TURBOCHARGING THE JOURNEY INTO THE LIMINAL SPACE AND BEYOND

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Abstract

In the last decade, tertiary educational environments have needed to accommodate increasing student numbers [1]. In the context of large group teaching, the challenge for educators is to re-think learning environments and delivery methods such that a student-educator partnership approach is adopted, resulting in deep learning and debate rather than the delivery of a service thereby invalidating the viewpoint that a degree is a commodity rather than a set of skills. [2] states that "students have long experienced a tension between approaching learning with an internal drive for self-development and the external requirement to have the right amount and type of knowledge to operate in the market". Notwithstanding, it is easy for students to fall into a passive role, leaving the educator bearing this responsibility or guidance. [3] recognises that active teaching in large groups has many challenges but concludes that these challenges can be overcome with educators and students working in partnership with a common focus. Whilst the approaches which are used to encourage and foster engagement differ, the authors assert that a pre requisite to deep learning is engagement; a common theme weaving through paradigms such as Active learning, Constructivism, the Flipped classroom etc. [4] contend that formal and informal settings allow educators to develop more opportunities for dialog, which can result in greater learner engagement. [5] argues that the educator needs to create a framework of engagement, so that students are encouraged to spend time in what is known as the Liminal space i.e. the learning journey in the process of mastering a threshold concept (and thereby learning). However, the journey through the Liminal space can either be a positive or negative experience [6]. The length of time spent negotiating this space can be correlated to the type of relationship that exists between the learner and the educator. The student may experience increased insecurities and doubts as they journey through the Liminal space [7]. Rethinking curriculum design and placing the student at the centre of the design process is an instrument to both invite students to enter Liminal spaces and dampen negative experiences thereof.

In this paper, the authors present the results of a student perception survey of 61 postgraduate and undergraduate students (from multicultural backgrounds). The purpose of this survey was to (1) determine their expectation level prior to taking the Lean Systems module and (2) elicit whether or not the classroom based curriculum redesign and delivery methods, both met their expectations and facilitated them in easing their transition through Liminal spaces in the mastery of related Threshold concepts. The authors will also outline the effectiveness of in-class activities which were used as portals or learning thresholds.

Note : Anecdotal commentary from the students is presented in [].

Keywords: Liminal space, student engagement, threshold concept, curriculum design, transformative learning, socialization, lean systems, engineering, deep learning, operational excellence.

1 DEEP LEARNING, LIMINAL SPACES AND THRESHOLD CONCEPTS

The purpose of the early insitutes of higher education, was the cultivation of "knowledge for its own sake—and perhaps even of finding Truth (sic)" [8]. However, there is now increasing pressure put on universities from governments to take on a more economic role and equip students with the practical skills required for their future employability [9][10]. "Students happily acknowledge more mundane goals that basically amount to a better salary and good access to status. They expect, in other words, a pedestrian training adequate to the requirements of the job market" [8]. An article by [11] on the purpose of higher educational institutions agrees that whilst universities need to serve an economic role, they also need to "push forward the frontiers of knowledge". [9] argues that regardless of the economics, the core purpose of a university should be the shaping of graduates with a sound knowledge base, deep understanding and embedded critical thinking and problem solving skills. By equipping students with "both domain knowledge and the twenty-first century skills in order to meet the requirements of a vigorously changing society" [12], they are more able to adapt to a fluid job market.

[13] contends that higher education should transform people's lives. "Higher education should challenge, provoke and inspire" [9]. However, rising enrolment figures, and the need to accommodate larger class sizes [1] [14] has intensified the challenge for educators to design learning environments and delivery methods such that a student-educator partnership approach is adopted, thereby resulting in deep learning, and active participation and debate rather than the delivery of a service. Deep learning is a necessary pre-requisite for the transformation of student lives. Deep learning (in contrast to surface learning) results in higher quality learning. It "involves establishing connections between new information and content and the old ones, organization and structuring of content ideas, cognitive restructuring, schemes, focus on evidence and arguments, establishing personal connections with real world experience" [15]. "Students adopting a deep approach to learning recognize the dynamic and interrelated structure of content to be learned. Learning thus becomes less a process of knowledge transfer than one of exploration, discovery, and, ultimately, growth" [16]. [*A concept is better understood if you participate/experience it rather than memorising notes][It is an alternative source of learning which encourages connections to be made, connections you wouldn't make just reading and listening].*

