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Developing the Higher Education Curriculum

Research-based Education in Practice

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Inspiring learning through research and enquiry

The Summer Undergraduate Research Fellowship (SURF) at Xi'an Jiaotong-Liverpool University (XJTLU)

James Wilson, Yao Wu, Jianmei Xie, Dawn Johnson and Henk Huijser

Introduction

Research skills can be seen as an umbrella term for a range of skills, such as problem solving, critical thinking and analysis. Since the latter part of last century, there has been an increasing concern in the higher education sector, and among governments and employers, about whether university graduates were being adequately prepared for current working environments and demands of the twenty-first century (Katkin 2003). In the US, this concern culminated most influentially in the work of the Boyer Commission on Educating Undergraduates in the Research University (1998). However, similar concerns have been voiced in other national contexts. More recently for example, in the UK context, Michael Arthur (2014), president and provost of UCL, has noted the urgent need to bridge the perceived divide between teaching and research, arguing that to do so requires the integration of research into every stage of undergraduate degrees. He identifies three main benefits or motivations for doing so:

One motivation is to help equip graduates with skills such as critical thinking and problem solving that will aid them in the workplace. Another is to help students feel inspired and valued. A third

is to help UCL in the increasingly fierce and global competition for the best students and researchers, by leveraging the university's huge research power in close support of its teaching.

This very much applies in the current Chinese context. China is engaged in significant educational reform (Ryan 2011), and the founding of Xi'an Jiaotong-Liverpool University (XJTLU) and its approaches to learning and teaching is one of the logical developments. This applies in particular to its focus on research-led teaching, and the Summer Undergraduate Research Fellowship (SURF) initiative at XJTLU in turn is an example of this focus.

XJTLU is a joint venture between Xi'an Jiaotong University in China, and the University of Liverpool in the UK, based in Suzhou, China. It merges two different higher education systems. Thus, the university offers four-year rather than three-year degree programmes, to accommodate both Chinese law and English language level expectations. Within this context, SURF offers opportunities for a select group of undergraduate students to work on research projects for 10 weeks during the summer period. While not directly integrated into university programmes, SURF provides students with the opportunity to develop practical research skills related to knowledge they have acquired in class (Healey, Jenkins and Lea 2014). It aims to provide students with an authentic research experience. The key objectives of SURF are:

- to stimulate active research interest and creativity of undergraduate students;
- to provide an opportunity for undergraduate students to support academic staff in their research;
- to provide an opportunity for undergraduate students to develop their practical skills and to apply knowledge acquired in class;
- to provide an opportunity for undergraduate students to present their research findings internally and externally, and to develop presentation skills;
- to boost the reputation of XJTLU's students and student research in the Suzhou region and Jiangsu province where the university is located.

All students are required to present results of their projects at a university-organised event, which involves a public poster presentation. At the end of the event faculty-based winners and overall winners are

announced, based on a vote from a jury, comprised of academic staff from each faculty, and students elect what they view as the best poster. In this chapter, we demonstrate that the SURF initiative aligns closely with UCL's Connected Curriculum framework (Fung 2016; Fung 2017). For example, (1) it allows students to connect with staff at XJTLU and learn about ongoing research; (2) it provides step-by-step guidance and learning activities; (3) some projects are interdisciplinary, allowing students to make conceptual connections between their own subject and other disciplines; (4) students can connect academic learning with wider learning and skills, for example, teamwork, project management, creativity, enterprise and leadership; (5) students can connect with external audiences through their poster presentations; and (6) through working on their projects, students often gain a sense of belonging, of being part of a learning community at XJTLU and beyond. However, SURF is not integrated into undergraduate degrees in the way Arthur (2014) imagines, and is rather based on voluntary participation, which imposes certain limitations.

Overall, we see SURF as a first step in a process of developing a broader research-based learning and teaching approach at XJTLU (Gibbs 2014), and we argue that UCL's Connected Curriculum framework is highly applicable in this transnational context.

