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Chapter

Leagility in Pedagogy: Applying Logistics and Supply Chain Management Thinking to Higher Education

Roy I. Morien

Abstract

Higher Education Institutions (HEIs) are commercial organisations facing the same operational problems as any business organisation, thus needing an appropriate business model, particularly for the teaching and learning processes which we refer to as the pedagogical system. The Logistics and Supply Chain Management (LSCM) paradigms are suggested as this new business model. The terminology of "agile education", "agile pedagogy", "the agile classroom", and "lean education" imply similar constructs for education derived from the literature on LSCM, and the intention is to overcome the perceived 8 wastes of education, based on the 8 wastes of manufacturing from the lean thinking model. The Internet is discussed in terms of it being both a disruptive and enabling technology for educationalists and students alike. A high level of digital literacy is now required of both. This paper is a discursive discussion, based on personal experience and perceptions of the author in the university sector. The educational research paradigm known as the "teacher-researcher" or "the teacher as researcher in the classroom" is elaborated, together with Educational Action Research, to meet the possible criticism of this proposal and discussion as being based on the personal opinions of the author.

Keywords: agile education, agile pedagogy, lean education, educational leagility, education technology, the 8 wastes of education

1. Introduction

Higher Education Institutions (HEIs) are commercial organisations facing the same problems of customer service levels, and cost inefficiencies, and competition, as any commercial organisation, therefore a radically different view of the pedagogical processes is required for future survival. A pedagogical paradigm based on LSCM for the HEI pedagogical system is proposed.

Even a brief study of the literature and the popular media reveals these competitive threats to the future of many HEIs. From [1] "*... in the current ecosystem, past success doesn't guarantee future success. No institution is too big to fail*". HEIs face daunting challenges, and to ensure financial sustainability, many HEIs are responding with changes to their business models [2, 3]. This is in contradiction to the classical attitude towards education that HEIs are not commercial enterprises, and must

accept that students are customers [4, 5]. HEIs cannot be the "ivory tower detached from the real world" style and must provide job skills, organisational "social" skills, problem-solving skills, know-how, as well as know-what and know-why as well as subject matter expertise [6].

Students pay to attend the HEI, therefore they are the customers. The provision of education is a multi-billion-dollar industry, ranking high in the importance scale of export industries. for example, in Australia, international students generated a record AUD$28 billion in income for Australia in 2016/17 [7].

Clearly, HEIs are commercial enterprises operating as a competitive, commercial industry, and it equally clear that a new model of HEI pedagogy is needed that considers HEIs as competitive, commercial enterprises whose education processes are appropriately seen as being akin to product development, production, and LSCM processes [8].

We also must consider both the disruptive impact of the Internet, and the opportunities that the Internet provides, on current and future scholarship and pedagogy. A high level of digital literacy is now becoming almost an existential requirement for teachers, researchers, and students.

2. Three higher education systems

HEIs have three systems in play; the General Administration System, the Education Administration System, and the Pedagogical System. While being related, these systems can be defined separately as to their function and processes. The application of Lean Thinking and Organisational Agility to the general and academic administrative processes is not controversial, and many HEIs are applying both Lean and Agile to these processes. However, less attention has been paid to applying these to the Pedagogical System, which I have defined below:

2.1 The general administration system

Includes all of the general administrative functions necessary for the HEI to continue operations: HRM, payroll, purchasing, accounting, budgeting, and so on.

2.2 The education administration system

Includes all of the administrative functions necessary for the university to manage student applications, course and subject enrolments, organise teaching timetables, record examination results and grades, and appeals against assessment, graduate research and dissertation submission, and deciding on curriculum.

2.3 The pedagogical system

Includes all of the processes and activities involved in curriculum design, sourcing, development and availability to students, monitoring the learning activities of the students, and the assessment and evaluation activities necessary to monitor student progress and to monitor the quality and success of these processes; i.e. all the teaching, learning, assessment and curriculum matters.

This is the system that we see as being of particular relevance when considering "agile education" or, also terms used in the literature, "agile classrooms" and "pedagogical agility". As joint players in this system, the role of both teachers and students working together collaboratively in the twenty-first century is of great importance.

3. The traditional pedagogical system: Problems and solutions

The pedagogical system in all of the HEIs with which the author is familiar, having been involved in higher education for more than 50 years, have followed a particular traditional and unchanged pattern for decades, if not centuries.