Obligatory for and intrinsic to deep learning is active engagement. [17] argues that the educator needs to create a framework of engagement, so that students are encouraged to spend time in what is known as the Liminal space. Liminality describes "the transition experiences involved in the process of separating from one (the old) state of being and incorporating into another (the new)" [18]. Liminality is the learning journey in the process of mastering a threshold concept. A Liminal space meanwhile is the space through which the student must traverse in order to move from this old state to a new state. A Liminal space can thus be seen as a "space of Transformation" [19]. The successful exiting of the Liminal space to the new state, coincides with the acquisition and mastery of a threshold concept. A threshold concept meanwhile is a concept "which is critical for a learner's further understanding of the discipline" [20]. [21] argued that it is not possible to engage in advanced learning in a discipline, if the threshold concept for that discipline concept is not first mastered. In order to fully grasp the threshold concept, the student must journey into and through the Liminal space in order to comprehend new academic content to a mastery level that is identified as a threshold. The educator must also mentor, guide and coach the student. Prior to entering the space, a portal must be created and opened by the educator and students coaxed and encouraged to enter. Once inside, the journey experienced by students through the Liminal space to the threshold can either be positive or troublesome and even fraught with fear. The length of time spent in this space can be correlated with the type of relationship that exists between learner/student and educator. Support is critical for students who are unable or who take a long time to find an exit from the space to the threshold. There is a responsibility on both the educator and the student in this co-dependent relationship "as threshold concepts are inherently problematic for learners because they demand an integration of ideas and this requires the student to accept a transformation of their own understanding" [22]. Within the Liminal state [23] identifies that "a metacognitive issue for the student of self-regulation" evolves and [24] states that "both directly by activating control processes and indirectly by influencing the self-regulation process that determines whether the student will get engaged in threshold concepts or not".

2 ENGAGEMENT

Direct learning (i.e. the didactic approach, where the student is the passive recipient of the information) is necessary in circumstances where students have little or no prior knowledge. "Challenging student thinking, guiding them to solving practical problems, and encouraging direct application of material through active learning with the instructor present" [25] are fundamental to teaching and learning paradigms/instructional approaches such as:

- *The Flipped Classroom* - where content is offloaded to students to review in their own time and at their own pace, so that class time can be devoted to the educator and the students engaging in active learning [26].
- *Constructivism* - where "knowledge must be constructed or reconstructed by individuals by trying to make sense of new information in terms of what they already may know" [25]. Constructivism emphasises the criticality of social interaction in the process of learning and cognitive development [27] [28].
- *Active learning* – where the "activities that students do construct knowledge and understanding. The activities vary but require students to do higher order thinking" [29].

Interweaving through all of these paradigms/instructional approaches is the need for engagement and play. “Play will be to the 21st century what work was to the last 300 years of industrial society – our dominant way of knowing, doing and creating value” [30]. Through the use of directed and related group activities, the instruction becomes student-centered with the students becoming active in the process of learning. “Student-centered instruction can lead to higher levels of learner autonomy, performance, and motivation” [31]. Further, engagement equips them with social skills in a more formal context than the normal socialising through clubs and societies. In order to provide groups with an opportunity to engage in dialogue through activities, the barriers of authority and power need to be removed and a partnership approach to learning nurtured. It is important to understand that some students can be engaged and quiet, whilst others can be engaged and vocal [*Activities helped me to remember and get to know people in the class][It helped to improve my communication skills][Every activity has positively impacted on my knowledge criteria*].

