Improving English as a Foreign Language Education in China with Creative-Science

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Abstract. Professional English is a mandatory module in all Chinese universities, being taught alongside the students major. However, students often find learning English somewhat tedious as it can seem disconnected from their major and aspirations for the future. To try to overcome this shortcoming we have introduced the use of creative science as a means of linking language learning to exploring futuristic technologies with the aim of fuelling their engagement with language learning while at the same time helping them acquire valuable creative-thinking skills. In this paper we describe a two year trial be conducted at Shijiazhuang University where we operated this scheme with two batches of students, reporting our findings which show this approach produces significant learning gains over traditional methods. Finally, we describe our plans for developing an online EFL facility based around an i-Lab n the form of a virtual spacestation.

Keywords. Immersive Education, Creative Science, Science-Fiction Prototyping, Diegetic Innovation Templating, English as a Foreign Language, Innovation Lab

Introduction

English is a mandatory module for science and engineering students in in Chinese universities or colleges. Students normally take this course when in their 3rd or 4th year. This module aims to improve the students' ability to understand and communicate professional knowledge in English [1]. One example is '*Computer English'* which combines specialist English vocabulary for computer technologies with '*Public English*' [2]. In part, this policy is a response to the strategy of the Chinese government for China to be well prepared to compete in the new global economies of the 21st century [3]. Likewise, the intensity of global competition is driving a need for employees to have good innovation skills. Creativity is an important element of innovation. Given creative topics are often associated with pleasure; its inclusion in academic disciplines offers the possibility of making them enjoyable, while introducing valuable innovation skills. The question this paper considers is, how might a combination of '*English as a Foreign Language*' (EFL) and academic disciplines be infused with creative processes?

Creative writing in the form of science-fiction or fantasy has often been linked to product innovation, most popularly evidenced in TV programs such as Star-Trek that were said to be the inspiration behind innovations such as Motorola's *StartTAK flip-phone* (based on Star Trek's flip-open communicator) and the *Police Taser* (based on

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Star Trek's Phaser which can immobilize an adversary) [4]. Moreover, many scientists and engineers cite science-fiction as something that influenced their career choice.

Thus, we argue that combining science-fiction with science-fact offers an effective way for scientists or engineers (or indeed anyone) to study EFL, a hypothesis the rest of the paper will explore. Furthermore, we argue that delivering this package via online immersive reality offers a way to benefit a wider set of students.

1. Related Work

Traditional '*Computer English*' lessons in China are often conducted using the grammar-translation method where the teacher translates sentence-by-sentence and explains language usage. While this may have pedagogical merit, the process can sometimes prove somewhat tedious, with students lacking motivation which undermines the good intentions of the teacher [5]. In order to develop technology-enhanced pedagogy and innovative approaches to teaching and learning professional English, many strategies have been tried by researchers. For example, Zhou [5] introduced the eliciting technique, used in EFL (English as a foreign language), to '*Computer English*' classes in order to increase teaching efficiency. This involves drawing out information and language from the students, rather than giving it to them, which is regarded as being more effective than teachers' simply explaining [6]. Hart et al. [7] pointed out that English language learners experience the added burden of trying to learn science in a language they have not yet mastered. Lee et al. [8] proposed that coupling science vocabulary teaching with science activities (e.g. scientific thinking and questioning) was a more effective approach. In this vein, Jian & Yuan [9] utilised problem-solving as a means to exercise language and stimulate the students' interest in scientific research and innovation. Kohno & Johnson [10] adopted the Science Fiction Prototyping (SFP) approach within a computer security course, showing that SFP can serve as a bridge for broader contextual and societal thinking about computer technologies. Wu introduced an ideation methodology called an *Imagination Workshop*, to teach business innovation, a session framework we have adopted in our work [11].

2. Course Background and Goals

Our paper describes our effort over the last two years to introduce creative science as a tool for teaching '*Computer English*' to students at Shijiazhuang University in China. The course, like elsewhere in China, is a mandatory and is normally delivered in the 3rd or 4th year, although it can occasionally be found in the 2nd year. As such students will have taken some earlier courses relating to their specialism (Computer Science, in this case) and at least one more general English curriculum course. *Computer English* courses are fairly similar across Chinese 'universities and generally include basic computer science.