4. A progression of subjects

A course is a series of subjects undertaken by the students, each subject bounded by the time constraint of a teaching term, usually of a duration of 16 teaching weeks, with 2 teaching terms per year with usually a long holiday period over the summer. The number of subjects per term varies, depending on the HEI, with each subject covering a relatively small part of the overall learning load.

Each subject is studied by the whole cohort or "batch" of students with little or no opportunity to "get ahead" by private study or at the student's initiative. This is therefore reminiscent of a batch production system with fixed product output essentially based on the Ford model of production circa 1920. A batch, or cohort, of students enters together at the same time, advances through the course at a designated pace without the ability or incentive to accelerate their learning, and with little or no opportunity for individualistic education according to the student's interest, producing a product well described by Henry Ford's sales motto "you can choose any colour as long as it is black".

The production and LSCM paradigms, together with the new opportunities offered by the Internet, will free up students from the lock-step, batch processing approach, enabling a more student self-guided but mentored approach to teaching and learning, allowing students to advance at their own accelerated or reduced pace: "agile and lean education" thus "leagility".

To achieve this, knowledge units of various kinds including videos, PowerPoint presentations, downloadable lectures and any variety of information, be made available on an Anywhere/Anytime/AnyDevice basis, allowing continuous and longitudinal learning online learning and assessment opportunities. The learning process based on term-length subjects would be abandoned. Students would be able to advance at their own pace, an accelerated pace, or a slower pace, thus overcoming the restraints of the batch or cohort processing production line. Appropriate teaching methods would be applied which would include teachers holding appropriate meetings or having brief seminars and practical sessions to elucidate the subject matter as necessary.

5. Taught usually by a single teacher or lecturer

In each subject, a particular teacher, usually referred to in HEIs as a lecturer, is the Lecturer-in-Charge (LIC), acting alone or with teaching assistants or tutors. The LIC usually assumes "ownership" of the subject with the responsibility to present the required subject curriculum, which presumably is commensurate with what is being taught in other subjects. This "ownership" concept also implies that the LIC of a particular subject may object to "interference" from another lecturer, and may also refuse to assist other lecturers. Thus, teaching often occurs in "silos" without interaction or collaboration. To overcome this problem, teachers would be designated learning leaders, and would work in teaching teams to ensure that the broadest knowledge base would be available to students at any time, in any knowledge unit.

6. In a lecture hall or classroom

The lecturer's primary presentation method is traditionally to have a stand-up lecture on a weekly basis of usually 2 hours' duration. This has often been termed the "chalk and talk" approach, and even, somewhat disparagingly, the "Sage on the Stage" approach. The "teaching" process also includes an associated period of a further 1, 2, and sometimes 3 hours per week, variously termed a tutorial or "prac.", or a workshop or lab, are undertaken by the students on a weekly basis.

There are many problems here which are barriers to quality teaching and learning. Student boredom in such classes is an obvious and often observed fact. Students are required to listen to lectures and attend classes that may be held at inconvenient times and need to attend the lectures or classes on the campus come rain, hail or shine, regardless of the distance the student needs to travel to attend the lecture. Often significant amounts of time are wasted in travel. The fact that students are often engaged in full- and part-time work is also a factor that demands attention.

Classroom teaching of this style has been found to be the least effective for learning. According to **Figure 1**, sourced from (NTL Institute, https://www.ntl.org/), attending a lecture is the least successful learning experience. Online delivery of knowledge units with supporting as-needed classes and seminars should be the usual mode of delivery of curriculum, and formal stand-up classes should be abandoned. Anywhere/Anytime/AnyDevice access to online stored curriculum should be the preferred method of knowledge delivery. The Internet can be used as a significant curriculum delivery technology and a collaboration platform between teachers and students. We need to adopt a radical terminology to replace "classroom". Instead, we suggest "learning spaces", such as have been set up in various HEIs in Australia, for example [9], referred to in [10] as a teaching hub. Note also in [10] the references to "no lectures, no exams".

