressing information in the 'expected' constructed prosaic form (traditional texts or essays), has always been a challenge for me. Writing in a segmented, yet often flowing, form is a useful strategy that, as I discovered, allows me to express and process concepts that I would have more trouble rendering in full sentences. The non-normative structural possibilities of poetry, with their focus on emotion, imagery and sound, make it a useful way to portray inner experiences that are difficult to express through traditionally constructed and structured language. It helps me formulate my thoughts and feelings without having to hold as much information in my head at once. It also creates a much clearer visual structure that is easier for my dyslexic self to follow.
Both professionally and privately I share the arising complexities of my scholarly, inner intellectual and felt life through poetry. For instance, I have recorded research sessions with a person with dementia in poetic form, which allowed me to write quickly and immediately after contact. I would have otherwise got stifled trying to make traditional notes and, in the process of trying to write conventionally, I would have forgotten more or would have had to make sound recordings (this being a hindrance in this particular interaction). Poetic forms simply take the pressure off as they allow me to let the information flow and the experience come out rather than trying to push it out through a more conventionally shaped hole.

Though there are many variants and depths of dyslexia, from a teaching point of view, this example shows how finding alternative ways can support an individual with dyslexia and help them process and express in a way that feels more natural and is less confusing. External normative constraints are indeed often draining and create a stressful learning environment where one can easily feel inadequate.

This piece is a flow of consciousness about my own dyslexia.

Reading between the lines

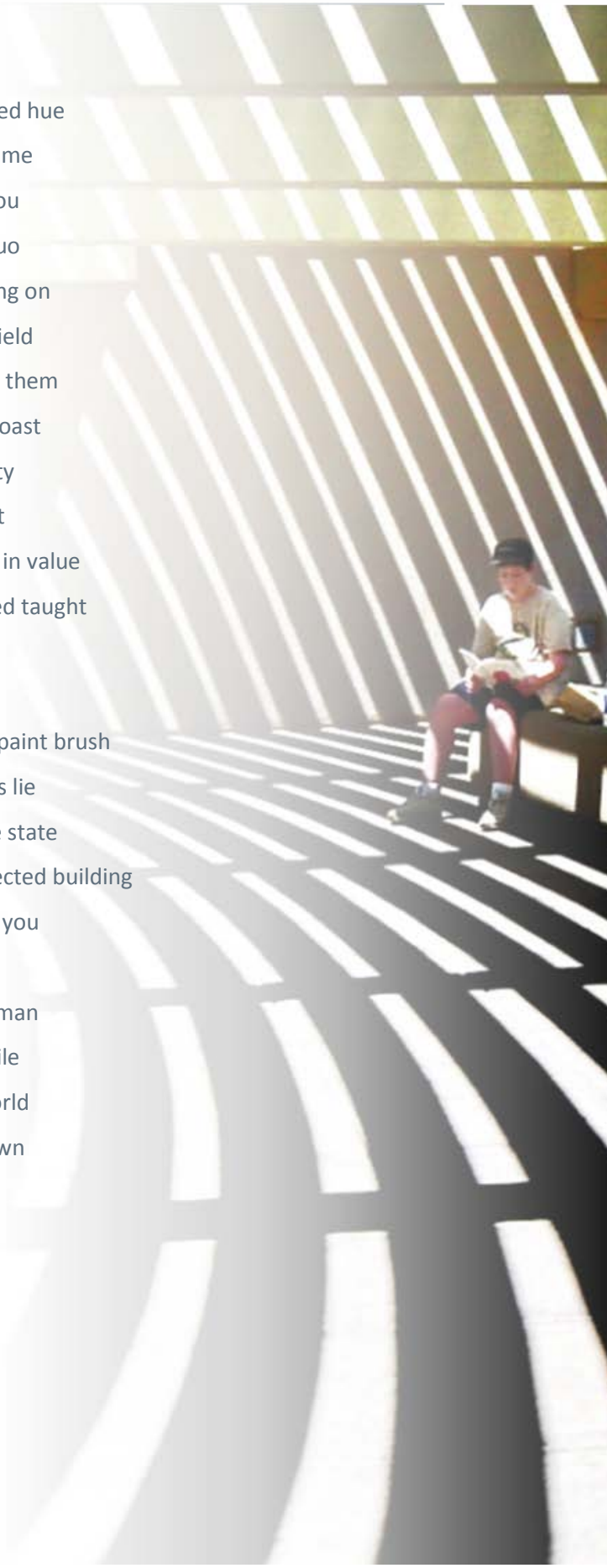
Reading between the lines
The white abyss
The maze of foam
Distracting from the shore
Is it the negative
Or the positive
That sees me through
This draining
Exercise
Beyond you

There's a gap

Perception
Of sounded opinion
Or fact
Of others
Just a flaw
In personality
A character
Traited
To be misplaced
With the others
In the hour glass
In the hands
Of passing time
Away from me

This clouded hue
Is light for me
Dark for you
A status quo
Just hanging on
Or new shield
For us and them
To find a coast
Of plasticity
Of thought
Measured in value
A measured taught

It is seen
As a wide paint brush
But secrets lie
Within the state
Of the affected building
In front of you
Grasping
To be Norman
All the while
In your world
And our own
Multitude
In us
Of you
In you
Of us



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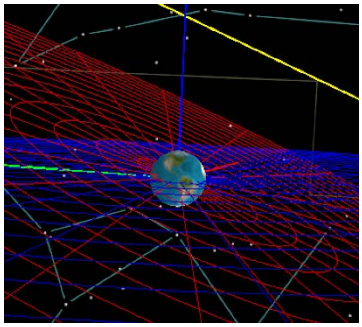


Bannister, N. P. (2018). Active Learning in Physics, Astronomy and Engineering with NASA's General Mission Analysis Tool. *Journal of Learning and Teaching in Higher Education*, 1 (1)

Case study

Active Learning in Physics, Astronomy and Engineering with NASA's General Mission Analysis Tool

Nigel P. Bannister[1]

[1] nb101@leicester.ac.uk, Department of Physics & Astronomy, University of Leicester.

Abstract

Astrodynamics is the study of the motion of artificial satellites and spacecraft, subject to both natural and artificially induced forces. It combines celestial mechanics, attitude dynamics and aspects of positional astronomy to describe spacecraft motion and enable the planning and analysis of missions. It is of significant interdisciplinary interest with relevance to physics, astronomy and spaceflight engineering, but can be challenging to deliver in an effective, engaging manner because of the often abstract nature of some concepts, the four-dimensional nature of the problems, and the computation required to explore realistic astrodynamics behaviour. The University of Leicester has adopted NASA's General Mission Analysis Tool (GMAT) as a core resource to support active learning in this subject for students at Level 6 (BSc) and Level 7 (MSc). This paper describes our approach to the implementation of GMAT as an essential element of teaching and learning in the subject.

Keywords: Teaching Practice; Flipped Classroom Teaching; Physics & Astronomy; Astrodynamics; Simulations; Celestial Mechanics; Visualisation.

Introduction

Astrodynamics is the study of the motion of artificial satellites, subject to both natural and artificially induced forces (Griffin & French, 1991, quoted in Vallado, 2013). Aside from its obvious relevance in courses related to space exploration and spaceflight systems engineering, it provides opportunities to demonstrate the application of fundamental concepts such as gravitation, Newton's law of motion, and Kepler's laws; it is as applicable to a description of the motion of natural bodies in the universe, as it is to the planning of space missions.

Learners and instructors face several challenges when exploring the subject. At High School level, a simple treatment of orbits based on the balancing of gravitational and centripetal forces can lead to familiar results such as Kepler's laws, which can be appreciated in two dimensions. But the subject is intrinsically four dimensional, involving time-varying parameters in three spatial dimensions; extension of the theory to three or more bodies leads to rapidly increasing complexity, and this intricate, multi-dimensional problem is poorly served by the traditional 2D learning environment of blackboard and paper. While generations of successful flight dynamicists had their first encounters with the topic in those traditional teaching environments, the availability of sophisticated and validated software tools developed for the research and industrial space community is allowing a step change in the way astrodynamics and related subjects can be taught, using approaches which are aligned with current pedagogies to improve the effectiveness of the experience for both learner and facilitator.

The Constructivist theory of learning states that acquiring knowledge is not simply a matter of the teacher transmitting information to the learner; such an approach can lead to rote learning and inert knowledge (Bruer, 1993; Perkins, 1992). Instead, Constructivism holds that the learner constructs knowledge with their own activities, building on what they already know (Biggs & Tang, 2011). As discussed concisely by Dori & Belcher (2005), "Such ownership enables the learner to understand the knowledge in an intimate way that cannot be achieved by mere memorization". Active learning takes place when new information arrives to challenge the existing mental framework; in this situation, the learner takes an active role in the learning process, adjusting their cognitive framework so that it is consistent with the new information. This fosters meaningful learning and deep understanding of physical phenomena.

Considered in these Constructivist terms, the role of simulations and models such as GMAT is to provide the information which challenges the existing cognitive framework, in an effective and engaging way. The use of visualisation as a tool to facilitate this active process and to support learning is discussed widely in the literature. Notable examples include Zhang & Linn (2011), who describe a study into the use of dynamic visualisations to support science learning, specifically chemistry. Dori & Belcher (2005) discuss a technology-enabled active learning environment incorporating visualisation and simulation technologies to support student learning in electromagnetism, aligned with the philosophy of social constructivism. Several reviews of the subject have also been carried out. Rutten, Van Joolingen, & Van der Veen (2012) consider research in the use of computer simulations in science education, finding that all reviewed studies report positive results where simulations were used to replace or enhance traditional lectures, but that it was necessary to provide learners with instructional support during the use of the simulations to assist in e.g. hypothesis generation, investigation planning, and monitoring of learning activities (reporting work by Alfieri, Brooks, Aldrich, & Tenenbaum, 2011). Rutten et al. note findings by Windschitl and Andre (1998) that traditional objectivist approaches to instruction can reduce the use of simulations to "cookbook" treatments which deprive the learner of the opportunity to create, test and evaluate their own hypotheses. In terms of fundamental pedagogy, this observation is consistent with Bruner (1966), who proposes the theory of "discovery learning", closely related to

Constructivism, which holds that the learner is more likely to recall and understand concepts which they have discovered independently, than those which have been taught directly. Appropriately designed and applied software simulation offers a "discovery space" within which these explorations can take place - particularly in subjects that are challenging to support through more practical experimental activities. However, when designing learning activities with the implementation of this paradigm in mind, criticisms of discovery learning and related approaches must be considered; Kirschner, Sweller, & Clark (2006) put forward evidence from studies in human cognition and practical implementations of "Problem Based Learning", suggesting that unguided or minimally guided instruction is ineffective, arguing strongly for the superiority of guided instruction.

The design of the GMAT Astrodynamics Workshop described in this paper attempts to capture the opportunities which evidence suggests are offered by appropriate simulation, allowing students the freedom to explore their own ideas particularly in the latter stages of the activity, while providing a support framework that avoids the "cookbook" approach and the deficiencies identified by Kirschner et al. (2006).

The General Mission Analysis Tool

The General Mission Analysis Tool (GMAT) is open-source software developed in a partnership between NASA, industry, and public/private contributors, and is available to download without charge (http://gmatcentral.org). GMAT is designed to support the design and analysis of space missions, and has an extensive range of capabilities. It permits orbits to be modelled, analysed and visualised in detail, orbital perturbations to be studied and manoeuvres planned, propulsion system requirements to be determined, and mission lifetimes to be estimated. Though its focus is on the modelling of spacecraft orbits, it contains a detailed representation of the solar system and can be used to visualise coordinate systems, orbits, and other natural phenomena (such as axial tilts giving rise to seasons, or the phases of the moon; see, for example, the representation of the Vernal Equinox in Figure 1). GMAT also interfaces with external platforms such as MATLAB and Python, providing an extensible architecture for future expansion both internally and external to the core code (Hughes, 2016). Significantly, GMAT is not a dedicated educational tool: it has been validated against real missions, and has been used to support the planning and analysis of programmes including MAVEN (Jakosky et al., 2015), Lunar Reconnaissance Orbiter (Tooley et al., 2010), and OSIRIS-REx (Beshore et al., 2015). Hughes (2016) cites 13 commercial firms who describe their use of GMAT in the literature, as well as international organisations such as ESA and NASA who use the code. This number is growing. Thus, while the focus of this paper is the exploitation of GMAT as a tool to facilitate learning, there is a significant additional benefit to its adoption in Higher Education institutes, by equipping graduates with experience in the use of a system that is becoming widely adopted in the space community.

Workshop Philosophy

Buchberger (1990) discusses the use of learning technologies in the context of symbolic computation software systems for mathematics courses, and his philosophy is directly applicable to the subject of the current paper. Buchberger proposes the "White-Box/Black Box Principle for Using Symbolic Computation Software in Math Education". As interpreted by Hoyles & Lagrange (2009), a learning technology is being used as a "white box" when students are aware of the mathematics they are using the technology to perform, and is a "black box" when they have no conceptual understanding of the mathematics being implemented. Cedillo & Kieran, 2003 (cited in Hoyles & Lagrange, 2009)

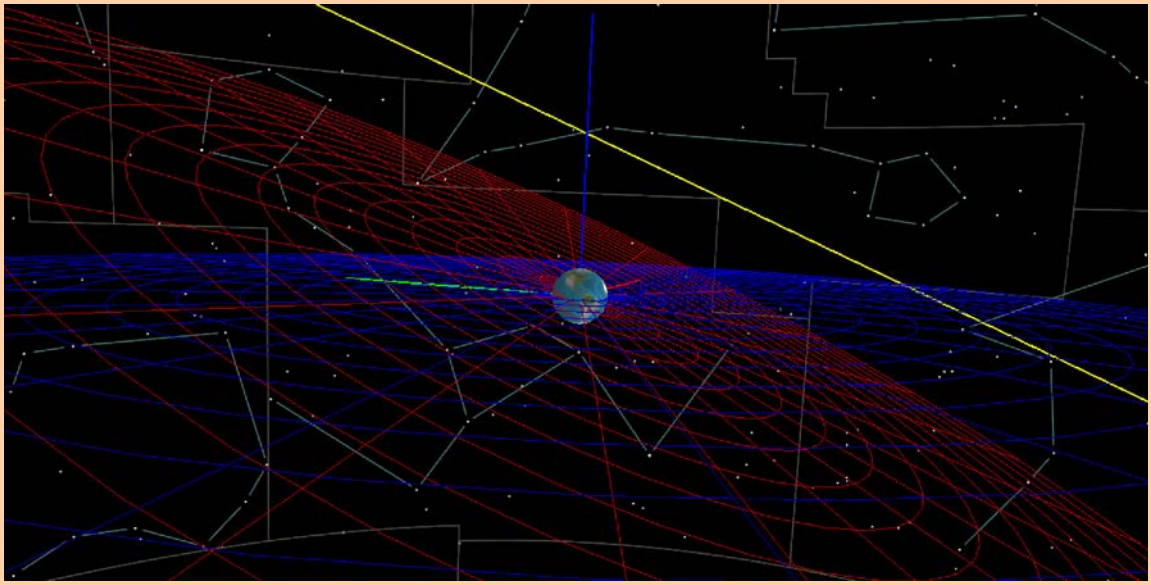


Figure 1: An equinox represents the point at which the Earth's equatorial plane passes through the centre of the Sun; there are two equinoxes each year, familiar as the Vernal (Spring) equinox, at which the sub-solar point moves from the southern to the northern hemisphere, and the Autumn equinox, when the subsolar point moves into the southern hemisphere. This frame from a GMAT scenario shows the position of the Vernal Equinox as the vector (red) lying along the intersection of the equatorial (blue) and ecliptic (red) planes; the Sun's apparent path is shown in yellow.

propose that the metaphor be extended to include a "grey box" approach, which "intertwines both the white and black boxes", used at appropriate points during the learning. Neill & Maguire (2006) review these ideas in the specific context of Computer Algebra Systems, but their statement that the tool "should only be used within a pedagogically sound framework" is equally true in the context of a code that solves the algebra underpinning celestial mechanics and astrodynamics.

GMAT's open source code makes it possible to treat the entire system as a white box: students can examine the code to see how the physics has been implemented, although given the complexity of the supporting code, this approach is unlikely to be efficient or to bring clarity to the learning. Conversely, the presence of a sophisticated Graphical User Interface can shield the student from the detailed operation of the code, with their interaction reduced to entering randomly chosen parameters for the initial state of an orbit and pressing "play". This mode of interaction results in GMAT propagating the initial state through a gravitational model and displaying whatever trajectory results, more closely representing Buchberger's "black box" approach. However, the principle of "garbage in, garbage out" applies to astrodynamics simulations – without sensibly defined initial values for orbital parameters, useful orbits with specific properties are unlikely to be generated, and many simulations will simply fail. Hence, the "hands-on" elements of the workshop which exploit the capabilities of GMAT, are embedded within a wider set of activities designed to consider, question and explore the physical principles of astrodynamics, aligning the activity with Cedillo & Kieran's "grey box" approach to the use of learning technologies.

The workshop is associated with a third year undergraduate module comprising 12 conventional lectures and supporting screencasts providing an introduction to astrodynamics. The lectures begin with a derivation of key concepts, including solutions to the two body equation of motion, leading to fundamental results that describe the essential features of orbits in the presence of a single gravitating body with a spherically symmetrical gravitational field. GMAT is used to produce visual

demonstrations which are played to the class as movies during the lectures, or recorded as screencasts. The lecture module then builds on this framework to help students understand and analyse problems such as “time-of-flight” (relating to the prediction of satellite position as a function of time), perturbations (how disturbing forces introduce deviations from the idealised situations considered at the beginning of the module), examples of specific orbit types (e.g. Sun-synchronous and Geostationary), and interplanetary trajectories.

The lecture module is not a prerequisite for the workshop; student’s attention is drawn to the complementarity of lecture course and workshop, and approximately 80% of students taking the workshop also take the lecture module, but the workshop is designed to be accessible to those who have had no exposure to the theory of orbits beyond a simple first-year undergraduate treatment of gravity. While it is arguably easier to design an effective workshop assuming knowledge from the taught module, the applicability of the concepts beyond the immediate astrodynamics topic makes it desirable to offer a self-contained practical activity in this area. Thus, the workshop begins with a review of conic sections and the “restricted two body” equation of motion, which leads quickly to the important results summarised in Figure 2. Appealing to the concept of the scaffolding of learning (Wood, Bruner, & Ross, 1976), these “cornerstone topics” are appropriate points from which to develop an exploration of basic orbital motion, including the effects of forces deliberately applied to the spacecraft through the application of propulsive manoeuvres to change the orbital parameters. It is therefore essential that these topics are considered by workshop participants at the start of the activity, and before work with simulations begins, to avoid a “black box” approach. Hence, some preparation is needed on the part of the student before the workshop begins.

$$r = \frac{p}{1 + e\cos\nu} \quad (1)$$

$$\frac{V^2}{2} - \frac{GM}{r} = -\frac{GM}{2a} \quad (2)$$

$$e = \frac{a - b}{a + b} \quad (3)$$

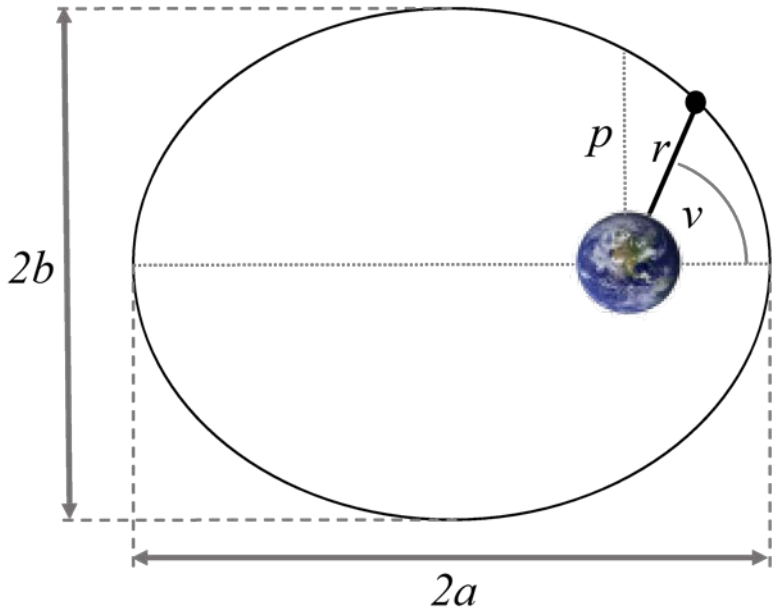


Figure 2: The trajectory equation (1) the vis-viva equation (2), and the equation for eccentricity (3), together with a definition of the basic geometry of a closed orbit (right) provide the basis for an in-depth exploration of orbital dynamics in GMAT. In this diagram, a is the semimajor axis of the orbit, b is the semiminor axis, p is the semiparameter, r is the radial distance between the satellite (moving at a velocity V) and the centre of the gravitating body of mass M, and v is the true anomaly of the satellite at a given instant, measured from the point of closest approach to the gravitating body (the periapsis). Hence p is seen to be the radial distance of the satellite from the centre of the gravitating body when the true anomaly v = 90°. The point furthest from the gravitating body is the apoapsis.

As noted elsewhere (e.g. Sappington, Kinsey, & Munsayac, 2002; Bishop & Verleger, 2013), noncompliance with reading assignments is widespread, with some studies reporting that over 70% of students rarely read required material by the due date. Thus, while student support notes for the workshop cover the development of these core concepts, and students are advised to study the notes before the first session, there is no assumption of compliance. Evidence in the literature (e.g. Stelzer, Gladding, Mestre, & Brookes, 2009; Falconer, DeGrazia, Medlin,& Holmberg, 2009) indicates that the use of multimedia content can increase significantly the level of student engagement in preparatory assignments, and these findings are supported by a recent internal study conducted within the Department of Engineering at the University of Leicester (Williams, private communication - https://screencastsinengineering.wordpress.com). Consequently, screen casts have been produced to cover the cornerstone topics of the 8 workshops, and are offered to students in the two weeks prior to the first session via the workshop area of the Institute's Virtual Learning Environment. Additionally, the first 90 minutes of each 3 hour workshop, are used to cover cornerstone topics and engage in an interactive discussion with the students about the key concepts.

Workshop Structure

GMAT has been made available on all University of Leicester computers and is freely installable on personal machines, so students can work on problems outside scheduled contact sessions. The package has an extensive set of help documentation and is supported by online resources including an active user forum and YouTube videos. In the December 2015 pilot workshop, students were instructed to follow an introductory tutorial leading to the production of a simple orbital model. However, student feedback from the pilot indicated that an academic-led approach was strongly preferred at this early stage, and so following a review of the cornerstone topics, the workshop now includes an introductory "walk-through". Students and the academic tutor begin by creating a blank GMAT scenario. The tutor shows their GMAT session on the projector screen, and talks the students through the definition, entry and demonstration of a closed, elliptical orbit around Earth, which they replicate on their own machines as the walk-through progresses – allowing exploration of the concepts shown in Figure 2. This approach has the advantage of allowing the tutor to explain the architecture of the user interface in the context of a practical example, while encouraging real-time exploration of the physical parameters which are being defined in the scenario. At this stage, the emphasis is on inviting open discussion: questions such as "*how might we expect this orbit to change if we increase the argument of periapsis by 90°?"* elicit conversations that can be used to highlight misconceptions and demonstrate meaning through the exploitation of GMAT's 3D visualisation capabilities.

The training environment is an important element in the success of the workshop. Because extensive use is made of the tutor's display to present walk-through support and demonstrate aspects of the simulations and associated physical concepts, it is appropriate to adopt a row-based configuration in which students have good line of sight to the main projector screen while looking at their own display. However, it is essential that students can share the results of their models, or show some aspect of their calculations to the wider group, and so the IT infrastructure has been configured to allow any student to send their GMAT session to the main screen at the invitation of the tutor via a network-connected projector. This feature finds its greatest use (leading to typically lively interactions and exchanges between students, as well as with the tutor), when students observe unexpected effects in their simulations, due either to errors in the calculations used to configure the model, or to the influence of a physical effect which the student had not considered. Deviations from "expected" behaviour are a rich seam of discussion, and students are encouraged to ask questions, highlight interesting observations, and investigate small modifications to the walk-through parameters, to foster this discussion. In almost all cases where mistakes are made in

configuring a simulation, the resulting behaviour of the spacecraft reveals interesting and important aspects of the physics that merit some attention.

Introducing Simple Celestial Mechanics

Following the walk-through, the workshop presents a number of problem scenarios (referred to as "missions") which students must model and analyse. In the first instance, students are tasked with implementing a simple scenario in which a spacecraft is in a polar Earth orbit with specific requirements on the size, shape and orientation of the orbit. This orbit is then "propagated" (the initial conditions are passed through an algorithm which includes a force model describing how factors such as gravity, atmospheric drag and radiation pressure affect the motion of the satellite) such that a simulation covering one day of mission elapsed time is generated. The motion of the satellite can be visualised in 3 dimensions on an accelerated timescale to give students an appreciation of fundamental orbit behaviour described by Kepler's laws, and the task can be achieved entirely using the knowledge acquired during the walk-through.

The "cookbook" approach is avoided at all stages by posing questions as part of each mission. This begins with a set of well-structured questions, but as the learner progresses through increasingly sophisticated scenarios with less prescriptive summaries in the supporting text, the questions move to a more "ill-structured" form where problems and the expected pathways to solution are less prescriptive (Simon, 1973; Jonassen, 1997). In the case of the simple polar orbit problem, students are asked to verify that the characteristics of the orbit shown in the simulation, agree with theory. As an example of this approach, Analysis Case Study 1 shows how learners can answer the following challenge: "How can you establish, quantitatively, that the velocity of the satellite at apoapsis is consistent with the predictions of theory?"

Analysis Case Study 1: Verifying apoapsis velocity in a simple closed orbit

GMAT offers data reporting tools including custom-designed tables and plots to access the numerical results which underpin the graphical simulation. The simplest interrogation method is the "Command Summary", which displays values for fundamental parameters of the orbit and the state of the spacecraft at the end of the simulated period. An example output for the polar orbit exercise is shown in Figure 3. The sections titled "Cartesian State" and "Keplerian State" contain the coordinates and fundamental orbital parameters of the satellite at the end of the simulation period. Other sections report time-dependent properties of the satellite at the final instant of the simulated period (such as *VMAG*: the magnitude of the satellite's velocity) or summarise fundamental properties of the resulting orbit (such as *Orbit Period*).

One of the early mission tasks requires students to verify that the velocity of the spacecraft at apoapsis (the point in the orbit which is furthest from the planet) is in accordance with predictions. The student can use a variety of approaches to address this question. For example, in "Other Orbit Data" the apoapsis velocity is reported as *VelApoapsis* = 3.783 km/s. This can be compared with the prediction of Equation 2, which requires knowledge of semimajor axis a (reported as *SMA* by GMAT), and the radial distance at a specific point in the orbit, r, (reported as *RMAG*). Astrodynamics problems are commonly soluble using a variety of approaches and one way of addressing this

```
Time System   Gregorian                    Modified Julian
-------------------------------------------------------------------
UTC Epoch:    01 Jan 2000 17:04:08.516     21545.2112096753
TAI Epoch:    01 Jan 2000 17:04:40.516     21545.2115800456
TT  Epoch:    01 Jan 2000 17:05:12.700     21545.2119525456
TDB Epoch:    01 Jan 2000 17:05:12.700     21545.2119525449

Cartesian State                            Keplerian State
---------------                            ---------------
X  =  -0.0090921506305 km                  SMA  =   15000.021473907 km
Y  =  -19500.045373677 km                  ECC  =   0.3000019555741
Z  =   21.521321873013 km                  INC  =   89.999620994477 deg
VX =   0.0000250200828 km/sec              RAAN =   89.999973703386 deg
VY =  -0.0041747649839 km/sec              AOP  =   359.93676512396 deg
VZ =  -3.7826755591279 km/sec              TA   =   180.00000000000 deg
                                           MA   =   180.00000000000 deg
                                           EA   =   180.00000000000 deg

Spherical State                            Other Orbit Data
---------------                            ----------------
RMAG =   19500.057249733 km                Mean Motion         =  3.436616465e-04 deg/sec
RA   =  -90.000026714905 deg               Orbit Energy        =  -13.286662362230 km^2/s^2
DEC  =   0.0632347457959 deg               C3                  =  -26.573324724460 km^2/s^2
VMAG =   3.7826778629580 km/s              Semilatus Rectum    =  13650.001941005 km
AZI  =   179.99962099425 deg               Angular Momentum    =  73762.434884977 km^2/s
VFPA =   90.000000055822 deg               Beta Angle          =  10.593761427751 deg
RAV  =  -89.656620674839 deg               Periapsis Altitude  =  4121.8493980805 km
DECV =  -89.936764174228 deg               VelPeriapsis        =  7.0250033672391 km/s
                                           VelApoapsis         =  3.7826778629580 km/s
                                           Orbit Period        =  18283.056520209 s

Planetodetic Properties
-----------------------
LST       =   269.99998180260 deg
MHA       =   356.70576235807 deg
Latitude  =   0.0648764342238 deg
Longitude =  -86.705780555470 deg
Altitude  =   13121.920977043 km


Spacecraft Properties
---------------------
Cd                      =   2.200000
Drag area               =   15.00000 m^2
Cr                      =   1.800000
Reflective (SRP) area   =   1.000000 m^2
Dry mass                =   850.00000000000 kg
Total mass              =   850.00000000000 kg
```

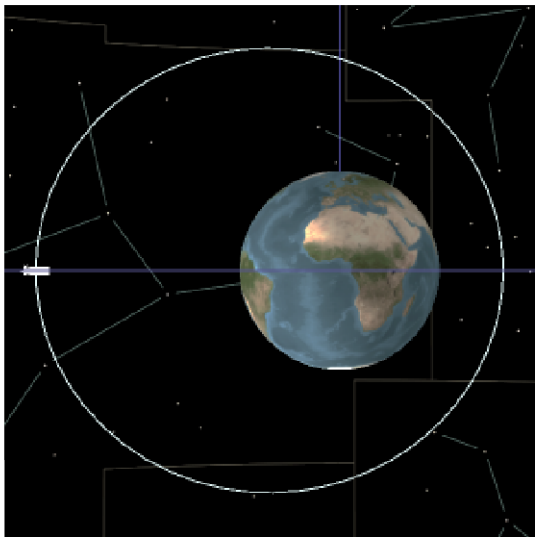


Figure 3: Part of the Command Summary for the simple polar orbit exercise (graphical output shown inset). The initial state for the orbit is shown in the Keplerian State section of the report. The sections "Spherical State", "Other Orbit Data" and "Planetodetic Properties" reflect the status of the satellite at the end of the simulated period.

question is to use the Trajectory Equation (Equation 1) to solve for *r* at apoapsis, recognising that apoapsis corresponds to a value of $v = 180°$, and using the GMAT-reported parameters *ECC* (for eccentricity *e*), and *Semilatus Rectum* (an alternative term for semiparameter, *p*). Substitution of these values into Equation 1 results in an identical apoapsis value of 19500 x 10^3 m.

Then, assuming values of G = 6.674 x 10^{-11} N m^2 kg^{-2} for the gravitational constant and M = 5.972 x 10^{24} kg for the mass of Earth, the student can use the *vis-viva* equation to give

$$v = \sqrt{\frac{2GM}{19500 \times 10^3} - \frac{GM}{15000 \times 10^3}} = 3782.550 \text{ m s}^{-1}$$

This value differs from the value reported by GMAT by only 13 cm s^{-1} (a difference attributed to the higher levels of internal precision with which GMAT performs calculations); hence, the student may conclude that the results of the simulation are consistent with the predictions of the restricted two body problem illustrated in Figure 2.