3 METHODOLOGY

A student perception survey of 61 postgraduate and undergraduate students (from multicultural backgrounds) was carried out at semester end of a 5ECTS Lean Systems Module. The purpose of this survey was to (1) determine the students’ expectation level prior to taking the Lean Systems module and (2) elicit whether or not the classroom based curriculum design and delivery methods, both met their expectations and facilitated them in easing their transition through Liminal spaces in the mastery of related threshold concepts. The authors also wanted to ascertain the effectiveness of in-class activities as successful portals of learning thresholds. Of the 61 surveyed, there was a 67% response rate (n=41). Of the respondents, 90% were males and 10% were females. The age profile was; 90% 20-25 years of age, 2.5% 26-30 years of age whilst the remainder were greater than 30 years of age. 98% of respondents were full-time students. 15% of the respondents were Biomedical Engineering students, 46% were Electronic Engineering students, 7% were Mechanical Engineering students, 3% were Civil Engineering students, 12% were System Engineering students and 17% were other i.e. international students and energy systems engineering students. Of the respondents, 100% were taking the Lean Systems module as an optional module. The undergraduate cohort represented 39% of the respondents with the remainder being postgraduate students. 27% of the respondents were in either full or part-time employment. International students accounted for 15% of the respondents.

In the following sections, the Lean Systems module and the manner in which classroom based activities were used to turbo charge the journey into the Liminal space and beyond is described.

4 THE LEAN SYSTEMS MODULE

The Lean Systems module is a 5ECTs module, which both undergraduate and postgraduate students from engineering disciplines can choose as an optional module. This module explores the challenges facing organisations in a global extended enterprise, and introduces a number of process improvement tools and techniques that businesses can use to retain competitive advantage and maintain profitably. This module is designed to give students exposure to Lean Systems. It involves formal lectures as well as discussions, exposure to current literature, practical exercises and guest lecturers from external senior management in Industry [*Having guest speakers is a great addition to the module].* Upon completion of this course, students should be able to: develop an understanding of and appreciate the role of Lean tools and techniques in solving real life engineering and business problems; adopt value stream mapping to real life engineering management problems and generate solutions; have a sound base in the current and future state mapping; analyse data in support of lean balancing, lean layouts, action plans and contribute to decision making by advising management using lean problem solving and generate; prioritise alternative solutions for real life operations problems [*We can see the impacts of lean /six sigma in real life];* participate in a workshop on lean gaming and project work; and present Lean solutions to operations problems. The course comprises weekly lectures across 8 weeks and an Industry led Workshop (8 hour - full day). The allocation of hours are as follows; Lecture hours:24, Independent study:80, Associated time:19 and Examination:2 with the total student effort being:125 hours.

4.1 Re-thinking the Curriculum in the context of Threshold Principles

The redevelopment/rethinking of the curriculum was motivated by the readings of [5][19][21] in addition to student feedback citing areas of troublesome content. The application of the four

thresholds principles within the curriculum design (by nature; participative, qualitative, reflective and responsive) was as follows [21][19];

- *Jewels in the curriculum* refer to the transformation points which are defined by the threshold concepts. Transformation points are used to progress from one state to another. The threshold concepts are the jewels in the curriculum as they identify the key areas that need mastery, which in turn can highlight the need for early intervention with troublesome knowledge and conceptual difficulty [32]. From the authors' personal experience, it is easy to forget how students learn and how new and complex theories can intimidate, leaving some in 'total limbo'.

  Action: Student feedback on completion of the Lean Systems module identified concepts which they found challenging. These were red flagged as threshold concepts that needed further clarification in the subsequent iteration of the module delivery. The threshold concepts that mainly seemed to challenge students included; how to visualize and draw a value stream map and the visualization of flow principles.

- *Listening for understanding* involves reaching out to students and 'walking in their shoes' during class time.

  Action: Relationship building took place during the delivery of the module [*I was pleasantly surprised by the engagement between the students and the lecturer*]. As a result of the supportive environment, students were more open to outlining the curriculum content challenges which they faced. This helped to clarify the main threshold concepts. *

- *A holding environment for the toleration of confusion* - Having identified that troublesome knowledge and conceptual difficulty are normally experienced by students and that each student is on a personal journey of learning and understanding concepts, it is vital to provide the necessary supports. Support, in this context, is described as holding students through Liminal states. The research highlights that some students can fear they are alone in not comprehending difficult concepts and can then feel relieved when they discover other students feeling the same way. This early sharing of fear among students is advantageous in providing comfort [*Unsure at first but after the first exercise, I saw the power of the activities. It went better as we had lost the shyness*].