Our work builds on earlier formats of *Computer English* courses but differs in one essential respect; the language and science are unified through the use of a science-fiction or science-fantasy writing thread that is designed to provide an engaging and useful focus to stimulate the students' leaning interest by engaging with their imagination and visions for the future, cultivating their innovation capabilities and

English language proficiency with the aim of benefiting their careers and, as part of the bigger picture, the national economy.

3. Cultivating innovation skills through creative science

Science-fiction or science fantasy has been shown to be an effective innovation tool for creating designs that are sensitive to the needs of people and society [12]. There are two popular approaches, *Diegetic Innovation Templating* [13] which uses pre-existing fiction (mostly written for the purpose of entertainment) and *Science Fiction Prototyping* that involves writing bespoke fictions [14]. In our current course we focus on the latter, *Science Fiction Prototyping* (SFP), since it involves the process of writing. In this approach the writer creates a fictional story to that extrapolates a technology, business or social setting forward in time, pushing the writer to think deeply about the interactions between people and the innovations in question while at the same time exercising a rich technical written and oral vocabulary, which is at the heart of language learning [15]. Thus, we argue that science and engineering students (and perhaps others) can benefit from the SFP approach to language learning as, apart from acquiring language skills, students gain a creative skill set, which they can utilise for innovation activities. Thus, we argue that science-fiction is a good fit to the skill set we are trying to impart to students since it contains elements of technology and language and, of course, has traditionally inspired generations of scientists and engineers, who have grown up in a diet of science-fiction that has sometimes been the inspiration for them following science and engineering careers.

Therefore, we decided to explore the use of SFP as a vehicle to motivate students' interest in learning language while cultivating their creative talents, a process we elaborate on below.

4. The Creative Science 'Computer English' Classes

We structured the *Creative Science Computer English* classes (CSCE) around three main elements; *imparting an understanding of creative science* (section-1), i*ntroducing computer technologies* (section-2) and *formal language learning* (section-3). Of course, these sections have some overlap as, for example, all elements of the course were delivered in English, and so language learning permeated everything. This paper will focus on the aspect of the course that concerned teaching creative skills (section-1) since that is where the novel contribution of work occurred and will not provide a detailed account of the teaching of computer technologies or language aspects which are fairly standard.

The creative science section of the course (section-1) revolved around the students writing short science fiction stories based on a concept they generated through brainstorming. To support the lectures, there were several assignments that walked the students through this process. In brief, the SFP method concerns writing a short fictional story, set in the future (typically 10-20 years out), around an idea that targets the generation of a new product, business or social enterprise. Such stories are different to the traditional novel as they act as a prototype for people to assess the value of the proposed innovation. In some respects SFPs are "*what if*" questions. SFPs vary in

length from µSFPs that can contain as few as 5 words to mini-SFPs that can be as long as 12 pages [16].

4.1. Micro-Fiction (µSFP) Assignment

One hundred and sixty students attended the *Computer English* class at Shijiazhuang University. They were divided into 24 groups of either 5 or 7 people in which their first task was to brainstorm ideas for new innovations using the *Imagination Workshop* approach first proposed by WU in 2013 [11]. This process involved the students selecting one of a number of themes (eg smart cities), discussing issues (from a 'thought-exercise' question template) followed by a brain-storming session which produced a number of ideas for the students to consider. Then, as individuals, they selected their favourite ideas for which they wrote a µSFP (in this case <30 words long) [16]. Additionally, students were asked to provide a short explanation of the SFP (<100 words). The final task of the µSFP session was for each group to debate which idea to take forward to more detailed mini-SFP (10-12 pages). The template that students used for creating µSFPs is shown in Figure 1.

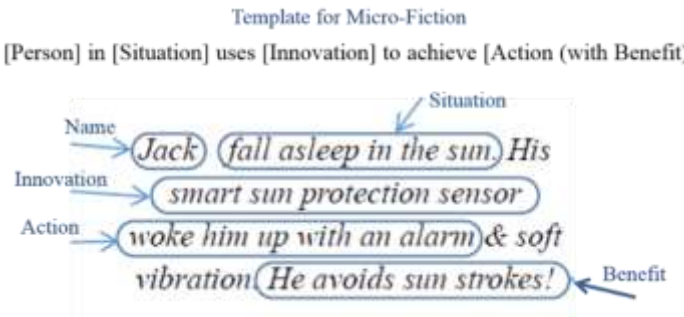

Fig. 1. A simplified template and example of a µSFP

4.2. Example – The 'Smart Vest'

Having generated their µSFPs the students were then required to expand it into a mini-SFP comprising between 10-12 pages, which included a more detailed story together with illustrations, introduction, summary, references and a rational. In this case the students did this by using an '*SFP Box Template*' devised by Jennifer O'Connor of the University of Ireland, Galway, which is basically a form-like template that students complete [17].