Increasing Detail: Perturbations

Analysis Case Study 1 uses the Restricted Two Body Problem (R2BP) to help students gain familiarity with GMAT while demonstrating the value of numerical simulation and visualisation in astrodynamics, using tractable closed form solutions to explore the application and implications of the most fundamental aspects of the subject. The R2BP assumes that the spacecraft is subject only to the force of gravity, that there is a single source of gravity, and that the gravitational field is perfectly radial (i.e. the gravitating body is treated as a point mass). One of the key results arising from the R2BP approach is that the motion of the satellite is confined to a plane, which is easy to represent in 2D treatments. In reality, spacecraft are subject to other forces such as atmospheric drag; there are typically several significant sources of gravity (for example, the Earth and the Moon), and because real planets are not perfectly spherical or uniformly dense, their gravitational fields are not perfectly radial. These factors lead to spacecraft behaviour which deviates from the predictions of the R2BP; these deviations, referred to as perturbations, lead to spacecraft motion which more closely represents “real” spacecraft behaviour. The GMAT Astrodynamics Workshop allows students to explore these concepts and the relationships between the mathematical descriptions of the environment and the resultant orbital motion.

Sun-synchronous orbits are used to illustrate how relaxation of the R2BP assumptions leads to more complexity. The assumption of a point mass gravitational source gives way to a description of the gravitating body as an extended object that is not perfectly spherical. Screencasts and discussions in teaching sessions are used to show how a mathematical description of this non-ideal shape can be constructed using the technique of “spherical harmonics”.

One of the most significant consequences of the Earth’s non-sphericity on a spacecraft orbit is a perturbation caused by the fact that the Earth is *oblate* – meaning that the equatorial diameter is larger than the polar diameter, due to the planet’s rotation. Using a simplified representation of the Earth as a perfectly spherical body surrounded by a discrete band of material, students appreciate how this shape introduces non-radial forces on the satellite, which lead to a torque being exerted on the orbit (Figure 4). References to topics from core mechanics modules in the first and second years of the course, and demonstration of how a torque applied to a gyroscope leads to the familiar axial “wobble” of a spinning top, can be used to support the learning (e.g. McGlynn, 2007) so that students make the link between the applied torque, and the effect of *precession* (rotation of the angular momentum vector – or equivalently, the rotation axis).

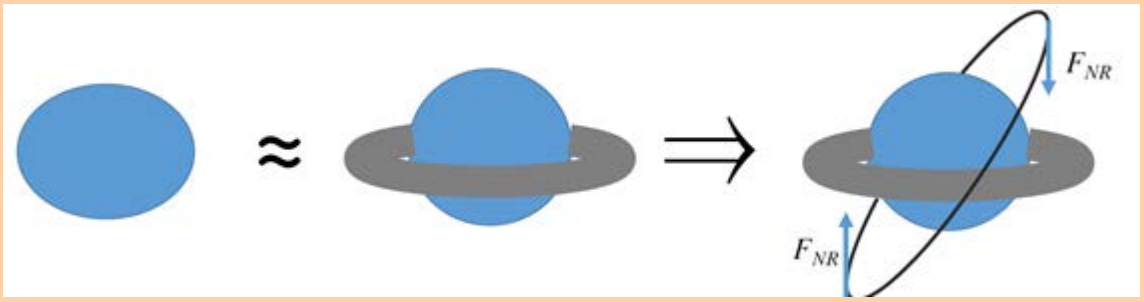


Figure 4: Earth's oblateness (left) can be approximated by a spherical gravitating body surrounded by a band of additional mass in the equatorial plane (middle). This leads to the introduction of a non-radial

This leads to an expression for the rate of orbit plane precession, $\dot{\Omega_{J2}}$ (radians per second) for a circular orbit of radius *r* and inclination *i,* described by Equation (4).

$$\dot{\Omega}_{J_2} = -\frac{3}{2}\sqrt{\frac{GM}{r^3}}J_2\left(\frac{R_\oplus}{r}\right)^2\cos i. \qquad (4)$$

Here, J_2 is an experimentally determined coefficient with a value of 1.081874 x 10^{-3} and is related to the magnitude of the perturbation, while $R_\oplus$ is the Earth's radius. Analysis Case Study 2 illustrates how perturbations are introduced in the workshop by considering Sun Synchronous orbits.

Analysis Case Study 2: Exploring perturbations with Sun synchronous orbits

Perturbations can be appreciated by studying how the behaviour of a satellite is modified as the gravitational model used in the simulations is changed, from a simple spherical representation, through the oblate spheroid of Figure 4, to increasingly complex representations that include other localised deviations from the ideal spherical case. This study begins with the polar orbiting satellite from Analysis Example 1 which, when simulated over a period of several days or weeks, is seen to occupy an orbit that is fixed in the inertial frame (i.e. with respect to the distant stars) – consistent with the prediction of the R2BP that orbital motion is confined to a plane. The satellite can then be "copied" so that two identical spacecraft are represented in the simulation. The student adjusts the level of detail in the force model applied to the second satellite, so that it includes the Earth's oblateness - the most significant source of gravitational perturbation. Re-running the simulation, the non-radial component of force results in a torque which causes precession as expected.

Investigations begin with a qualitative examination of the resulting orbits displayed in the 3D Orbit View. A more quantitative approach is enabled using custom-defined reports and plots to examine parameters as they vary with time. Work from one student (Student A) is shown in Figure 5. The student chose an orbital radius *r*, of 6778.14 km, and used Equation 4 to calculate that an inclination *i* = 97.03° would produce an orbit whose rate of precession matches the rate at which the Earth orbits the Sun (and hence the rate at which the Sun's apparent position changes, as measured against the inertial frame represented by the distant stars). This rate is equal to 360°/365.24 mean solar days, or 1.991 x 10^{-7} radians sec^{-1}, and an orbit with a precession rate matching this value is known as a "Sun-synchronous orbit", because the orientation of the orbit remains fixed with respect to a line drawn between the Earth and the Sun.

An orbital parameter known as the *Right Ascension of the Ascending Node* (Ω) can be used to

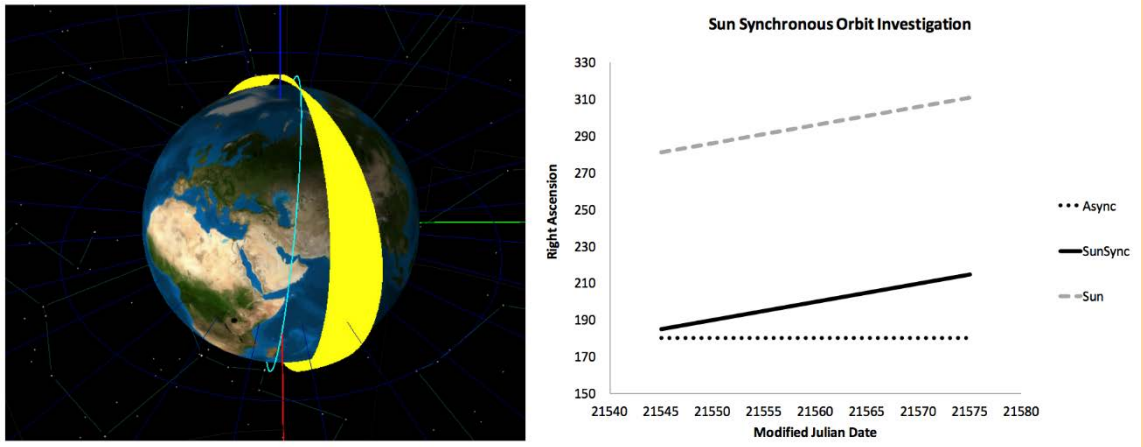


Figure 5: Left: a student's simulation of two satellites initial orbit parameters that are identical apart from a small difference (5°) in ascending node value to make them distinguishable on the plot. The motion of one satellite (cyan path) is predicted using a force model which assumes a spherical Earth. The motion of the other satellite (yellow) is calculated using a gravity model accounting for Earth's oblateness. The simulation covered 30 days of motion, and the precession of the second satellite is clearly visible in the orbit trace. Right: a graph generated using data exported from GMAT, showing that the Right Ascension of the Ascending Node remains constant for the first satellite, but varies with the second at a rate that matches that of the Sun's apparent position.

describe the orientation of the satellite orbit. Ω is the angle, measured in the plane of the celestial equator, between the origin of the celestial coordinate system analogous to latitude and longitude on Earth, and the point where the satellite crosses the plane of the Earth's equator moving from the southern to the northern hemisphere. When no precession is experienced, this angle remains constant. But with precession included, the location of that crossing point (or ascending node) changes. Student A plotted the value of Ω for the two satellites, and showed that the purely spherical potential resulted in no precession (a fixed value for Ω), while including the Earth's oblateness caused Ω to change over time. In this case, the student took the study one step further, and researched the Right Ascension of the Sun at the start and end dates of the simulation. Using a simple linear relationship, they added a third line to the graph in figure 5, showing that the gradient of the Sun-synchronous orbit matches the gradient of the Sun's position as it changes throughout the year, providing confirmation of the expected behaviour.

Manoeuvres & Targeting

The topics of Analysis Case Studies 1 and 2 are equally applicable to celestial mechanics and astrodynamics. Propulsive manoeuvres, however, are generally the preserve of spaceflight dynamics, and can be represented in GMAT. Manoeuvres demonstrate another application of numerical simulation: the systematic exploration of parameter space to identify solutions satisfying one or more user requirements.

Propulsive manoeuvres are enabled in GMAT by adding "Hardware" (fuel tanks and thrusters) to the spacecraft, and then adding "burns" which use the hardware to change velocity. Thruster representation can be detailed, with chemical and electric propulsion options available, and thrust levels, directions and reference frames definable. This level of detail means that the GMAT can be used to support courses in space propulsion and spacecraft systems engineering. But to maintain the workshop's focus on astrodynamics, chemical thrusters with the default settings are generally used,

and most, though not all, propulsive manoeuvres are assumed to be "impulsive" – i.e. the change in velocity is assumed to be instantaneous rather than taking place over a finite period of time.

A simple manoeuvre typically used as an introduction to the topic, is the Hohmann Transfer which uses an elliptical orbit to transfer a spacecraft from one circular orbit to another in the same plane (Figure 6). The apoapsis of the transfer orbit is coincident with the higher circular orbit, while the periapsis matches the radius of the lower circular orbit. The transfer is achieved by performing two burns, one at apoapsis and one at periapsis, to increase or decrease velocity. The first manoeuvre causes the spacecraft to leave the initial orbit and join the transfer, the second one allows the spacecraft to join the destination orbit.

The mathematics of the transfer use the vis-viva equation (Equation 2). Four velocities are calculated: the velocity of the spacecraft in the two circular orbits, and the velocity in the elliptical orbit at periapsis and at apoapsis. The differences between the circular and elliptical orbit velocities at apoapsis and periapsis represent the velocity changes or ΔV ("delta-vee") which the propulsion system must provide to achieve the transfer. To transfer from high altitude to low altitude, the first burn is ΔV_a, and is negative, indicating a reduction in velocity (thrust applied in a direction opposite to the spacecraft motion). With this first manoeuvre complete, the spacecraft would continue to follow the elliptical transfer, and so to join the lower altitude circular orbit, a second burn, also a velocity reduction, is required at periapsis. Orbit raising is conducted in the same way, but the periapsis burn is performed first, and both periapsis and apoapsis burns increase the spacecraft velocity. Two approaches can be taken to investigate the Hohmann transfer: (1) definition of the initial orbit and manual calculation of ΔV magnitudes and directions which are then used by GMAT to arrive at a new orbit whose radius is checked by the student to ensure it agrees with the expected value, or (2) definition of the initial and final orbits, and use of a "target" module in GMAT to vary ΔV and find the value which achieves the required transfer. In neither case does GMAT operate as a

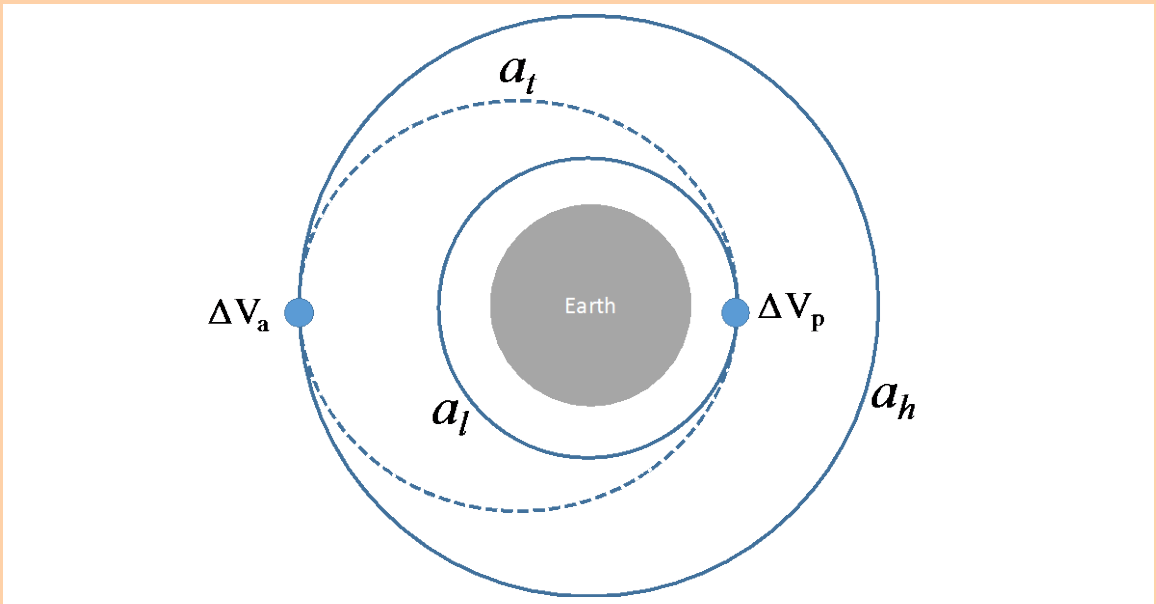


Figure 6: Geometry of the Hohmann transfer. The elliptical transfer orbit is shown as the dashed ellipse and is used to raise or lower a spacecraft between two other, co-planar orbits which, for a simple introductory treatment, are assumed to be circular. The semimajor axis of the higher altitude circular orbit is a_h, that of the lower circular orbit a_l, and the semimajor axis of the elliptical transfer is a_t which, from geometry, is simply $0.5(a_h + a_l)$. The propulsive manoeuvres generating a change in velocity take place at apoapsis (velocity change ΔV_a), and periapsis (ΔV_p).

Black Box – success requires the learner to apply key concepts, but the simulation can aid in the process of making meaning, by showing the student the effects of changing parameters, and proving conjecture (mirroring the experience of Furinghetti & Paola, 2003). Students explore both approaches in the workshop.

The GMAT tutorials available online include a Hohmann transfer, and the reader is directed to that resource for further information on how this type of manoeuvre can be represented in GMAT. Instead, here we will show how a student approached a different manoeuvre problem: an orbital inclination change. The inclination, *i*, of an orbit is the angle between the plane of the orbit and the Earth's equatorial plane. Beginning with the situation of circular orbits, simple vector geometry (figure 7) shows that the velocity change required to adjust the inclination of a circular orbit through an angle Δ*i* while keeping other parameters fixed, is

$$\Delta V = 2V \sin\left(\frac{\Delta i}{2}\right), \qquad [5]$$

where the magnitude of the velocity in the initial orbit, V_i , and the final orbit, V_f , is identical (because the two circular orbits differ only in their orientation) hence $|V_i| = |V_f| = V$. Experience in previous years of the astrodynamics course shows that students understand this concept and can estimate ΔV magnitudes, but they often overlook two important points: first, the manoeuvre must be undertaken at a point which is common to the initial and final orbits, and second, that the propulsive manoeuvre has a direction which is not perpendicular to the orbit plane. Analysis Case Study 3 summarises how one student investigated inclination changes during the 2016 workshop.

Analysis Case Study 3: Plane Change in a Circular Orbit

Student B was presented with a mission in which a satellite began in a circular Earth orbit of radius 7200 km and inclination 20°, and required the inclination to be reduced to 0° (an orbit lying in the Earth's equatorial plane). The student began by setting up the initial orbit in GMAT, and performing

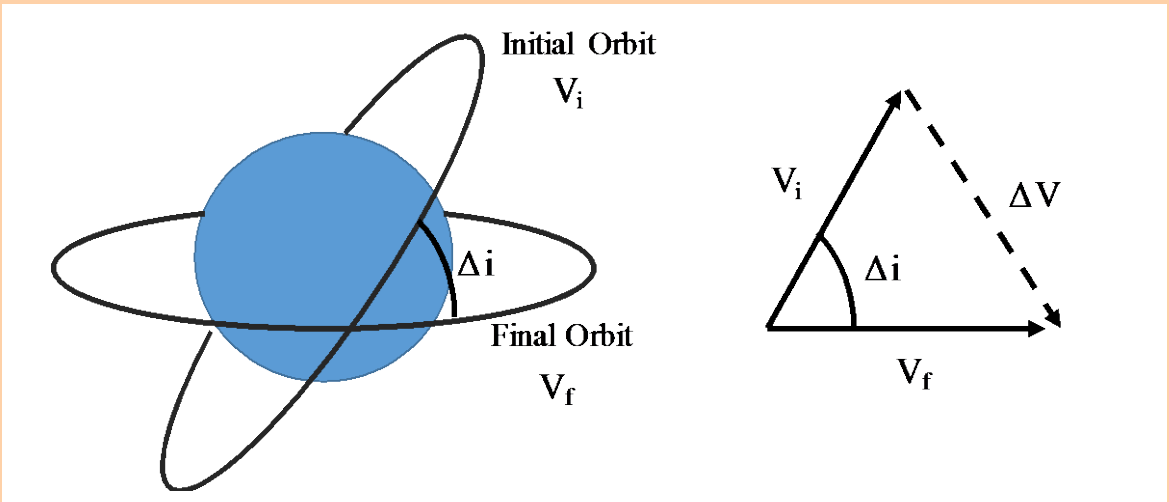
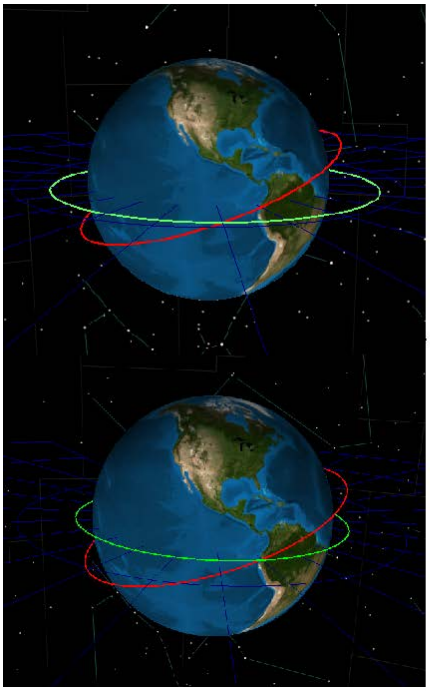


Figure 7: Geometry of the simple plane change. A spacecraft in a circular orbit with velocity V_i begins with some initial inclination, and a manoeuvre is required to change to a new inclination while keeping all other orbital parameters fixed. The total change in inclination is Δi, and the initial and final velocities are equal in magnitude, differing only in their direction. The total change in velocity required for the change is ΔV.

a manual calculation to find the circular orbit velocity $V = \sqrt{GM/r}$ = 7439 m/s, concluding that a ΔV of 2584 m/s would be required for the plane change (Equation 5). They recognised that the plane change should be performed at the intersection of the initial and final orbits, which corresponds to the celestial equator, and hence propagated the orbit in GMAT until the spacecraft reached a point in its orbit where it was over the Equator. They then implemented a motor burn perpendicular to the orbit plane, and configured GMAT to find the ΔV which resulted in a 0° inclination. GMAT reported successful solving (convergence) of the problem, but examination of the 3D view showed that while the new orbit had the required 0° inclination, the semimajor axis had changed. Reviewing the command summary revealed a 1100 km increase in *a,* and a ΔV = 2706 m/s for the manoeuvre, significantly more than predicted (figure 8, top panel). The workshop leader asked the student to consider whether a perpendicular burn was consistent with the geometry of the plane change. Reflecting on the vector sum in figure 7 and the corresponding internal angles, the student recognised that the ΔV had components in the perpendicular and velocity directions. In their second attempt, the student configured GMAT to perform a burn with components in these two directions, and added a new condition that the final orbit must have a semimajor axis matching the original. This time the model resulted in a final orbit identical to the initial one but in the equatorial plane. The burn parameters were 451 m/s in the anti-velocity direction and 2551 m/s perpendicular to the orbit plane, giving a total magnitude of 2590 m/s, only 6 m/s different from the manual calculation, and showing that the angle between the velocity vector and the burn direction was 90°- $\tan^{-1}$ (-451/2551) = 79.97°. The student then used manual resolution of the vector triangle to confirm that this result was consistent with the base angles in an isosceles triangle with vertex angle 20°. Outputs from Student B's work are shown in figure 8.



```
Maneuver Summary
----------------
Impulsive Burn:      ImpulsiveBurn1
Spacecraft:          TransferSat
Origin:              Earth
Axes:                VNB
Delta V Vector:
   Element 1:     0.0000000000000 km/s
   Element 2:     2.7055282227315 km/s
   Element 3:     0.0000000000000 km/s

No mass depletion


Maneuver Summary
----------------
Impulsive Burn:      ImpulsiveBurn1
Spacecraft:          TransferSat
Origin:              Earth
Axes:                VNB
Delta V Vector:
   Element 1:    -0.4510921786489 km/s
   Element 2:     2.5508562297418 km/s
   Element 3:     0.0000000000000 km/s

No mass depletion
```

Figure 8: Top panel: student's first attempt showing initial orbit (red), and final orbit (green) with required inclination but increased semimajor axis. Bottom panel: second attempt with directed burn showing pure inclination change. Command summary outputs for propulsive manoeuver shown on the right, indicating the correct burn has components in both velocity and orbit plane normal axes.

Advancing Beyond Earth

Much of the current workshop focuses on Earth-orbit, but the final phases introduce topics relevant to interplanetary missions, including the use of different coordinate frames to target planetary fly-bys and orbit insertions. GMAT includes position and physical property data for the major planets along with Pluto and Earth's moon; other bodies can be added using data from NASA's SPICE system (Acton, 1996). A wide variety of concepts can be explored within this solar system model, including deep space missions that use gravitational assist (GA) manoeuvres to reach the outer planets.

GMAT is not designed to calculate launch windows or to identify multiple GA trajectories; such computationally intensive studies are best solved by alternative methods. Tools such as NASA's Trajectory Browser (Foster, 2013), or the European Space Agency's Global Trajectory Optimisation Problems Database and associated codes Pykep and PyGMO (Izzo, 2010) can help in this regard, while pre-computed trajectories for specific targets are published (e.g. George & Kos, 1998). Alternatively, course facilitators may consider introducing undergraduate projects on relevant concepts. For example, solving *Lambert's problem* can lead to the identification of launch windows, directions and energy requirements (generating the so-called "pork chop plot") to provide initial state vectors for GMAT. See, for example, Vallado, 2013, for a discussion of Lambert's problem and a range of algorithms for its solution.

Despite the considerable preparation needed before complex interplanetary trajectories can be built in GMAT, exploring relevant concepts is within the scope of the workshop. Spacecraft initial states can be given in terms of the arrival direction, energy and distance of closest approach in the frame of the destination planet. Hence, students can investigate the geometry and energetics of a gravity assist manoeuvre, without the need to calculate a trajectory from the Earth to their chosen planet. Missions at this stage in the workshop are less prescriptive than they are at the beginning, with students having developed in-depth familiarity with the system over the course of the activity. In the specific case of gravitational assist manoeuvres, students are asked to carry out an investigation of planetary encounters, using GMAT to demonstrate underpinning concepts and verifying the results quantitatively. Analysis Case Study 4 summarises one student's exploration of gravity assist manoeuvres in the workshop.

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Analysis Case Study 4: Gravity Assist Manoeuvres

Student C chose Jupiter for an investigation of Gravity Assist manoeuvres, creating a scenario in which Jupiter was the central body, with the Sun and Earth included. He defined multiple spacecraft with initial state vectors describing the radius, energy and direction of the incoming trajectory in the reference frame of the target planet, varying the parameters to explore their influence. Two

particular spacecraft were given similar arrival conditions except that one spacecraft arrived on the side of the planet facing into the direction of the planet's orbital motion around the Sun, while the other passed by the trailing hemisphere. The student generated reports for each spacecraft, outputting spacecraft energy and velocity in the Jovian and Sun-centred frames, the direction of the spacecraft incoming and outgoing trajectory, the radius of periapsis r_p (i.e. the distance of closest approach), and the eccentricity of the orbit. The student sought to validate several relationships developed in screencasts and contact sessions:

- The angle ϕ through which the trajectory was rotated during the encounter (the "turning angle") is related to eccentricity by $\sin(\varphi/2) = 1/e$ [6]
- The eccentricity of the swingby trajectory is related to r_p , the arrival velocity v_∞ and the mass of Jupiter M_J by $e = 1 + \frac{v_\infty^2 r_p}{GM_J}$ [7]
- The energy in the frame of the arrival planet is unchanged, while the energy in the heliocentric (Sun-centred) frame increases/decreases when the swingby is on the trailing/leading hemisphere respectively.

A selection of outputs from the student's investigation are shown figure 9. The family of flyby trajectories are shown in the top left panel; all but one arrive at Jupiter from the trailing hemisphere, while the red orbit approaches from the leading hemisphere; the middle left panel shows this trajectory and its trailing hemisphere counterpart in more detail. In the lower left panel, the results of those two encounters are seen to produce a reduction in orbit energy during the leading hemisphere flyby, resulting in a bound heliocentric orbit, while the trailing hemisphere encounter increases the energy of the trajectory in the heliocentric frame, leading to the escape of the spacecraft from the Jovian system. The lower right panel shows the same flybys in terms of trajectory energy in the heliocentric frame. The upper and middle right panels illustrate how the student tested equations [6] and [7], showing results from the simulation as data points, plotted on top of the predicted behaviour (solid lines). By exploring these fundamental relationships, completion of this investigation enabled the student to begin designing gravitational assist manoeuvres which achieved specific outcomes in terms of turning angle and spacecraft energy.

Workshop Assessment & Final Challenge

The preceding discussion highlights selected examples of mission problems covering basic orbits, perturbations and manoeuvres. The current version of the workshop contains eleven exercises or "missions" which students follow in a progression from exploration of basic orbital parameters to an introduction to deep space mission techniques. Each mission is worth a number of marks, depending on the level of complexity of the problem. The set of current missions is summarised table 1, along with the available marks for each.

Summative feedback is provided to students throughout the workshop in the form of group discussions and one-to-one conversations with the facilitators. Formative assessment is provided in two phases. First, a student's work on each of the missions is assessed in real time, in conversations between the student and the facilitator. The student demonstrates their solutions, and discusses their approach to and understanding of the problems with the facilitator. These marks (up to a total of 40) contribute 70% of the overall workshop mark.

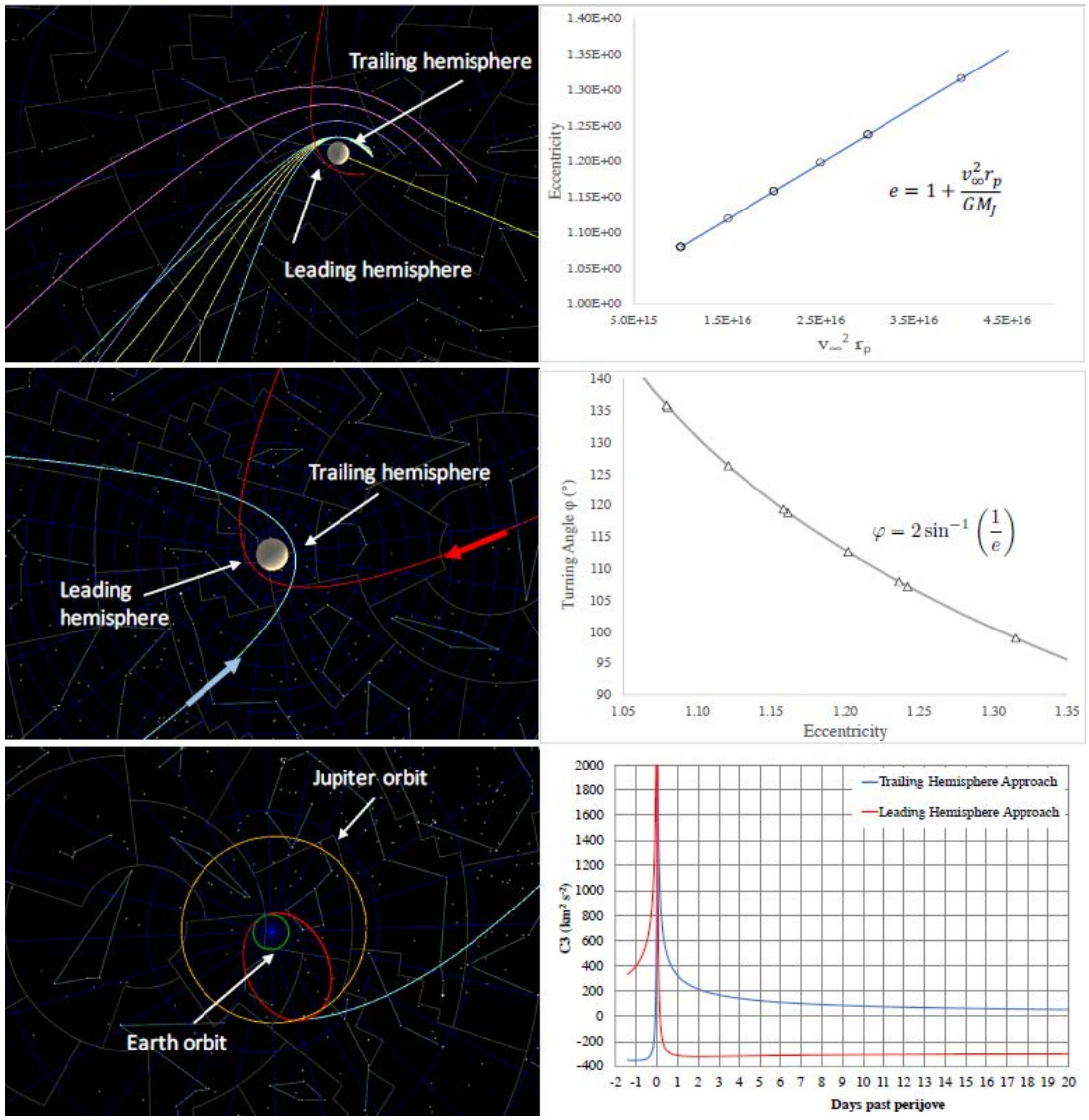

Figure 9: Student's investigation of gravitational assist manoeuvres. Top left: multiple spacecraft approaching Jupiter (view direction onto the North Pole). Middle left: two "matched" spacecraft in similar orbits but approaching from different hemispheres. Lower left: View centred on the solar North Pole, showing Jupiter's orbit and the result of the two matched flybys, with an escape trajectory resulting from the trailing hemisphere encounter and a bound solar orbit from the leading hemisphere encounter. Top right: confirming the relationship between eccentricity, arrival velocity and periapsis radius. Middle right: testing the relationship between turning angle and eccentricity. Lower right: the energy of the two matched spacecraft (in the heliocentric frame) before, during and after the encounter, showing the increased energy of the trailing hemisphere encounter and the reduced (negative, bound) energy of the spacecraft in the leading hemisphere encounter.