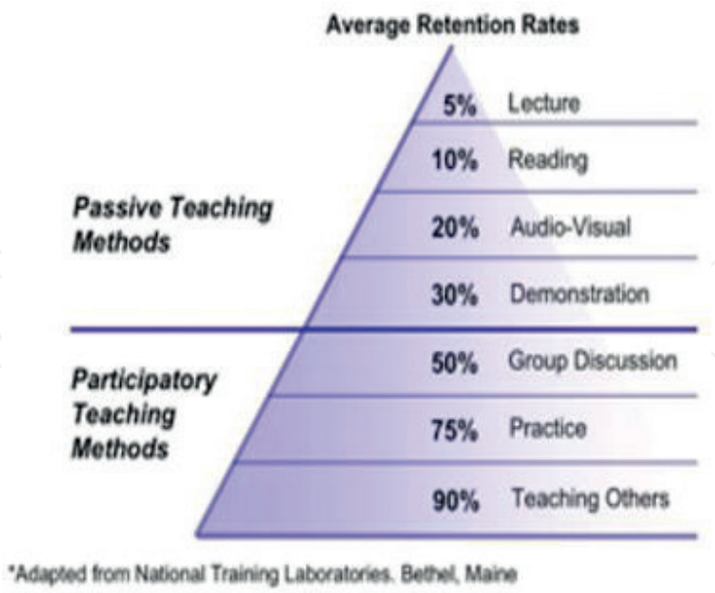

Figure 1.
The National Training Laboratories' learning pyramid.

7. Assessment of student learning achievement

Assessment is a huge area of quality problems, with often highly stressed students sitting important exams and being unable to perform to their full capabilities.

"end-of-term" assessment, referred to in the production process literature as "end-of-line" QA, is ineffective, and often requires students to acquire sufficient "last minute" knowledge to pass, which is then forgotten because it was shallow learning, and discarded following the exam, having served its purpose. Assessment often includes also a mid-term test, which is a sit-down test of perhaps 2 hours' duration, and there is inevitably a Final Examination which is also a sit-down test of 2 or 3 hours' duration, which will contribute the majority of the assessment grade.

Formal examinations are not necessary if a variety of well-researched assessment methods are applied; student self-assessment [11], peer assessment (within student learning teams) [12], assessment based on project outcomes, online quizzes that can be repeated as many times as necessary until a result of 100% or close is achieved. Formative assessment that informs teachers to enable them to monitor, mentor and assist students to achieve a high level of knowledge acquisition is much preferable to summative assessment. Again, the Internet offers a solution here, at least as an effective and efficient method of assessment.

8. Continuous assessment during term

Student assessment usually "continuous assessment" that includes weekly assignments and/or a "term paper" of some substance. This style of assessment is fraught with problems, particularly plagiarism, copying, and also paying for an external "expert" to do the work. The Internet has had an important impact on this, giving students a much greater opportunity for plagiarising. The knowledge acquisition and assessment problems here are that the student may not actually learn anything from their assignments, yet gain high marks for this continuous assessment activity, but then fail the final exam dismally. The continuous assessment activity may be a hands-on project, such as is common in computer system development subjects, with the scope of the development problem is necessarily limited, often to the point of being useless as a learning activity. This problem can be overcome by applying a variety of assessment methods, and presenting curriculum in a significantly different manner, as has been discussed above. In [13], a proposal specific to computer system development courses, suggests a major project that is developed over the entire period of the course which would include "Just-in-Time" curriculum, another LSCM concept.

9. Sit-down exams

Sit-down examinations are extremely problematic, especially when used for summative assessment only. First, the stress felt by students in the exam room has a significant impact on student achievement in the exam, particularly for those students who are already at risk by being ill-prepared. Then, there is the problem of shallow learning, actually encouraged by the common practice and requirement to give students "exam hints" in the last lecture of the term, thus narrowing the scope of learning for the students preparing for the exam. This practice encourages a last-minute mad scramble to learn something about the indicated topics sufficient to perhaps pass the exam, and can then be forgotten, having served the purpose. This activity occurs in what is often termed "swat vac" which is a 1 or 2 weeks "laytime" between the end of the lecture series and the exam. This "cram, sit and then forget" problem creates on-going problems when that information is pre-requisite knowledge for subsequent subjects. It also counts as a waste of education; wasted time particularly, sub-standard quality of learning.

The solution has been discussed above; a teaching, learning and assessment process based on the Internet as the primary curriculum delivery technology, offering Anywhere/Anytime/AnyDevice accessibility to knowledge units.

It is incumbent on HEIs to offer students an interesting, even exciting and fun, learning environment to draw and keep student willingness to learn. This requires hands-on, practical learning, project-based, and using all of the facilities and tools offered by the Internet, together with "learning spaces" equipped with TVs, fast Internet access, e-learning material, and a portfolio of Internet-based software.