Research-led teaching and learning in a Chinese context

Research-based teaching in the context of Chinese higher education is part of a wider agenda of education reform, which is concerned with moving away from teacher-centred and exam-focused approaches (Wang and Byram 2011) towards more active learning and student-centred approaches. As Jin and Cortazzi (2011a: 2) note, China has in recent years officially emphasised 'quality education', including 'a turn to more modern approaches to teaching and learning, including learner-centred ones'. Thus, educational reforms in China in recent times,

have emphasised more active participation from learners in classrooms and collaboration in learning tasks, together with developing a wider range of learning strategies and students' ability to learn independently and with greater autonomy. (Jin and Cortazzi 2011b: 67)

However, such changes do not necessarily have much impact in the short term, for ‘the reform of teaching methodology does not necessarily go hand in hand with a change in teachers’ beliefs, especially where these are closely linked to cultural heritage’ (Li and Cutting 2011: 40). Seah (2011: 172) touches on this when he asks, ‘if students are expected to take more initiative in the learning process, to what extent will teachers be prepared for students to pose “what if” or “why” questions during lessons?’ It is not our intention here to draw a binary between ‘Chinese’ and ‘Western’ approaches to learning and teaching (Yuan and Xie 2013; Wang 2013). Rather, we explore the kinds of teaching approaches that would be conducive to research-based teaching, which involves posing plenty of ‘what if’ and ‘why’ questions; precisely the kinds of questions that students and teachers are expected to ask in a research-based learning and teaching environment. Furthermore, ‘undergraduate students’ participation in hands-on research is widely believed to encourage students to pursue advanced degrees and careers in science, technology, engineering, and mathematics fields’ (Russell, Hancock and McCullough 2007: 548), which in turn is seen by many governments, including the Chinese government, as important in driving (economic) development (Rui 2015). SURF offers early opportunities for hands-on research experience. In addition, it creates a situation whereby ‘students’ projects are derived from the academic staff research interests, [which] helps create a learning environment in which research and teaching are integrated’ (Al-Atabi, Shamel and Lim 2013), which in turn is seen as mutually beneficial.

According to the XJTLU website (XJTLU 2016), if (as a student) you choose to study at XJTLU, you can expect to be:

- encouraged to develop and test your own ideas;
- exposed to the ideas and challenges of your classmates;
- ready to question received opinion, including the opinion of your teacher; and
- equipped with the skills to pursue your own research, by means of projects, dissertations and theses.

This clearly has a research-led focus, which suggests research-related skills such as critical thinking, analysis and problem solving.

Of course, there are different levels of research-led teaching and the various widely cited versions of Healey and Jenkins’ model (2009;

Jenkins and Healey 2005) allow us to distinguish between different levels of 'research' that students are actually engaged in. This runs along a continuum from students as an audience (research-oriented and research-led) to students being active participants in research (research-tutored and research-based) (Healey and Jenkins 2009: 7). The most ideal end of the spectrum, as implied in their model, is 'research-based', whereby students undertake research independently or as part of a team. This in turn raises the question of the development of research skills in the curriculum. In Healey and Jenkins's model (2009: 7) this is covered in the 'research-oriented' part of the model, which consists of 'developing research skills and techniques'. The development of research skills is important in relation to SURF, as SURF aims to offer an 'authentic research experience', in some cases at first year level, but not necessarily any research skills training. Indeed, research skills training at XJTLU is explicitly tied to postgraduate research at masters or doctoral level. At undergraduate level, this skills development is largely implied rather than systematically applied across curricula, for example in the form of a consistent teaching approach such as enquiry-based or problem-based learning (Blessinger and Carfora 2015; Henderson 2016). In relation to SURF, then, research skills are largely assumed or there is an implicit expectation that SURF supervisors will teach such skills. SURF nevertheless offers an environment where students potentially 'are themselves involved in staff research activity, and not just as willing participants in yet another student survey on pedagogic practice, but as active contributors to and/or beneficiaries of that research' (Fuller, Mellor and Entwistle 2014: 384–5). This aligns nicely with some of the benefits of undergraduate research that the Boyer Commission identified.