The second element of assessment takes the form of a "final challenge" in which the cohort is divided into groups of 4-5 students. A briefing session is held after the last formal workshop session, in which students are introduced to an extended problem which they have ~4 weeks to study, without tutor support.

Table 1: Problem scenarios (referred to as "Missions") which make up the assessed components of the current workshop. Missions used as analysis case studies in the current work are shown in italics. The number of marks available in formative assessment is noted in the final column.

Mission	Description	Marks
Polar Orbit	Simple closed orbit & exploration of basic keplerian laws, R2BP.	2
Sun Synchronous Orbit	Introduction of perturbations, J2 effect.	2
Geosynchronous Orbit	Exploration of east-west drift, stable/unstable points & drag paradox; reference frame choices.	3
Critically Inclined Orbit	Precession of the argument of periapsis, generation of Molniya orbits	3
Hohmann Transfer	Introduction to propulsive manoeuvres, orbit transfers and goal seeking.	2
Bielliptic Transfer	Demonstration of Oberth Effect; deep space transfers which exceed Hohmann transfer efficiency.	3
One Tangent Transfer	Introduction to flight path angle; fast transfers; ΔV versus transfer time.	5
Inclination Change	Introduction to out-of-plane manoeuvres. Multiple goal seeking.	4
Combined Inclination & RAAN Change	Identification of common points in orbits; efficiency of sequences vs single manoeuvres.	5
Aerobraking	Planetary atmosphere models; atmospheric drag; apoapsis lowering manoeuvres; planetary capture; entry corridors.	5
Gravity Assist	Hyperbolic orbits; introduction to gravitational assist manoeuvres; relationship between eccentricity, periapsis and turning angle.	6

The topic is sufficiently challenging that the groups tend to self-organise, allocating different phases or techniques to specific individuals, then working to fit the elements into a single coherent mission. The topics to date have been:

- A Phobos sample-return mission, calculating trajectories to/from Mars, and a series of rendezvous operations in Mars space allowing spacecraft to land on the moon Phobos then return to Earth.
- Studying and reproducing specific Apollo missions to explore the difference between the various trajectories used in the moon programme, understanding the need for trajectory correction manoeuvres and comparing actual flight data (for e.g. burn times, directions, re-entry locations) with the predictions of the student's GMAT scenario. This challenge ended with a final stretch goal to design an Apollo-like transfer for the present day, testing

student's ability to apply techniques to find new solutions, rather than relying on historical parameters known to give the required behaviour.

The Final Challenge is assessed during a Mission Presentation morning, in which each group presents their solution to the rest of the class and a small panel of 2 - 3 academic staff. A key feature of this event is the prohibition of Powerpoint presentations; students instead present their work directly in GMAT, showing supporting analysis in e.g. MATLAB or Excel as required. This is an important approach which the author was introduced to during a visit to the European Space Agency's Concurrent Design Facility (see e.g. Bandecchi, Melton, Gardini, & Ongaro, 2000); practicing scientists and engineers who use this facility to design real missions, present solutions in this way because it is more efficient than copying work into a presentation slide, which is by its nature non-interactive; it facilitates a higher level of discussion by enabling interactive "what if" questions to be explored in the session, and enables subject experts to probe aspects of the models which the presenter may have overlooked. Effective use of this presentation style is a transferrable skill and a specific learning outcome of the workshop.

Student Feedback and Future Development

Student feedback is solicited at the end of each year's workshop, and the results for the first two years of operation are summarised in figure 10. Significant changes were made after the 2015

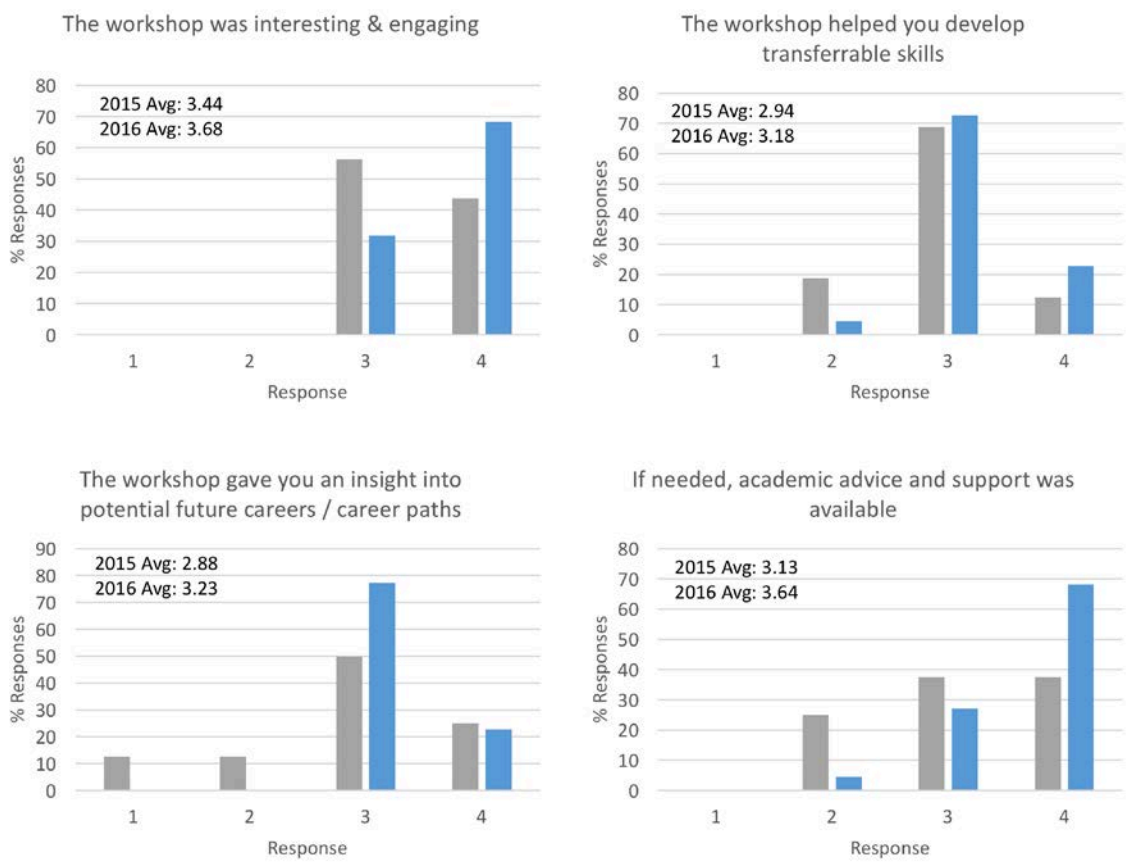

Figure 10: Feedback from students at the end of the 2015-16 (grey) and 2016-17 (blue) sessions, normalised to the total number of respondents in each year (16 in the 2015-16 session, 22 in 2016-17). Responses correspond to "Definitely Disagree" (1); "Mostly Disagree" (2); "Mostly Agree" (3) and "Definitely Agree" (4).

workshop in response to feedback, including the introduction of "walk-through" sessions to help students gain familiarity with the basic software architecture; short breakout sessions to cover specific astrodynamics concepts in a more conventional lecture-like form while remaining in the workshop room, and a final year PhD student facilitator to increase the level of support available. While the statistics are based on a small number of respondents, the results suggest that these changes have led to an improvement in satisfaction in each of the four areas questioned.

As reflected in these results, a majority of respondents viewed the workshop very positively. The most common requests in response to the question "How would you suggest the workshop could be improved?" were to increase the number of walkthroughs provided, and increase the number of contact sessions.

It is not viable to increase the number of contact sessions to a level which keeps students satisfied. But as a means of developing insight into the concepts which make up the undergraduate astrodynamics ILOs, and helping students develop a more intuitive understanding of the subject, the computational workshop appears to be more engaging and effective than the traditional lecture delivery, with the added advantage that it provides students with experience in the use of an analytical tool that is being adopted in the professional community. Consequently, it is planned to address the student's desire for additional contact sessions by adopting a flipped approach to the overall astrodynamics module in future, increasing the use of screencasts to cover some of the "bookwork" currently delivered in conventional lectures, and freeing up lecture contact time for the workshop and other interactive GMAT-enabled sessions.

Summary and lessons learned

NASA's General Mission Analysis Tool is enabling students to engage in active learning in astrodynamics, celestial mechanics, and elements of spacecraft systems engineering and mission design. Based on feedback from survey responses, conversations with students, and the level of discourse in the workshop, it is evident that they gain much from the ability to visualise and test fundamental concepts of astrodynamics in the GMAT environment; further, they have gone on to apply the skills developed in the workshop to other areas of their studies, particularly in project work.

Using software simulation in teaching requires more than identification of a package and timetable slots in which to use it. A number of lessons have been learned during preparation and implementation of the GMAT astrodynamics workshop, which may benefit those seeking to incorporate simulation-based workshops in their own teaching.

Synchronisation with taught modules

When using simulations to support a conventionally delivered taught module, the timing of the activities must be carefully planned so that prerequisite knowledge can be accessed by the student before using simulation to support their learning. This not only affects the starting dates of the two kinds of activity, but can also drive the pace of the taught module (item 2, below). An alternative approach, planned for adoption in the University of Leicester Astrodynamics course, is to use a flipped structure in which the simulation sessions represent the contact time, and lectures are replaced by screencasts and directed reading in a schedule that is published in advance. The ability to track a student's access of online resources such as screencasts within a VLE can be useful for monitoring private study behaviour, and can be discussed in class if necessary.

Do not over-estimate the pace of progress through the workshop

The use of simulation requires the student to gain familiarity with the software platform as well as the fundamental concepts to be explored. This overhead tends to be greatest at the beginning of the workshop, but is present throughout the duration of the work as the student is required to use the system in increasingly sophisticated ways. This overhead must be allowed for in the workshop schedule. Specific training sessions based around techniques such as “walk-through” tutorials, are likely to be required at various points in the workshops to introduce new layers of simulator capability (student feedback suggests that reliance on self-guided tutorials is less effective). Nevertheless, in the author’s experience these overheads are a price worth paying for the improved clarity of understanding that can come from the use of simulations, and, designed correctly, the walkthroughs can still be used to provide insight into fundamental concepts rather than being simple “driving lessons”.

Test thoroughly before deployment

Course leaders will have excellent familiarity with the subject, and using time to test simple problems in software may appear needless. But simulation platforms can introduce unexpected complications. For example, the targeting algorithms used in GMAT can occasionally lead to a model failing to converge on a solution which could easily be derived from first principles on the blackboard. Here, the tutor may wish to spend time explaining the principles and potential problems of numerical methods such as Newton-Raphson iteration, where oscillations around local minima and maxima can prevent a solution being reached, or adjusting problem initial parameters to avoid regions of such behaviour. Similarly, minor software bugs and “features” can lead to surprising results. In GMAT, two apparently equivalent methods of setting up a multi-spacecraft model can lead to different final outcomes, one of which is obviously wrong. Adequate preparation and bug-testing of the workshop (preferably with the use of a volunteer who may make the same mistakes as a student) can identify these issues, and workshop instructions can be updated to avoid the problem disrupting the taught sessions. Note however, that allowing students to experience these behaviours can lead to interesting discussions about the construction and limitations of numerical simulations. Although extensive testing was carried out before deployment of the GMAT workshop, new problems are occasionally encountered, and the workbook produced to accompany the activity is regarded by both facilitators and students as a “living document” updated regularly to reflect these issues.

Simulation is not a replacement for more conventional learning methods

A simulation environment such as GMAT is a powerful system for visualising and exploring the consequences of concepts. But it cannot replace the effort needed to understand the scientific principles underpinning the system being modelled. Even the most simple tutorial or walk-through is little more than an exercise in entering numbers into a black box, without first of all providing the instructional scaffolding that gives meaning to those numbers and their origin. Referring again to lesson (1), the scaffolding may be provided in a variety of formats including screencasts or conventional lectures, but should be provided separately from the simulation, and should start before the first simulation session. Only in this way can simulations fulfil their potential as environments which support learners to make meaning, rather than becoming black boxes that achieve little other than filling contact time.

Insufficient data are currently available to determine whether use of GMAT is leading to a significant long-term improvement in examination results for the conventional astrodynamics module, but adoption of this white / grey box tool within the course has enabled students to explore and test the relationships developed in texts and lectures in a way that cannot be matched in more conventional

teaching sessions, helping students to make meaning in their studies. From this perspective alone, introduction of GMAT as a core learning tool has been of substantial benefit. In addition, GMAT is not simply an educational platform available only within the Higher Education ecosystem: it is a professional tool, produced by NASA and used by the agency for mission planning and development, and is being increasingly adopted in the academic research community. Gaining a working knowledge of GMAT therefore has the additional benefit of enabling students to develop skills which are directly transferable to employment in the academic and industrial space sector.

Finally, while this paper has focused on the use of GMAT in a Higher Education environment, instructors in upper secondary education (ISCED 3), should find it an asset in science classes, whether to demonstrate fundamental principles by showing the outputs of simulations to students, or by leading groups of students through the construction and basic analysis of e.g. simple closed orbits for spacecraft, or exploiting the ability of GMAT to model the Earth's orbit, helping students to understand concepts such as seasons and moon phases.

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Hurkett, C. P., Symons, S. L., Gretton, S. N., Harvey, P. E., Williams, D. P., and Raine, D.J. (2018). The benefits of sustained undergraduate inter-programme collaborations between international partners. Journal of Learning and Teaching in Higher Education, *1* (1)

Case Study

The benefits of sustained inter-programme collaborations between international partners

C. P. Hurkett[1] , S. L. Symons[2] , S. N. Gretton[3] , C. T. Harvey[4] , P. E. Lock[5] , D. P. Williams[6] , and D. J. Raine[7]

[1]cph9@leicester.ac.uk, University of Leicester, UK. [2] symonss@mcmaster.ca, McMaster University, Canada, [3]sng8@le.ac.uk, University of Leicester, [4]harvech@mcmaster.ca, McMaster University, Canada, [5]lockpe@mcmaster.ca, McMaster University, Canada, [6]dpw10@le.ac.uk, University of Leicester, UK, [7]jdr@le.ac.uk, University of Leicester, UK

Abstract

This paper explores the use of relatively small-scale, virtual, classroom-level interactions that have developed into a sustained partnership between two institutions on two sides of the Atlantic. These interactions have benefitted the student bodies and faculty members as well as addressing institutional strategic agendas (e.g. internationalization). This partnership goes beyond the common exchange program paradigm: it impacts upon the academic and transferable skillsets of the entire student body rather than just exchange students. We provide examples of these collaborative activities and discuss their particular benefits. Whilst the two programs share similar pedagogies and degree content, which has helped these interactions, we aim to show how individual faculty members can initiate and maintain inter-program interactions between any Higher Education providers with sustainable effort.

Keywords: Undergraduate education, institutional cooperation, exchange, international collaboration, innovative pedagogies, experiential learning

Introduction

Inter-programme interactions are, in general, not a traditional or mandatory part of the undergraduate experience. However, with increasing student numbers, financial constraints, and the availability of university-level online courses of various shapes and sizes, universities are having to re-evaluate their role, their teaching strategies, and their degree expectations on both sides of the Atlantic (Barber et al., 2013; Weingarten et al., 2013). Responses to the current situation include strategic plans which encompass internationalization and globalization, building interdisciplinarity into courses and research, closer meshing of research and teaching, adoption of innovative pedagogical approaches, increased student-staff partnerships, and re-casting of instructional roles and job descriptions (Wilson, 2012; Barber et al., 2013; Egron-Polak & Hudson, 2014; Wihlborg & Robson, 2017). In addition to these drivers most institutions, faculties and departments have a mandate to increase visibility and distinctiveness in the academic arena in order to attract high calibre students and researchers. Some common goals are increasing the quality of the undergraduate experience, strengthening collaborative research links, and enhancement of academic reputation in order to attract increased funding. Collaborative links in both research and teaching are central to many of these ideas and can be directly related to strategic planning documents at the institutional level (e.g. Deane, 2011; University of Leicester, 2017a).

Strategies to address these goals are commonly framed and implemented in high level top-down terms, which can bear considerable cost and resource overheads to ensure their long-term sustainability. However, initiatives at the programme or classroom-level have the potential of being more agile than larger, institutional projects and can provide significant enhancements and progress towards targets with minimal resource outlay. This paper explores our own experience of individual faculty promoting inter-faculty (i.e. instructor-to-instructor) collaboration as well as furthering the internationalization agenda at the programme level for a wider range of students than can be achieved through traditional activities (e.g. student exchanges).

For the past eight years the interdisciplinary science undergraduate programmes at McMaster University, Ontario, Canada and University of Leicester, UK have engaged in a number of joint activities, beyond the established student exchange programme, that have benefitted students and instructors. This paper focusses on joint activities that have developed between two undergraduate science programmes, the Honours *Integrated Science* Programme at McMaster University, Ontario, Canada (www.science.mcmaster.ca/isci/; Eyles & Racine, 2007), and the *Natural Sciences* Programme, originally called “Interdisciplinary Science” or “IScience”, at the University of Leicester, UK (www.le.ac.uk/natsci). Both programs include research faculty or instructors on their teaching teams, but key instructors are teaching professors (McMaster) or teaching lecturers (Leicester) who have expertise in both teaching and scientific fields, having been trained in scientific research and being currently engaged in either scientific or pedagogical research or both. They are a relatively new category of instructor, having existed in Ontario since 1991 (Vajoczki et al., 2011) and in the UK since the 1990s (Husbands & Davies, 2000).

In this paper we will describe and reflect upon the nature of the existing interactions, identify some success factors in order to suggest how our experiences might inform further interactions between other programmes in the same institutions, in the same countries and internationally, and explore the benefits to both faculty/instructors and the student bodies.

Example inter-programme activities

The examples presented here represent *sustained* interactions between the two programmes (i.e. they have been ongoing for multiple years or are activities that are expected to readily become so), therefore we exclude one-way resource-providing interactions (for example the common transfer of a finished product). The interactions are at the classroom- or programme-level and are instructor- or student-led, and do not require high level institutional agreement or administration. They are usually resource-neutral or part-funded. All of the interactions described here incorporate synchronous and asynchronous virtual presence and technology-mediated communications, negating the need for costly international travel and enabling activities to fit within busy working and teaching schedules.

Virtual Learning Experiences

We are able to invite partners to teach classes, students to share research presentations, and groups to author materials collaboratively using collaborative software (such as Adobe Connect, Skype, GoogleDocs, Dropbox, etc.) and existing videoconferencing equipment (which is not otherwise heavily exploited at our institutions). These interactions, while not unusual in themselves, are the 'entry level' activities that form the foundation of communication between faculty and student bodies in the two institutions. Over time, these have built a collegial environment where the novelty of discussing ideas with remote colleagues is no longer a distraction.

Access to research expertise

This level of collaboration has enable greater flexibility in module content as module developers on both programmes can access research level expertise that would otherwise be unavailable. For example, McMaster students were able to interact with a Leicester astronomer while he was engaged in data collection on Mauna Kea in Hawaii. In that case, the timing of a planned classroom video-conferenced interaction, instead of being disrupted by the research visit, was enhanced by the availability of suitable video-conferencing equipment in the telescope's control room. Leicester students benefit from interactions with an expert on ancient time-keeping methods from McMaster which grants them access to a combination of history of Science, Egyptology, and astronomical expertise that is otherwise unavailable at Leicester. This can be highly motivating and beneficial to students (Sniezek, 2005). Student comments captured through end of module feedback forms indicated that such interactions were viewed positively e.g.: "[I appreciate having] different teachers who have a huge passion for their subject" (student). These interactions are also beneficial to the faculty as familiar content can be taught in novel situations, which keeps the task interesting whilst requiring minimal preparation overheads.

Student-led collegiate activities

The faculty-led connections between the two programmes have also resulted in the formation of student-led and student-mediated links between the two student bodies in both social and academic contexts.

Both student bodies run independent societies situated in their respective Student Union structures. Initially these catered only for students within each separate institution, but international links were catalysed by a Leicester student upon returning from an exchange programme to McMaster. Both societies identified the benefits of these links, stating that they feel like they are part of a wider learning community in terms of subject knowledge and pedagogical delivery style, which they would not have experienced if they had attempted to make similar links to single-discipline student

societies within their own Universities. These international links have allowed the societies to access additional grant funding and to acquire society and personal recognition awards (e.g. The Leicester Award).

Another example of a student-led interaction is the inclusion of Leicester students in the McMaster *Synthesis* undergraduate research symposium (van Wersch et al., 2013). *Synthesis* acts a focal point for the Integrated Science programme that draws together all four years of students in a single activity and provides them with an opportunity to experience most aspects of a real research conference, from planning and reviewing to attending, submitting, and presenting. During the first year (2013) of *Synthesis,* McMaster students noted that Leicester exchange students who were present for a single term (leaving Canada in December) would not have the opportunity to present their individual research at *Synthesis* in April. The McMaster students proposed that all Leicester students, not just those who had been on exchange, could participate via videoconferencing. An initial barrier to participation was scheduling as *Synthesis* falls within the UK Easter break, but this problem was overcome by the participating Leicester students joining in from diverse locations during their break using either University of Leicester or their own videoconferencing facilities. Sessions involving Leicester students are wholly planned and run by student leaders drawn from both student bodies. Topics include not just discussion of research, but also debates on student life, the exchange programme, and future opportunities.

As alluded to earlier, our students can exchange between the two institutions, but the agreement is specific to the two programmes (plus the two Departments of Physics and Astronomy). Standard institution-led support structures are in place for both sets of students, but beyond this they may already be connected, via social media, with a large fraction of the partner's student body as a result of the activities outlined above. Therefore they find joining a study group, or participating in a videoconference pre-exchange meeting, to be a low-stress experience, as they already have a feeling of who will be participating. In our experience the existence of other inter-programme links outside of the exchange programme have helped foster a distinctly different set of outcomes for our exchange: instead of being a key individual academic experience only for the students who travel, the exchange activity has a wider impact on our students as a whole. When exchange students return there are many opportunities for continuing contact with their former hosts and for engaging their home institution peers in activities with the host programme students as well. Our exchange students often become driving forces in maintaining or creating new interactions and keeping in touch with their international peers and instructors. We consider this sustained contact to be unusual and beneficial not just to the exchange students themselves, but also to the non-exchanging students, who then develop wider perspectives and an understanding of student life at the partner institution for those students who have not had the opportunity or desire to travel.

Participation in Undergraduate Journals

Both programmes have teaching activities that develop scientific writing skills aimed at communicating complex information to a variety of different audience types, where students write as individuals or within a group. Whilst such assessment pieces aim to provide practice in writing for diverse audiences, in reality the experience has limited authenticity as students recognise that they are writing for their assessors (Herrington & Herrington, 2006). In order to provide a more authentic experience, that would also aid students in their transition to post-graduate academic activities, in 2012 the NS programme developed an online student-run journal (JIST: the Journal of Interdisciplinary Science Topics, https://journals.le.ac.uk/ojs1/index.php/jist) as part of a third year module. This was based on an initiative that began as a paper-based activity in 1996 in Leicester's Department of Physics and Astronomy (Raine, 2002) and relaunched as an open access e-journal in 2009 (Hurkett, Raine, & Roy, 2014; Hurkett, Roy, & Wynn, 2016). Students from both programmes

act as authors and thus gain experience of writing primarily for an international cohort of their peers, but also with a global general public audience in mind as these short scientific papers are often picked up by news media outlets (e.g. Sanchez, 2015; Thompson, 2015; Ali, 2015) and occasionally radio and TV (e.g. Wheeler, 2014). Leicester students additionally serve as reviewers and the editorial board for all papers received.

The benefits of having two international contributing student bodies include:

Professionalism in communication: Communication between authors, reviewers and editors is via the journal software and editorial board minutes. They cannot rely on 'ad hoc' or casual communication (face-to-face or via social media) to further explain their responses or reasoning. Therefore all reviewers' reports and editorial board communications must be clear, detailed, professional and take into account the different scientific background of the McMaster students.

Broad range of paper topics: Whilst both sets of students study similar scientific concepts the exact scope and detail of the programmes is different. McMaster authors must therefore frame their scientific arguments carefully to ensure that adequate contextual and theoretical discussions are present as they cannot assume the exact scientific knowledge of the Leicester reviewers. This gives them a greater appreciation of how to construct a discussion for a wider readership than their own peers. In turn the Leicester reviewers have to respond to a broader range of topics, or familiar topics presented in a novel format, which is a more robust test of their synoptic knowledge.

Authentic, critical reflection: All authors have the opportunity to resubmit papers that are initially deemed ineligible for publication by reflecting on reviewers' comments. McMaster authors benefit from the style and content advice offered by the Leicester reviewers as this gives them an intermediate step between their writing being shown only to classmates and instructors, and being sent off to completely unknown reviewers if and when they submitted a paper for publication in the wider academic publishing world. Leicester students additionally benefit by critically analysing the McMaster papers and using this to reflect on their own writing style. In an informal discussion with one of the Leicester students they commented:

> My group members used to tell me that my drafts for continuous assessment pieces were too long, but when they edited the drafts down I couldn't understand why they'd made some of the cuts. Then I had to review a McMaster paper with a writing style that was as rambling as mine and I suddenly realised what I had been doing wrong.

From a faculty point of view, having multiple contributing student bodies makes it much easier to achieve the critical mass required to supply an authentic experience. It also generates a genuine level of excitement in the reviewers that get to read and evaluate material created by peers outside of their normal cohort.

The flexibility of the module design in both institutions enables the asynchronous workloads to be incorporated in a rational way. For the Leicester module the relatively low number of papers submitted by students from McMaster results in a small increase in reviewing activities, which has been taken into account in the marking scheme. The structure of the McMaster *Science Literacy* module meant that, when JIST was identified as a potential destination for McMaster students' writing, a framework already existed to give students credit within this module. This has added to the McMaster students' menu of options for *Science Literacy* in their second and third years, and offers them an alternative publishing format, as JIST requires short, original, quantitative articles that would normally not be suitable for their familiar McMaster-based destinations (a science blog and a project-based research journal).

This activity has been so well received by both student cohorts, and has been proven to work well from an administrative standpoint, that participation has been extended to students from L'Université Paris Descartes (*Licence Frontières du Vivant* programme) and a further degree programme at McMaster University (*Health Sciences* programme). This activity also informed and supported the development of the *iScientist* journal at McMaster (https://journals.mcmaster.ca/iScientist).

Foundations for successful inter-programme collaborations

Implementing some interactions, e.g. virtual learning experiences, are relatively straightforward if willing institutional partners can be found, but others, e.g. student-led activities, may not be easily transferrable to other programmes without 'entry level' activities being in place first. We reflect upon our interactions, and explore what has led them to be successful, in order to inform practitioners who may be considering initiating their own activities.

Ownership by faculty: A key to the success of these activities is that they were not imposed by external or top-down agencies, but are designed and owned by the faculty. This 'ground-up' familiarity with the framework and activities meant that instructors were better able to adapt activities whilst in-progress in order to tailor them to individual cohorts.

Teaching orientated instructors: It was beneficial to have teaching-orientated instructors as they have a mandate to actively engage in improving learning and develop new, enriching and creative activities. They are also likely to be people who enjoy co-teaching, discussing pedagogy, comparing and sharing techniques, and trying new things in the classroom. These traits predispose instructors to be receptive to collaboration across programs if given time to engage.

Similarities in pedagogical approach: Neither of our programmes teach in the traditional university lecture style. Leicester uses Problem-Based Learning (PBL), although in a form that incorporates some extensive scaffolding (Gretton, Raine, &, Bartle, 2013), while McMaster has developed a PBL-related style, heavily influenced by research methods (Symons et al., 2017). While not identical, the two are close enough that when we introduce students to our partner institution's resources, they do not find the pedagogical approaches there to be alien, or to be a barrier to learning. Having a PBL-like approach is not crucial; however, we have found that pedagogical approaches that encourage student exploration facilitates inter-program interactions, as students have already adopted the mind-set of being finders or even creators of knowledge (Healey et al., 2014). They are thus more motivated to explore any new arenas that we provide for them (for example: library resources, specialist personnel, modelling tools, lab equipment, fields for data collection).

Authenticity and buy-in: Authenticity is a strong motivator for student engagement, but all stakeholders, particularly students, must have a clear reason to buy-in to the activity (Lombardi, 2007; Brophy, 2013). Sustaining long-term engagement in these activities does not require symmetric participation, or a complete match between curricula (e.g. the undergraduate journal), as long as it is clear how both student bodies benefit.

Flexible assessment structures: Our student assessment structures are flexible enough to allow these activities to be awarded credit, without disturbing our fundamental assessment model. This flexibility helps to motivate the students to engage, especially if the activity takes significant time and effort. We also note that it is certainly possible for motivation for smaller-scale interactions to come from sources other than assessment, for example from opportunities to strengthen CVs, develop new skills, network, or merely to enjoy the proposed activity.

Asynchronous activities: Interactions such as inter-programme lectures are necessarily synchronous, but larger activities, such as the journal, can be designed so that they can be asynchronously deployed to take into account time-zone differences, scheduling constraints at each participating institution, and busy student timetables.

Low resource overheads: No time or personnel, and very limited money, is allocated specifically for our inter-program interactions. We have nevertheless managed to develop and maintain collegial links between student and instructional bodies in a resource-neutral or lightly funded way. We started by developing activities that allowed interactions with little or no additional costs by utilising existing virtual lines of communication, rather than physical presence, and no additional 'specialist' equipment. Care was also taken to start with small, administrative- and resource-neutral activities. Once faculty had gained familiarity with the activities, and were fully aware of the resource implications, they were expanded to match the available faculty and resource capacities rather than initially committing to large-scale schemes that could not be sustained in the long-term.

Discussion

Cumulatively, no student can finish either programme without some influence from the activities discussed above shaping their undergraduate experience. As a form of experiential learning these activities can enrich and vary students' pedagogical repertoire, leading to greater engagement or a wider perspective of their subject area. They also exert a positive influence during recruitment activities. Students in non-standard, smaller, or pedagogically innovative programs such as ours can be anxious about whether their "non-standard" learning experience may turn out to be detrimental to their post-university prospects, and whether they are keeping up with their traditionally-taught colleagues. These activities aid the development of collegiate interactions with students and instructors (Cotton & Wilson, 2006) who understand their academic environment which, in turn, helps the students feel "at home". This has been shown in studies such as Severines et al. (2015) to correlate with effort, engagement, and grades. Inter-programme interactions also benefit the students by providing greater access to resources in terms of instructors and project supervisors with different skills and specialisms, whole courses, data etc. of which they otherwise may not even be aware.

As instructors, we recognize that students are often so focused on their personal university experience that, when they need to articulate their achievements (for example in a job interview), they fail to identify the unique selling points which their program may have given them (e.g. Haigh & Kilmartin, 1999; Burke, Jones, & Doherty, 2005). Interacting with students outside their own programmes gives students a better perspective of their own skills, achievements, biases, and potential roles (Jones 2013).

Inter-programme interactions increase students' perspectives of themselves as members of wider communities and foster an international mind-frame by introducing them to the international knowledge marketplace, and the drivers thereof, which their normal curricula activities may not offer, thus providing a window into different academic and career opportunities. This widens their horizons in terms of work locations (e.g. Wiers-Jenssen, 2007; Pool & Sewell, 2007; Crossman & Clarke, 2010; Root & Ngampornchai, 2012) and helps to raise their employability by gaining experience of working collaboratively with people not in their immediate academic cultural group (Williams, 2005; Schech et al., 2017).

Collaborative authorship activities do not exist at only the student level. This paper is a result of ongoing pedagogical research links between the programs, which offer a larger or more diverse or

comparative study population than considering each cohort separately, helping to distinguish between local effects and general trends. Other examples of this research collaboration include McMaster's Longitudinal Study (Symons et al., 2017), which examines the effectiveness of the programmes in preparing students for their next academic step and has produced instruments which Leicester now uses for evaluating skills development in their students. Future plans include comparative studies and using the combined pool of students for student-initiated pedagogical research projects. At both institutions the effect of faculty engaging openly in pedagogical research has engendered a respect for the field and a desire to participate as investigators in both student cohorts. Given a choice from any subject area for their independent project or thesis, around 10% of students annually opt to undertake a pedagogical project at both institutions.