  Action: The author found that some students mainly seemed to find themselves 'stuck' in the Liminal space regarding the transfer of theory to application. When students experience 'being stuck', it can have negative and counterproductive consequences e.g. frustration, anxiety, fear, disengagement, despondency [30]. When students 'become 'stuck', they are unable to progress, while realising that there is 'something' that they need to understand but cannot quite grasp. Researchers further argue that when stuck, students are likely to mimic behaviour past the point of being a positive learning experience [32]. Through conversations and observations, mimicry was detected and a supportive environment was established to hold the students when they were 'stuck' [*When we had problems the activities helped us in understanding the main concepts]*[*By putting the learned theory into practice it gives first hand experiences in dealing with realistic situations].*

- *Recursiveness and excursiveness* - Learning is a journey, where students can step forward and back over a number of iterations in the mastery of a threshold concept.

  Action: A number of approaches were used (e.g. workshop, guest speakers, activities etc.) to turbocharge the journey into the Liminal space in the mastery of the threshold concept. This tri-tactical approach was deployed to engage students and help them overcome insecurities and doubts as they journeyed through the Liminal space [*The activities break the class up and help to keep attention][The activities allowed me to embrace the lean systems and made them easier to learn]* [*Each week had a different activity which ensure engagement in the module*].

4.2 Engagement on the Lean Systems Module

As a precursor to inviting the students to enter the portal into the Liminal space, the relationship between the students and the educator was nurtured. This was underpinned by activities such as 'think, pair, share'. As an example, students are asked to work in pairs; with one assuming the role of the worker and the other assuming the role of the engineer whose responsibility was to calculate standard time. The worker had to prepare the workstation with the necessary tools to complete the work. Meanwhile the engineer had a counting instrument. The objective was to gather the variation of times involved in writing down 2 words; 'Lean Systems'. The worker had to carry out the work (i.e.

writing) and the engineer had to time the activity. Following this exercise and subsequent to the plotting of the time variations on the whiteboard, the R&D team had to inform the class that a new product was to be introduced. This new product would only use half the number of letters compared to the previous exercise. The class was asked if this halving of the workload would reduce the time associated with the activity. In general, all agreed that it should. However, the class did not realise that the activity was more complex in nature and that they would have to write, in its mirror image, every second letter of the words Lean Systems. This activity took additional time and helped the engineering students recognise that new product introduction, increased complexity and reducing workloads would not necessarily reduce standard times. This exercise was also used to highlight the management and reduction of process variability to achieve 6σ or 3.4 defects per million opportunities.

4.2.1 Engagement for the Threshold Concept; how to visualize and draw a value stream map

Value Stream Map (VSM) as a Lean Tool is used to document, analyse and improve the flow of information and/or material required to produce a product or service for a customer. VSM employs a flow diagram of every step of a process. It is used to identify waste, reduce process cycle times, and implement process improvement. The challenge lies in visualising the 'value stream' as VSM visualisation skills are pivotal to the basic concepts of Lean Systems. A specialised VSM workshop was organised which facilitated a flow demonstration. This workshop involved a role playing exercise which presented issues such as; complaints from customers, returned products, untidy workspaces, processes out of sync, and poor performance. Firstly, students conducted a Kaizen on the case using the basic principles of *Plan, Do, Check* and *Act methodology and* set about looking at the 'value' through the customer lens. Both value add and non-value add activities were identified and analysed to determine the performance efficiency of the company. The *TIM WOODS* approach to visualise waste was then conducted after which a *Current State Map was created* using industry-recognised symbols so that the process could be more easily understood. Post-its (which were used to capture the value add and non-value add activities) were transferred to a notice board and a current state map/VSM was developed with the post-its acting as flow. This provided a clear visual picture of process flow. This map can be seen in Fig 1. Once the VSM was structured, an analysis of improvement occurred i.e. value add and non-value was calculated [*Activities provide a different method for interpreting the material. This is due to more information being encoded with the primary information]*.