Initially, the key point that the Boyer Commission (1998: 5) made was that universities were 'shortchanging' their students in several ways, 'most notably the prevalence of models of teaching and learning that fail to engage students, enable them to make connections across spheres of knowledge, or enhance their development of critical skills' (Katkin 2003: 21). This realisation then led to 10 key recommendations in their report (Boyer Commission 1998) that relate to SURF in various ways:

1. Make research-based learning the standard – XJTLU equivalent: promotion of a research-led teaching approach, which is not yet systematically implemented, as noted above.
2. Construct an enquiry-based first year – XJTLU equivalent: SURF is the most explicit example, but is not integrated in the curriculum, so an enquiry-based first year is still dependent on individual

- lecturers, which in turn requires a significant shift in some lecturers' sense of their 'teacher identity' (Li and Cutting 2011).
3. Build on the first year foundation – XJTLU equivalent: a number of students return to SURF in the second or third year, which implies a symbiotic relationship between what they learn in their programmes of study and their SURF projects, and they straddle different elements of Healey and Jenkins' model (2009).
 4. Remove barriers to interdisciplinary education – XJTLU equivalent: apart from SURF, degree programmes are more likely to stay within their disciplinary silos. Not coincidentally, it is SURF's relative 'disconnect' from degree programmes that allows for this potential interdisciplinarity.
 5. Link communication skills and course work – XJTLU equivalent: SURF stimulates students to communicate their research outcomes in a public event, in the form of a poster presentation, and to an interdisciplinary audience.
 6. Use information technology creatively – XJTLU equivalent: there is a university-wide push (coordinated from within the Academic Enhancement Centre by the Educational Technologies team) to use information technology creatively, including in SURF.
 7. Culminate with a capstone experience – XJTLU equivalent: all students at XJTLU are required to do a final year project, which involves independent research, giving SURF students a distinct advantage.
 8. Educate graduate students as apprentice teachers – XJTLU equivalent: some PhD students are involved in mentoring SURF students.
 9. Change faculty reward systems – XJTLU equivalent: SURF would benefit from more direct incentives for lecturers to get involved.
 10. Cultivate a sense of community – XJTLU equivalent: SURF plays a key part in developing a sense of a university-wide research community.

While there are clear ways in which XJTLU can be seen to address most of the Boyer Commission's recommendations to some extent, especially through SURF, there are still significant challenges. For example, while SURF has many benefits for those who choose to participate in it, it is ultimately students' own choice. Moreover, there are not necessarily enough SURF supervisors available nor sufficient funding, so entry into SURF is a competitive process and not every

applicant gets to take part. Thus, only selected students gain this valuable research experience, and even then, they do not earn any direct credit from it towards their degree. Katkin (2003: 27), writing about the impact of the Boyer Commission's Report on undergraduate research, identifies two main challenges: 1) involving significantly more students and determining which students to target; and 2) expanding the pool of qualified [and willing] supervisors and identifying new venues and new resources to support their work. These challenges apply directly to SURF. However, if research-based learning and teaching were to be more systematically implemented across all degree programmes at XJTLU, for example in the form of a consistent enquiry-based and/or problem-based learning approach, it would overcome the first challenge to a significant extent, and it would tackle the first three of the Boyer Commission's recommendations head-on. However, it would also require a significant shift from a teacher-centred, exam-based approach to learning and teaching (Seah 2011), towards a more active learning and research-based approach. Furthermore, it would need to address the often perceived divide between research and teaching, between the teacher as an authority figure and 'dispenser of knowledge' on the one hand, and that same teacher as a 'research partner', on the other (Schapper and Mayson 2010).