Whilst international inter-programme interactions provide clear benefits to the student cohort they also benefit faculty as well. The interactions between faculty in our programs has opened up a wider peer community for mutual support, new perspectives, formative feedback, idea sharing and evaluation of each other's practices. All of these aspects can contribute enormously towards professional development and garner extrinsic and intrinsic rewards (Friesen, 2012). In the authors' cases, engaging in collaborative activities is taken into account in tenure, promotion, and annual merit awards (McMaster; Bizzozero, 2014) and in Distinguished Teaching Awards, promotion and recent teaching awards (Leicester; HEA, 2017a,b,c; University of Leicester, 2017b). In both programs, our current interactions are seen as an enhancement, innovation, or benefit by our institutional oversight and quality assurance structures, rather than as a distraction from our core duties.

One of the unexpected outcomes of these interactions has been increased institutional visibility for pedagogic developments. At McMaster the interactions with a European program were more visible (based on mentions in press releases, promotional videos, and strategy documents) to McMaster's upper administrative structures than the many in-class innovations that were occurring at the same time. Conversely, the existence of the successful *Integrated Science* programme at an elite Canadian university contributed to the case for continuing support of the *Natural Sciences* initiative at Leicester.

Conclusion

Internationalization has become a major driver in the UK and Canada in recent years at both the research level, in terms of collaborative programs, and in the context of teaching, in the shape of international student exchanges. It is interesting from a sociological view point that classroom-level, instructor-negotiated teaching collaborations across continents appear to the authors to be easier to set up and maintain than institutionally-mandated, high-level links between departments on the same campus. In order to think big we perhaps need to start by thinking small.

The activities described within this paper are low-risk, sustained programme and classroom-level interactions that are largely resource neutral. They can be asymmetric and asynchronous in nature. Once a successful activity is in place it becomes increasingly easy for all faculty involved to spot synergies between programmes and suggest additional activities or links. Exceeding a threshold number of faculty-proposed activities will result in students also suggesting new activities. Once such activities become culturally embedded the process becomes mutually reinforcing. Given the current level of interaction cumulatively, no student can finish either program without some influence from the activities discussed above positively shaping their undergraduate experience.

These activities are one way that an instructor can demonstrate impact of their teaching beyond their own programme, which can be useful for career development and can also enhance the

program's reputation on the national and international level and help differentiate it from similar offerings.

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Edirisingha, P., Cane, C., Cane, R. and Jiang, M. (2018) Student-contributed podcasts to support transition to higher education. *Journal of Learning and Teaching in Higher Education, 1(1)*

Conceptual and evidence based research article

Student-contributed podcasts to support transition to higher education

Palitha Edirisingha[1], Chris Cane[2], Robert Cane[3], Mengjie Jiang[4]

[1] pe27@le.ac.uk , School of Education, University of Leicester
[2] crc@le.ac.uk , Department of Genetics and Genome Biology, University of Leicester;
[3] rob.cane@gmail.com, Loughborough University
[4] mjj16@le.ac.uk, School of Education, University of Leicester

Abstract

Studies of undergraduate student satisfaction, academic performance and retention in Higher Education (HE) identify the critical importance of the first year for shaping their attitudes and approaches to learning. Positive transition into HE has a direct impact on students' later learning experience, particularly during their first year. Most interventions to support transitions are based on institution-driven approaches such as courses on learning and study skills. Here we describe how podcasting can be used to developing a new approach to support transition by tapping into the knowledge and experience of current undergraduates.

Keywords: Transition to Higher Education; Student-contributions to learning; Podcasting; Learning Technologies; First-year experience

Introduction

Issues related to transition from school to university

Transitions are defined as the 'capability to navigate change' (Gale & Parker, 2014). Entering HE is a big transitional phase in students' lives and they need to manage these changes well in order to complete their studies successfully. Multiple critical factors contribute to students' successful transition into HE, which requires looking at a more complete picture of students' experience and involves not only what happens within universities but also in their networks and families (Cashmore, Green, & Scott, 2010). Previous studies have discovered a range of factors associated with students' transition and retention rate, including pre-entry activities and induction (Thomas, 2013; Murtagh, Morris, & Thorpe, 2013); students' preparedness; transition support, curriculum development and data monitoring (Jones, 2008), and students' sense of belonging as well as engagement (Cashmore, Scott, & Cane, 2012).

For students, poor preparation for university life, unsatisfactory academic experiences, lack of social integration and financial issues are often identified as pivotal contributors to underachievement and drop out (Jones, 2008; Thomas, 2013). New entrants may hold misconceptions, as many are inadequately prepared for the university's assessment procedures, hours of face-to-face contact, the independent study required, the large size of lecture groups, and the choices to be made among modular options (Brunton et al., 2016; Mckendry, Wright, & Stevenson, 2014; Leese, 2010).

The issue of transition to HE is sometimes addressed using the concept of 'habitus' or 'institutional habitus'. 'Habitus' is derived from Bourdieu's work as a generative schema of embodied dispositions acquired through formative experiences, and it is often interpreted as social practices and beliefs as well as perceptions of a particular social class (Bourdieu, 1994; McNay, 1999). With regard to HE, Reay, David and Ball (2001, 2005) appropriated the concept of 'habitus' and they used 'institutional habitus' to explore the relationship between HE institutional practices and students' choices. Preparation for HE should therefore include understanding the 'institutional habitus' of HE, meaning the values and practices of cultural or social groups that are embedded in and mediated through the culture of an institution (Reay, David, & Ball, 2001, 2005). Here, 'cultural group' refers to young people and their families who bring their habituses into universities that could exert an impact on institutional culture, and vice versa. The organizational culture of a university will present a different institutional habitus that could mediate students' habituses (Morrison, 2007).

Educational expectations can be understood as part of one's habitus, and a mismatch between students' expectation and actual experience can lead to students' withdrawal (Rowley, Hartley, & Larkin, 2008). HE students' age, ethnicity, socio-economic background and family HE history are key attributes to students' preparedness for HE (Leese, 2010; Reay, Crozier, & Clayton, 2010). Qualitative studies show that financial burden confronted by working-class students often undermines their commitment to academic study and cuts them off from university activities that could enhance their social and cultural capital. Moreover, often being the first generation to attend university, these students do not have a privileged understanding of HE system, given that limited insight is provided by their parents (Bradley & Ingram, 2013; McMillan, 2014). Those students who are unprepared to study at the university can feel like a 'fish out of water' (Thomas, 2002, p. 431).

Support for transition could bridge the gap between 'institutional habitus' and personal habitus, but higher education institutions typically respond by providing formal courses in study skills (Hultberg et al., 2008; Walker, Matthew, & Black, 2004; Knox, 2005). The knowledge and experience of students who have already made the transition have been little exploited. Such knowledge, referred to as 'hot knowledge' (Ball & Vincent, 1998), is 'the socially embedded' informal knowledge prevailing in networks of friends, family, relatives and neighbours, the people who are considered as

'people like me' (Hutching, 2003, p. 110). Contrastingly, 'cold knowledge' can be conceived as formal knowledge produced and disseminated by institutions, in this case, universities (Ball & Vincent, 1998). 'Hot knowledge' is often considered by potential applicants to be more trustworthy and more crucial for their decision-making process than that communicated through 'official' sources (Hutchings, 2003; Smith, 2011).

Podcasts

Literature reveals the social and technical potential of technologies to smooth students' transition with informational and social support, preparing students prior to arrival, assisting students' ongoing engagement and enhancing multi-dimensional communication (Lefever & Currant, 2010). Previous studies showed that technologies appear to be well-suited for helping students capture 'hot knowledge', finding common ground and reassurance that others are going through similar issues as well as in exchanging emotional support (Ellison, Lampe, Steinfield, & Vitak, 2010; Gray, Vitak, Easton, & Ellison, 2013).

"students using podcasts for their learning have reported that they value the flexibility offered as well as the cognitive and motivational benefits obtained from listening to them"

Podcasting originated as a technology to create and distribute personal "radio shows" via the internet. It has now become a technology used to support learning, at least in more economically developed countries. Browne et al. (2008, p. 2) showed that podcasting is a tool that has "increased significantly in prominence" in UK universities. Increasing numbers of research papers published on podcasting indicate a growing interest from teachers, technologists and researchers in this field. Salmon and Edirisingha (2008) documented four approaches to using student-created podcasts to provide first-year support: addressing students' misconceptions and anxiety about HE; developing their reflection skills; advising them on their assessed work; and developing their research skills. Pegrum, Bartle and Longnecker's (2014) research with first-year Chemistry undergraduates examined the use of podcasting to promote a deep approach to learning that resulted in better learning outcomes. Their research showed that "under some circumstances creative podcasting may … help to promote a deep learning approach" (ibid, p. 1). Popova, Kirschner and Joiner (2014), showed that "primer podcasts" - podcasts for students to prepare for lectures - "have a positive influence on learning" (ibid, p. 330). Podcasts have also been effective as a supplement to face-to-face teaching on a music and visual arts course taken by student teachers (Tam, 2012). As this literature shows, students using podcasts for their learning have reported that they value the flexibility offered as well as the cognitive and motivational benefits obtained from listening to them.

Aims and research questions

Using podcasting and mobile devices familiar to HE students, our project aimed to tap into the knowledge and experience of students who recently made their transition to HE for the benefit of new entrants to HE. The project was associated with Leicester's GENIE (Genetics Education Networking for Innovation and Excellence) Centre of Excellence for Teaching and Learning, which aimed to improve learner experience in HE. This study was built on earlier work on investigating the student experience of first year Biological Sciences students, where undergraduates chronicle their learning and social experiences by weekly video diaries.

Our project investigated the ways in which student-created podcasts might support new HE entrants' transition into HE.

Methods

Developing podcasts and researching the impact

Our approach consisted of developing two sets of podcasts, making them available for students; and investigating their impact on student transition. Type A podcasts were developed for students about to start their first HE course, and Type B for those already in their first year. The content relevant for podcasts was identified through focus group interviews with Level 1 and 2 biological sciences students at the University of Leicester, and from the earlier GENIE student experience project. We developed and distributed podcasts with the help of a learning technologist with a science and teaching background.

Thirteen Type A podcasts (each 5 minutes) were developed and distributed to prospective students through a publicly accessible website and iTunes. These podcasts covered topics such as leaving home, making new friends, accommodation, managing money and the differences between school and university. Information about these podcasts was made available to the schools and colleges that were associated with GENIE CETL outreach programmes.

Type B podcasts were made available for the same cohort of students during their first year via Blackboard Virtual Learning Environment (VLE). Twenty four Type B podcasts were made to address transition issues for students in their first year, for example, progressing from first to second semester and first to second year, coping with exams, choosing modules, laboratory work, library projects, and productive activities in the summer vacation.

Personal hour-long interviews with eight students who had listened to Type A podcasts, and a further eight who listened to Type B podcasts were carried out to examine their views on how transition to HE can be supported by both types of podcasts. Type A research interviews were carried out during Semester 1. Type B interviews were carried out after students had completed their first year.

Recordings were transcribed and thematic analysis was used to identify, analyse and report patterns within the data (Braun & Clarke, 2006). Data analysis was guided by relevant themes obtained from the literature on transition; for example, background (Leese, 2010), expectations and experiences (Rowley, Hartley & Larkin, 2008), and processes of making adjustment (Gray, Easton, & Ellison, 2013).

The analysis was also open to new evidence from the dataset, which challenged, extended or provided new knowledge on transition. The purpose of the data analysis was to enable modelling of the views, perceptions and feelings of the research participants regarding podcasts for transition. Thus the analysis focused on identifying respondents' experience of making the transition into HE and the perceived benefits of the podcasts in the transition process.

Results

We discuss the results under three themes:

- Usefulness of podcasts for transition
- Relevance of podcasts in the context of wider resources used for transition
- Students' experience of transition to HE

Usefulness of podcasts for transition

All students said that, to some degree, they had found information and advice in the podcasts useful, even while listening to these podcasts critically. The usefulness of podcasts for students' transition to HE can be split into three categories: the communication of new information and personal perspectives, the provision of advice regarding new positive behaviours, and reassurance regarding existing perspectives and behaviours.

Information from personal perspectives

Many interviewees detailed specific points of information that they had gleaned from the podcasts that they had not found elsewhere. Many suggested that such information was more likely to occur when it was being provided informally by those with direct experience of being a student on their course:

> With lecturers, or with the information that module convenors give out, it's important information, but not necessarily things that you need to know. Whereas, when it's a student talking, it's only things that they've dealt with and if they feel the need to tell you then it's obviously important.

This was particularly prevalent in relation to the podcasts on second year modules, especially regarding course content (e.g. the fact that the module… "Genomes is about the Genome as a whole rather than genetics in general"), and the nature of practicals (in particular, that "some of them are six hours long"). The students suggested that they would use such information to orientate themselves going into their modules in the next year. In a similar retrospective vein regarding the podcast on examinations, one student suggested that:

> If I had heard them [a Type B podcast on the exams] before I had my exams, it would have been quite useful because it sort of said how the exam was set out

Similarly, and looking to the future, some students also suggested that they had discovered, from podcasts, information about the work that they would have to do in their second and third years, their third year laboratory and library projects, and about the possibility of studying abroad (particularly information about funding available).

The information detailed above consisted of facts, and replicated some written material, i.e., existing sources of information. However, six out of the eight students who had listened to Type B suggested that the podcasts made new evaluative perspectives and opinions available to them in a way that the less personal and more formal written materials could not. They also recognised that a large amount of information provided in the podcasts was deeply subjective and students need to critically evaluate the information provided in Type B podcasts. As we mention later in the paper (in under *Semi-formal sources*) our involvement in recording and editing the podcasts, to some extent helps to mitigate lack of objectivity and the potential spread of incorrect information.

Advice on productive behaviours

Some interviewees also described specific advice that they had received from the podcasts. This took the form of suggestions for behaviours that the students on the podcasts believed would be productive and would aid others as they advanced through their studies. Students who had listened to podcasts considered that such advice was relevant because they were rooted in the experience of other students who have been through the same experience as themselves. These suggestions were particularly prevalent in relation to study skills and module selection. In some cases, the interviewees even announced that they would be following the advice provided by the podcasts:

> This summer I'm definitely going to try and start [doing some] background reading, because obviously that's really important. It was mentioned in loads of the podcasts.

However, given that the interviews were conducted at the end of the first year, much of the advice discerned by the students interviewed was described not as suggestions of new actions that they would undertake but, rather, as suggestions of actions that they should have undertaken during their first year. This included, most notably, advice regarding the process of module selection, and, in particular, the suggestion that it may have been useful to contact peer mentors before making any final decisions.

Reassurance and reinforcement

The podcasts' main benefits in terms of their reinforcement function was that they served to reduce uncertainty and the consequent anxiety regarding particular actions, behaviours and choices.

The final category of the usefulness of podcasts was around the provision of support for students' existing knowledge and behaviours. Whilst some students criticised information in some of the podcasts especially those on the differences between the levels (year of study) and exams for merely stating the obvious, many of them described how the podcasts reinforced certain pieces of information, as well as the need, of which they were already aware, for certain courses of action:

> I think, some of the points raised – things like doing extra reading – it does seem obvious, but I think just hearing people say it, kind of instils that it is vital.

> I guess, I think that they just sort of reinforce what you have gathered from blackboard and from your tutors.

However, according to many interviewees, the podcasts' main benefits in terms of their reinforcement function was that they served to reduce uncertainty and the consequent anxiety regarding particular actions, behaviours and choices. In the case of the module selection, this meant that they helped to reassure the interviewees that they would enjoy the modules that they had chosen:

> [The podcast about the Genomes module] says: 'if you're really interested in genes and if you're doing genetics, then it is really useful'. I'm interested in genes. It's quite good to know I've made the right choice.

Some interviewees also suggested that they were similarly reassured by the podcasts on other topics, most notably on examinations, which were a significant source of stress. These podcasts demonstrated to them that their concerns and difficulties were perfectly normal, which served to comfort them. As one interviewee said:

> It's nice just to listen to that and to find that people have the same worries and the same problems that you did.

Many interviewees suggested that they would have used the opinions expressed in the podcasts to inform their own choices of second year modules, had they listened to them before selecting their modules. One interviewee, for example, said:

> When choosing modules, as well, I think it is good to know other people's experiences [from the podcasts].

Such opinions and personal perspectives were found in all podcasts. For example, the podcast on the differences between the levels provided several perspectives regarding the actual difference between first and second years and the nature of laboratory work.

All the interviewees agreed that the podcasts contained useful information and advice. Certainly, two students even directly identified them as a solution to the lack of opportunities to learn from the experiential, informal knowledge of second and third year students:

> There's no real way to speak to second years and third years apart from [by listening to] the podcasts.

> So, if this [podcast] is available to us on blackboard we wouldn't need to go look for second years to ask them, because this is already available.

Indeed, the main source of legitimacy identified for the podcasts was the fact that the information contained within them was relayed by other students, from their own experiences:

> They've been there, they've done that, so they can give you the proper advice.

> I'd rather hear it [information] from students than – almost more than my tutor. The students have experienced what I have. They can understand my worries a bit more.

One student even expressed the opinion that only their peers would give fully honest advice, whereas personal tutors and module convenors may only communicate the official line.

Relevance of podcasts in the context of wider resources used by students for their transition

To help them address the difficulties involved in transition, the students interviewed consulted a range of resources, which can be usefully sorted into three categories of: formal, informal, and semi-formal resources (Figure 1).

Formal resources

Formal resources are those that are officially produced and provided by the HE institution; these include highly structured, factual and abstract information. They provide what might be called 'cold knowledge' (Ball & Vincent, 1998). These include the various printed materials used for information seeking, as well as module booklets used in selecting modules for the second year, alongside information taken from websites and the VLE, and formal information provided during lectures or on open days.

While all students reported using such resources, most of them felt that they were either poorly suited to aiding them in the various stages of their transition or not enough on their own. Whilst some students acknowledged that the written information available in print (module handbook) and online (the VLE) provided a good 'outline' of relevant 'facts'. Others criticised it for not containing 'enough description', and, most critically, not being able to provide 'opinions' and information derived from personal experience, which can highlight particularly salient elements of the first year

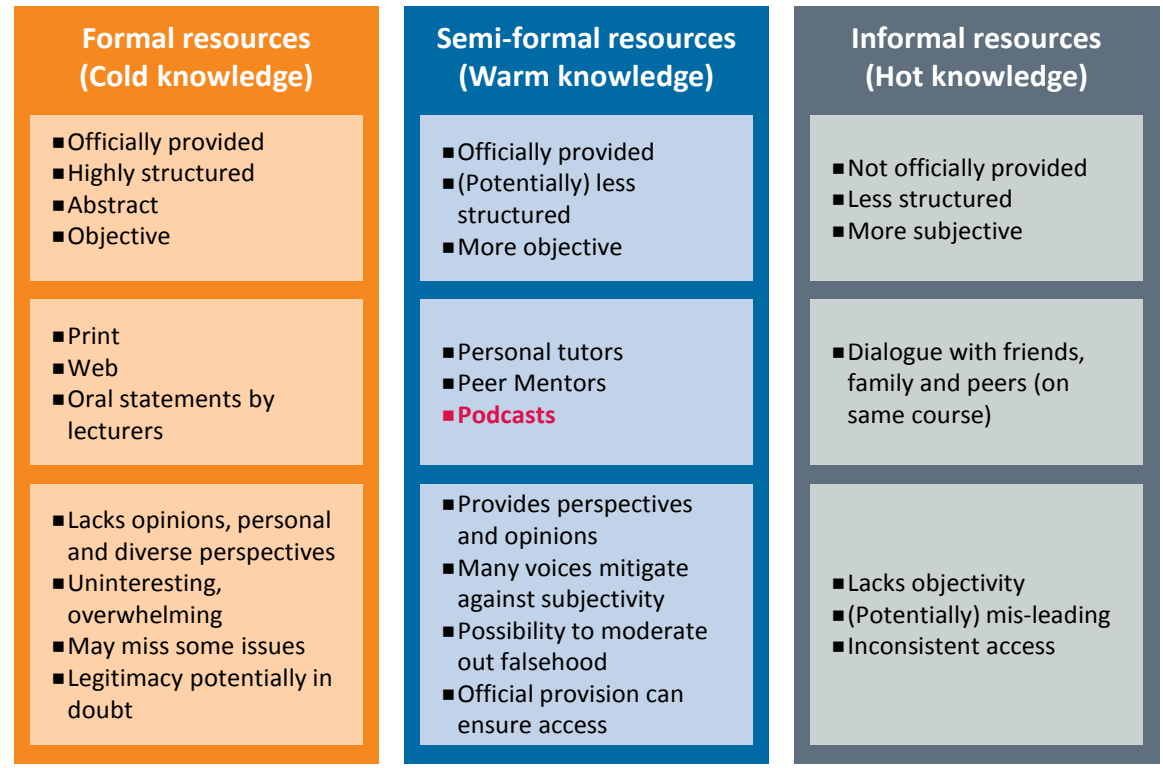

Figure 1: Types of resources used by students to support their transition

student experience. Some students even expressed displeasure at having to read large amounts of text containing dry, factual information.

As discussed in previously, many students found information in the podcasts that was relevant to them; such information was not available via the formal sources. One student even argued that the official and formal nature of such sources (which for them included lecturers and personal tutors) meant that they would only say 'what they're supposed to say' and not what the student needs to hear. Finally, on a related point, many students expressed that while the formal sources of information were good for initial 'factual stuff' many decisions required the use of opinions and different perspectives that were simply not present in the formal resources.

Informal sources

One way in which students overcame these concerns about formal information was by using informal resources, such as family members or friends who had been through university, or, when they were in their first year at university, by consulting their peers. These resources are unofficial and accessed in an informal environment, and thus provide a source of 'hot knowledge', which is based on personal experience and opinion, rather than 'cold', abstract facts.

Although most students referred to advice and guidance received from family members before attending university, only one (who had family members in the medical profession) suggested that the family members had the knowledge required to provide the significant guidance needed in the

first year of studies. One student even explicitly stated that they felt that their family did not have the necessary experience to provide the advice required for the later stages of their transition.

Whilst such resources did, for many of the students, overcome the defects of the formal resources (such as the lack of diverse perspectives and opinions, and the insensitivity to particular circumstances), they were not without their own faults. First, since the information provided is often highly subjective, many students expressed a fear that they may not be the objective facts, or, at worst, that they may actually be told something that is simply not true, especially when talking to people who had little more experience than they themselves did (e.g. other students in their own year). Perhaps, even more problematically, in some cases the students stated that they did not actually know anyone with relevant HE experience. This was particularly the case for those who were amongst the first in their family to go to university. Informal was also particularly relevant with regard to the issues covered in the Type B podcasts (for example, module selection, examinations) that are specific to the biological sciences courses at the University of Leicester.

Semi-formal sources

One potential solution for many of these problems was to use semi-formal resources (a category which includes the podcasts produced in our project). These resources are officially provided by the university; examples include peer mentors and personal tutors. Students can access these resources on a personal level to hear insights drawn from relevant personal experience. These sources have the advantage that they do provide the opinions and experiential perspectives of hot knowledge, but also as they are officially provided, they can be monitored for quality and be made available to all students.

Our podcasts fit into this semi-formal category, potentially acting as a new source of information for students to support their transition. Students perceived these podcasts to be recordings of individuals sharing their insights and opinions on particular topics, moderated to prevent incorrect information from being spread, providing multiple subjective viewpoints, which was understood to mitigate the lack of objectivity (a point commonly raised by the students when commenting on the podcasts).

We suggested that the knowledge contained in podcasts and other semi-formal resources might be termed ‘warm knowledge’ as it lies somewhere between the ‘cold’ and ‘hot’ knowledge of the other two resources. It is the knowledge that is highly personal, but moderated through the selection of information and the editing process to ensure the accuracy and the balance of opinions expressed. It is the captured and edited ‘hot’ knowledge.

Semi-formal resources, too, are not without their pitfalls. Many students reported that they had not made consistent or widespread use of their peer mentors or personal tutors, and the quality of information provided by individuals fulfilling such roles was extremely variable. Indeed, some students reported that their personal tutors provided a large amount of personal advice, whereas others treated them as an extension of the formal resources and suggested that their personal tutors may not have had relevant experience and relied upon the abstract and dry formal information.

The podcasts can, potentially, avoid the problems that other semi-formal resources have faced. By being accessible from anywhere with a suitable internet connection, they are easier and quicker to access than personal tutors or peer mentors with whom meetings must be arranged or e-mails exchanged. They can also be used by students even before they choose to attend the university. Furthermore, since they are edited together from several interviews, incorrect information can easily be removed. Podcasts can contain many interesting and relevant viewpoints from different

contributors. They can also provide a level of consistency to everyone, which would be difficult to manage with the peer mentors or personal tutors.

Thus, the podcasts can provide a useful addition to the other resources that are already used to assist with the transition process. All the students agreed that the podcasts could be useful to them as sources of opinions, perspectives and information that they could use whilst adapting to the higher education environment and making crucial decisions for their future.

Students' experience of transition to HE

The students who had listened to the podcasts described their transition from school / college and home into HE as occurring in three environments: institutional, teaching and learning, and social, each with unique attributes. Figure 2 summarises the attributes of these three environments together with how the Type A podcasts helped in this process.

First, for students, transition was moving from one level of the educational experience up to a new and higher level, HE. They compared their experience of being at school or college with that at university. For them, the class size, a non-uniformed and less regulated environment and tough demands made of them in their studies were notable differences in studying at university.

Second, students considered transition in terms of new ways of engaging with teaching and learning processes. Whereas at school or college they had worked in small groups and under close supervision and the guidance of class teachers, they reported that learning in university took many forms such as lectures, practical sessions, individual and group assignments, presentations, a lot of

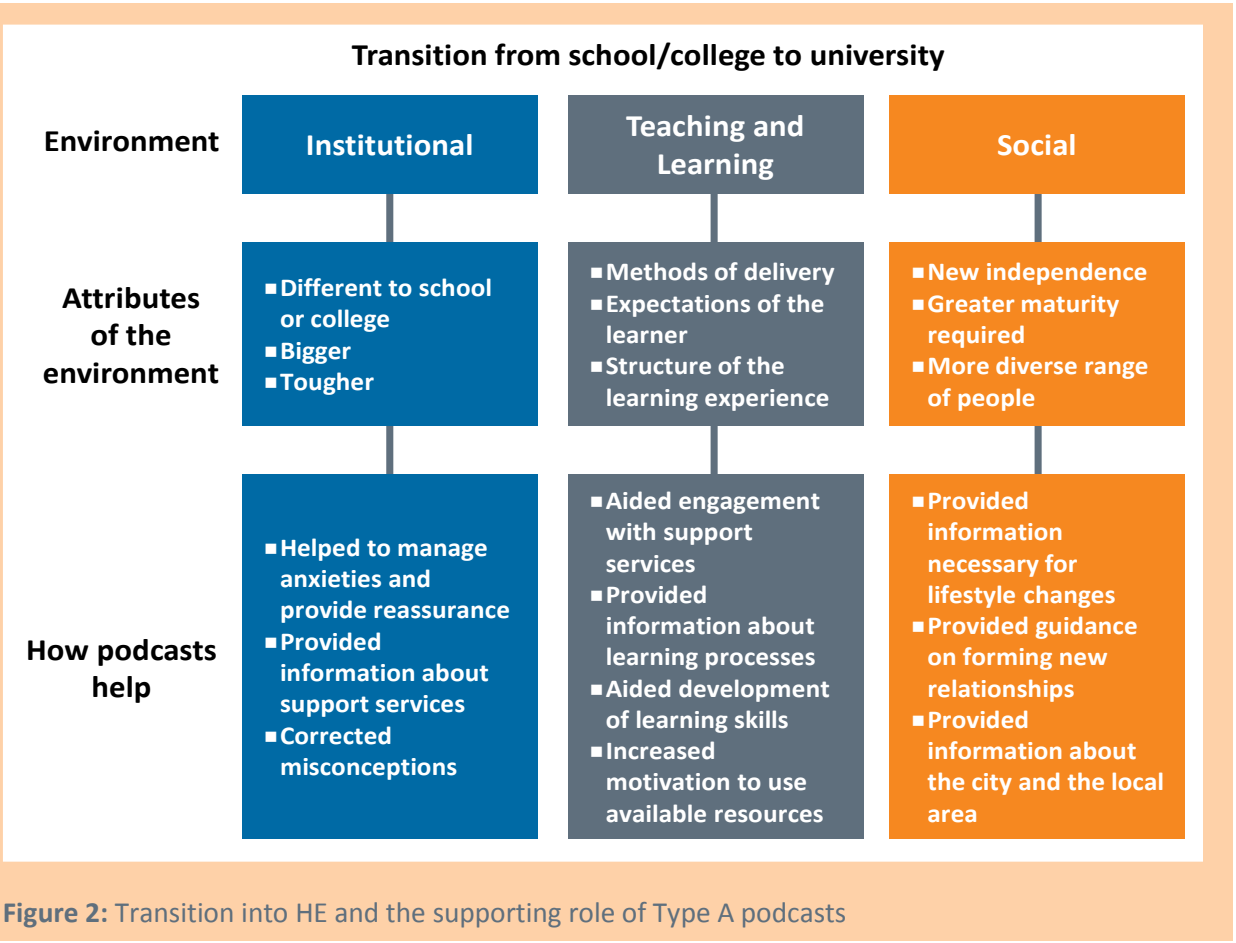

Figure 2: Transition into HE and the supporting role of Type A podcasts

reading and independent study. To them this made learning at university more demanding. They also experienced tighter deadlines.

Third, transition constituted a move into a new socio-cultural environment. They expressed transition in terms of leaving home, gaining independence, living away from loved ones, maturing and growing up, and being exposed to a variety of new people.

The analysis shows that students perceived transition as bringing 'discontinuity', that is, ending particular ways of behaving or doing things as they pertained in school or college.

Figure 2 shows the initial stages of students' transition from school or college to university and the potential of Type A podcasts to aid this process. As our data analysis showed, the Type B podcasts were useful for students' continued adaptation to the learning environment following early assessments and moving from first year to second year of their studies.

Discussion

The role of podcasts to support transition

From the analysis of our evidence outlined above, it is clear that our podcasts covered a range of issues with which the students interviewed had problems, both at the point of entering the university and during their first year of study. It is also clear that existing sources of information and guidance available to the students contained many limitations, leaving a gap that can be filled by different materials or programmes designed to aid students in their extended transition into higher education.

As shown above, the interviews demonstrated that students believe the 'warm' knowledge contained within the podcasts could serve a number of roles within their process of transition. 'Warm knowledge' is the kind of knowledge that is highly personal, but moderated through the selection of information and the editing process in order to ensure the accuracy and the balance of opinions expressed. 'Warm knowledge' in our podcasts included new information and perspectives; offering advice regarding positive behaviours; and the reinforcement of existing knowledge and behaviours; and the provision of emotional reassurance. In each case, the status of the podcasts as sources of 'warm knowledge' (captured and edited 'hot knowledge') and the fact that all the information in the podcasts was drawn from students' direct experience, meant that many students interviewed were more willing to integrate the information and advice into their process of transition.

Student-contributed podcasts can fulfil a useful role when cultural capital is inadequate to support transition to HE, especially at the final phase of the transition process

Overall, this suggests that student-contributed podcasts can fulfil a useful role when cultural capital (Bourdieu & Passeron, 1977) is inadequate to support transition to HE, especially at the final phase of the transition process (see Fig. 5). Our interviews showed that even when students had access to cultural capital to aid their transition to HE (most of which came from at least one family member with experience of studying at university), such cultural capital was not useful to prepare them for studying in the specific environment of courses (in our case the subject of biological sciences at a particular university). Students' interviews showed that podcasts provided useful information to prepare them for this stage of transition.