By way of an example, Group 1 proposed a *smart vest,* see figure 2. Essentially, as the name implies, this was a wearable vest that would be embedded with different networked sensors. The students envisaged the *smart vest* could be used to monitor users' vital signs such as heart rate, blood pressure, body temperature and mood, which are communicated via a network. However, as this is a somewhat futuristic SFP, they added an imaginative leap whereby the vest was attached to an inflatable balloon that could act as an aerial (Balloon Network) for people in more remote regions (eg holiday makers or explorers hiking in remote areas). They even wondered if the balloon might be used to lift older people to their feet after a fall. Of course much of these features are rooted in the fictional nature of the SFP which, even if not realisable, act as food for innovative thought and exercise their language.

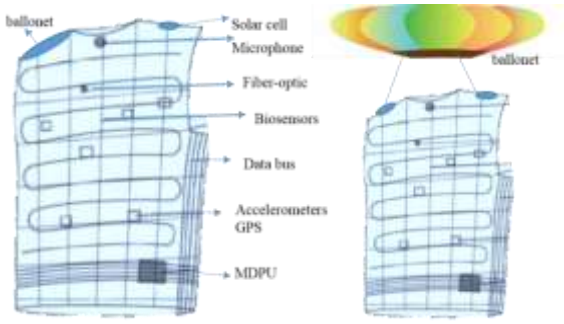

Fig. 2. Student sketch of the '*smart vest*'

Group 1 had five members who wrote the following µSFPs based on the smart vest (unmodified, to show illustrate the level of language).

- **µSFP-1**: *Bill is 90 years old. One day, he was tripped on a stone when he walked outside, his smart vest rises him up. He avoids a dangerous fall*.
- **µSFP-2**: *Tom is playing football on a sunny day. But it is raining and windy suddenly, his smart vest releases warm air automatically. He avoids catching cold and falling ill.*
- **µSFP-3**: *Peter is 80 years old and a dementia patient. His smart vest reminds him when he forgot some important things, so he is still living at home independently*.
- **µSFP-4**: *Mary is travelling in USA first time. She communicates with the GPS system embedded in his smart vest via microphone. She saved lots of time for looking a map.*
- **µSFP-5**: *Steven encountered the traffic on the business meeting way. He left the car to his driver and flew to the meeting by pressing the ballonet button on his smart vest. He arrived in time*.

These are just a few examples taken from the 160 µSFPs we received which are provided to convey the type of imaginative material that the Shijiazhuang University students produced from the Imagination Workshop. We have not included examples of mini-SFPs since we don't have sufficient space (they each comprise 12 pages each) but to illustrate their standard, one was accepted for publication in a workshop of the International Intelligent Environments conference [18]. Of course not all their ideas are neither novel nor feasible; even their English expression and grammar contains errors. However, the main purpose of this course was not to generate innovative products, rather it was an exercise to improve their professional English communication skills, while to cultivating their creative thinking skills. This scheme enabled both aspects and was recognised by the management of Shijiazhuang University as being a big improvement on their earlier method of teaching '*Computer English*', which is explained in the following section.

5. Evaluation

In order to assess the effectiveness of the '*Creative Science Computer English*' (CSCE) methodology, students' overall language and innovation abilities were

assessed from 5 key skills (listening, speaking, reading, writing, and creativity). Results were reported using a 5 point Likert scale (5- very good, 4- good, 3- modest, 2- limited, and 1- extremely limited), based on the criteria described in Table 1.