Finally, there are two more related issues. Firstly, in our arguments, there is an underlying assumption that 'doing research' and having a 'research experience' at undergraduate level is inherently valuable. However, even though we believe strongly in the beneficial outcomes of an undergraduate research experience, Katkin's (2003) warning, that some would question whether engaging all students in research activity is even desirable, in a context of large student numbers and a related emphasis on direct employment-related skills, should be considered. The other issue relates to different understandings of what research means, to both students and lecturers. Healey and Jenkins (2009) make distinctions between different levels of research activity, and there is a lot of slippage between these different levels of research with lecturers sometimes assuming that they are operating at the research-based level, when in fact they are engaged in research-oriented or research-led levels. The same applies to students. Murdoch-Eaton et al. (2010: e152) found that while 'undergraduates recognise the benefits of research experience [they] need a realistic understanding of the research process'. SURF is designed to provide them with such an understanding.

Evaluating SURF at XJTLU

Methodology

For this study, a mixed-methods research design and approach (surveys, interviews and focus groups) was used, with a primarily qualitative focus, as the aim was to reflect upon a particular instance of educational practice, in this case SURF at XJTLU (Freebody 2006). This study also incorporated the student voice, as we were interested in student perceptions about research in general and about SURF in particular, including student experiences. This study was approved by XJTLU's human research ethics committee and all participants in the study have provided their written signed consent.

Data were collected from a wide range of SURF participants:

- One survey was sent out to SURF alumni from the past three years, to get a sense of the longer term impact of SURF – Responses: 38.
- One survey was sent to new SURF students in 2016, to gauge the reasons why students want to engage in SURF projects and their initial expectations – Responses: 65.
- One survey was sent to academics who acted as SURF Poster Day Judges and Marshals – Responses: 18.
- Two focus groups (four students each) were conducted with returning SURF students. Data collection took place at the beginning of the 2016 SURF period, which explains why no focus groups were conducted with current SURF students, as they had not started yet. However, their voices were captured by the survey mentioned above.
- Two in-depth interviews were conducted with returning SURF supervisors.
- Two in-depth interviews were conducted with first time SURF supervisors in 2016.

SURF in numbers

XJTLU initiated SURF for all departments in 2012, when 36 research projects from eight different departments were carried out during the summer by year 1 to 3 undergraduate students, under the close supervision of academics. Since then SURF has rapidly gained popularity across the campus. From 2013, the university has allocated half a million RMB

(around US\$75,000) for around 70 SURF projects and 150 student fellowships every year. For some projects, one student may work closely with one supervisor, while for others academics and students from different departments work together for up to 10 weeks on projects that are interdisciplinary to varying degrees.

SURF starts every year at the beginning of the second semester by calling for proposals from all academics. Tentative SURF projects are then selected for ethics assessment. Once a list of SURF projects is finalised, an announcement is made for all year 1 to 3 students to apply, and students are subsequently selected by supervisors. During the SURF period, the university organises mid-summer social get-together events for SURF students, as well as a more formal workshop about developing a public academic poster presentation. At the end of each SURF period, a SURF Poster Day is held to allow students to come together to showcase the results of their research projects. This is an increasingly popular event, attended by the broader university community. From 2012 to 2016, more than 600 XJTLU students have worked on research projects, choosing to stay on campus over the summer, making the SURF application process more competitive every time.

Starting in 2016, an international student scheme was piloted under which a non-XJTLU international student was accepted to come to the university to participate in one of the research projects. This summer, a year 3 student from Italy came to XJTLU and collaborated with XJTLU students on a Mathematics project. This scheme is expected to be expanded next year.

What follows is an analysis of the data, broadly based around the themes in the Connected Curriculum framework (Fung and Carnell 2017; Fung 2017).

Theme 1: Connecting with staff and learning about research

In the surveys, students were asked why they participated in SURF. Most students expressed their interest in learning about research from academics, both in terms of the research subject and research methods. Responses to open-ended questions included: ‘to enrich my research experience’; ‘to improve my laboratory skills’; ‘to do research under the guidance of the brilliant professors’, and so on. SURF students are able to connect with experienced academics as ‘research partners’ for a period of two months. This creates highly valuable opportunities for aspiring undergraduate research students.