10. Quality assurance for assessments

Quality assurance of assessment instruments and their contents is highly problematic. It is extremely difficult to ensure fully fair and proper exam paper content. To be so, many questions arise on the appropriate and proper presentation of the subject matter to the students during the term, on the quantity of subject matter presented being appropriate to the time constraint of the length of the term, on the quality of teaching. Are the questions clearly understandable and unambiguous? Is the assessment rubric appropriate and sure to provide objectively fair assessments? Were the questions too simple and too easily answered, thus lowering the standard of learning required? Were the questions unreasonably difficult? The solution has been suggested above: peer-assessment, self-assessment, longitudinal assessment, and a variety of assessment methods which are not based on sit-down examinations. I might even suggest here a new term: "agile assessment" meaning frequent and repeatable assessment, and the application of various assessment methods as a triangulated assessment process.

11. Failure to learn assessed as a pass

This is a significant quality problem. While a 50% pass grade is lauded, and gratefully received by many students, what this really means is that the student has failed to learn 50% of the required curriculum.

Passing grades may vary between 45 and 60% to achieve a "C" grade, meaning a pass. This implies that it is acceptable for the student to exit the subject having failed to learn half of the subject matter, and if the student's grades are consistent, it is possible for that student to graduate from the HEI even though they have failed to learn some 50% of the total subject matter included in the course.

As a quality measure, students should be required to, and be able to, repeat any assessment task until a grade of at least 90% is achieved: "agile assessment" again. A program of longitudinal assessment, as discussed above, with teacher responsibility for supporting and mentoring students to achieve this outcome, should be in place. Frequent tests, often computer-administered, during and at the end of each knowledge unit, will indicate if students are progressing well, will enable appropriate intervention as necessary, will provide continual satisfaction and confidence to the student, and will never allow a student to fail, resulting in the heartbreaking problems discussed next.

12. One-chance assessment

Two weeks after the final exam of the term the student may be told "sorry, you failed, come back next year and try again". This often imposes a social, familial,

financial and psychological burden on the student which could have been avoided if assessment had been done differently, and for a different reason, that being formative assessment, accompanied by a very different role of both teachers and students, in the former case as mentors, curators of content, and learning leaders, and in the student case, as willing students able to undertake guided learning, self-directed learning and self-motivated learning assisted by the teachers.

13. Assessment of teachers/lecturers

In many HEIs, assessment of lecturers is undertaken, using a number of different methods, including, often as a significant component, up to 50%, of the overall assessment, student feedback. Assessment of teachers is done for many reasons including promotion opportunities, salary increments, and contract extensions. So assessment of teachers' performance can have a profound impact on the teachers' career prospects. This does have an often profound impact on the teacher or lecturer's performance and standard of curriculum developed and presented and students' assessment outcomes. Assessment criteria of lecturers may include the pass rate of the students in the subject, the overall grades by simple statistics of mean, mode, median etc., and scrutiny of lecture materials prepared which, in this day and age, seem to be well-designed PowerPoint slides as being essential. Assessment of lecturers is included in this discussion as being part of the pedagogical system because of the potential impacts, both positive and negative, that such assessment may have on lecturer behaviour, assessment standards and lecturer-student relationships. It has been my experience that lecturers are not infrequently tempted to "game the system" by promising easy exams, signalling exam content, reducing curriculum content and even showing favouritism to particular students in their assessments to ensure positive feedback from the students, and boosting assessment scores for the same purpose.

14. The mass education enabling revolutions

As we are looking forward into the twenty-first century, it is informative to look back at what can be termed the mass education enabling revolutions. By this, we mean the development or invention of technology that enabled mass education to be delivered to all members of society. The 1st mass education enabling revolution occurred with the invention of the Gutenberg printing press, circa 1440. This printing device enabled the printing of books on a large-scale, taking the production and publishing of books out of the medieval monasteries and making information available to be widely distributed, thus heralding, and enabling, mass education.

The 2nd mass education enabling revolution was the invention and wide availability of the Internet. Nowadays, as has been well demonstrated, vast quantities of information are available to students and scholars, more than has ever been available "in one place" in the history of mankind. "Availability" implies not only the existence of the knowledge (the US Library of Congress is the largest library in the world, with millions of books, recordings, photographs, newspapers, maps and manuscripts in its collections) but also "accessibility". One significant aspect of this Internet-based information revolution is the accessibility of that information to anyone who has a cheap computer and an Internet connection in their home, or in their classroom. The information is available 24 hours a day, 7 days a week, on an Anywhere/Anytime/AnyDevice basis.