Our interviews with students also revealed that potential sources of information and advice were neither ubiquitously available to all students, nor properly used by every student. The interviews revealed that many students could not identify readily accessible, reliable sources of informal knowledge and advice (which many of them suggested that they would find useful). Podcasts, incorporating knowledge and experience of students who had already made successful transition into HE, have the potential to fill this gap.

In this sense, with reference to the core concern of our project, the podcasts, particularly as sources of captured informal knowledge and experience, did help the students in their process of transition. In fact, as was shown above, the students attributed particular legitimacy to the podcasts on the very grounds that they were a relevant source that provided informal knowledge and the opinions of their peers who had already experienced similar situations.

The legitimacy placed upon the availability of such knowledge, which we call 'warm knowledge' in the podcasts was not in any way dimmed by the fact that academic and technical staff members were involved in the production process. None of the students interviewed said anything negative regarding the fact that the students' voices had been selected and edited. In fact, the only comments made were that the multiplicity of voices provided made the podcasts more relevant.

Of course, there can be a risk that such 'warm knowledge', being unofficial and based on subjective experiences, may contain distortions, and that, consequently, there is a risk that the podcasts will do more harm than good. However, the students treated that information with some caution; they acknowledged that much of it may be subjective and rooted in individual opinions, and placed those opinions in the spectrum of information available to them. In many ways this behaviour is similar to the category of 'Doubt' (as opposed to the more negative 'Suspicion' and more positive 'Acceptance') described by Ball & Vincent (1998) in their analysis of the use of information from 'the grapevine' when parents choose schools for their children. The behaviour in that category entails some reliance upon the information obtained from the grapevine, but recognition of its fallibility and the need to use it as 'one factor amongst many' (Ball & Vincent, 1998, p. 385). This is not surprising, and to be expected of intelligent students who are educated to critique information. In fact, it can be argued that one of the most important aspects of transition to HE is to develop this ability to evaluate and use information.

Once the podcasts have been developed and made available to students, their content remains static unless they are updated, which can be resource intensive. 'Hot knowledge' captured from a group of students at a particular point in time may not be updatable either. Some of our students however indicated that they wished that certain points made in podcasts could be elaborated and/or to have tutors' views on these points alongside students' opinions. Indeed, one student suggested that all the podcasts should have some commentary from lecturers or module convenors on them to provide more official and more formal information.

These objectives could be achieved by incorporating Web 2.0 tools to add comments (such as though a blog or a wiki) for podcasts. With the growing numbers of students using social software and networking tools, we can envisage the potential of blogs (Stirling, 2016), or peer mentor systems (Edirisingha, 2009) to capture and present 'warm knowledge' about topics that are relevant for students' transition to higher education. A comments facility can make podcasts more lively (rather than their current static state as a sound file to be downloaded or to be opened from a web browser), with on-going commentary by tutors on important issues and by other students who might elaborate some of the points made in the podcasts, although this might require external moderation.

Conclusions and recommendations

We examined how student-created podcasts can support HE entrants' transition from schools and colleges to university, and for those already in their first year, to make a successful transition within their programme of study. In the interviews, the students identified that all the issues addressed in the podcasts were ones with which they experienced difficulties; these issues constituted a significant and challenging part of their process of transition. Coping with leaving home and close networks of friends, making new friends, adjusting to a new life in university accommodation, managing finances and adjusting to studying as an undergraduate were particularly significant issues for them. For students in their first year, the selection of modules, examinations, study practices and whether or not to undertake a year abroad or in industry were also of concern. Students described these as areas in which they needed to make difficult decisions (in some cases, causing significant anxiety), and they lacked necessary information and guidance. Our study found that students believe that podcasts provide them with some benefits in their process of transition into HE. Findings from studies such as ours can be useful in developing institutional strategies to support transition.

We recognise a number of limitations of our research. One is that it was carried out in just one academic department and only a small number of students took part in the interviews. It would be useful to conduct a larger study representing different academic disciplines, from a wider cross section of HE institutions, to examine the applicability of our findings to the wider HE sector. Our research design and interview questions were not adequate to collect data to examine the specific aspects or features of podcasts that students felt were particularly valuable for them: for example, whether it is the nature of the content in podcasts (semi-formality of messages from other students) or podcasts as a distribution mechanism. It would be useful to carry out a further study with an appropriate design can examine these aspects. Further research can also include investigations into combining podcasting with comments written by students using blogs or wikis (Cane & Cashmore, 2016) that may help us to identify the value of a range of web tools for supporting transition.

We see student-contributed podcasts as a beneficial resource to support student transitions, especially where other potential sources of informal knowledge are absent or underused. This small-scale study has demonstrated that university students have a wealth of knowledge of, and experience in, a range of issues related to successful transition into higher education. Freely available and easy to use web-based technologies can be used to tap into their knowledge that can be useful for in-coming students. A lot can be achieved by working with students and drawing from their knowledge and experience.

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Teaching Enhancement Project Fund Report

Exploring Complex Learning Spaces

Philip B. Wood[1] and Paul N. Warwick[2]

[1]pbw2@le.ac.uk, School of Education, University of Leicester, and Bishop Grosseteste University.
[2]pnw6@le.ac.uk, School of Education, University of Leicester, and Plymouth University.

Abstract

This paper reports on a project seeking to understand the complexity of learning spaces which are inhabited by students in higher education institutions. Developing work already carried out by the project leaders on experimental learning spaces within the university, this is a project which aims to gain a better understanding of the 'learning lives' of students beyond the formal learning spaces such as the lecture theatre, laboratory and seminar room. Using a mixed methods approach focusing on survey and photo-ethnographic methods data will be developed from the general to the particular to investigate the other spaces which students use to develop their learning. These spaces include both physical and virtual spaces, as well as on and off campus spaces, including cafes, libraries, study bedrooms as well as virtual learning environments and social networking/Web 2.0 technologies. This research intends to consider the complex interplay of these different spaces in the learning of students and also how they relate to the formal spaces of which we have a clearer understanding. This project will therefore aid academics in better understanding the dynamics of the learning ecologies which underpin the experiences of students within the university.

Keywords: Formal learning spaces, Informal learning spaces, complexity theory, Deleuzean Rhizomatics, Striated/smooth spaces

Introduction

Modern universities are increasingly complex places, which no longer rely on a simplistic process of lectures and tutorials as the only, or major, medium of learning and discourse. At the same time there is a growing interest in many countries concerning the design of formal learning spaces to ensure the development of places which are geared towards the diverse learning needs of students (JISC, 2006; Jamieson et al., 2000; Oblinger, 2006; Johnson & Lomas, 2005). It is within this context that the present researchers undertook some small-scale research into the utility of three experimental formal learning spaces based on the perceptions of various stakeholder groups (2010). Based on our results and analysis we proposed an initial framework or model for understanding and evaluating formal learning spaces which we named the DEEP model due to its main elements (Dynamic, Engaging, Ecological, Participatory). During the course of the research it became apparent that the formal learning spaces used by students was only one element of a much wider series of spaces which they made use of in their learning. These observations were further developed through an exercise which was undertaken with a group of students following an MA in International Education, focusing on their use of space for learning, and which formed the methodological basis for part of the present project. The informal insights which emerged from this exercise were strongly suggestive of an 'ecology' of spaces, interacting suites of spaces which together create the wider learning environment of students. The present paper summarises our initial attempts to capture and understand complex and emergent patterns of learning space use, and offers a theoretical framework as a basis for analysing and understanding the data which has been collected.

Complex spaces of learning in higher education – complexity thinking and smooth/striated spaces

Williams et al. (2011) highlight the impact that technology has had on the media through which students learn, and argue that this has led to more complex processes of learning at HE level. They suggest that these more complex processes are leading to blurred boundaries, increasingly resulting in 'emergent learning', which they define as,

> …learning which arises out of the interaction between a number of people and resources, in which the learners organise and determine both the process and to some extent the learning destinations, both of which are unpredictable. The interaction is in many senses self-organised, but it nevertheless requires some constraint and structure. It may include virtual or physical networks, or both. (p.41)

This definition emphasises the varied processes involved in learning in the modern HE sector, and as such can be seen as associated to complexity theory, a theoretical framework which Williams et al themselves identify as significant in their thinking. Complexity theory was initially developed within the physical sciences as a way of describing and explaining systems which are too complex to understand through linear modelling, and which cannot be accurately predicted into the future, but which nevertheless demonstrate underlying patterns. Many such systems exist in the natural world, such as ant hills (Johnson, 2001) and convection cells, and are characterised by activity where individual actions appear almost random, but which show coherent characteristics at the level of the whole population.

Having established a position within the physical sciences, complexity theory has also become increasingly used to describe and analyse social settings, which themselves can be seen as complex systems which demonstrate coherent patterns, but which are not linear. Early examples of work in the social sciences included research on cities (Johnson, 2001), and the processes and patterns of organisations (Stacey, 2001; Fonseca, 2002). The developing interest in complexity thinking at this time led to an emerging interest in educational research. Fullan (1999) was an early adopter of complexity thinking within education, basing his ideas on the work of Stacey (1996) in management and business studies. Fullan saw the importance of complexity thinking in its ability to explain the adaption of organisations to rapidly changing environments and also in its claim that cause, effect relationships are rarely linear with change emerging out of coherent, but diverse and complex processes. Morrison (2002) further developed the use of complexity theory as a lens for understanding school leadership, taking further the arguments of Fullan (1999) that schools are complex, non-linear systems which have a level of unpredictability.

Davis and Sumara (2006) offer a summary of the factors which together create complex systems within an educational context. Emergence is described as a central element of complexity thinking as it is the interaction of systems and sub-systems which leads to change and the development of new ideas and ways of working. It is the complex interaction of agents and systems at a number of scales which emerge in different ways, leading to unexpected and novel outcomes, and where change in one area or sub-system can have disproportionate impact elsewhere within the organisation, and vice-versa. For emergence to occur, there is the need for:

- internal diversity
- internal redundancy
- neighbour interactions
- distributed control
- randomness
- coherence

Diversity highlights the need for any complex system to have a natural variability so as to allow the opportunity for different actions or behaviours to occur and develop. This is allied to the concept of redundancy, as in any system which allows for diversity it has to be accepted that both duplications and excesses will occur, leading to what would traditionally be seen as superfluous resources, and inefficiency. However, it is by encouraging diversity and allowing a degree of redundancy that systems can evolve, change and emerge. In the case of learning spaces, this suggests that a wide variety of spaces (both physical and virtual) should be encouraged and trialled so that students have the opportunity to organise their spatial needs from the bottom up, and through organic experience or trial and error. This means that there may be some redundancy in the spaces provided, perceived ‘inefficient’ uses of space, but as students’ preferences and activities change over time, this redundancy effect may well shift from space to space and change in magnitude over time. Therefore, having a level of diversity and redundancy in the system may actually be a positive factor in increasing student satisfaction as well as facilitating varied ways of working.

Complex systems are trans-level phenomena. In the case of learning, Davis and Sumara (2006) argue that: "…for a social collective to expand its repertoire of possibilities, the individuals that comprise it must themselves learn and adapt" (p.142)

Individual and group interests need not compete for space, and in learning, creating spaces where neighbours are encouraged and enabled to interact, enrich the process of learning. Davis and Sumara (2006) emphasise that in talking about neighbours, it is ideas and other forms of representation which need to be given the opportunity to interact, moving beyond a mere consideration of people as physical organisms. Therefore, spaces that allow for both individual study, and collective sharing of ideas are important, as learning is not always an individual process; it occurs at a number of different levels depending on the focus, intentions and processes involved. In turn, this leads to the importance of distributed control. Distributed control includes the idea of sharing, and hence, a belief that control in learning becomes a matter for all rather than as an activity controlled by an 'authority' figure, leading to notions of consensual working. Nested levels of activity and distributed control have a ready overlap with the development of 'ecologies' of learning spaces as students need the opportunity to work both individually and interactively – again, in both physical and virtual space. This requires a spectrum of spaces and opportunities for learning to allow for the diverse and personal preferences students have for their learning environments.

Finally, complexity theory focuses on the need to have both coherence and randomness/freedom. For a system to operate successfully it cannot be chaotic, it needs a level of consistency or order. However, if the level of system coherence is too restrictive, it limits the possibilities and diversity in emergent activity. In the case of learning spaces, coherence can be argued to emerge from the formal, timetabled learning opportunities, and 'official' structured online materials which are central to learning within a university course. Learning as an activity becomes structured, and therefore to retain the diversity and distributed nature of an emergent complex system, it is important that other learning spaces and opportunities are less structured and allow freedom for students to find their own emergent behaviours and preferences in terms of media content and locations for learning.

As a complex system, learning and the spaces it takes place within are emergent and constantly changing, but at the level of the population of students may appear coherent and stable. The creation of a number of different spaces and associated learning opportunities are crucial for providing such healthy, emergent systems.

One way in which we can consider how architectural/learning space configurations can bring the coherent freedom suggestive of complexity theory, is to use the concept of 'Rhizomatics' developed by Deleuze and Guattari (1987). They describe a theory of relations which allows for connection and heterogeneity, with no hierarchical structure, as opposed to traditional hierarchical spatial frameworks. They associate these relational distinctions with two forms of cultural space, 'striated' and 'smooth'. Striated spaces are those which are stratified and managed cultural spaces, such as activities in formal learning spaces, which act to contain and direct. Smooth spaces are those which are rhizomatic in nature, which are spaces of possibility, fluid spaces of opportunity which allow for creative and original expression. Movements from striated, hierarchical spaces to smooth, rhizomatic spaces are described as lines of flight, allowing us to act and think differently (Avalos & Winslade, 2010). Allied to differentiated cultural space is the concept of territorialisation and

deterritorialisation. Territorialisation occurs where there is spatial and cultural stability, as in striated space, and is the process through which social and spatial boundaries and identities are created. Therefore, lecture theatres may be deemed as spaces of territorialisation as they have not only spatial boundaries, but encourage the creation of stable identities. The pursuit of a line of flight into smooth spaces beyond that of the formal learning space is described as a process of deterritorialisation as boundaries are broken down and fluid movement and cultural heterogeneity emerges. This can present issues, as Savin-Baden (2007) states:

> The contrast between smooth and striated learning spaces introduces questions about the role and identity of universities and academics in terms of what counts as a legitimate learning space and who makes such decisions of legitimacy (p.14).

However, if we see the interplay of striated and smooth spaces, territorialisation and deterritorialisation, as a positive process rather than inherently problematic, adding to diversity and opportunity for learning, territorialisation and deterritorialisation can be seen as creative juxtapositions. As Dovey (2010) states in using Deleuze and Guattari to understand issues of architecture, identity and power:

> The concept of territory here is broad enough to encompass everything from the rhythms of the urinating dog to nationalism; yet for Deleuze and Guattari (1987: chapter 11) territoriality is creative rather than defensive, a form of becoming at home in the world (p.17).

So what does the introduction of the theoretical work of Deleuze and Guattari add to a complexity view of learning spaces? We argue that the emphasis on striated and smooth spaces gives a context for understanding the emergence of complex systems through diversity, redundancy, freedom and coherence. The utility offered through lines of flight and the exploration of smooth spaces and deterritorialisation, ensures that learning spaces, both cultural and physical, are diverse in nature and offer distributed control, thus allowing the emergence of both individual and group interactions with(in) space. It is in the creation and enactment of discourses both within and between striated and smooth space which provide the contexts in which emergence can occur.

In conclusion, complexity theory and Deleuzean discourses of spatial interaction and power can be brought together to demonstrate that to be generative, learning spaces need to be diverse in both physical and cultural terms, allowing students to negotiate their learning in the most positive way possible, as they move between and negotiate their use of spaces as the context for their learning.

Methodology

To capture perceptions and experiences of students concerning their preferences and use of learning spaces, we used two methods. An online survey was used to gain an overview of a series of spaces related issues. The main categories of questions were based around:

- Learning approaches preferences
- Views on formal learning spaces such as lecture theatres and laboratories
- Views on informal learning spaces such as cafes and the library

- Students' use of technology
- Student views on the need for green spaces
- Student views regarding their vision of the 'perfect' university of the future

In each section there was a mixture of Likert Scale questions based on a 5 level categorisation, and open questions which allowed students to give short explanations of their views.

A link to the online survey was sent to the Students' Union organisation at the university, as well as the environment team for distribution to university students, and was also posted to the university's e-newsletter. This would have given a widespread exposure for the survey. The results were then collated and used to gain simple descriptive patterns from the data.

To support the results from the survey, a photo-ethnographic method was used which had been developed a year earlier in a small pilot study. The method focuses on capturing the spaces students use for learning over the course of a week by asking them to take a photograph of each space. At the end of the week, students are asked to bring thumb-nail copies of their photos to a workshop. At the workshop, they are asked to place the photos on an A3 piece of paper (example given in Figure 1), and next to each write some short notes about their emotions whilst using the spaces, who, if anyone, they use the space with, and the types of technology they use there, if any. They are also invited to link the photos if they feel that the spaces relate to each other.

This exercise was intended to be used across six academic departments, one from each of the six colleges at the University of Leicester. Unfortunately, the contact at the Students' Union who was to broker the workshops left his post before they were organised. As a result, we collected data from teacher trainees and international Masters students in the School of Education. In total, the technique was used with 35 students which was the same as the intended sample, but from a more restricted spectrum of students. This restricts the breadth of the study compared to its original design, but still offers some interesting insights.

The photo summaries were analysed by considering the types of space present, the extent to which students saw links between spaces, the patterns of use made of technologies, and their emotions concerning the spaces.

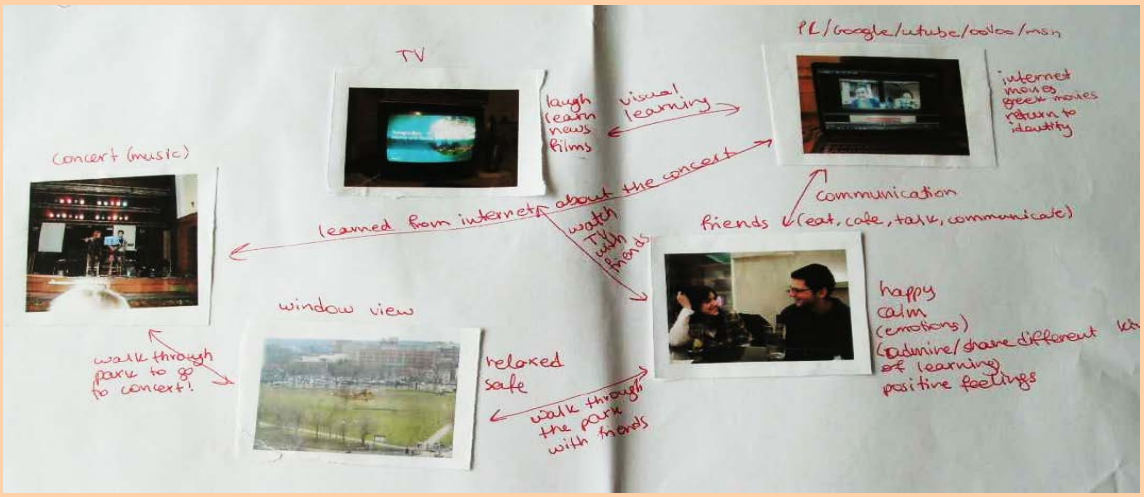

Figure 1: Example of a photo summary of spaces used during the course of a week

Results

The survey only returned a total of 97 responses, which is relatively small, but none the less gives an impression of a variety of views from a wide spectrum of students. Of those responding, 77% were female and 23% male, with 78% in the 18-25 age range, with roughly equal percentages in increasing ages, with the oldest respondents being in the 45+ category (7%).

Table 1: Breakdown by percentage of the five largest respondent courses.

Course	Percentage of Respondents
Biological Sciences	20
Education	14
Geography	10
Maths	6
Geology	3

Thirty nine courses were represented (Table 1), showing that there was a spread of views, although not statistically representative of the university.

There was also a broad spectrum of course types amongst the respondents, shown in Table 2, with the greatest group studying for BSc, followed by BA, PGCE and PhD.

Table 2: Breakdown by percentage of the five largest respondent degree levels.

Course	Percentage of Respondents
Bachelor of Sciences	20
Bachelor of Arts	14
Post Graduate Certificate in Education	10
PhD	6
Master of Sciences	3

Whilst the survey return was small, there was a wide spectrum of respondents, with a number of different experiences. The results are small-scale and therefore in a sense impressionistic, but give some interesting insights into patterns of learning and the use of learning spaces.

Learning preferences (Table 3) show that there are a wide number of learning activities which students enjoy. Preferred learning activities include finding information through using the internet (84% agree), and informal discussion with friends (83%). Other activities are less well received, including lectures and note taking (51% agree) and the use of simulations and roleplay (29%). Reading for understanding (60%) and small group discussion through the use of tutorials (64%) falls somewhere in between. The

results suggest that students find a spectrum of different learning opportunities useful, but seem to value more informal learning activities more than formal.

Formal Learning Spaces

Table 3: Percentage responses to questions relating to learning preferences.

	Strongly agree	Agree	Sometimes agree, sometimes disagree	Disagree	Strongly disagree
I like teaching approaches which focus on facts and content	24	54	21	1	0
I like teaching approaches which focus on discussion	19	41	34	6	0
I like teaching approaches which focus on lectures and notetaking	9	42	36	12	1
I like teaching approaches which focus on problem-solving and decision-making	24	42	28	6	0
I like teaching approaches which focus on simulations and/or role-play	6	23	39	22	0
I like to learn by myself	15	34	41	9	1
I like to learn with others	13	33	47	5	2
I like to read books and journal articles to develop my understanding	27	33	25	14	1
I like to use the internet to find information sources	36	48	12	3	1
I like to discuss ideas informally with friends to help me learn	39	44	14	2	1
I like tutorials	23	41	26	7	3

Views about the 'formal' learning spaces within the university are generally positive (Table 4). 58% agree that they like these learning spaces, although the results for specific spaces are lower, with the lecture theatres (40%), seminar rooms (42%) and laboratories (41%) all scoring below 50%.

Table 4: Percentage responses of views concerning formal learning spaces within the university.

	Strongly agree	Agree	Sometimes agree, sometimes disagree	Disagree	Strongly disagree	Not applicable
I like formal learning settings (such as lecture theatres and seminar rooms)	16	42	29	13	0	0
I like the lecture theatres in our university	7	33	42	7	0	11
I like the seminar rooms in our university	5	37	34	7	1	15
I like the laboratories in our university	15	26	5	1	0	53

Some formal spaces are not always perceived as appropriate for the task, or are seen as needing refurbishment. For example two typical responses were:

> Some of them are outdated and old, some of them lack in space and facilities but others are more appropriate in terms of facilities and modernity.

> The Fraser Noble Hall is often cold, badly lit and has poor acoustics.

However, the more modern stock of lecture theatres is more positively received, for example:

> They are modern so are comfortable and you can easily see the board/overhead projector from all areas in the room. The advanced computer systems also mean the sound system is good-quality so we can watch videos etc. easily.

These responses suggest the importance of retaining a high quality of maintenance in formal spaces so that the learning environment remains conducive for learning.

A number of other formal spaces are identified by students, most of which are specific spaces within departments, and in all cases, even though the numbers of students identifying the spaces are small, they are very positive about them. This might be due to the specialist design of these rooms which fits with the needs of specific courses, for example, a comment on a computer room by a computer sciences student:

> plenty of computers well spaced out and with excellent seating. raised platform at the front makes lecturers easy to see.

The students spend a varied amount of time in formal learning spaces, which will reflect the type of degree being followed. The overall breakdown across respondents is shown in Figure 2. 54% of respondents spend 10 hours or less a week in formal spaces with only 15% spending more than 20 hours. Therefore, formal learning spaces are not used for long periods of time by most individuals in any typical week, suggesting that more time is spent in informal spaces.

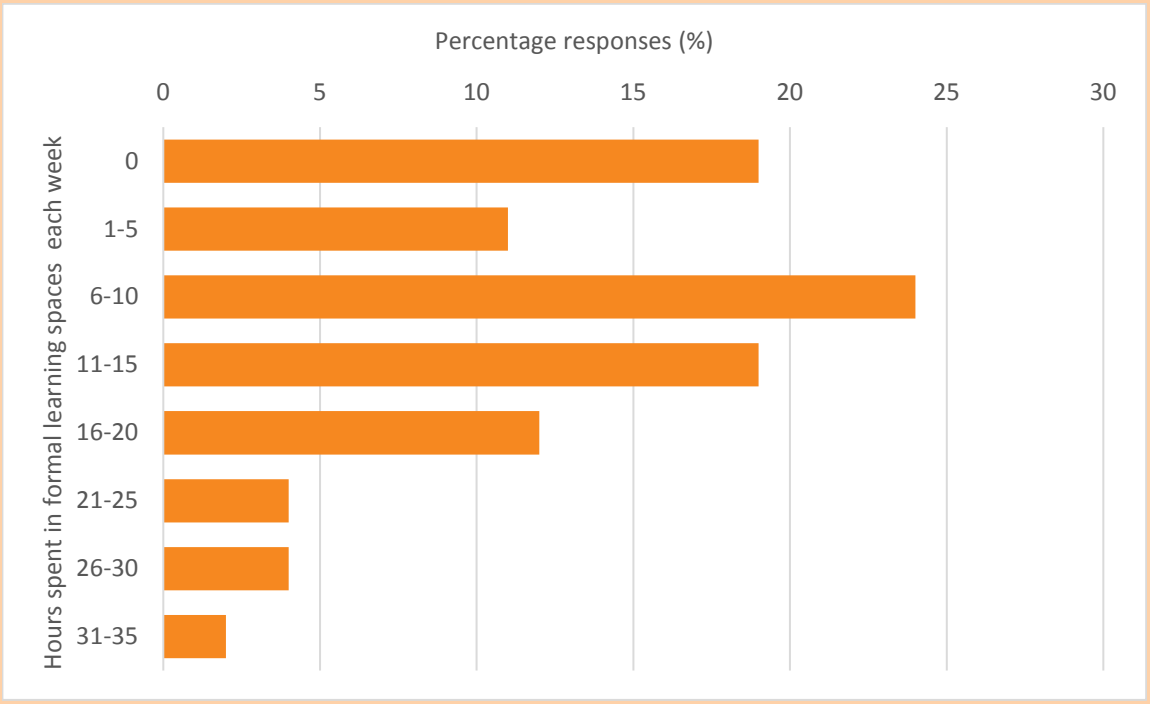

Figure 2: Percentage responses to the number of hours spent in formal learning spaces each week

Informal Learning Spaces

Four main informal spaces were identified within the survey, domestic spaces such as home and study bedrooms in university accommodation (77 respondents), university libraries (67), cafes (22), and public spaces (17) such as parks and public transport. The amount of time spent in these spaces varies (Figure 3), with more shared spaces such as cafes and public spaces being used for small numbers of hours each week. However, they are clearly useful collaborative spaces for learning, for example:

> This is a good space [café] for discussion with other students and provides a more relaxed atmosphere which makes people feel able to chat and contribute ideas which can sometimes be difficult in other spaces.

> Cafés on the main campus. These are accessed before or after library visits. Sometimes there are on an individual basis but are often a group space where i meet other students and discuss progress and problem areas of work. I like this area as it is a social event as well as a learning space. Informal and relaxed but with stimulating conversation and a meeting point when on the main campus.

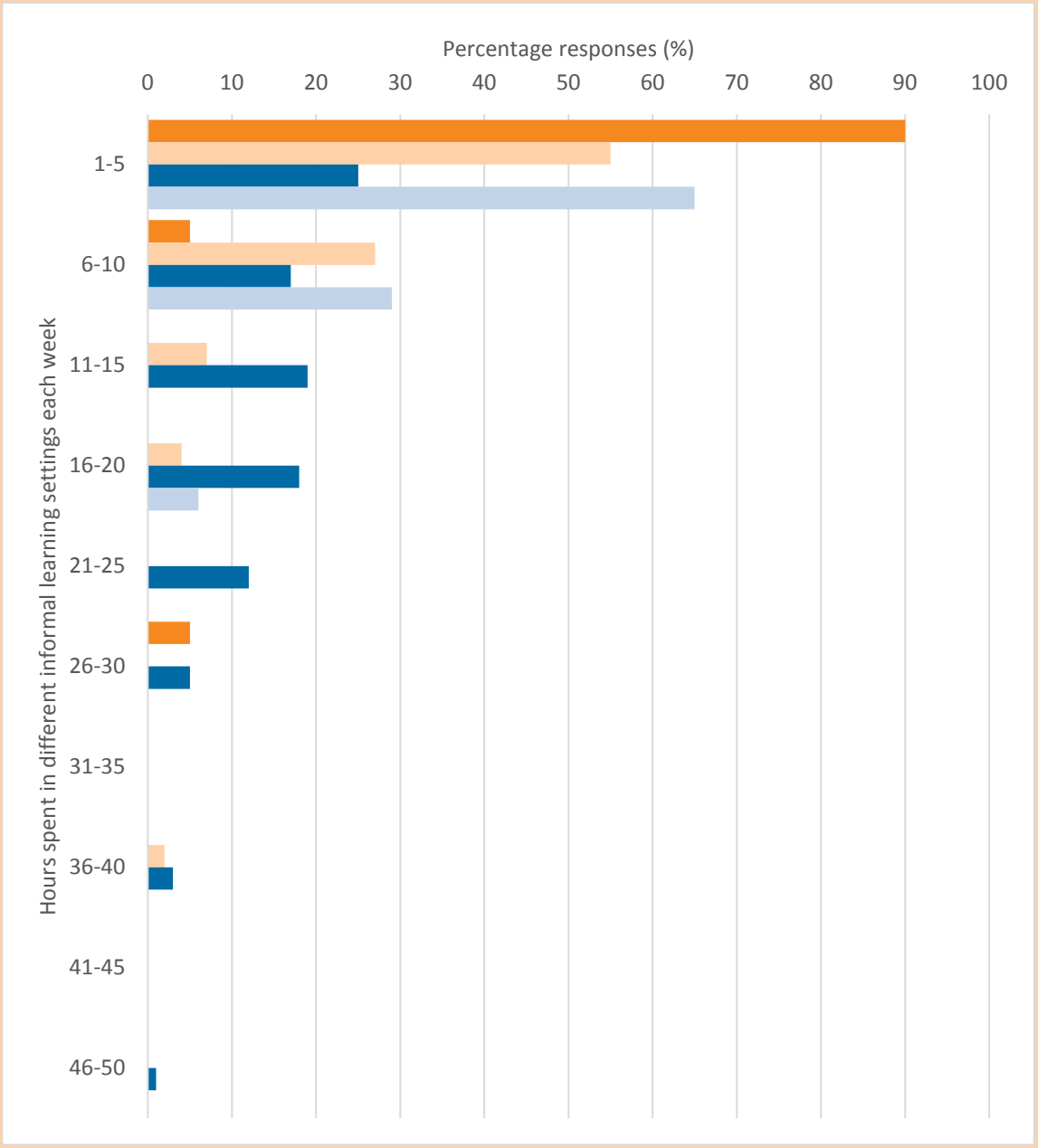

Figure 3: Distribution of time spent in different informal learning settings by percentage.
Key: dark orange – café; light orange – libraries; dark blue – domestic spaces; light blue – public spaces

Fourteen (from twenty-two) of those saying they use the cafés, do so most often as part of a group. This suggest that the cafés are sometimes used as individual spaces, but more often as social learning spaces. Domestic spaces are used for longer hours on average with more than half of respondents using these spaces for 11 hours or more each week. Domestic spaces are predominantly used as individual, reflective spaces where quiet and freedom are highlighted as positive factors. 86% of respondents who listed these spaces use them for individual study only. Typical views expressed are exemplified below:

> It is quiet and I have all my notes and books at hand. I can control the temperature and light in the room. If I need to take a break I don't have to worry about my belongings from being stolen. I can bring my food to my desk and keep working. I can adjust how I am seated and change my workspace every so often to keep comfortable.
>
> Has all of the resources and equipment I need in it. More relaxed atmosphere than the library or seminar rooms. Easy to switch between work and leisure activities.