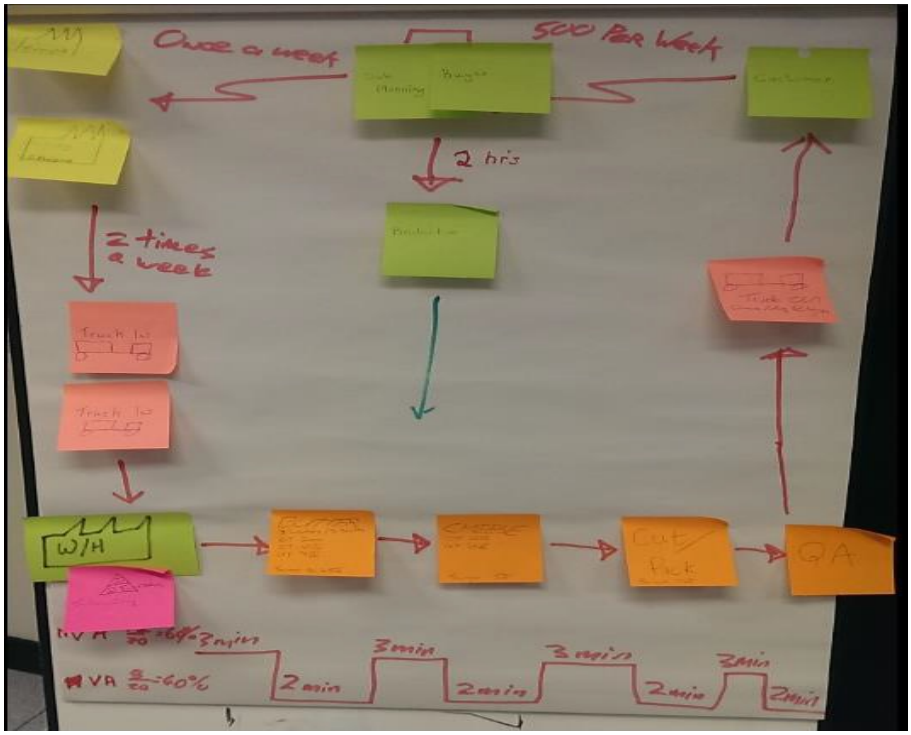

Fig. 1 Value Stream Ma.

Students applied a quality tool i.e. the Ishikawa diagram (Fig. 2) to screen cause and effect. Other tools (i.e. House of Quality, Kanban, SMED, Cell Layout, Takt Time) were also used to identify root causes. A future state map was then created to improve the flow and operational excellence. Students were tasked with benchmarking the old VSM with the new improved VSM, using predefined metrics [*Being able to understand a problem is what makes lean methodologies work*][*The lean workshops helped to link the practical skills using the workplace to what we learned in the class].*

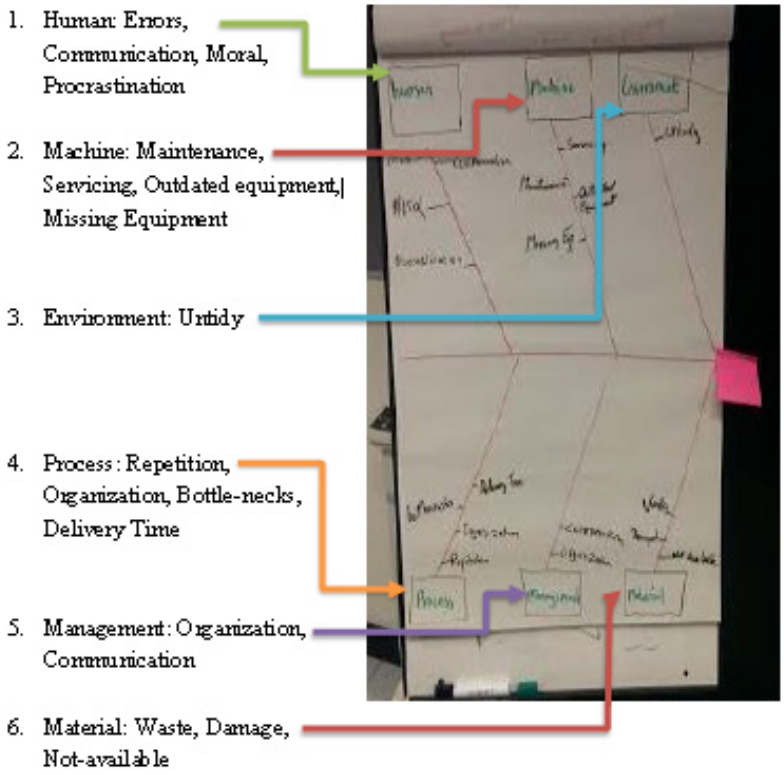

Fig. 2 Ishikawa Diagram.