The impact of the Internet on mass education, actual and possible, is, without doubt, revolutionary and enormous. The Internet and its associated information storage, accessibility and searchability, with a world-wide web of hyperlinking capability, is also possibly the most disruptive technology in the history of mankind, not the least of which is its impact on education. The Internet enables, demands even, that education delivery, the stuff of the HEI pedagogical system, change in a radical, overwhelming way, and methods and procedures for the properly organised use of and the efficient and effective utilisation of the Internet is now an imperative facing educators, scholars, and students at all levels.

The Internet opens up wider, broader, deeper, more abundant information to students and teachers, accessible in a way never before seen. It is now imperative that teachers at all levels of education; pre-school, primary, secondary, tertiary, and in all educational environments, trades oriented, academic studies, develop a significant level of what is now being termed digital literacy, and a new mindset on how to use the Internet to full advantage. This is so significant that a new theory of Internet access and use has been developed: connectivedness theory.

Using the Internet as a learning tool in the classroom, organising lessons and applying teaching approaches in a new and novel way, is a must, and each and every teacher needs to develop expertise in a personal set of Internet tools, including word processing, presentation tools, graphics programs, data storage sites to allow Anywhere/Anytime/AnyDevice access to materials, social networking tools, remote accessing, search engines; all of those now essential tools to fully use this digital environment, and to be able to teach them competently.

As such, the Internet is a highly disruptive technology in education, having opened up huge opportunities in education, but demanding a very high level of digital literacy on both teachers and students to be able to take full advantage of more technology in the classroom, for research, and for administration. In fact, it is quite possible that the Internet challenges the very existence of "red brick" HEIs.

15. The eight wastes of education

An underlying principle of this proposal is related to the eradication of waste in the pedagogical system [14]. What is now known as the 8 wastes of education have been derived from the original seven wastes (Muda) of manufacturing, developed by Taiichi Ohno, the Chief Engineer at Toyota, as part of the Toyota Production System (TPS), and subsequently extended to 8 [15, 16]. These "Wastes" provide the philosophical *raison d'etre* of the lean movement which is dedicated to the eradication of waste in any endeavour. Following on from these "8 Wastes of Manufacturing", other authors have described these wastes in terms of particular endeavours, such as software engineering [17], as part of the Agile Software Development movement that arose in 2001. This association is important in the education sphere as at least one of the agile software development method published, Scrum [18] has been adapted and adopted into the classroom, under the heading of Agile Classrooms [19]. More recently, Lean Thinking has been applied to education as "Lean Education", "Lean Pedagogogy" [20–22].

I have defined the 7 wastes of education, first published in [23], which was elaborated in [24], and then extended to be the 8 wastes of education published in [25] (**Table 1**). This is certainly neither the only rendition of these "Wastes", nor the first, it must be stated.

There have been many other attempts at defining the wastes of education to be found in the literature, not necessarily following the "8 Wastes of Manufacturing" Pattern. [26] applies these to the three main groups of actors in higher education;

Type of waste	Explanation
Overproduction	Extra and unnecessary curriculum content and knowledge that is not useful or useable. Time spent developing curricula that may be purchased
Waiting	The knowledge gained by students that must be "put on hold" until required later in the pedagogical process which tends to be forgotten or becomes irrelevant
Transport	Movement of knowledge from one subject to another, wasting resources by the need to re-teach. The physical movement of staff and students to and from teaching locations, attendance in a classroom at a specific time
Inappropriate processing	Inefficient and ineffectual teaching and learning processes, such as classroom teaching, and failure to apply Internet technology efficiently, and ineffective assessment activities
Inventory	Concepts, ideas, specific knowledge that must be stored (i.e. remembered) for a future time which is forgotten or becomes obsolete and irrelevant (leakage in LSCM terms)
Unnecessary & excessive motion	Student and staff physical and intellectual movement between subjects and classes, overly dependent on pre-requisite knowledge, lack of coherent streaming of curriculum resulting
Defects	Shallow learning, forgotten subject matter, failure to comprehend subject-matter, plagiarism, cheating, inappropriate curriculum. Obsolete curriculum
Recognition of staff	Failure to recognise and acknowledge teacher and student abilities and suggestions, failure to develop, failure to make use of students research

Table 1.
The 8 wastes of education.

administrative staff, academic staff, and students (paralleling the three systems: General Administration, Academic Administration and pedagogical, stated above), and in each case most of the wastes are in regard to the physical workplace and physical movement of the actors.