Score	Listening, Speaking, Reading, Writing			Speaking		creativity
	vocabulary	grammar	understanding	fluency	pronunciation	ideas
5	Full range and high precision	Consistently accurate structures	Fully understood	Full and varied vocabulary, no hesitation	Effortless and easily understood	Wholly original
4	Occasional inaccuracies	Occasional basic errors	Occasional minor misunderstanding	Occasional repetition or hesitation	easily understood throughout	Mostly original
3	Some inappropriate choice	Some persistent grammatical mistakes	Some comprehension problems that undermine overall understanding	Moderate repetition or hesitation	Mostly understood throughout	Some discernable originality
2	Frequent errors in word choice	Frequent errors	Frequent & significant comprehension problems	Frequent hesitation	Frequent mispronunciations	Mostly based on existing ideas
1	Insufficient vocabulary to communicate adequately	Errors obscure meaning	Failed to understand anything significant	Unable to assemble intelligible sentences on the fly	Mostly unintelligible	Wholly based on existing ideas

Table 1. Criteria for assessing overall language skills and creativity

All the language skills were evaluated from three perspectives; vocabulary, grammar, and understanding. Additionally, speaking was assessed based on two facets; fluency and pronunciation. The student's creative ability was evaluated by a panel based assessment of the originality of their product innovation ideas. To provide a benchmark for comparison of our findings, we organised the students into two groups; one group were taught using the traditional method (ie a teacher reading an English

book, translating it into Chinese), and the other group were taught using the SFP method introduced in this paper. Both groups were assessed using the evaluation criteria introduced above and our findings, including comparison between these two groups, are presented in Figures 3 and 4. Figure 3 shows the performance of the students' English skills for listening, speaking, reading and writing. In the traditional approach the methods involved reading and translating an English book whereas in the SFP approach, students were involved in writing their own stories based on reading and group discussions, as introduced earlier in this paper.

Figure 3 shows that by using the SFP method a higher percentage of students' achieved performance point 3 & 4, while gaining the bonus of cultivating their creativity, a significant improvement over the traditional method. For example, when the SFP method is compared to traditional approach, for higher proficiency at point-4, the following improvements were found: in speaking (15% vs. 2%), in reading (23% vs. 10%), in listening (10% vs. 0), and in writing (30% vs. 20%). On the contrary, the SFP method reduced the number of lower scale occurrences at point 2 compared to traditional method as follows: listening (30% vs. 80%), in speaking (25% vs. 73%), in writing (5% vs. 12%). For the creativity, 2% students got 5 point, 20% got 4 point, 60% got 3 point, and 18% got point 2, as shown in Fig. 5 (the traditional method did not include creativity cultivation).

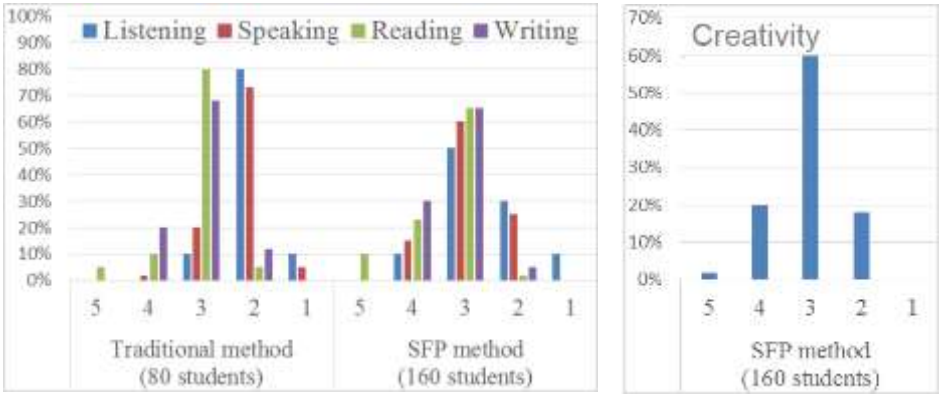

Fig. 3. (left) Comparison of teaching methods. **Figure 5** (right) Assessment of creativity (note: the traditional method did not include creativity cultivation).

Thus, it is apparent that the SFP method results in an overall upward movement of the centre of gravity for student attainment, from the low performing point 2 to the higher performing points 3 to 4. From this we deduce the SFP method introduces greater improvements in the more active aspects of language (eg writing and speaking), which were areas that SFP excel at. Apart from the language aspect, the other benefit of using SFP is that it increases student motivation by integrating language, technology and the students' aspirations. Something we didn't record, but was clear to our teachers is that the SFP based course was much more enjoyable for all concerned which contrasted positively with earlier experiences! The other major advantage was the ability to train the students in creative skills, something that was missing entirely from the traditional approach.