4.2.2 Engagement for the Threshold Concept; the visualization of flow principles

Flow visualization is a tool which employs a logical systematic arrangement of every step of a process. By identifying obstacles and bottlenecks for improvement and enhanced flow, Flow visualization is used to assess, analyse and improve operational excellence. While students tend to find the visualisation of flow principles challenging, flow visualization skills are critical to Lean Systems analysis. Various activities were used to support this threshold concept including Lego flow and Catheter flow [*It gave a physical representation of push and pull systems][It gives a more visual explanation of what is being discussed in class][I did not expect it to be so much fun].*

Lego Flow Activity

The principles of Lego Serious Play (LSP) were used in the Lego Flow activity to support students as they mastered the flow visualization threshold concept. LSP is founded on four main constructs [17,33]:

1 The importance of play as a way to learn through exploration and storytelling.

2 Constructionism.

3 The hand-mind connection as a path for creative and expressive thinking.

4 The role of the different kinds of imagination.

Lego kits were provided to teams comprising 6 students. Each team had to build a production line containing four Kanbans (Q=10) at each stage, in order to distribute products to a schedule. As the rate of orders increased, this resulted in orders not being filled. Students were encouraged to redesign the line following Lean principles. This activity embedded the concept of flow and helped propel the students through the Liminal space regarding this particular threshold concept [You don't need to

process or imagine how the information would behave since it is happening in front of your eyes thereby making learning very easy].

Catheter Flow Activity

In this activity, students had to deliver a high quality catheter product for medical use. Design drawings, inventory, tools and equipment were provided. Leaders (who were randomly selected) were required to select team members. Each team was then tasked with designing processes to operate to a takt time and additionally, respond to customer demand (see Fig. 3). The use of a real life situation where students were immersed in catheter tube assembly line flow issues, meant that the students applied theory to practice, thereby giving them a perspective about systems under various work conditions. Students were also required to maintain a weekly reflective log book [The activities were a good if not better representation of the text material][They use increased my retention of lean techniques significantly. Similarly in some ways provided real life employment experience of the area].

Fig. 3 Students engaged in catheter flow activity.

The Catheter Flow activity was deliberately 'rigged' to simulate realistic situations. As an example, a number of customer orders contained a purple component rather than a red component. Students assumed that it was acceptable to use the closest component in colour to purple, whilst in fact, the supplier had purple components in stock in the warehouse. However, as the teams did not communicate with the supplier, this resulted in products being rejected by the end user as unsuitable. This error could have had a detrimental impact on an end customer in a real life situation. The Catheter Flow activity was shortlisted as a finalist for the Irish laboratory Awards.

5 DISCUSSION

An analysis of the survey results highlighted that 25% of respondents (n=36) had no experience of classroom based activities. 53% (n=34) had some expectations of the use of classroom based activities prior to taking the module. 100% (n=35) said that their expectations for engagement and interaction were exceeded. 100% (n=36) concurred that the use of a variety of workshops, industry speakers and activities reinforced their learning of the content. Feedback from the respondents confirmed that the development of an effective student-educator partnership is paramount in the creation of a supportive environment where respondents feel sufficiently comfortable to both express themselves and explore concepts as they journey through the Liminal space in the mastery of threshold concepts. 15% of the respondents (n=41) represented the international community. All of these respondents had experience of some form of classroom based activity. While some international students attest that language and dialect can present barriers, 100% responded positively about the use of activities to reinforce deep learning [E*asier for me to see it happening versus talking about it][The activities gave extra knowledge forcing information in a more practical and visual way making it easier to understand*][*I have learned content which I used to despise. After learning and participating in these class based activities I feel enlightened*].

By identifying the main concept challenges i.e. threshold concepts faced by students and using integrated tactics to re-enforce learning, benefits included;

- Teamwork in action.
- Happy and engaged students.
- Resilience and relationship building.
- Creation of a fun space.
- Practical application of theory.
- Deep learning.