For academic staff, the waste of motion is "Walking to deliver lectures and seminars in different areas or buildings in the same teaching day". For students, the waste of motion as "Scheduling classes for a single course in widely separated locations", and the waste of waiting as "Waiting for results/waiting for a lecture to start/waiting for equipment to be returned (or waiting for books to be returned to the library by another borrower (my addition))".

These wastes are obviously particular to the physical environment and class scheduling, and identify some significant wastes that can be overcome by the imaginative and effective use of the Internet as a vehicle for the simple and time-saving dissemination of course material to students by the academics, accessible by the students on an Anywhere/Anytime/AnyDevice basis, alleviating a significant problem of the physical movement and time requirements of the traditional "come to class from wherever you live" to learn from the lecturer who must move to the lecture location (unless of course the class must be cancelled due to the absence of the lecturer, or the student is unable to come due to personal matters such as sickness, or inclement weather or transport problems).

16. Adopting production line, product development, logistics and supply chain management paradigms

The HEI pedagogical system must be dramatically reorganised and re-designed, and the LSCM paradigm be adopted, including the production line processes of modern manufacturing, and, possibly even more importantly, lean product development.

17. What can we learn from logistics and supply chain management

The term "logistics" is used to refer to the process of coordinating and moving resources—people, materials, inventory, and equipment—from one location to storage at the desired destination [27]. More generally, logistics is the act of coordinating complex movements or projects or solving complex problems (https://www.yourdictionary.com/logistics) or the planning, implementation, and coordination of the details of a business or other operation (Dictionary.com). Therefore we can obviously apply processes applicable to logistics, such as quality assurance and quality control measures, to the pedagogical system. Supply chain management, while being associated with logistics, is defined separately in [28], supply chain management directly impacts product quality and the overall profitability of a company. For these reasons, quality control in the supply chain is critical for maintaining a competitive edge in the marketplace and reducing operating costs. Without quality control, waste becomes prevalent beyond a tolerable amount. Adapting from [27], to define LSCM in terms relevant to the pedagogical system of HEIs, logistics refers to what happens within an HEI, including the development, purchase and delivery of curriculum materials, the packaging for presentation to students of those curriculum materials (which I have defined as knowledge units), and the delivery of those knowledge units to students, to create a final product: the "Knowledge Product". Supply chain management refers to a larger network of outside organisations and stakeholders that work together to deliver the final product; a knowledgeable graduate leaving the HEI with the knowledge product created in the pedagogical system, to all stakeholders, defined in this chapter as including not only the students, but also other important stakeholders in the education process, who include future employers, students' families, society at large, and government.

18. Why refer to logistics and supply chain management here?

Supporting the assumption that we can see the pedagogical system of an HEI in terms of LSCM, there is a significant volume of research available on the application of "agile", "lean" and "leagility" from which we can learn: [29–31]. We can learn, for example, about quality circles and their relevance to product development and production line processes from the Toyota Way and apply this concept to the pedagogical system; an adaptation of a definition of quality circle [32], appropriate to education, is "A quality circle is a participatory teaching and learning technique that enlists the help of both teachers and students in solving problems related to their course of study". Circles are formed by teaching academics working in cooperative groups, or teaching teams, and students working together in learning teams, to discuss problems of quality and to devise solutions for improvements, as well as supporting more effective and efficient teaching and learning processes. In general, the literature on LSCM research is rich with information on "agility", "lean management" and "leagility", thus being an excellent and informative source of information appropriate to the pedagogical system.

19. What are "agile pedagogy", "lean education" and "leagility"?

The concept of agile education emanates from the concept of "organisational agility", which has been described by [33] and modified here to suit HEIs: *"… the ability of an HEI to renew itself, adapt, change quickly, and succeed in a rapidly changing, ambiguous, turbulent environment".* Elsewhere, the definition of organisational

agility, adapted for HEIs, is "*The capability of an HEI to rapidly change or adapt in response to changes in the demand for graduates with particular skills. A high degree of organizational agility can help an HEI to react successfully to the emergence of new competitors, the development of new industry-changing technologies, or sudden shifts in overall market conditions*" [34]. Agile practices have been adopted and adapted into, agile software development [17], and agile LSCM [28–30], agile shipbuilding [35] and in agile education [7], which, together with the concepts of lean thinking, is now being seen in combination, termed as leagility.