The library is also seen as a very positive space for learning, and due to a recent refurbishment and extension, is a modern and well-designed learning space. The majority of respondents only use the library for 5 hours or less per week, and whilst 64% state that they use it for individual study, 36% state that they like to use it for group work, including the use of the group work rooms designed for informal group work beyond lecturer led learning. Examples of comments made by respondents which reflect their opinions of the library are:

> The library is fantastic for studying because of the group-study, quiet and silent areas. Although it can be difficult to access a computer, but working in the silent zone is a great way to improve work efficiency.
>
> quiet studious atmosphere, comfy chair, internet access, large amount of reading material close by, away from distractions (limited mobile signal), sofas for reading and lovely toilet facilities.

Students were also asked about their use of web based applications to gauge the degree to which technology is an important element of their learning space (Table 5). The use of both email and the internet are almost ubiquitous, with 94% and 97% of respondents respectively making daily use of these applications. This links to the strong preference in using the internet for learning through searches for useful information. Facebook is also popular, although 13% of respondents do not make use of it. Blackboard is used regularly, with 60% of respondents using it daily.

Table 5: Percentage response to use of web-based technology.

	Not at all	Daily	Two or three times a week	Once a week	Once every two weeks	Once a month
Blogs	74	11	2	2	4	7
Wikis	44	14	12	15	4	11
e-mail	0	94	4	0	1	1
Facebook	13	76	3	3	0	5
Internet	0	97	2	1	0	0
Blackboard or other	1	60	19	10	5	5

However, both blogs and wikis are used much less, and suggests that many of the respondents are consumers of information from the internet, but are not producers, but make daily use of technology in their learning.

Students were also asked to give their views on the importance of ecological and sustainability issues in relation to the learning spaces they use (Table 6).

Table 6: Percentage of responses to questions concerning the environmental sustainability of learning spaces.

	Strongly agree	Agree	Sometimes agree, sometimes disagree	Disagree	Strongly disagree
It is important to me that my learning spaces include natural elements such as plants and natural light	42	40	15	3	0
It is important to me that my learning spaces are sustainable giving attention to fair procurement and careful resource use	21	44	26	9	0
It is important to me that my learning spaces are sustainable giving attention to the opportunity to recycle	28	49	16	7	0

Students agree (82%) that learning spaces which include elements such as natural light and plants are important in creating a positive and conducive environment. They also believe the opportunity to recycle is important (77%), whilst a majority also think fair procurement and careful resource use are important (65%). In general this strongly indicates that environmental consideration is important in the design and upkeep of learning spaces.

Thoughts for an ideal future

Finally, students were asked to think into the future, and consider what their 'perfect' university would be like. To begin with, they were asked to list five words which would best describe their perfect university (Figure 4). The results are shown as a word cloud, with the most often mentioned words being the largest in the diagram. The most often used words are linked to the environmental qualities of the university, such as comfort, light, access, quiet, relaxed and spacious.

Figure 4: Summary word cloud of the words used by respondents to describe their 'perfect' university

In addition to a list of words, students were also invited to write a short description, of up to 100 words which would describe their university. Of the 97 respondents, 15 took this opportunity. Responses stress the need for space, natural environments, flexible learning and working approaches, and extended use of technology. Two examples which exemplify the predominant views are given in full below:

> My ideal university would have spaces which are accessible for all and interact with each other. Faculties would not work in isolation. Spaces would be interchangeable and adapt to current needs. Moving walls/screens would enable rooms to be changed. Spaces would be layered and visible by others with transition spaces interesting and useful. Sustainability would be paramount. Latest technology would be available with opportunities for sharing facilities and resources, linking to other universities worldwide (joint sessions). Innovative design of furniture and environments.

> My ideal university would have a wide range of different types of learning rooms because people learn differently and some people might want individual spaces whereas others might need group learning spaces. Ideally these should all be; well lit, clean, accessible from accommodation / near lecture halls and have a computer station.

Photo-ethnographic outputs

Having gained a general picture of the uses of extended learning space across and beyond the university, we then carried out the photo-ethnographic workshop to sample in greater depth the use made of learning spaces by students. The variability in the 'spaces-boards' which resulted was surprisingly large, as was the variety in the ways students decided to categorise and locate the spaces they use.

Figure 5 shows a response from a student on the MA in International Education, School of Education. This student identifies six different learning spaces. On the formal side of the board, two classrooms are identified where the level of interaction with others depends on the activities which are completed, and emotions vary from keen interest to boredom depending on the topic being covered. Laptops are used in these sessions. The spaces are seen as interrelated as the learning which goes on in them support each other. The domestic informal spaces identified (bed and bath) are both more reflective and individual in nature and technology plays no part, but the process of learning is more informal, for example, the student's children do come into the bathroom to discuss their learning. These spaces are also identified with happiness and contentment. The last two spaces are a cafe in the School of Education and the student's car. The café is a place to discuss and debate issues covered in formal learning sessions with other students. Technology is only occasionally used here, and again, the debate and informality of the space make it positive emotionally. The student links this space with the classrooms in that the café is used within and after formal learning sessions and therefore acts as an opportunity to fix and deepen understanding covered in the formal sessions. Finally, the student's car is identified. The use of this space for learning depends on whether the student is giving a lift to other students or not. When other students are in the car, it is another space for debate and discussion, similar to the café. However, when alone, the student uses the time to 'unpack sessions/workshops', developing thinking processes, and again this is a positive space for the student emotionally.

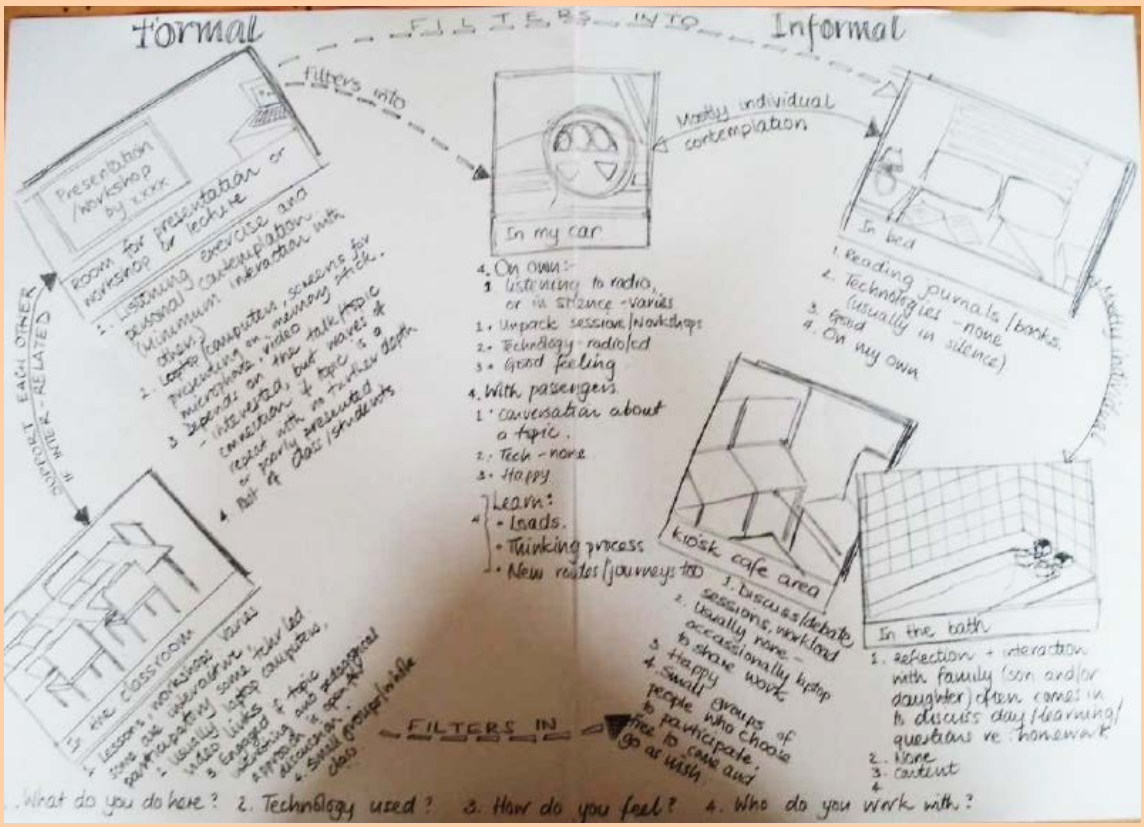

Figure 5: 'Spaces-board' for student on MA International Education course, School of Education

Figure 6 shows the summary for a student from the Postgraduate Certificate in Education course. This student decided not to include photographs, but again, links suites of spaces into wider networks of

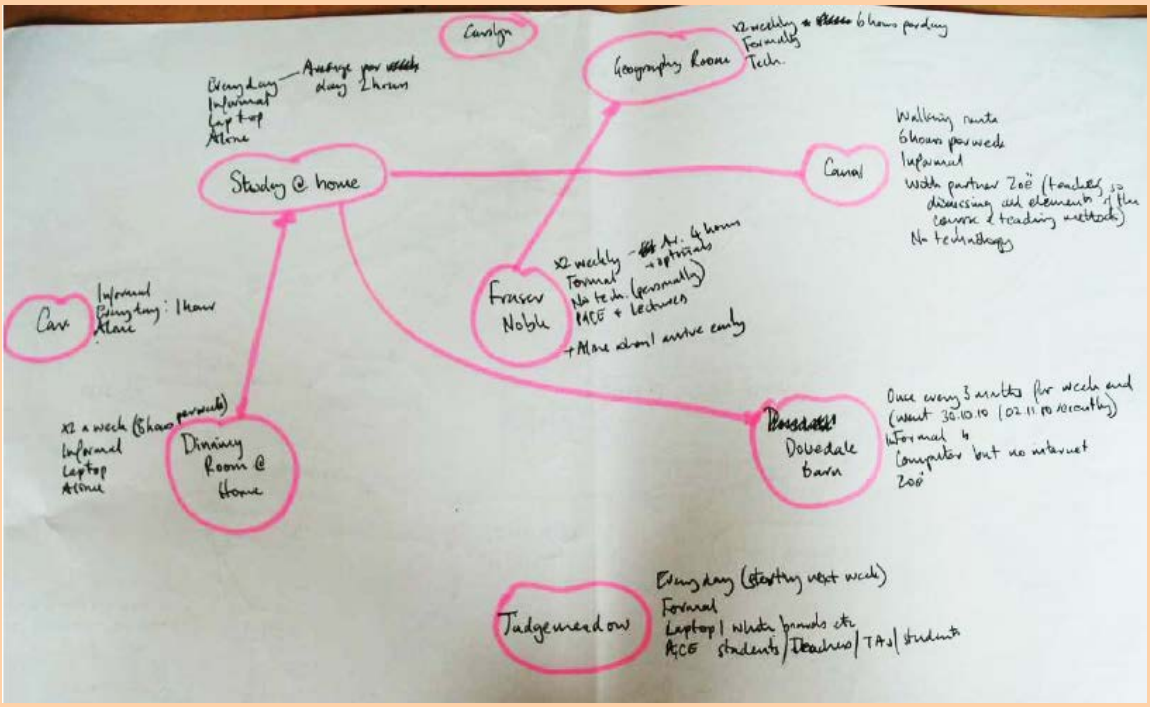

Figure 6: 'Spaces-board' for student on Postgraduate Certificate in Education course, School of Education

space for learning. Domestic spaces are again important, but here, a study and dining room are highlighted. In both cases, learning is individual and use is made of a laptop. However, linked to this is a space identified as 'canal' and is a route regularly walked by the student with her partner. Her partner is already a teacher, and they discuss issues arising from the course, and methods for classroom teaching. Two rooms at the School of Education are also identified, a lecture theatre (Fraser Noble Hall), and a small seminar room used for specialist subject sessions. These are linked in the mind of the student, and are more group orientated with use again of technology. As with the first student, a car is used by this student and is again highlighted as a space for learning and reflection.

The student spaces-board in **Figure 7** is one created by another PGCE student. Again, a number of spaces are represented. In this case, domestic spaces are important, and are positioned centrally in the 'spaces-board'. Some of these spaces are encountered in relation to others, such as the dining room and living room, both of which are seen as resulting in 'communal learning' through discussion with family members, in some cases in reaction to the television. Learning space extends out to a local reservoir where the student jogs by themselves resulting in a lot of reflective thinking, but at other times, with parents, again leading to discussion.

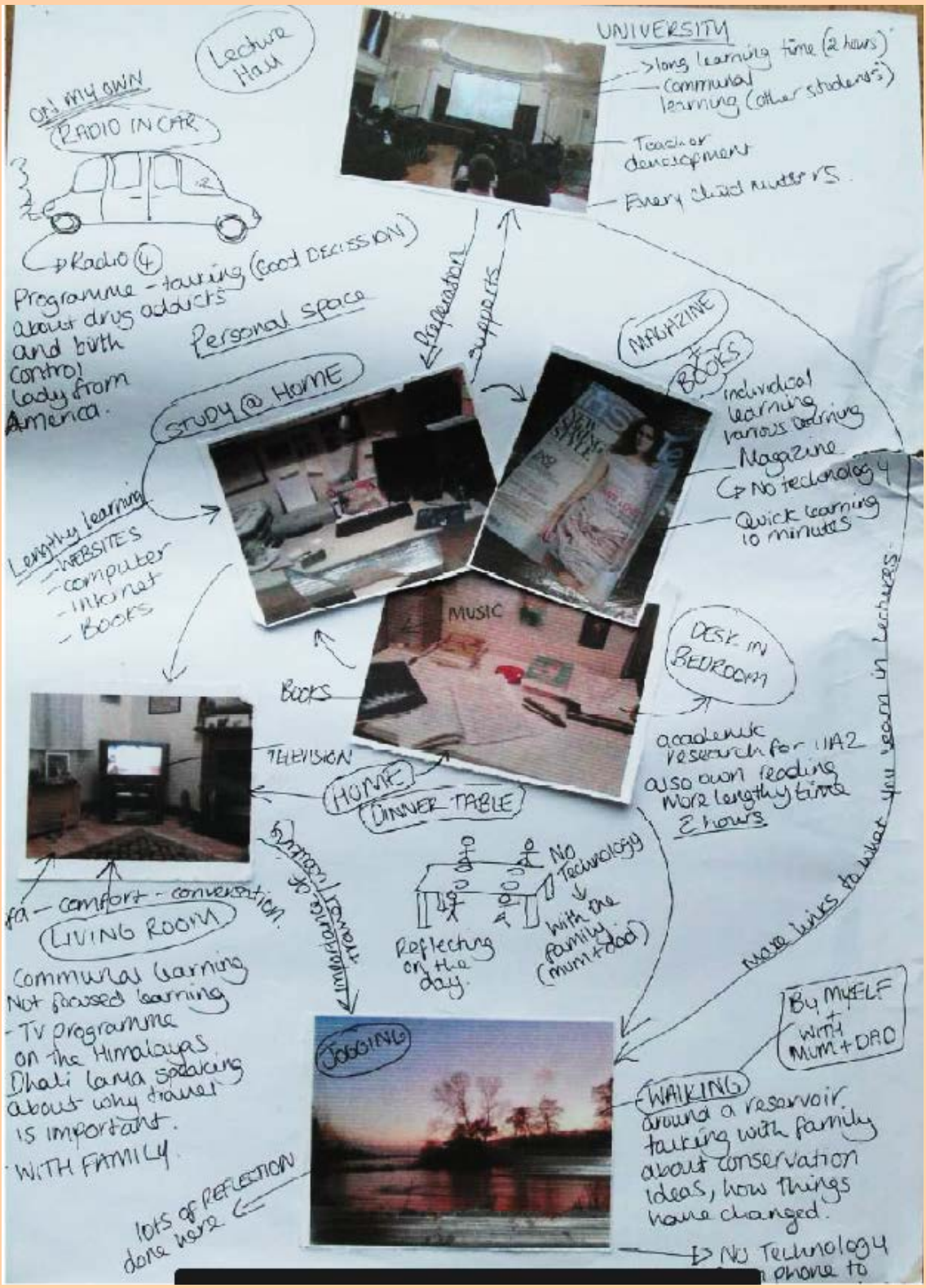

Figure 7: 'Spaces-board' for student on Postgraduate Certificate in Education course, School of Education

Further spaces within the home are solitary spaces, and may include a greater use of technology, including a study which is identified as the location for 'lengthy learning' as well as a desk in a bedroom. University spaces are actually only represented in one element of the 'spaces-board' and highlights a lecture hall which again is identified as communal learning with other students. Finally, one again, a car is included and listening to a radio is highlighted as the main media for learning. This particular student foregrounds personal and family spaces in domestic settings far more than the other two students, but also demonstrates a wide range of learning activities within these spaces.

These examples are illustrative of the wide spectrum of spaces used by the students who completed 'spaces-boards'. As such, whilst the spaces students use can be classified into a small number of 'categories' the lived experience, and links between spaces and learning are highly complex and particular to each individual, depending on location of home, social habits, such as smoking, and preferences in terms of uses of technology and emotional responses to particular learning spaces.

The results from the study show a number of patterns in relation to preferences in the wider spaces used for learning. The survey, whilst relatively small in terms of responses, does capture a number of views from across the university, and give a clear view of the trends of use and opinion at the level of the 'population'. However, when we begin to look at individuals, there is a wide range of experiences, demonstrating that learning space use and dynamics are very complex at the individual level.

Discussion

The results from this study demonstrate that students' learning and the locations in which it occurs are extremely varied. In terms of learning preferences, students appear to prefer more informal approaches, all be it building on the foundations of formal learning opportunities. They make use of a wide range of spaces, but again prefer informal settings such as the cafes, library and domestic spaces whilst appreciating and understanding the importance of formal learning spaces and activities. Given this pattern of results, the learning space s which exist within the University of Leicester have many of the features of a complex emergent system. There is a great deal of diversity in the available spaces, and the spaces that students choose to utilise. The three students' 'spaces-boards' described in the last section show that they use different spaces within and beyond the university, whilst none of them use the library on a consistent basis, many others who took part in the workshops do; this is an example of the complex factors which are present in personal choices of spaces use. It is possible in this case that there is a distance-decay effect as all three live some distance from the university and travel by car. Others who are based in locations close to the campus more regularly talk of their use of the library and overwhelmingly do so in positive terms.

Given the diversity of spaces, individuals will preferentially use some but not others finding them redundant for their use. However, overall the spaces throughout the university seem well used and whilst any redundancy might be taken as a mark of inefficiency, the related diversity means that students have the opportunity to experiment with and find spaces which suit them as individuals when undertaking various learning activities. There is evidence that the mixed formats of space, such as a café and library being located together, allow for a range of interactions where individuals and groups need not compete for space, but where spaces allow for generative associations of group and

individual learning to occur. Many students talk about cafés as places to discuss and debate ideas, sometimes as a 'break' from individual study in the adjacent library space.

Taking learning dynamics together with domestic spaces, for many students there appears to be a high level of distributed control in their learning activities, with lectures and seminars setting the context and conveying core understanding before allowing students to develop their work in whatever way they see fit. For many students this includes a lot of time in domestic spaces such as study bedrooms in halls of residence, or in dining rooms, studies, kitchens and bedrooms at home. These spaces are central to personal, reflective processes and hence for consolidation and extension of learning.

Finally, the learning spaces and the activities which fill them have a clear level of coherence, through 'structured' coherence, i.e. course frameworks, suggested reading, and timetabled periods of learning which are determined by academic departments and central room booking services, and through 'emergent' coherence. This is the developing coherence of study and the spaces in which it occurs, determined by the individual student's spatial and learning preferences. Beyond 'structured' coherence there is an inherent level of freedom/randomness when and where students are able to create their own identities and approaches as 'emergent' learners.

The results of the study are therefore in keeping with the features of a complex system, with variety, interaction, distributed control and elements of coherence and freedom all giving rise to self-organisation by students which in turn leads to emergent, complex systems of learning and utilisation of space.

The striated spaces of lectures and seminars give the students the coherent basis for their learning, and are therefore of paramount importance. As Dovey (2010) highlights, the territorialised spaces of the lecture theatre are creative and positive in that they are a form of becoming and identity. The lines of flight which students then follow in inhabiting smoother, informal spaces form a positive juxtaposition where they can personalise their learning, and find generative and creative approaches which suit them in taking their learning further. The 'spaces-boards' of the three students shown in the results section demonstrate that such lights of flight are different for each individual, as they follow their own journeys of becoming. This critique offers a more positive reading of the roles of striated and smooth spaces than that offered by Savin-Baden (2008), as it is founded in a belief that emergence is only possible through a generative relationship between the two types of space.

In our initial research on innovative formal spaces (Wood et al., 2010), we developed the DEEP model of learning spaces **(Figure 8)** based on designing and evaluating formal spaces. We argued that learning spaces should be considered as dynamic and changing in space and time.

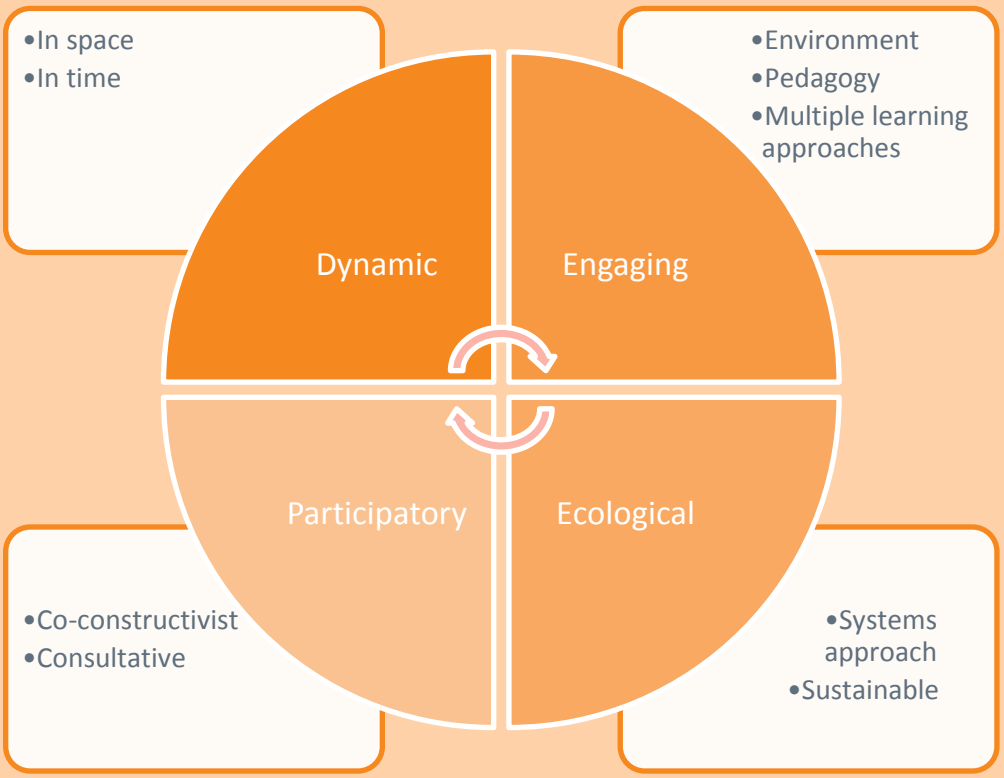

Figure 8: Original DEEP model (Wood *et al.* 2010)

In addition we argued that learning spaces should be engaging in terms of their physical appearance (environment), and pedagogies, that they should be ecological in that they should be sustainable, but also be seen as a wider ecology of learning (systems approach), and that they should be participatory, actively involving all participants.

In light of the research we have reported in the present research project, we believe that the original DEEP model needs to be extended **(Figure 9)**. The dynamic element of the model now needs to take account of the activities and processes beyond formal settings, and must allow for the fluid and emergent nature of the learning of students, over both space and time. The 'Engaging' element of the model must also take account of the results presented here, as it is not only a case of making a formal space pedagogically and engaging. Extending these characteristics across and beyond the university campus account of the multiple learning spaces students utilise. In the ecological aspect of the model, we now make the process of emergent complexity explicit, relating to the dynamic and extended nature of the system. Finally the participatory element of the model still stresses the co-constructivist nature of formal learning spaces, but extends this to other spaces as an element of distributed control, leading to a more holistic notion of participation across a spectrum of spaces and activities, both formal and informal.

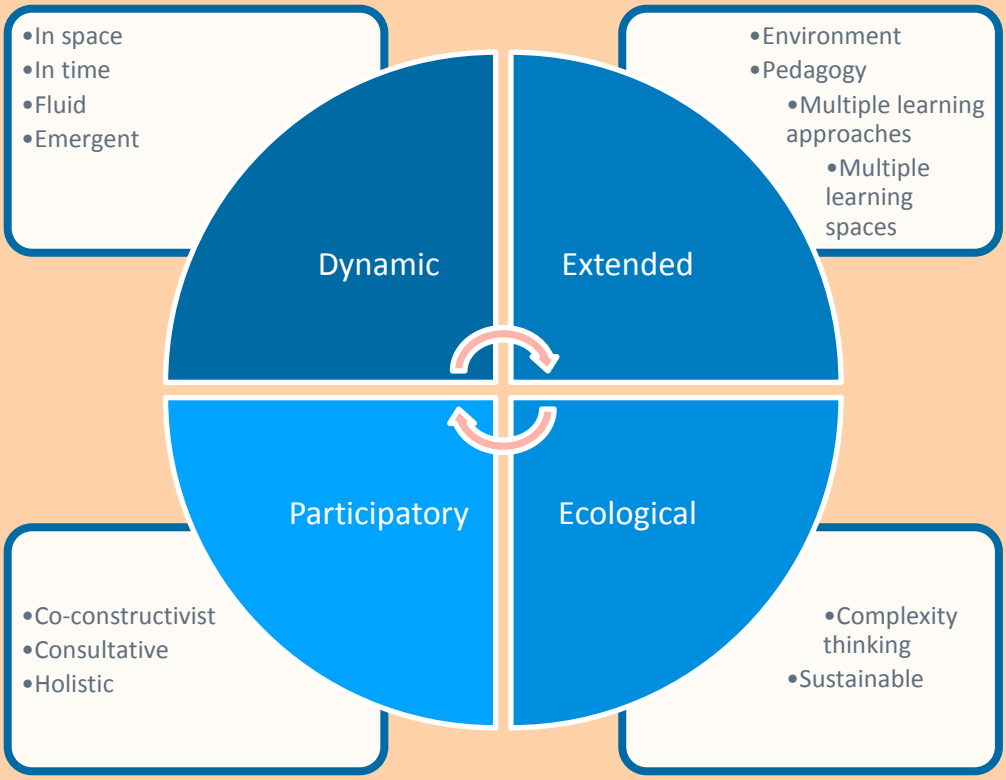

Figure 9: Updated DEEP model

Conclusions

The results of this study, whilst based on a relatively small sample, give us the confidence to develop the DEEP model of learning spaces to reflect the evidence of the emergent, complex nature of both learning spaces and the learning activities and processes which occur within them. Based on this, the use of complexity theory and Deleuzean rhizomatics appears to help us to gain a critical understanding of space and its relationship with learning. A level of coherence and stability at the level of the population is underlain by diversity, difference and self-organisation at the level of the individual. As universities move towards the future, we suggest that several points need to be considered and developed if the diversity of student needs is to be successfully met:

- Planners and users need to consider the juxtaposition of striated and smooth spaces and the lines of flight which link them. How spaces are to be designed which allow for coherence and at the same time allow for diversity and generative lines of flight?

- In a similar way, there needs to be the facilitation of emergence and change in design. This again relies on diversity in the design and nature of physical spaces, but also requires careful consideration of virtual spaces, resources, and the forms of pedagogy proposed for courses.

- Continued integration of technology to add to diversity and self-organisation as well as creating virtual smooth spaces.

- A consideration of how to encourage and understand personal lines of flight in relation to learning, especially given the diverse background and personal circumstances and preferences of individuals.

- A research interest in characterising and understanding the rich spectrum of learning spaces which students utilise beyond the university, especially those in domestic settings. For many of the students in this study, a greater amount of time is spent learning away from the university campus than within it. We still know precious little about the activities and affordances such spaces may afford.

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Project report

Games as Education in the United Kingdom

Alison Harvey[1]

[1] ah463@le.ac.uk, School of Media, Communication, and Sociology, University of Leicester

Abstract

Digital game studies and design have rapidly become popular teaching areas in the United Kingdom. They also have a long history as tools for education in a range of disciplines through game-based learning. This project sought to inform teaching and learning within the College of Social Sciences, Arts, and Humanities, the College of Science and Engineering, and the College of Life Sciences through an exploration of the challenges, practices, and feedback of instructors and instructional designers on teaching with, through and on digital games. A workshop was held in the School of Media, Communication, and Sociology in May 2016 to understand emerging challenges and opportunities related to games-based teaching practice, innovations in assessment, available and needed resources for teaching, and game-based curricula. Participants included staff across the University of Leicester using digital games for learning and assessment as well as digital game studies and design instructors across the United Kingdom. Through collaborative discussion and workshopping of best practices related to teaching with games, this workshop generated a sharable portfolio of materials. It also provided insight into several possibilities for integrating this media form into higher education as well as significant challenges to consider moving forward, which are reported on here.

Keywords: Games-based learning, educational games, digital games design, games in teaching and learning, games and assessment

Background

The precursors for the Leicester workshop were workshops related to the teaching of game studies at international conferences in the field in recent years (at the Digital Games Research Association Annual Conference in Germany in 2015 and the United States in 2014, and the Foundations of Digital Games Annual Conference in 2014). These sessions with international scholars highlighted the value of sharing the challenges and best practices for teaching digital game studies across diverse faculties, ranging from Engineering to Art and Design to Communications and Culture.

The workshop held at Leicester sought to complement these meetings and the documentation they produced in two ways:

1) To draw together UK-based instructors in order to provide a sense of the nuance and special considerations of this national context for teaching with games and
2) To bring together both game studies instructors and those seeking to integrate game-based learning within a range of disciplines to share broader best practices related to teaching, learning, and assessment with digital games.

The power of game studies lies in a long tradition within educational technology circles considering the potential role of games in learning (Gros, 2014; Kiili, 2005; Prensky, 2007; Van Eck, 2006), including instructors at the University of Leicester (see for example Whitton & Moseley, 2012). Indeed games-based learning is practised in varying ways in History, Genetics, and Archaeology, and among other subject areas, leading to the formation of an Educational Games group at the University of Leicester, which includes participants from Mathematics, Physics and Astronomy, Computer Science, and Genetics.

Digital games are often grouped with other forms of digital media as providing new ways for delivering course content in the contemporary classroom (Race, 2014), and for better engaging with students immersed in new technologies (Pearce, Weller, Scanlon & Kinsley, 2010). What game studies indicates however is the central role of the social practice of teaching games (Squire, 2002) - how games are situated in the pedagogy and how they are scaffolded in learning environments to account for enduring inequalities in access, competence, and expertise in digital media use (Taylor, Jenson, & de Castell, 2007) in a range of formal and informal educational contexts (Fisher & Harvey, 2013).