SURF supervisors were similarly positive about this opportunity to connect with students on a deeper, more meaningful level. One returning supervisor noted:

I think it's great, for both me and my students, they can learn to do research on real cutting edge projects, be trained in the lab in terms of safety, lab skills and time management. The students also get a great opportunity during the poster session to present their work to a diverse range of people, which is great for their future careers. (Supervisor A)

However, some supervisors expressed a level of frustration and divergent expectations in this respect. For example, one first time supervisor (Supervisor B) suggested that the students liked the idea of research, but had very little understanding of what research entails in reality. This supervisor expected the students to come into the project with a certain level of research skills, which was not reflected in reality. He did not feel it was his role to teach them such skills.

Judging from the survey data, many supervisors have a different perspective than Supervisor B's thoughts. The following survey responses reflect a common theme in this respect: 'Not only were research skills improved [during SURF], but it also brought me a great vision of what research looks like'; and 'SURF is a great opportunity to gain a deeper understanding about research.'

Theme 2: Step-by-step guidance and learning activities

Usually, at the beginning of SURF, supervisors and students meet and propose the project plan for the 10-week duration; then, they meet regularly as needed. Students received step-by-step guidance during the projects as a fundamental part of the SURF process, which, as noted above by Supervisor B, was not necessarily everyone's expectation of the process. Student responses during the focus groups with returning students included: 'My supervisor was really helpful in providing daily feedback. He kept tabs on every activity related to the project and would come up with suggestions on problems we encountered'; 'He helped us a lot in theoretical field and with the hardware and we held a regular meeting every week for us to discuss our process and obstacles'.

The step-by-step guidance in particular was commonly mentioned in the survey responses. At XJTU, undergraduates are required

to do a Final Year Project (FYP), and especially the previous SURF students frequently mentioned that the step-by-step guidance they received during their SURF experience gave them a distinct advantage in their FYPs.

Theme 3: Students making connections

Not only do academics get to know students' learning styles better, but students are also able to pursue interdisciplinary research and make connections with students and staff from other departments, an opportunity often not available in their degree programmes. In SURF, academics and students with very different backgrounds commonly work together on the basis of similar research interests. For example, 2015's winning SURF project demonstrated a successful collaboration between a Mathematics supervisor and two Computer Science students. Also, 2016's overall SURF winner was a collaboration between the Department of Urban Planning and Design and the International Business School.

However, divergent expectations mean that this does not always work. Supervisor B talked for example about students not really understanding that their project was in essence a humanities-focused project that relied on research around client behaviour, while the students expected a more technical-based project based around design skills. Thus, while potentially cross-disciplinary connections were made by students, the feedback from this supervisor drew attention to the importance of spelling out clear expectations.

Furthermore, not all projects necessarily lend themselves to interdisciplinary approaches, while yet others are not necessarily appropriate for first year students. As Supervisor C notes:

In chemistry we only allow students who have successfully completed their second year to participate in the SURF projects: this is mainly due to safety, but they also need a theoretical basis in chemistry. After the second year they should have the basics, and I can fill in the gaps on project specific material.

He touches on a common dilemma around project- and enquiry-based learning, where lecturers often feel they need to explicitly *teach* subject-specific material first to provide students with a firm grounding, especially where research involves a certain amount of risk (Blessinger and

Carfora 2015). Others argue that interdisciplinary connections and projects cannot start early enough, and many SURF projects therefore involve first year students (Huijser and Kek 2016).

Theme 4: Connecting academic learning with workplace skills

Some supervisors explicitly embed practical workplace skills in their supervision. For example, one returning supervisor (Supervisor C) noted that in his first SURF meeting with students, they arrived 20 minutes early. This was the first time for these keen students to realise that arriving too early may impede other people's pre-arranged schedule. Thus, while being keen fits well with their identity as a student, it fits less well with their new (SURF) identity as a 'professional research partner'. Of course, this is a highly valuable lesson in itself.