20. The pedagogical system as a logistics and supply chain management problem

Most, if not all, current LSCM practices can be valuably applied to education: quality management, quality circles, supplier networks, just-in-time manufacturing, eradication of waste in the manufacturing processes under the heading of lean management, adaptability of processes under the heading of "organisational agility", with these latter two approaches now being combined under the heading of "Leagility" [5].

To set the scene for these proposals, a quick definition of each of these three terms is appropriate. In general terms, "agile" means "*fast, quick decision making and behaviour to meet changing circumstances, implying timely decision making*". This is seen as being "effective". Lean, or lean management, is stated as "*get the right things to the right place at the right time, the first time, while minimizing waste and being open to change*". This is "efficient", "leagility" is a combination of these terms, to imply *"overall efficacy, effective and efficient, behaving in both an agile and lean manner"*.

I define the concept of "pedagogical agility", adapted from [36]: "The capability of an HEI to rapidly change or adapt in response to changes in the market for Graduates. A high degree of pedagogical agility can help an HEI to react successfully to the emergence of new competitors, the development of new industry-changing technologies, or sudden shifts in overall market conditions".

Further, in the HEI situation, we define "Leanness" as developing a pedagogical value stream to eliminate all waste, including time, motion and transportation, and to ensure the continuous and levelled delivery of a schedule of knowledge enhancement. "*A lean HEI understands knowledge value and focuses its key processes to continuously increase it. The ultimate goal is to provide perfect Knowledge to the graduate through a perfect value creation process that has zero waste*" (definition adapted from [37].

Similarly, "Leagile" is a hybrid of lean and agile systems, and a paraphrased definition, also derived from [38] "Leagile has emerged, in HEIs, as an answer to the problem of reconciling long curriculum lead times with unpredictable technological and employment changes". These definitions of LSCM, drawn from the Internet, have been modified to be applicable to HEIs, particularly by referring to "students" rather than "customers".

21. What is the "product" that is produced by an HEI?

Where this question may have been addressed previously in the literature, there has been an assumption that the "customer" of the HEI is the student (who is, after all, paying to attend). We can imply this from [39] "*What 21st-century employers need ... is singular, creative talent nurtured by a higher education system that offers opportunities for everyone*": "talent" implying a person with talent.

For our purpose, I will define the product being produced by any HEI as "Knowledge", or, to give it a more "production line" relevant identity, the product being produced by HEIs is a "Knowledge Product" constituting the entirety of the knowledge gain designed into the course of study, or the "production line" activity, by way of the sub-assemblies, parts and components that we refer to as knowledge units, or, in simple terms, curriculum components. The "customers" of HEIs must be seen as being a part of the greater society, extending this to include not only the students, but also other important stakeholders in the education process, who include future employers, students' families, society at large, and government.

By defining what is being produced by the HEI on the education production line as the knowledge product, and not the student or graduate as the product, allows the idea of the students themselves being active production line process workers, together with their teachers and other curriculum providers and participants. By providing a research-oriented environment, rather than a passive learning environment, students' research outcomes and inductive realisations can create students themselves as curriculum providers, or "production line workers". It also allows the knowledge product to be seen as the product that is designed, and produced by a process of adding sub-assemblies and component parts; the knowledge units, at each work station, which in today's conceptualisation is essentially the subject taught in a semester.

In a LSCM-based pedagogical system, knowledge units will be much smaller, much more focused, and continuously available to the students passing along the pedagogical system "production line". A knowledge unit can be a 2-week intensive classroom or seminar situation, or an online e-learning video series, or an entire MOOC presentation, or YouTube video, or a 20-minute video on a particular topic. This definition provides the freedom to deliver curriculum content, or knowledge, in a variety of ways, and which can be sourced from anywhere, or developed in-house. Also, by offering knowledge units online, with AnyWhere/Anytime/AnyDevice access, students remote from the university, or who reside in remote locations ad are not able to attend a campus, can access the content, thus pursuing their course in their own time, at their own location.