This project contributes to this conversation by highlighting the actual practices of teaching digital game studies and design and in assessing learning in this context, as well as how student learning is enhanced through games. Derived from grounded insights and concrete discussion of how games are used for education, this project compiles best practices and relevant documents from the teacher perspective, which in turn informs the development of empirically-informed recommendations for innovating on teaching and assessment practice in emerging fields across the Colleges at the University of Leicester.

Project Aims and Objectives

The objective of the project was to develop, plan, and execute a workshop hosted in the School of Media, Communication, and Sociology with game instructors from across the UK and instructors using games for education at the University of Leicester to provide the grounds for dialogue and collaboration as well as the development of a sharable repository of teaching resources. Participants in the workshop came from the School and the College as well as instructors from across the United Kingdom teaching in digital game studies and design. The aim of the

workshop was to form the basis for a network of collaborators interested in larger initiatives and projects related to game-based learning and teaching enhancement. We also sought to assemble a repository of useful games and educational materials, and to discuss challenges and opportunities moving forward with games in teaching and assessment. This report collates the findings of these objectives.

Project Outcomes and Achievements

The proposed output of this project was a repository of teaching tools and assessment activities that use digital games for education, as well as a report with recommendations for moving forward in games-based learning. Through this, the project sought to contribute a UK-focused document collating examples of pedagogical excellence in module design, assessment, and evaluation related to games-based learning. These documents have been collated and shared with participants as a public Google Drive folder, and include module handbooks, articles and books on games-based learning, presenter slides, and links to educational games, publications, communities, and game-making tools.

What follows below under Evaluation is the report from the workshop with recommendations based on discussions and presentations as well as the materials shared by the participants.

Evaluation

This report is based on transcriptions of the discussions facilitated by the author at the workshop in May 2016. The event was attended by students and staff from the University of Leicester and beyond, and included lightning talks on a range of topics including gamification and learning, the use of games for discipline-specific skills such as mapping and public speaking, and exploration of the value of games for learning theory, failure, engagement, and reflection. The sessions were recorded, transcribed and analysed based on themes raised by participants. The findings are organised according to four general thematic areas: the role, promise, and problems of games in higher education; applications of games in learning; the role of games in assessment; and the future of games-based learning.

Chocolate-Covered Broccoli? Games in Education

There is a long history of understanding digital games as a tool for embedded stealth learning. In this formulation, digital games are the metaphorical spoonful of sugar that helps the medicine of learning go down. A parallel simile characterizing games-based learning and educational games is that of chocolate-covered broccoli. As this suggests, this vision of games is thoroughly appealing if unwholesome (a tasty chocolate coating) while education and learning are seen as vitally important but dull, dry, and not inherently interesting (the nutritive broccoli).

Discussions during the workshop revealed that this perspective is not always accurate in teaching in higher education. In particular, students enrolled in subjects such as mathematics and physics seek applications and understandings of real-world experiences and problems, and playful modes such as games may be seen as antithetical to the more authentic grounding they desire in their learning experiences. Indeed, in some disciplines such as maths, the use of games is familiar from primary and secondary education and can be interpreted therefore as infantile in higher education. Therefore students may resist the use of play in their teaching and fail to engage with precisely that which is intended to grab their attention and appeal to their perceived interests in fun. As this example demonstrates, the universal characterisation of games as necessarily appealing must be

questioned, as it can for instance suggest a lack of seriousness and abstraction from practice that can actually be repellent to students in higher education contexts.

There are also challenges related to the design of educational games. For instance, games that are explicitly about education have not been well-tolerated by students, in the experience of the workshop participants. For many students, games in learning seem optional rather than summative or core. For this reason, the use of games as an alternative where students can self-select their participation in games-based learning is advised. Another option is to avoid the terminology of games, and frame them as virtual training environments, which can dispel expectations and assumptions linked to the medium of the digital game.

That said, the format of digital games can be productive depending on the student, the topic area, and the desired learning outcome. For instance, games can appeal to those learners who have preferences for competitive formats in a similar manner to debates and other agonistic teaching modes. As this suggests, preferences for game genres (and not just the medium itself) will impact on the power of games for learning. In terms of topic area, disciplines that require safe, consequence-free trial and error work, such as physics and geology, can valuably draw on the virtual worlds of games. When designed properly, games can allow students to engage with abstract concepts and allow them to grasp these instinctively. The example given for physics is Angry Birds, which is an entertainment game that models velocity and acceleration. While the game is not explicitly about education, its mechanics are based on physics, which makes it a good learning tool in this area. Indeed, games that are designed for entertainment can be educational. For example, games like fantasy football, which are very popular, are at their core spreadsheets entailing projections based on player coordination and analysis of a range of quantitative data. However, games that are purpose-made for educational purposes can be off-putting to students and this is an enduring challenge for educators. Perhaps one of the greatest challenges to face is simply that games as an industry have been consistently tied to leisure and entertainment in a way that differs from other media forms and student response to them is shaped by this.

Additional reasons for student resistance have to do with the historically low quality of educational games design, which does not align with expectations that digital games are increasingly immersive, realistic, complex, and visually appealing. There is, therefore, a disconnect between expectations of those who are players, fans, and consumers of digital games, who are assumed to be attracted to the 'chocolate-coating' noted above in terms of how games look and feel. These students may resist games that they feel too expert for, as in the case of using Minecraft in the classroom.

However, there is the other side to be considered here, which is that not all students are game players and there may, therefore, be elements of digital games that are not attractive to them, including the emphasis as noted above on competition rather than collaboration. For these reasons, the base notion that digital games are inherently attractive needs to be discarded in favour of a more nuanced approach to what the affordances of this media form can offer for a given subject area, intended learning outcome, or set of desired skills.

One observation that emerged from the workshop was that we need to question both elements of games in learning - the digital as well as the game. The assumption that students are 'digital natives' compelled by technology regardless of application is fallacious. Indeed, experience shows that the digital element can act as a hindrance to students, and therefore there may be opportunities worth pursuing in terms of low- or no-tech role-playing, interactive fiction, and board and card games. When considering the use of digital games for teaching and learning, it is also valuable to consider whether the skills, ideas, and approaches the educator seeks to model can be achieved through analogue modes, which have the advantage of being less expensive and time-consuming to design

than digital games. However, this can present a challenge to students who are passionate about games; insights from game design instructors reveal that such students have high expectations of the worthiness of games for engagement, including analogue games.

In terms of questioning the use of the game form, this is vitally important. The chocolate-covered broccoli metaphor demonstrates that games are assumed to be a compelling vehicle for delivery of educational materials. But challenges faced by educators indicates that gamifying education is in practice neither easy not necessarily effective. Educators need to question what it is about games that is useful for their teaching. Is it the role-play element? The movement through virtual spaces? The simulation of relationships? The decision-making? The creation of fictional universes? The interactivity and participation? In other words, the use of games should be guided by the desired learning outcomes rather than by a fetishisation of the media form as a sweetening agent for learning. Games have many unique affordances that can be valuable for educational purposes, but the focus needs to be on the player rather than the game itself. What experiences and outcomes do we seek for them? How might games provide them and might there be other means of achieving this that is less complex than creating a digital game? This is particularly poignant given the multiple and complex expectations of students related to games as noted above.

A final point to note on games in learning is that there exists a disconnect between the objectives and conditions of play and those of the University. As one participant noted, "the boringness of the university is always going to beat the fun of games". The point being made here is that when play is imposed, mandated, and arbitrated, it loses its necessary condition of voluntariness and therefore is no longer fun. In order to have games function as playful and creative modes for teaching purposes, we would require greater flexibility and openness in our modules and in particular in our assessment to allow students to determine desired outcomes, explore, fail, and try again without serious consequences (such as failing the assessment or module). In this way there is a disconnect between fixed and rigid quality metrics in higher education institutions and the possibility spaces allowed by games. Because of this disconnect, participants discussed whether we need to move away from the expectation of games in education as fun, and to consider their value for being engaging in way that differs from traditional approaches such as lectures, examinations and essays.

"Where's the Zombie?" Games-Based Learning in Practice

Despite the challenges noted above, in practice, the use of games has been a gradual introduction for many instructors interested in games-based learning, with largely positive feedback from external evaluators as well as students related to these approaches. The presenters at the workshop contextualised the questions raised above in their own practice and how they dealt with them, and highlighted other, more specific opportunities and challenges in their experiences. In discussing their discipline-specific learning outcomes and teaching practices, the presenters noted that games can provide unique and promising tools for trial-and-error experiments/experiences and challenge the status quo in terms of testing and assessing students. Games are also about process as much as outcome, and can be useful for teaching procedural skills such as those valued in forensic science, policing and pharmacy education.

It was clear from these presentations that each instructor had approached games-based learning in divergent ways based on their subject matter and student populations. One presenter noted that he evaded the expectations related to high quality graphics in professionally-produced games by using interactive fiction tools such as Twine, Inform 7 and Wunderverse for teaching public speaking. These are relatively accessible tools that can allow inexperienced teachers and students alike to engage in narrative-based game-making. This emphasis on less technically-complex games was emphasized by other presenters, including one who uses role-playing analogue games as a means of

promoting transferrable skills development amongst research scientists. For the players of this game, publishing in an academic journal is a form of recognition with media attention highly rewarded in the game. In this way role-play becomes a means of fostering professional and employability skills, but the presenter also noted that taking the time to develop an immersive experience is fundamental to effective role-play in teaching.

Another presenter found that while games for learning were viewed by students as engaging, enjoyable, and effective, the type of game made a significant impact on learning outcomes and they therefore advised others to be selective about genres and play styles. The assumption that games must be characterised by win conditions was questioned by another presenter, who explored whether we could design games where it is not the best player that wins but the one who demonstrates the skills and knowledge being tested by the game. He also noted that asking students to design and make their own games can be a valuable teaching tool as they must then engage in thinking about process and cause-and-effect themselves.

Generally, presenters began from the question of how to teach their subjects and identified in games the ability to simulate and assess practical work such as fieldwork and groundwork in a virtual realm, particularly in the sciences where these can be expensive, sometimes inaccessible, and logistically challenging. While games can present solutions to these challenges in teaching, experience has shown that lessons need to be heavily signposted for students in these activities and learning spaces as students do not expect to see games in many learning contexts. Within virtual worlds and realities, students can develop time management and note-taking skills, and games can make fieldwork more accessible to those with mobility issues as well as physical and mental health difficulties, which is an important consideration for widening participation in higher education.
In implementing games-based learning, instructors have faced several challenges that are cultural, institutional, and technical in nature. Across the board, university constraints on acquiring and updating software and hardware can limit the ease in which instructors deploy games in learning. Many tools for game design need regular updates and upgrades, but this often does not align with fiscal years and teaching timelines in higher education institutions. In this way, the culture and ethos of games does not align with that of UK Higher Education and can make the implementation of games-based learning very difficult.

Some of the presenters in the workshop had been able to subsidize the payment of professional game designers for educational games through grant income, and they noted here another misalignment between cultures, in this case between instructors focused on intended learning outcomes, and designers focused on the principles of entertainment and games design. The question "where's the zombie?" indicates the mismatch between pedagogical goals and the norms of game-making, and the need for the development of a shared language between these stakeholders.

Overall the effectiveness of games for education is not linked to realism or expense per se, but how well engagement and motivation are tied to the desired learning outcomes. The benefits range from simulating challenging learning environments virtually to role-playing for transferable skills, but what is clear from the practices of these instructors is that reward in games must be well-linked to the intended learning outcomes. For this reason, assessment in games was a key topic of discussion at the workshop.

Lone Wolves and Social Loafers - the Role of Games in Assessment

Games and assessment may seem to have some conceptual affinities. In games, mastery of processes are rewarded with feedback and quantified metrics of achievement, including trophies, points, stats, leader boards and other rewards. In this way, it may seem evident that games as

assessment are an important opportunity and, indeed, the power for using game-like elements to encourage engagement is at the core of the trend towards gamification, which we see at play in consumer loyalty schemes from airline status to social media platforms.

In practice, however, the role of games for assessment is still largely theoretical. As noted above, there are challenges related to aligning games with institutionalized standards related to quality and assessment as the strength of games lies in how their players engage in their processes rather than simply the end state of winning or topping a leader board. Participants from game design backgrounds noted that students who play games will always be able to 'game' a game as assessment because they are experienced in identifying how systems work and seeking advantages in playing more efficiently. Peer assessment was a mode of evaluation that was identified as a particularly easy mode for students to gain advantage. For this reason, games when used in assessment have been largely supplementary and formative, providing ongoing feedback and a means to monitor ongoing progress. The lowered stakes of formative assessment can provide a solid basis for allowing students to engage in trial-and-error and failure in the process.

A contentious topic of discussion in the workshop was whether games could be deployed to automate and rationalize assessment of abstract concepts in a more objective manner than an individual instructor's subjective opinion. There are two assumptions at work in such a goal, the first being that assessment can or should be objective, and the second that a game can be objective in its evaluation. Participants largely disagreed with both precepts, as the vast majority of intended learning objectives in higher education are seen to need qualitative evaluation. Gamification entails distilling learning into quantifiable metrics, which in the case of critical thinking and original thought would be impossible. Participants from a range of disciplines felt this to be the case with the desired learning outcomes of their subject areas as well. Furthermore, the inculcation of values into games through design is itself not an objective activity and this reveals that games like other technologies are not objective either. One participant asked how we could know that the final score a game gives a student for the module is reliable and this indicates the ways in which the currently functioning modes of ascertaining fairness in marking at the university - through double marking, moderation, and external evaluation - are seen as necessary regardless of how technological teaching may become.

While not all assessment can or should be objective or gamified, participants agreed that there was more room for playfulness and creativity in assessment, depending on the discipline, teaching area, and educational needs within a module. This was expressed with the caveat that we need to tie games for learning into reward systems that benefit students beyond the mark and the degree. Games could be deployed in the pursuit of greater flexibility and openness in assessment, particularly in terms of group-based assessment. One opportunity that was discussed was having students design games themselves across disciplines. In a multidisciplinary task, students could work together and have the intended learning objectives of diverse subject areas such as geology and mathematics tested based on team roles.

Building communities around games as assessment was an exciting prospect for the participants, but the game design instructors were quick here to note that clearly defined team roles are vitally important in group work with games in order to assess each contributor's work rather than content produced overall. In game development, producers cannot do it alone, and even a solo developer has to work with others throughout the process. Therefore in constructing a team, be it subject-specific or multidisciplinary, the instructor must consider the synthesis of attributes, talents, skills, and personalities in a team. Those using team-based game assessment must also consider how to structure the teams. Some game design programmes draw on the principles of agile development with scrum methods such as sprint and flat hierarchies. Whether to adapt the working practices of software development or to rely on more traditional team structures depends on the module

objectives and needs to be defined by the instructor for all teams. Team-building activities are common in game design education, as are incentives for making an effort in supporting the team and iterative milestones for evaluating progress. Rewarding the values you want to teach in regards to the team/community is as important as evaluating the final outcomes of the design work.

As with all group work, instructors grappled with those who are less oriented towards collaboration- the so-called lone wolves (perfectionists who prefer to work alone) and social loafers (slackers who claim the work of their team-mates). Game design instructors noted that this is also a component of employability and transferrable skills in team-work, but that disciplinary issues must be planned and accounted for in these forms of assessment. This includes the use of social media. Many game design students use Facebook to discuss their work, but bullying and harassment did occur on these sites until the instructors took control over groups. In this way, it is important to remember that communities can facilitate antisocial as well as prosocial activity. Team work also cannot comprise the entirely of assessed work as this leads to student complaints, but deploying it carefully and in proportion with individual work can be a unique selling point that appeals to parents in recruitment activities.

Playing Together- Collaboration and the Future of Games-Based Learning

To conclude the workshop, our final discussion was of the resources needed for implementing games-based learning more effectively across subject areas and module and discipline-specific needs. Of course, the major need identified by participants was financial and temporal support. This is not surprising as game design is highly complex as a practice alone. Integrating learning within it in a manner that is nuanced, subject-specific and avoids the prevalent issues noted above is yet another layer of complexity for time-pressed educators.

Aside from additional funding and time relief, the majority of participants saw the need for greater collaboration with game designers. Educational games for the most part operate as closed loops with set actions leading to set outcomes with every play. With more advanced and complex game design, it would be possible to have procedurally generated content within educational games, which would allow for randomness and less predictable gameplay. In order to achieve this, networking and connections with professional game designers (or those in training) is vital.

Matching game design students and their projects to those interested in games-based learning was discussed as a potential direction for this, though the sharing of talent pools is somewhat limited by the expectations of game design students themselves. Game design instructors noted that the emphasis is still largely on entertainment games in many programmes. The culture of game design is still about slick and high-end entertainment games. Pitching serious games such as educational games is a challenge unless the educator emphasizes growing markets to these students. Programmes focused on independent game design that are not so oriented towards the industry may be a potential area of collaboration, but as yet this is an untapped resource. There are other challenges as well in that pedagogy is a different outcome and set of considerations than immersion, engagement and other game design principles. Therefore, collaborations would have to be carefully coordinated and scaffolded, and game designers could not simply be approached as providing value to educators. Skills and knowledge exchange across stakeholders would need to be a core element of this collaboration.

Other kinds of support were also required in terms of latitude to experiment with games-based learning and research this investigation. As games-based learning activities take a great deal more time to develop than other teaching materials, there is an increased risk entailed in this practice. If students do not respond to the engagement, the consequences can be quite high unless we

encourage innovative teaching and assessment with a tolerance for failure. This is related to support for pedagogic research on these activities; there is currently insufficient funding available to explore these initiatives in any depth.

Based on these needs, the repository of shared existing resources that were not necessarily known by those interested in games-based learning was validated. The repository was also seen as a useful tool for those interested in sharing game design tools as well as trading information and skills across disciplines and institutions. The repository is available through the Leicester Learning Institute website (2017). One possible direction for collaboration and connection was the use of local game jams for designing educational game prototypes. Hosting a University event as part of the annual Global Game Jam activities each January was seen as a way of kickstarting game design collaborations.

To summarise, games were discussed as an exciting means of supporting learning, though its value was dependent on a number of elements, including the quality of the game design, the skills of the educator in linking them to intended learning outcomes, and student abilities, preferences, and interests. Therefore the value of games as tools for learning, both teaching and assessment, can be harnessed but not in a quick or artificially-imposed manner. Processes must be as valued as outcomes in assessing the effectiveness of games in learning environments. The practical challenges faced in implementing games-based learning must be addressed institutionally to ensure greater support and games as teaching tools must not be viewed as universally productive or efficient in all contexts. The motivation and engagement games provide will depend on both the students and the game's quality, and context will shape how well the goals and expectations of students and learners are met by games and gamification. Games will not always be the best way to deliver subject area content, nor to assess it, and their adoption should be considered carefully at the outset. Game mechanics may be useful for measuring some intended learning outcomes, but not all, and they will not universally meet the needs of a student population, regardless of popular discourses such as that of 'digital natives'. Therefore game-based learning must be seen as a complex and time-consuming approach to education rather than a simple matter of candy-coating our teaching materials.

Continuation of the project

This report and the sharable portfolio of resources are the major outputs on the project, and they are intended to be widely useful to educators in a range of disciplines. The added benefit of the workshop is the formation of a broader network of UK instructors interested in games in education and the planning of resources for teaching, assessment and evaluation in this domain. As noted above, greater collaboration, networking, and connections were identified as centrally important to developing games-based learning in the contemporary university. The workshop was the basis for this nascent networking, as well as the portfolio of sharable resources. All portfolio materials are open to editing and addition as well as sharing by workshop participants and presenters, which will fulfil the aim of wider dissemination.

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JOURNAL OF LEARNING AND TEACHING IN HIGHER EDUCATION

Walker, S and Patel, A.J.F. (2018). More than skills: What can approaches to Digital Literacy learn from Academic Literacies? *Journal of Learning and Teaching in Higher Education*, *1*(1)

OPINION PIECE

More than skills: What can approaches to Digital Literacy learn from Academic Literacies?

Stephen Walker[1] and Alexandra J. F. Patel[2]

[1] sw344@leicester.ac.uk, Leicester Learning Institute, University of Leicester.
[2] alexandra.patel@leicester.ac.uk, Leicester Learning Institute, University of Leicester.

Abstract

Defining digital literacies is challenging because 'literacies' has been used in different ways, shifting from its association with the critical engagement with texts to encompass broader definitions relating to skills-based agendas (Lea, 2011). Support for the development of digital literacies in citizens, students and lecturers has over the last decade become a popular debate, with hundreds of digital literacy frameworks developing (for review see All Aboard!, 2015; and Hoechsmann & DeWaard, 2015). Yet, treatment of digital literacies as transferable, discrete sets of skills may not do justice to anyone. The academic literacies approach has developed from similar challenges around teaching text based skills (Lea and Street, 1998; Lea & Street, 2006; Lillis, 2006). Their consideration of the nuanced and complex practices around texts offers a sociological insight into the development of digital literacies. In this article, we contrast an academic literacies approach with JISC's current thinking around digital capabilities, followed by a discussion of the parallels between Lea and Street's (1998, 2006) academic literacies model and Bennett's Digital Practitioner Framework (Bennett, 2014; Sharpe & Beetham, 2010).

Keywords: Higher Education; Academic literacies; Digital literacies; Digital technology; Digital learning; Learning technology; Teaching practice

Introduction

Support for the development of digital literacies in citizens, students and lecturers has over the last decade become the subject of a popular debate, with many researchers, policy-makers and commentators creating digital literacy frameworks (for a review of frameworks see All Aboard!, 2015; and Hoechsmann, 2015). Defining digital literacies in itself is challenging because the term 'literacies' has been used in different ways. This ranges from the academic literacies meaning of critical engagement with texts, to a technological focus on skills-based agendas such as computer or digital literacy (e.g. European Computer Driving Licence; Dolan 1998; Lea, 2013). The academic literacies approach has developed from similar challenges around teaching text based skills and is relevant to digital literacies (Lea & Street, 1998; Lea & Street, 2006; Lillis, 2006). Their consideration of the nuanced and complex practices around texts offers a sociological insight into the development of digital literacies. In this article, we contrast an academic literacies approach with the 'digital capabilities' approach in Higher Education discourse, as promulgated by national organisations such as JISC (Joint Information Systems Committee – a UK organisation that supports digital and technological approaches in Further and Higher Education). In our discussion, we seek to draw parallels between Lea and Street's (1998, 2006) academic literacies model and Bennett's Digital Practitioner Framework (Bennett, 2014; Sharpe, & Beetham, 2010) and have created a representation of how these literacies interlace.

What are academic and digital literacies?

Academic literacies research has a robust and established framework "which has already made a significant contribution to understanding learning in a range of educational contexts, including those that are digitally mediated" (Lea, 2011, pp. 7-8). The approach shifts emphasis away from academic conventions and rules, and instead encourages an appreciation of the contested nature of academic writing, differing genres and their development, the impact of power relations on writing, the development of identity through writing, and the dynamic and pluralistic nature of academia (Lea, 1998; Lillis, 2006). Applying this sociocultural framing to digital literacy foregrounds practices in an institutional context – what academics and students actually do, and the place of the institution in its wider social context.

In Higher Education in the UK, the work of JISC defines 'digital capability' as the predominant and popular conception of digital literacy. "Digital capabilities are those capabilities that fit an individual for living, learning and working in a digital society" (JISC, 2017). But while JISC describe these capabilities as a set of situated practices that "looks beyond functional IT skills…" (JISC, 2017), the language of 'capabilities' suggests an instrumentalism in which achievement is measured solely by outcomes and where ends are taken for granted (Campbell, Kyriakides, Muijs, & Robinson, 2004). A focus on individual, primarily cognitive, skills acquisition and development sees students and academics in deficit, in need of remedial support and correction, which is then provided often in the form of generic study or skills guidance. Street (1984) argues against this deficit approach in the context of academic literacies, and Lea (2013) picks up the case against the approach in the context of digital literacy. It is a view that assumes that digital skills would be unproblematically transferable to the 'world of work', or across different contexts within a university, and that the acquisition of these skills is vital for a fully functioning 21st century university (Lea, 2013). Such an expectation of digital technology leaves little room for autonomy and agency among academic staff and students and does not lend itself to a critical and transformative approach to higher education. Thinking of digital literacies as discrete employability skills that can be packaged up and passed on to students regardless of disciplinary practices may, in fact, support broader commodification and consumerist models of education. This is where an academic literacies approach proves helpful.

Why use an academic literacies approach for digital literacies?

The ethos for taking an academic literacies approach to digital literacies comes from a belief that universities have a transformational role in society via the production and validation of knowledge; that digital literacies are emancipatory, enabling human agency in a digital society; and that we need joined up thinking not technological determinism when it comes to teaching and learning with technology (Kirkwood, 2014). Two ways in which technological determinism manifests itself in education are the utopian view of technology as a driver for educational change, and the dystopian view that technology is forced upon teachers, disrupting their way of doing things and adversely affecting the performance of students. Both views overestimate the role of technology, and underestimate human agency (Kirkwood, 2014). Brown (2017) suggests that if digital literacy is core to what it means to be a digital citizen in the 21st century, then we need to go beyond preparing people to 'fit' the inequitable and unjust societies that we have created. We should instead be preparing people to challenge and reshape such societies. JISC's association of digital literacy with the demands of a 'digital society' may inhibit the potential for digital literacies to encourage an ethical and empowering role for teaching and learning. In this way, it matches Street's criticism of 'isolat[ing] literacy as an independent variable' (Street, 1984 p.2) and minimising the role of literacy as a social practice with an 'ideological and therefore culturally embedded nature' (Street, 1984 p.2) (Lea, 2013).

> The university, in its capacity to legitimate knowledge, and by developing appropriate graduate attributes, can influence what is meant by a digital society, citizenship and literacy.

Universities have never been about simply preparing students for the workplace. As Mann says "Universities do not just produce 'employees', they also produce, legitimate and reproduce knowledge through research, scholarship, publication, and the accreditation and awarding of degrees" (Mann, 2008, p.123). This means that the university, in its capacity to legitimate knowledge, and by developing appropriate graduate attributes, can influence what is meant by a digital society, citizenship and literacy.

Furthermore, the joined up thinking alluded to by Kirkwood (2014) requires a consideration of technology use in context, rejecting the simplistic 'pedagogy before technology' dualism that misrepresents the complex weave of agents involved in education. It is difficult and unhelpful to disentangle curriculum, assessment, teaching, learning, technologies, physical learning spaces, politics, and culture. Recognising this complexity means that we can avoid "valorising either the digital or textual practice" (Lea, 2013, p.111), and in so doing avoid insisting that digital practices across disciplines are identical, and also that a digital approach is the most appropriate. An academic literacies approach means that rather than seeing academics and students as in deficit and dictating what they ought to be doing, it considers their actual practices. It gives them agency by placing them as active participants in shaping a digital world.

Shifting from individual digital skills and capabilities to situated practices

Sharpe and Beetham suggest that *practices* involve learners making informed choices about how to use technologies, and developing "flexible strategies in response to situational needs" (Sharpe & Beetham, 2010, p.175). Practices, in other words, require both a critical consideration of the pedagogic value of technology, and an agency with which to implement that decision. In support of a change in focus from digital skills to digital practices, Bennett (2014, p.117) interviewed early adopters of technology. She explored how Sharpe and Beetham's work on students' digital literacy could be applied to HE lecturers, and found that lecturers were not primarily motivated by digital skills development or by becoming digital practitioners; instead they wanted to achieve their pedagogic goals using digital tools where appropriate. Bennett found that lecturers first focus on the level of pedagogic practice, considering ways of teaching and learning, and then experiment with appropriate technologies to determine their value in meeting this goal (Figure 1). Emphasis on practices is therefore more meaningful and motivating for them than focusing on skills.

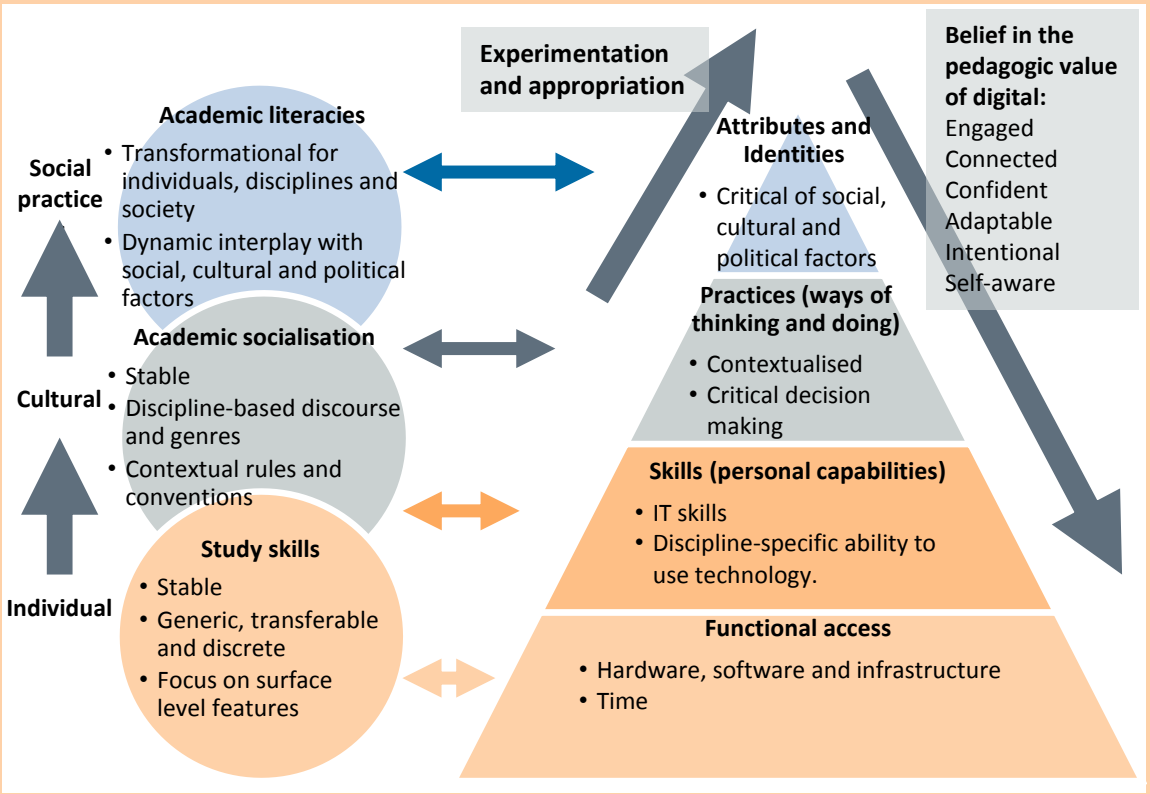

Figure 1: Drawing links between Academic Literacies (left, based on Lea & Street, 2006) and the Digital Practitioner Framework (right, based on Sharpe & Beetham, 2010; and Bennett, 2014). Both academic and digital literacy are often thought of as isolated skills (orange), including the requirement of functional access. Academic socialisation is an appreciation that practices must be contextualised within disciplinary/organisational culture (grey). A more nuanced understanding considers academic or digital literacy as a social practice, interwoven with identity, power and authority (blue). To be literate therefore requires a critical understanding of how practices interplay dynamically with social, cultural and political factors.

The academic literacies approach suggests these practices are contextualized, or situated within a discipline or community, as well as within wider society. The practice itself is adapted, modified and made relevant in accordance with factors such as access to tools and resources, and the conventions and beliefs of the community, that are in turn a balance of social interaction and power dynamics. It is therefore concerning to observe that "many efforts to propose definitions and develop related

models and frameworks are decontextualised from social and situated practice" (Brown, 2017). The *process* of co-construction of definitions by a community is as important as the outcome, and externally imposed definitions may limit meaning and reduce stakeholder buy-in (Belshaw, 2011). Thus, digital literacies need to be collaboratively defined by the community they are intended to be meaningful for, and not externally imposed.