6. Future Plans

The *Creative Science Computer English* course, described in the preceding sections of this paper, is supported by a textbook published by Tsinghua University Press [3]. At the heart of this method is an ideation process (eg brain-storming) which, in its most ideal setting would be conducted by each group in an independent space without interference from other groups. Clearly, in most situations that is impossible because of the physical space required. For example, in the case of Shijiazhuang '*Computer English*' course, their 160 students would require some 23 rooms (assuming maximum group sizes of 7 students), quite apart from any supporting facilities that would be required. Thus, groups mostly share a common space by, for example, operating in different areas of a room. Also there is a movement in academia to widen access to educational resources by making some resources available online. This has led us to creating an online virtual reality version of the '*Creative Science Computer English'* classroom; '*The HEX Spacestation*'. In brief this is a virtual-reality implementation of an innovation-*lab* (i-Lab); an "*inspirational facility designed to transport users from their everyday environment into an extraordinary space encouraging creative thinking and problem solving*" [19]. In our case this takes the form of a virtual-reality spacestation containing an almost unlimited number individual rooms, each outfitted with ideation facilities such as a communal electronic white-board, anonymised editing stations (so ideas and comments can be written to the white-board without identifying the writer) and facilitator tools for managing and archiving the sessions.

The prototype was implemented as a MOOC-style cloud based virtual world using the Unity-3D online gaming engine. Students log into the environment via a link from a private area of the Creative Science Foundation (CSf) website. The details of this platform are beyond the scope of this paper but can be accessed elsewhere [20].

7. Discussion and Concluding Remarks

This paper has described how a new methodology for teaching professional English to science and engineering students based on the use of Creative Science. In particular we have described the application of science fiction and science fantasy to supporting teaching 'Computer English' to students at Shijiazhuang University in China since 2013. In writing this paper we have outlined several benefits accruing from the use of SFP for teaching language which we now summarise.

First, through SFP work, students were motivated to undertake original writing and public speaking in English. In China, although English classes are offered from primary school onwards, most focus on English grammar and book reading. As a result, readers of this paper might find it surprising to learn that at the beginning of these *Creative Science Computer English* classes, none of the students could answer questions in English using their own words, rather they needed to read sentences from the book and couldn't understand what the teacher was talking about! This is simply a consequence of the traditional Chinese teaching model where, at school, the teacher reads an English book, translating it into Chinese. Of course, as a result, there were no volunteers to give a presentation for their early assignments in English. However, from the middle of the first semester onwards, students were actively participating in the class discussion, and giving presentations for the assignments. Both listening and

speaking are particularly important for foreign language learning, an area that the group-work aspect of SFP supports particularly well.

Second, students developed the habit of creative thinking and attained some elementary research ability which would not normally have been included in the Chinese undergraduate curriculum. Initially, the students (and some staff) thought that it would not be possible for second year undergraduate computer science students to write a paper in English embodying creative ideas in only 32 class hours spread over 16 weeks. In fact, all the students managed to submit a mini-SFP (ie a 10-12 page English narrative, together with verbal presentations and discussions) with one student publishing a paper in an international workshop (CS'14).

Thirdly, our results shown in figures 3 and 4 show considerable learning gains that by themselves make a strong case for the wider adoption of these methods.

In terms of the wider context, our methods are generic relying only on elementary ideas in language, technology and creative writing. What is unique in our work is the combination of these elements into a coherent methodology; *Creative Science based Language Learning* (CSLL). As such we argue that the results achieved in our work are transferable to other disciplines and other languages where students need to learn foreign language. Of course we have only explored this methodology within the context of teaching English language to Chinese speaking computer science students but we hope the promising results that we have shown will to encourage others to take this method forward into other languages and disciplines.

Concerning our future aspirations, we plan to continue refining these ideas and adding to the materials available for teachers wishing to adopt this method of teach English, especially adding to the online material available to users of our textbook. We are also interested in collaborating with other people in expanding the usage of these methods into other disciplines and languages and would welcome approaches on this. As explained earlier, one significant development we are working on is the creation of a MOOCs style virtual-reality teaching resource in the form of an online innovation lab; '*The HEX Spacestation*'.