Generic workplace skills, such as teamwork, critical thinking, communication skills and creativity, are key elements of SURF projects. In the focus groups, students mentioned frequently that working in a team on complicated projects was a very rewarding experience. Students learn how to negotiate with team members, combine and merge different goals of the team, communicate effectively and share the research results with a wide audience. When asked about their fondest SURF memory, many SURF alumni mentioned teamwork: 'Teamwork is the most valuable thing that I have learned'; 'cooperating with partners'; 'I worked with my fellow teammates to figure out some software and solve the problem'. One student put it like this: 'The most valuable thing was how to work in a group. This is something that I cannot learn from books and I have to experience it myself', suggesting that this skill can only be acquired by actually working in a team on a project, which is what most SURF projects are about.

From a supervisory point of view, there is perception by some that these generic workplace skills are learned 'on the job', and that SURF provides a perfect opportunity for this. As Supervisor B put it: 'It's quite ad hoc, because you don't have a lot of time actually to teach them these things. So you have to see what they want to do... It's very much learning on the job.' Students may not get many opportunities in their regular degree programmes to acquire such 'on the job' skills.

Theme 5: Producing output directed at an audience

In addition to the SURF Poster Day, where project achievements are presented and celebrated in public, some SURF reports have been turned into successful conference papers or publications, which is a valuable experience for undergraduate students. Focus group responses include: ‘I significantly enjoyed the academic atmosphere through that conference’; ‘a conference paper was published and a patent was claimed by our research team.’ SURF creates many opportunities for first-time research-based experiences for students, like attending an academic conference, or applying for a patent.

Theme 6: Students become part of a wider learning community

SURF allows students to become part of a research community at XJTLU early in their student life, where learning happens in a research-led tradition, rather than through direct teaching as is more common in their regular degree programmes. Supervisor A compared SURF to his own student experience: ‘As an undergraduate student I took part in a similar scheme, the Carnegie scholarship for Scottish students, and I worked in the lab, but we had no poster session at the end.’

Finally, supervisors sometimes recruit PhD candidates who are working on other research projects to support undergraduates’ SURF projects as well, and function as mentors. This further extends the network and links undergraduates into a wider XJTLU learning community.

Conclusion

The SURF journey at XJTLU has taken an interesting path of development and achievement since its inception in 2012. It is evident from the feedback from both students and staff that collaboration, teamwork, community building and skills development have been the core benefits derived from participation in the SURF programme. It has also been noticeable for those involved in the development of the SURF programme over the past few years how the quality of the research, the students’ communication skills and the poster dynamics and design have consistently improved. As is highlighted by a senior academic on the XJTLU website, ‘I think our students’ work matches anything going on at the top international universities around the world. To look at the

posters, you wouldn't guess that they were made by undergraduates and not established researchers' (Professor David O'Connor, Dean of Research and Graduate Studies at XJTU).

SURF appears to be an effective way of providing undergraduates with an 'authentic' student research experience, which is validated by the feedback in this evaluation. The addition of a poster presentation at the end of the period facilitates the development of generic skills that support the more specific disciplinary-based ones learned from the collaboration with their supervisors. As evidenced in the student feedback, SURF has benefited them in the development of their Final Year Projects and has given them a distinct advantage over peers without this experience. Furthermore, it is one of the core factors for success in receiving offers of postgraduate study at prestigious universities around the world.

Analysing the evaluation data through the Connected Curriculum lens has also identified challenges that an innovative project such as SURF brings, thus requiring constant evaluation and change. Major foci for the future will be to examine avenues of funding in order to be able to offer a SURF experience to more students at XJTU and the widening of the SURF umbrella to embrace a larger international student participation. Ultimately, the lessons learned from the SURF programme could be used to develop a more integrative approach to developing research skills as part of undergraduate programmes, which would also align closely with the earlier-mentioned higher education reform agenda in China. Providing students with the opportunity to become involved in research-focused projects at an early stage in their undergraduate studies can only enhance their skills and knowledge, and generate a context in which enquiry, critical thinking and reflection is at the heart of their education.