Digital literacies should be transformational

Digital literacies have the potential to transform practices, identities and societies. In terms of practices, Kirkwood and Price (2013) suggest digital tools can be used, not just to replicate and supplement existing approaches to learning and teaching, but to transform learning and teaching. Sharpe and Beetham (P. 174, 2010) have also touched upon this transformation; suggesting that digital creation is not simply replicating writing in a digital context, but that "new technologies are changing the nature of learning and knowledge" by expanding the traditional academic form of creation – writing - into other digital media (Sharpe & Beetham, 2010, p.166). Furthermore, they suggest that the digital inspires new skills, such as 'e-collation', where information nodes must be gathered into new networks, through for example, tagging, mapping, modelling, commenting, and use of favourites. In part, this aligns with the transformational ideology of academic literacies, where one aspect of being literate is appreciating that practices around the creation and use of text are diverse, plural, and dynamic, and being empowered to critically challenge conventions around academic literature (Lea, 2006; Lillis, 2006).

In terms of identities, Sharpe and Beetham's model speaks to the sociological aspect of learning; that adopting digital practices changes how an individual sees themselves or their identity. This may be characterised by a developing confidence and motivation to consider new digital tools; and by no longer differentiating between digital and non-digital approaches, instead critically selecting a suitable approach for the task. Bennett (2014, p.4) reports that, for early adopters, digital practices have become normalized in their teaching, and they are "connected and committed to ways of working using digital tools" , in other words intrinsically, not extrinsically motivated. Bennett furthermore suggests that early adopters have become 'Post-digital', moving beyond identifying something as 'digital' or 'non-digital', instead demonstrating an appreciation of the complexity of different digital technologies, and the need to make critically informed choices. This, again, has parallels with academic literacies - the appreciation that learners, through developing ways of doing, knowing and communicating, create their own academic identity within a community of practice or discipline.

Digital literacy involves a critical approach

Sharpe and Beetham (2010) describe *practices* as requiring critical or informed choice (Figure 1, right-hand pyramid, green). Developing digital practices and digital identities requires staff and students to evaluate and choose the most appropriate tool for the task. In addition to this, the sociological approach of academic literacies requires individuals to be aware that practices are situated in socio-cultural contexts, and to ask questions of this too. For example, Brown (2017) argues:

> …in exploring the underbelly and wider social practice of the concept we need to ask who is shaping the current digital literacies agenda and for what purpose? What is missing in the discourse? Whose interests are being served? Beyond a narrow focus on skills and keystrokes how might we re-envision digital literacies to promote active citizenry in order to reshape our societies to develop new ways of living, learning and working for a better future – for all?

In order to be digitally literate, we should not only look critically at the technologies we choose to use for learning and teaching, but also question how digital literacies sit within a wider social context.

Digital literacies should consider the role of power and agency in learning

Academic literacies "is concerned with ...identity, power and authority" (Lea, 2006, p.367) and in digital literacies we too should consider how these factors affect the development of digital learning. Through access, Sharpe and Beetham's (2010) model acknowledges that learning is situated within an institution that holds the power around provision of hardware, software and time, potentially leaving individuals with little agency (Sharpe & Beetham, 2010; Bennett, 2014) (Figure 1, right-hand pyramid, blue). Sharpe and Beetham (2010) identify access as a prerequisite for engagement, demonstrating that institutions must consider the ways in which they are supporting and inhibiting access. Institutions must be aware that they have the responsibility to provide access to hardware, software and time, without which individuals cannot become digitally literate. As we have seen above, developing digital practices requires individuals to make informed critical decisions about the technologies they use, and for this, they need to have agency to trial, purchase and integrate different technologies. A consideration of the complex balances of power and agency is therefore an important component in enabling individuals to become digitally literate.

Conclusion

We have argued that approaches to digital literacies should shift their focus from skills and capabilities to digital practices. Taking an academic literacies (Lea & Street 1998, 2006) approach means looking at digital literacies from sociological and cultural perspectives; critically considering the interplay between digital literacies and social practices within academic disciplines, within the practices and culture of the institution and within the sociopolitical struggles of wider society. Digital practices are not isolated skills – they are social practices and therefore bound up with the identity, power and authority of the actors involved. Digital literacies approaches are starting to consider digital practices as more than skills and this can be expanded further to consider more critically the drivers and consequences of digital literacy, and how digitally literate individuals can in turn reshape society. Finally, the balance of power and agency between institutions and individuals will need to be considered to avoid inhibiting the ability of individuals to become digitally literate. This means for meaningful development of digital literacy in individuals and a development of a digital culture, we must embrace the nuanced understanding of digital and non-digital practices being more than digital skills - having all the complexity of a social practice within a community, including aspects of access, power an authority that build a confident digital identity.

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JOURNAL OF LEARNING AND TEACHING IN HIGHER EDUCATION

Cork, L. M. (2018). Critical reflections on staff-student partnership and 're-interpreting' journal submissions. *Journal of Learning and Teaching in Higher Education. 1(1).*

Opinion piece

Critical reflections on staff-student partnership and 're-interpreting' journal submissions

Lorna M. Cork[1]

[1] lmc44@leicester.ac.uk, School of Education, University of Leicester.

Abstract

This thought-piece shares some personal reflections on a distinctively different approach to student-staff collaboration, whereby students 're-interpret' scholarly submissions to this new HE journal for a wider audience. Student and staff motivations for becoming involved in this work of partnering are examined, and values and 'intrigue' are uncovered as contributing to partnership-readiness and sustaining interest. Students engaged critically with Higher Education policy and theory; particularly the Teaching Excellence Framework (TEF) and the concept of a ladder of partnership. The collaboration offers different conceptual lenses, revealing possibilities for the co-creation of a student-staff scholarly community. Student reflections reveal digital literacies for producing re-interpretations and the 'softer' skills for collaborating in diverse groups. However, the key appeal of getting involved is not, as may be assumed, for benefits such as employability, it is the opportunity of collaborating across disciplines and as an equal partner with staff, where their voices contribute to real debates about teaching and learning in HE.

Keywords: Staff student partnership; ladder of participation; partnership-readiness; reinterpretation.

Introduction: A working definition of reinterpretation

'Reinterpretation' is the word we have adopted to capture how students are responding to the scholarly articles submitted for publication in a peer-reviewed open access journal. These responses in themselves form part of the publication, and have been produced in partnership with staff, both the authors of articles and with other members of the editorial team. For me, staff partnership with students who reinterpret 'traditional' journal submissions has been one of the most enthralling aspects of my involvement in the project to launch the University of Leicester's Journal of Learning and Teaching in Higher Education (JLTHE).

As a 'working-definition' a reinterpretation author:

> Rethinks' submissions to the journal in different/creative forms (e.g. short videos, podcasts, comics, infographics etc.). The key purpose is to help articles to reach a wider audience, particularly students.

This definition was itself debated and confirmed at an initial workshop with myself, as the new point of contact for reinterpretation authors, 2 other colleagues and 6 students volunteering to become reinterpretation authors. The workshop, and the opportunity to revisit the definition of reinterpretation, signalled the intention of a collaborative partnership culture from the onset. The first issue of the journal, several months after that introductory workshop, provides a pleasing opportunity to pause, exhale and reflect.

Student motivational drivers for partnering with staff

'My initial interest in the Journal of Learning and Teaching was grounded on nothing but intrigue' is a view from a student reinterpretation author, echoing elements of my own *staff* perspective. In discussions at the workshop, students explained that the most significant aspects of the journal's appeal were: 'accessibility, encouragement, equal welcome of staff and student submissions, research, and scholarship' and, what appeared most important - the opportunity to contribute more to the higher education debate. 'Interpretation offers an interesting way of building on the JLTHE's intentions to present debates about higher education in an accessible manner.' This postgraduate student, also noted the following barrier to that aspiration:

> 'Some students (perhaps particularly undergraduates) might be unfamiliar with some terminology or key concepts relating to pedagogy or to higher education more widely.'

Staff motivational drivers for partnering with students

Arguably, the motivation for partnership is intrinsically linked with values. Prominent researchers in the field (Flint, 2017; Healey et al, 2014) and the Higher Education Academy (HEA, 2011) advocate explicit sharing of values between partners. There were two drivers in my own case. Firstly, underpinned by values of equity, diversity and inclusiveness, working collaboratively with a diverse range of students: undergraduates, postgraduates across different disciplines, campus based and distance learners was appealing; secondly, being in a position to encourage diverse representation among the student demographics. With my teaching experience concentrated in the School of Education at Masters level, it was a welcome opportunity to develop cross-university working with the Leicester Learning Institute and colleagues and students from other disciplines. This reflects the University's values, emphasising teams and leaders collaborating to achieve strategic priorities.

Figure 4: Reinterpretation author workshop

Partnership-readiness for reinterpretation

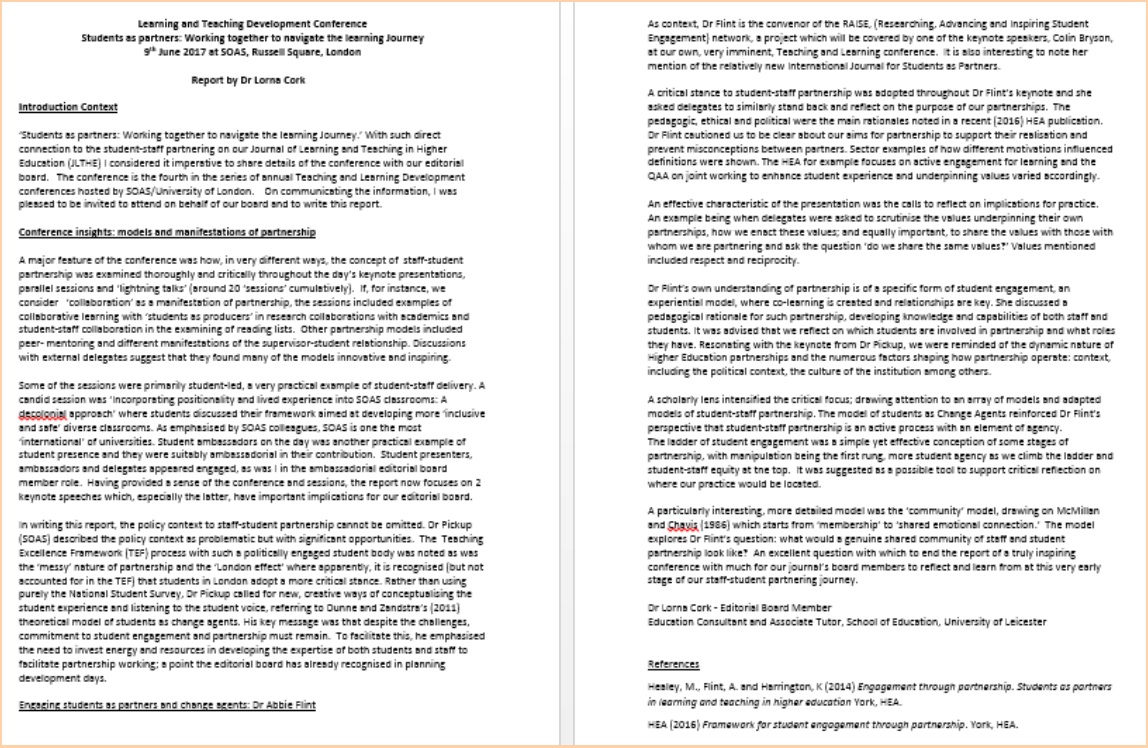
As a relatively novel concept, reinterpretation authors had no model or blueprint for the role. The initial challenge therefore was to develop a shared understanding of aims. Moreover, these were to be transfigured into tangible, indeed publishable,'re-interpreted' outcomes. Collectively, it was agreed:

> 'The most significant outcome of the project would be the readiness to publish an online journal as a collaboration between staff and students.'

Publication-readiness brings to the fore partnership-readiness. What constitutes 'partnership-readiness' in HE and how may this be facilitated at a strategic and day-to-day level? For this under-explored area, reflective questions from a student-engagement tool (HEA, 2014) provided support in raising questions about underlying issues, assessing institutional readiness and identifying gaps and priorities for the future.

Pedagogy for critical engagement with reinterpretation

Using a 'flipped learning' approach (Sharples, 2014), students came prepared to the reinterpretation workshop. Taking advantage of the content as well as the form of an example report, see Figure 1, they were prompted to consider how they might reinterpret this account of a 2017 staff student partnership conference, whilst at the same time engaging with theories and practices of staff student partnership.



Learning and Teaching Development Conference
Students as partners: Working together to navigate the learning journey
9th June 2017 at SOAS, Russell Square, London

Report by Dr Lorna Cork

Introduction Context

'Students as partners: Working together to navigate the learning journey.' With such direct connection to the student-staff partnering on our Journal of Learning and Teaching in Higher Education (JLTHE) I considered it imperative to share details of the conference with our editorial board. The conference is the fourth in the series of annual Teaching and Learning Development conferences hosted by SOAS/University of London. On communicating the information, I was pleased to be invited to attend on behalf of our board and to write this report.

Conference insights: models and manifestations of partnership

A major feature of the conference was how, in very different ways, the concept of staff-student partnership was examined thoroughly and critically throughout the day's keynote presentations, parallel sessions and 'lightning talks' (around 20 'sessions' cumulatively). If, for instance, we consider 'collaboration' as a manifestation of partnership, the sessions included examples of collaborative learning with 'students as producers' in research collaborations with academics and student-staff collaboration in the examining of reading lists. Other partnership models included peer- mentoring and different manifestations of the supervisor-student relationship. Discussions with external delegates suggest that they found many of the models innovative and inspiring.

Some of the sessions were primarily student-led, a very practical example of student-staff delivery. A candid session was 'incorporating positionality and lived experience into SOAS classrooms: A decolonial approach' where students discussed their framework aimed at developing more 'inclusive and safe' diverse classrooms. As emphasised by SOAS colleagues, SOAS is one the most 'international' of universities. Student ambassadors on the day was another practical example of student presence and they were suitably ambassadorial in their contribution. Student presenters, ambassadors and delegates appeared engaged, as was I in the ambassadorial editorial board member role. Having provided a sense of the conference and sessions, the report now focuses on 2 keynote speeches which, especially the latter, have important implications for our editorial board.

In writing this report, the policy context to staff-student partnership cannot be omitted. Dr Pickup (SOAS) described the policy context as problematic but with significant opportunities. The Teaching Excellence Framework (TEF) process with such a politically engaged student body was noted as was the 'messy' nature of partnership and the 'London effect' where apparently, it is recognised (but not accounted for in the TEF) that students in London adopt a more critical stance. Rather than using purely the National Student Survey, Dr Pickup called for new, creative ways of conceptualising the student experience and listening to the student voice, referring to Dunne and Zandstra's (2011) theoretical model of students as change agents. His key message was that despite the challenges, commitment to student engagement and partnership must remain. To facilitate this, he emphasised the need to invest energy and resources in developing the expertise of both students and staff to facilitate partnership working; a point the editorial board has already recognised in planning development days.

Engaging students as partners and change agents: Dr Abbie Flint

As context, Dr Flint is the convenor of the RAISE, (Researching, Advancing and Inspiring Student Engagement) network, a project which will be covered by one of the keynote speakers, Colin Bryson, at our own, very imminent, Teaching and Learning conference. It is also interesting to note her mention of the relatively new International Journal for Students as Partners.

A critical stance to student-staff partnership was adopted throughout Dr Flint's keynote and she asked delegates to similarly stand back and reflect on the purpose of our partnerships. The pedagogic, ethical and political were the main rationales noted in a recent (2016) HEA publication. Dr Flint cautioned us to be clear about our aims for partnership to support their realisation and prevent misconceptions between partners. Sector examples of how different motivations influenced definitions were shown. The HEA for example focuses on active engagement for learning and the QAA on joint working to enhance student experience and underpinning values varied accordingly.

An effective characteristic of the presentation was the calls to reflect on implications for practice. An example being when delegates were asked to scrutinise the values underpinning their own partnerships, how we enact these values; and equally important, to share the values with those with whom we are partnering and ask the question 'do we share the same values?' Values mentioned included respect and reciprocity.

Dr Flint's own understanding of partnership is of a specific form of student engagement, an experiential model, where co-learning is created and relationships are key. She discussed a pedagogical rationale for such partnership, developing knowledge and capabilities of both staff and students. It was advised that we reflect on which students are involved in partnership and what roles they have. Resonating with the keynote from Dr Pickup, we were reminded of the dynamic nature of Higher Education partnerships and the numerous factors shaping how partnership operate: context, including the political context, the culture of the institution among others.

A scholarly lens intensified the critical focus; drawing attention to an array of models and adapted models of student-staff partnership. The model of students as Change Agents reinforced Dr Flint's perspective that student-staff partnership is an active process with an element of agency.
The ladder of student engagement was a simple yet effective conception of some stages of partnership, with manipulation being the first rung, more student agency as we climb the ladder and student-staff equity at the top. It was suggested as a possible tool to support critical reflection on where our practice would be located.

A particularly interesting, more detailed model was the 'community' model, drawing on McMillan and Chavis (1986) which starts from 'membership' to 'shared emotional connection.' The model explores Dr Flint's question: what would a genuine shared community of staff and student partnership look like? An excellent question with which to end the report of a truly inspiring conference with much for our journal's board members to reflect and learn from at this very early stage of our staff-student partnering journey.

Dr Lorna Cork - Editorial Board Member
Education Consultant and Associate Tutor, School of Education, University of Leicester

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Figure 4: Short report from attending a one-day conference on Staff Student Partnership.

Students engaged critically with theoretical models, concepts and discourse mentioned in the report, and could see the benefits for their own learning beyond the project and the University. Critical reading, thinking and analysis being valuable intellectual, personal and societal powers. Presentation opportunities for students on the day were embedded in the design; one student voluntarily shared relevant insights from an intern position in a publishing house, another spoke about how podcasts were a highly accessible medium for students to access and share ideas. The development of critical literacy and presentation skills as a pedagogic rationale was integrated with 'facilitating planning' to 'present academic ideas using digital media' as encouraged by JISC (2015, p.2).

Co-creation and questions for a new understanding

Significantly, when the reinterpretation authors were asked to share questions at the start of the workshop planned to foster partnership-readiness, the queries firstly focused on the practical, seeking timescales and 'templates and frameworks' to guide them. Alongside the understandable emphasis on securing clarification, the students were probing the nature of the task: 'to what extent can you change the original,' and in working with authors, 'what are the protocols?'

By the end of the workshop, group members appeared clearer about different means by which they could reinterpret journal submissions, some of the sensitivities around interaction with authors and the practicalities of reinterpretation including that the first issue was planned in a few months' time. The group also seemed clearer, as was the intention, that as a new pursuit, and as a partnership in action, there was no pre-configured template. Instead, the processes would evolve through co-creation.

Although in depth-theoretical exploration is not an aim of these reflections, the approach to partnership is informed by scholarship and students' interest was a reminder of the extent to which a ladder is embedded in conceptualisations of staff-student partnership (Bovill & Bulley, 2011). This early stage of our own partnership-working suggests that depending on the nature of the activities, staff and students as individuals and groups may be at different levels, at different times, even within the same time period. The model suggested by a ladder, may, depending on interpretation, depict either a quite rigid hierarchy or flexibility to manoeuvre roles. The visionary horizon scanning essential for strategic leadership may also be embodied. Three students working as a group constructed reinterpretation protocols for us all, in draft by the end of the workshop; this was a rapid move from 'what are the protocols?' to 'here are some protocols.'

Student engagement with the Teaching Excellence Framework (TEF)

Initially unanticipated although not surprising is the extent of the students' interest in the Teaching Excellence Framework (TEF) for UK Higher Education. It was not intended as a prominent section of the conference report, originally written for the editorial board to explore examples of effective staff-student engagement practice. One group suggested reinterpreting the report into an 'an interactive document… what is the TEF…Hover over phrases and see a panel popup with expansion, or video clip explaining.' Beyond individual institutions, this may question the extent of sector-wide opportunities for students to be fully informed of such important aspects of HE policy. Recalling debates immediately following TEF outcomes, the student voice appears significant by its very absence.

Theories and practicalities of partnership

Staff-student partnership literature appears to be re-shifting again, more toward theories of collaborative communities of learning and practice (Bryson, 2016; Meacham et al, 2013). Frequent communication exchange, shared decision-making, the pooling of ideas and expertise are very evident in our own experience and together indicate that a culture of collaboration is emerging.

Marquis et al. (2017) acknowledges that 'some scholars have also questioned the generally positive thrust about student-faculty partnership', and this project too has distinct challenges, even in the frequently cited aspect of limitations of time. The deeply thoughtful, considered nature of the reinterpretation process seemed at times a sharp contrast to the quest, indeed need for moving forward within the tight timescale of journal scheduling.

Risks associated with this constructivist approach to the reinterpretation process were apparent as the publication deadline loomed. Communication revealed that some aspects could be further clarified at all levels of the collaborative. Intense dialogue continued in various spheres, revealing both the challenges and possibilities of staff-student partnership.

The on-line digital format of the journal can offset some of these risks and indeed be advantageous. Strategically, it offers scope to include post-publication reinterpretations, amassing ongoing interest and building on this to attract new authors, readers and reinterpretation authors for subsequent issues. Pedagogic and wider benefits include exploring and developing aspects of digital media to develop both staff and student digital literacy and competency. As pointed out in a recent report, these are being increasingly linked to employability (Meade/CELT, 2017).

Significant outcome

The readers of this first issue of the JLTHE will naturally be aware that the 'most significant' outcome of readiness for publication as a staff-student collaboration has been achieved. A podcast of a four-

way conversation about staff student partnership (Blacklaws, Mustafa & Mohamed, 2018) and a visual journey through University learning spaces (Abdelkarim, Alsahira & Watson, 2018) are the initial outputs from the approach. Reinterpretation authors have all been actively on board as learners and as producers, can be rightly proud of their collaboratively-constructed reinterpretations. The paramount learning from my own critical reflection is that, paradoxically, the very innovativeness, and exciting nature of this endeavour is intrinsic to the inherent possibilities, innate challenges and ultimate persistence needed to fulfil these possibilities.

Co-conclusion

The customary practice in writing about staff-student partnership is for 'staff' to write, citing academics, with quotes from students for their 'lived voices,' although some journals are giving these voices more space (Brooke: 2017). Whilst not intended as an academic research paper, this article is a product of scholarly convention: students' extracts have been integrated at natural points, in particular the section on student motivational drivers. Not claiming these reflections as fully collaborative writing, it seems essential to incorporate some 'un-interpreted' *verbatim*, student reflections as concluding perspectives to the article.

Student reflections: collaboration and reinterpretation

In terms of collaboration, the relationship between those developing the re-interpretations and the author of the original piece also merits consideration. The original author may have views on the most effective form a reinterpretation of their work might take, or wish to highlight particular findings or arguments that they would like to see given an alternative format. It seems important then, to clarify the relationship between the author of the piece and the reinterpretation process, as their input may make for more effective, more useful reinterpretations.

The ways in which the journal is circulated may have an impact on approaches to re-interpretation in order to address the aim of reaching a wider audience. For example, if social media will be widely used to promote particular journal submissions, then re-interpretation might be focused on formats which can be easily engaged with on those platforms – extremely detailed diagrams or infographics, for instance, might not work as well.

Student reflections: Different skills

I was quite surprised at the ease of which undergraduates, postgraduates and academic professionals were contributing towards building the design of the reinterpretation journal and each person had something very useful to share despite their different academic group. Especially with a project of this kind - opening up scholarly articles to those more unfamiliar with the subject, be it undergraduates or academics of a different discipline - there is scope to realise the true benefits of a student-staff collaboration. The different skills pertaining to each group have neatly come together in our endeavour so far to develop quite an exciting prospect. So far our journal looks like it will be a creative approach to accessing education which not only promotes the virtue of broadening our intellectual interests but also celebrates the successes that come out of respectful and diligent work between students and staff in higher education.

Student reflections: Excited for the possibilities

From the first meeting, workshop and email correspondence, my knowledge and understanding of the aim of the journal has become solidified. At the beginning the possibilities and outcomes were unclear, but what was clear was that this endeavour was about shared interest and partnership between

students and staff. Most importantly it was apparent to me that, I as an undergraduate was an equal to the staff in this partnership. Furthermore, the role of the reinterpretation author highlights the importance of student perspectives in discussions about teaching and higher education. Now following weeks of information exchange and discussions, I can wholeheartedly say, I am excited for the possibilities and outcomes that can develop from this venture.

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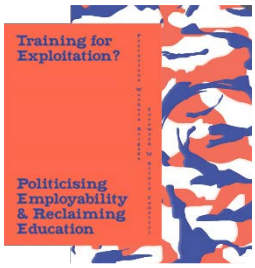

Rooney, S. G. (2018). [Review of the book *Precarious Workers Brigade (2017) Training for Exploitation? Politicising Employability & Reclaiming Education*, by the Precarious Workers Brigade*]. Journal of Learning and Teaching in Higher Education*, *1*(1)

BOOK REVIEW

Precarious Workers Brigade (2017) Training for Exploitation? Politicising Employability & Reclaiming Education

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Stephen G. Rooney[1]

[1]steve.rooney@leicester.ac.uk, Leicester Learning Institute, University of Leicester.

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Review

The Precarious Workers Brigade's (PWB) Training for Exploitation? Politicising Employability & Reclaiming Education is a rare thing indeed: a collection of practical educational resources designed to enable students to engage critically with what has become one of the most dominant agendas in contemporary higher education (HE). Which is not to say that critique of the employability agenda is itself rare. On the contrary, there is a wealth of scholarship questioning many of the assumptions underpinning, and claims made on behalf of, this agenda. Before turning to the PWB's work, then, and in order to set it within a broader context of existing critique, it is worth outlining briefly the issues this scholarship raises.

Some authors contest, on conceptual and empirical grounds, the veracity of popular representations of the so-called "knowledge economy" and the kinds of work it typically affords, as well as the somewhat simplistic assumptions often underpinning claims of increased labour-market demand for "graduate-level skills" (e.g. Naidoo, 2010; Brown, Lauder, & Ashton, 2011; Tholen, 2014). Others point to how current preoccupations with students' "possession" of supposedly "transferable" skills, attributes, personal qualities etc. (often expressed in bizarre, periodically adjusted, top-ten lists) fail to provide a theoretically coherent or empirically supportable basis for explaining and understanding transitions between education and different forms of waged work (e.g. Hager and Hodkinson, 2009; Clark & Zukas, 2012; Holmes, 2013; Finn, 2016). A further common line of critique concerns employability as an ideology and subjectifying discourse. It argues that the employability agenda works chiefly to reproduce certain hegemonic, neoliberal values and practices, reducing student learning to an "investment" in competitive human capital, and compelling students to fashion subjectivities according to the demands of contemporary capitalism. In doing so, so the argument goes, the employability agenda also helps to obscure behind references to socially neutral "skills and attributes", the important roles that class, gender, race etc. play when it comes to labour-market entry and career progression – a process which, in turn, shifts onto individuals the responsibility for the outcomes of continuing structural inequalities. Last but not least, these critics argue, employability discourse serves to legitimise and normalise contemporary realities of insecurity and exploitation via appeals to the supposed virtues of personal "flexibility", "adaptability", "resilience" etc. (e.g. Moore, 2010; McArthur, 2011; Allen et al., 2013; Chertkovskaya, Watt, Tramer, & Spoelstra, 2013; Gerard, 2014; Frayne, 2015; Heaney, 2015; Noonan & Coral, 2015).

Vital and instructive though this extensive and growing body of critical scholarship is, however, few have so far sought to turn critique to more practical and educationally transformative ends. Enter Training for Exploitation? with its impressive range of activities designed to bring into the open the socio-politics of employability, and the ways this socio-politics relates to students' own current and future working lives. (Before turning to the activities themselves, it is worth also noting that the book's brief introduction offers an accessible and digestible summary of many of the critiques outlined above and, as such, serves as a valuable educational resource in its own right.) Influenced by a range critical pedagogical and action research theories and practices (brief summaries of which are provided in the book's introduction), the theme binding together the materials is, as the title suggests, exploitation. The exercises – which utilise a welcome combination of visual and text-based stimuli –

> "…few have so far sought to turn critique to more practical and educationally transformative ends. Enter *Training for Exploitation?* with its impressive range of activities designed to bring into the open the socio-politics of employability, and the ways this socio-politics relates to students' own current and future working lives."

invite students to collaboratively investigate, reflect on, and challenge various forms of work-based exploitation as well as the ways in which mainstream employability discourse can work to obscure and/or legitimise these.

Whilst acknowledging the importance to students of securing employment and developing their own careers, the book's "authors" (part of the PWB's ethos is to eschew individual claims to authorship) make no secret of their counter-hegemonic, activism-oriented intentions in producing it. Activities range from short discussion exercises around key issues, to longer, enquiry-based projects in which students investigate topics in greater depth. The former include activities in which students analyse internship/volunteering adverts in order to discuss, for example, how the language of "enthusiasm" and "flexibility" can act as benign-sounding euphemisms for various forms of exploitation (pp. 38-39). Another of the shorter exercises invites students to script a photo-story featuring images of different, more-or-less powerful participants in common workplace scenarios (pp. 41-43). Larger-scale activities include setting up People's Tribunals to research the practices of a particular industry or sector and the experiences of workers in these. This exercise is supported by links to concrete examples of previous tribunals, including one conducted by staff and students at a UK HE institution (pp. 56-57). Throughout, there are also numerous resources designed explicitly to support and enable practical political action in response various forms of exploitation. One potential limitation of all this is that the imagined cohorts are creative arts students. However, given that the broader themes explored in the exercises apply across a range of disciplines and professions, the activities themselves should be readily adaptable beyond the particular contexts set out in the book. In most cases, I could easily imagine situations in which the exercises could be re-formulated for the contexts I teach in.

Of course, the book's persistently and unapologetically politicised and critical stance on employability may well invite the complaint that it fails to offer a "balanced view" – a complaint we might counter by asking: when are similar calls for balance ever levelled at those numerous texts which take as given the employability agenda's moral and intellectual legitimacy, and concern themselves simply with how to ensure one remains as "attractive to employers" as possible? This is not to deny the practical utility of such texts; they often provide much useful and valuable advice. It is merely to point out that choosing to work largely within the logic of the dominant discourse of employability is no less political, and no more "balanced", an exercise than choosing to work against it. As numerous critical pedagogues have long pointed out, and will no doubt feel compelled to keep pointing out, there is no such thing as a politically neutral educational practice (for a comprehensive overview of this tradition see Darder, Baltonado, & Torres, 2009). A less easily dismissed omission, however, is the absence of any explicit references to how some within the field of careers guidance and education have themselves, and for some time now, engaged in a serious and thoughtful critique of how their work risks being mobilised in order to serve a reductive and neoliberal agenda, and how advisers and educators might begin to work to challenge this (see, for example, Irving and Malik, 2005; Sultana, 2014; Hooley, 2015). This minor quibble aside, Training for Exploitation? provides a timely set of materials for those with an appetite for action-oriented critique. It should also help provoke critical reflection among those for whom more mainstream formulations of the employability agenda have become axiomatic. Many of those currently charged with implementing the employability agenda "on the ground" (careers professionals, academics, educational and learning developers et. al.) will, I am sure, find the book and its contents a welcome ally in the efforts they already make to foster more critical and nuanced approaches of employability.

If HE is indeed to be the space for critical thought and action we claim we want it to be, this must surely include interrogating more honestly and openly an agenda that so dominates current policy and practice. This is necessary not least if our much rehearsed commitments to social justice are to carry genuine meaning, and move beyond potentially dubious alignments with the largely empty

promises of "social mobility" (Brown, 2013; Reay, 2013; Savage, 2015). Training for Exploitation? offers a provocative, practically-focussed, necessarily incomplete, but nonetheless invaluable, resource in helping us to provide such a space.

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