Finally, for science and engineering students, the nature of their innovations is invariably of a technical nature ushering in visions of imaginative products that are very much in line with the wider aspirations for Intelligent Environments research, the topic of the host conference. Thus, we hope that conference attendees and readers in general will find these concepts interesting and maybe inspire them to experiment with these ideas themselves.

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References

[1] XIAN, M., & ZHOU, L. F. (2010). Discussion and Research of Continuity Mode of Computer Professional English. Computer Knowledge and Technology, 17, 058.

[2] Wen-fang, J. I. A. (2009). Discussion on Teaching Models of Computer English [J]. Computer Knowledge and Technology, 5, 063.

[3] Shumei Zhang, Vic Callaghan, Hongmei Wang, Bin Hedong "*Computer English Teaching Using a Creative Science Approach*, Tsinghua University Press, 2016, ISBN 9787302422730

[4] Nathan Hurst. (2012). Make It So Draws Design Lessons From Science Fiction. Wired, September 2012.

[5] Zhou Yuan. (2015). On the application of eliciting technique in efl computer English classroom teaching. Curriculum Education Research, V (18), 99-100.

[6] Hill, D. A. (2012). The tkt course: clil module. Elt Journal English Language Teachers Journal, 66(3), 416-417.

[7] Okhee Lee, & Cory A. Buxton. (2013). Teacher professional development to improve science and literacy achievement of English language learners. Theory Into Practice, 52(2), 110-117.

[8] Lee, O., Buxton, C., Lewis, S., & Kathryn LeRoy. (2006). Science inquiry and student diversity: enhanced abilities and continuing difficulties after an instructional intervention. Journal of Research in Science Teaching, 43(7), 607–636.

[9] Jian, L., & Yuan, Z. (2011). The Exploration and Practice in Innovative Personnel Training of Computer Science and Technology. Proceedings of the 2011 Third International Workshop on Education Technology and Computer Science - Volume 01 (Vol.1, pp.295-298). IEEE Computer Society.

[10] Kohno, T., & Johnson, B. D. (2011). Science Fiction Prototyping and Security Education: Cultivating Contextual and Societal Thinking in Computer Security Education and Beyond. Proceedings of the 42nd ACM technical symposium on Computer science education (pp.9-14). ACM.

[11] Wu, H. Y. (2013). Imagination workshops: an empirical exploration of SFP for technology-based business innovation. Futures, 50(3), 44–55.

[12] Callaghan V ""*Creative Science: Injecting Innovation into the IT Industry*", Oxford Journals, ITNOW, Volume 57, Issue 2, pp. 52-55.

[13] P. Zheng V. Callaghan "*The Role of Science Fiction and Fantasy in Facilitating Innovation: Empirical Evidence from China*", Futures, 2016

[14] Johnson, B. D. (2011). Science Fiction for Prototyping. Morgan & Claypool Publishers, ISBN ISBN-10: 1608456552

[15] Zhang, S., & Callaghan, V. (2014). Using Science-Fiction Prototyping as a Means to Motivate Learning of STEM Topics and Foreign Languages. Intelligent Environments (IE), IEEE on International Conference (pp.353-356).

[16] Callaghan V "*Micro-Futures*", Creative-Science 2014, Shanghai Jiaotong University, China, 30th June 2014

[17] Jennifer O'Connor "*On Writing SFPs*", http://www.creative-science.org/wp-content/uploads/2014/09/On_Writing_SFPs.pdf (last accessed 6.5.16)

[18] Liu P., & Zhang S. (2014). Some Thoughts About Future of Intelligent Buildings and Smart Transportation, Workshop Proceedings of the 10th International Conference on Intelligent Environments, pp 247-255, Shanghai, China, 2-4 July.

[19] I. Susnea, E. Pecheanu, C. Tudorie, "*Initiatives towards an education for creativity*", The 6th International Conference Edu World 2014 "Education Facing Contemporary World, Issues", 7th - 9th November 2014., Elsevier Procedia - Social and Behavioral Sciences 180 (2015) 1520 – 1526

[20] Callaghan V, Davies M, Zhang S "*An Online Immersive Reality Innovation Lab*", Immersive learning 2016 (iLRN'16), Santa Barbra, June 27th – July 1st, 2016