Further, the ability to successful traverse the Liminal landscape and master threshold concepts, fostered critical thinking. “Critical thinking skills are the capabilities to think reflectively and judge skillfully, so as to decide what information is reliable and what actions should be taken during reasoning and problem solving” [12]. By traversing the Liminal space and exiting with a mastery of a threshold concept, students were provided with meta cognitive strategies and tools, whilst engaging in higher levels of Bloom's taxonomy (i.e. application, analysis, and synthesis).

6 CONCLUSIONS

The Lean Systems module is a 5ECTs module, which both undergraduate and postgraduate students from engineering disciplines can choose as an optional module. This module explores the challenges facing organisations in a global extended enterprise and introduces a number of process improvement tools for the purpose of operational excellence. The rethinking of the Lean Systems curriculum was motivated mainly by student feedback citing areas of troublesome content. The curriculum redesign was framed within the context of the four thresholds principles of;

- *Jewels in the curriculum.*
- *Listening for understanding.*
- *A holding environment for the toleration of confusion.*
- *Recursiveness and excursiveness.*

The primary threshold concepts identified for the Lean Systems module were; (1) how to visualize and draw a value stream map and (2) the visualization of flow principles. Different activities (e.g. Lego Flow activity, Catheter Flow, workshops, guest speakers, activities etc.) were used to; entice the students through the portal, support them in the Liminal space and turbocharge their exit from this space in the mastery of the threshold concepts.

A student perception survey of 61 postgraduate and undergraduate students (from multicultural backgrounds) was conducted at the end of the re-thought Lean Systems (1 semester 5ECTS) module. The purpose of this survey was to (1) determine their expectation level prior to taking the Lean Systems module and (2) elicit whether or not the classroom based curriculum design and delivery methods, both met their expectations and facilitated them in easing their transition through Liminal spaces in the mastery of the related threshold concepts.

Feedback from the students (n=41) showed a resounding support for the use of activities for the mastery of threshold concepts and accruing benefits of;

- *Deep learning.*
- *Socialisation.*
- *Development.*
- *Mastery of the subject.*
- *Critical thinking skills.*

[*I would recommend my other modules to follow this approach-International student*]

[*Thank you so much for everything. I have enjoyed this module*]

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REFERENCES

[1] D. Reidy, "Projections of demand for full time third level education 2015 - 2029." *Department of Education and Skills.* https://www.education.ie/en/Publications/Statistics/Statistical-Reports/Projections-of-demand-for-full-time-Third-Level-Education-2015-2029.pdf, 2015.

[2] M. Molesworth, E. Nixon, and R. Scullion, "Having, being and higher education: the marketisation of the university and the transformation of the student into consumer." *Teaching in Higher Education* 14:3, 277-287, 2009.

[3] Mulryan-Kyne, "Teaching large classes at college and university level: challenges and opportunities." *Teaching in Higher Education* 15:2, 175-185, 2010.

[4] B. Bevan, and J Dillon, "Broadening Views of Learning: Developing Educators for the 21st Century through an International Research Partnership at the Exploratorium and King's College London." *New Educator,* 2010.

[5] R. Land, “Liminality close up Thought Paper presented for HECU7 at Lancaster University, 2014.

[6] U. Lucas, "Being ‘‘pulled up short’’: Creating moments of surprise and possibility in accounting education." *Critical Perspectives on Accounting* 19(3), 383–403.2008, 2008.

[7] R.G. Land, J, Meyer, H. F Cousin, and P Davies. "Threshold concepts and troublesome knowledge : Implications for course design and evaluation." In *Improving student learning 12 :Diversity and inclusivity (pp. 53–64). .*, by C. Rust (Ed.). Oxford: Oxford Brookes University, 2005.

[8] M. Weber, "On the Purpose of a University Education." *Educational Philosophy and Theory* 48:2, 207-210, 2016.

[9] J. McArthur, "Reconsidering the social and economic purposes of higher education." *Higher Education Research & Development* Vol. 30, No. 6, 737 –749, 2011.

[10] R.T. Pithers, and R. Soden. "Critical thinking in education: a review." *Educational Research* Vol. 42 No., 237–249, 2000.

[11] H. Swain, *What are universities for?* October 10. https://www.theguardian.com/education/2011/oct/10/higher-education-purpose, 2011.

[12] S. Cheung Kong, "Developing information literacy and critical thinking skills through domain knowledge learning in digital classrooms: An experience of practicing flipped classroom strategy." *Computers & Education* 78 - 160 to 173, 2014.

[13] S. Brookfield, *The power of critical theory for adult learning and teaching.* Maidenhead, UK: Open University Press, 2005.

[14] P. Baepler, J. D. Walker, and M. Driessen, "It's not about seat time: Blending, flipping, and efficiency in active learning classrooms." *Computers & Education* 78 - 227 to 236, 2014.

[15] C. M. Bran, and E. C. Balaş. "Metacognitive regulation and in-depth learning. A study on the students preparing to become teachers." *Procedia Social and Behavioral Sciences* 11 107–111, 2011.

[16] M. J. Platow, K. I. Mavor, and D. M. Grace.. "On the role of discipline-related self-concept in deep and surface approaches to learning among university students." Instr Sci 41:271–285, 2013.

[17] P. Kristiansen, P. K. Hansen, L Møller Nielsen, Articulation of tacit and complex knowledge. In: Schönsleben, P., Vodicka, M., Smeds, R., Riis, J. O. (eds): 13th International Workshop of the IFIP WG 5.7 SIG, pp. 77-86. Eidgenössische Technische Hochschule Zürich, 2009.

[18] L.E. Wagner, S. Newell, and K.William.. "Enterprise systems projects: the role of Liminal space in enterprise systems implementation." *Journal of Information Technology* 27, 259–269, 2012.

[19] R. Land, J. Rattray, P. Vivian, "Learning in the Liminal space: a semiotic approach to threshold concepts." *High Education* 67:199–217, 2014.

[20] M. Kiley,. "Identifying threshold concepts and proposing strategies to support doctoral candidates." *Innovations in Education and Teaching International* Vol. 46, No. 3, 293–304, 2009.

[21] R. Land, J. Meyer, & J. Smith, (Eds.).. *Threshold concepts within the disciplines.* Rotterdam, The Netherlands: Sense, 2008.

[22] C. Rust (ed), “Improving Student Learning: Diversity and Inclusivity, Oxford Centre for Staff & Learning Development”, 2003.

[23] D. M. McInerney, S. Van Etten,M. Dowson, “Standards in Education“ IAP, 2007

[24] J. Meyer, R. Land (ed. s), “Overcoming Barriers to Student Understanding: Threshold Concepts and Troublesome Knowledge Routledge, 2006.

[25] M.B. Gilboy, S. Heinerichs, and G. Pazzaglia. "Enhancing Student Engagement Using the Flipped Classroom." *Journal of Nutrition Education and Behavior* Volume 47, Number 1, 2015.

[26] J.E. McLaughlin,and D. H. Rhoney. "Comparison of an interactive e-learning preparatory tool and a conventional downloadable handout used within a flipped neurologic pharmaco therapy lecture." *Currents in Pharmacy Teaching and Learning* 7, 12–19, 2015.

[27] M. Barak, "Science Teacher Education in the Twenty-First Century:a Pedagogical Framework for Technology-Integrated Social Constructivism." *Springer Science+Business Media Dordrecht,* 2016.

[28] H.M. Huang,. "Towards Constructivism for Adult Learners in Online Learning Environments." British Journal of Educational Technology 33 (1): 27-37, 2002.

[29] C. Brame, "Active Learning." Vanderbilt Centre for Teaching. https://cft.vanderbilt.edu/wp-content/uploads/sites/59/Active-Learning.pdf, ND.

[30] P. Kane, “The Play Ethic: A Manifesto For a Different Way of Living” Pan Macmillan, 2011.

[31] Y. Hao, "Exploring undergraduates' perspectives and flipped learning readiness in their flipped classrooms." Computers in Human Behavior 59 - 82 to 92, 2016.

[32] J. Meyer, and R. Land. Overcoming Barriers to Student Understanding: Threshold Concepts and Troublesome Knowledge. Routledge, 2006.

[33] P.K. Hansen, A. Mabogunje, L.M. Haase, Get a Grip on Sense - Making and Exploration Dealing with Complexity through Serious Play. In: Sun, H., Jiao, R., Xie, M. (eds.): IEEE International Conference on Industrial Engineering and Engineering Management, pp. 1593-1597. IEEE Press, 2009.