In [2], the scenario now facing individual universities includes significant competition from many different sources, with courses being available from 3rd party online providers, and the Internet enabling the extensive availability of e-learning materials, the most illustrious of which are so-called Massive Open Online Courses (MOOCs) offered by prestigious universities and world-leading lecturers, online. Udemy offers many and varied online courses, and it seems that this is a low-cost source of academic material, competing for enrolments, thereby being competition for traditional providers of educational material (https://www.udemy.com/). Also, our experience in selecting textbooks for subjects over 3 decades includes seeing offers by textbook publishers to provide a complete, "canned" curriculum, requiring the teaching academic merely to set up the projector and present the slides provided. Confronted with these situations, together with the extraordinary developments and advances in computing, information technology, and communications technology, by huge organisations such as Google, Amazon, Microsoft, Tesla, and Facebook *inter alia*, one can only wonder at what HEIs can, and must, do to remain viable and relevant, even to continue to exist in anything like their current form.

Discussions published in many papers on or around this scenario [7] seem to be mostly concerned with improving the efficiency and effectiveness of the operational and administrative processes of HEIs as they currently operate, and do not address the actual education processes; the pedagogy. In our view. HEIs must make radical changes to their academic systems, what we have termed here as their pedagogical system. New ways to source curriculum materials, new ways to present those materials to students, new ways for students to access that material and learn,

and new ways to assess the learning outcomes, are required. It cannot be a mere reorganisation of current processes, but a radical change in almost every aspect.

The solution is seen here to be a new model of HEI pedagogy that considers HEI's as competitive, commercial enterprises whose education processes are appropriately seen as being akin to LSCM processes. To set the scene for these proposals, a quick definition of each of these three terms is appropriate. In general terms, "agile" means "*fast, quick decision making and behaviour to meet changing circumstances, implying timely decision making*". Lean, or lean management, is stated as "*get the right things to the right place at the right time, the first time, while minimizing waste and being open to change*", and, finally, "leagility" is a combination of these terms, to imply "*overall efficacy, effective and efficient, behaving in an agile and lean manner*". We must also consider the lean product development paradigm, as espoused in a variety of books on lean product and process development [39, 40].

22. The pedagogical production line

Figure 2 illustrates the overall pedagogical production line, with incoming students, usually from secondary schools, proceeding through a course (along the production line) until graduation (finished product) and employment. **Figure 2** also includes illustrations of the equipment and tools available to the process line workers: the academics in charge of controlling the system and the students' activities, and indeed the students themselves. The tools (Office®, YouTube®, Linux, Open Office and so on, DBMSs, and a plethora of other Internet-based tools available for social interaction, information searching and extract, graphics; in fact, a vast number of tools. The figure also illustrates the variety of curriculum providers. So we see the incoming "raw material", the progress through the process line to the finished product, the graduates who are now the bearers of the knowledge product, who venture into the world, usually to gain employment.

Figure 3 more readily illustrates the knowledge package along the pedagogical production line. The "brain" of course represents the knowledge product, first introduced by incoming students, developed in their past schooling. The knowledge product is then developed and extended by the addition of the knowledge units to ultimately result in the final knowledge product that meets the total knowledge requirements of the course of study.

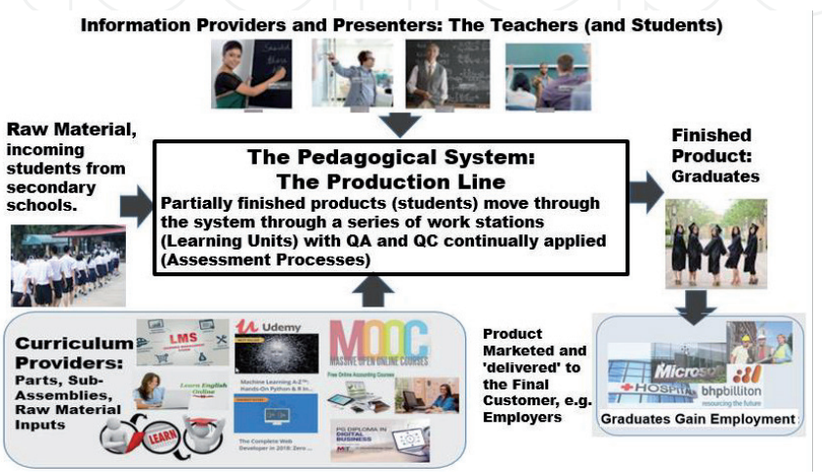

Figure 2.
The pedagogical production line.

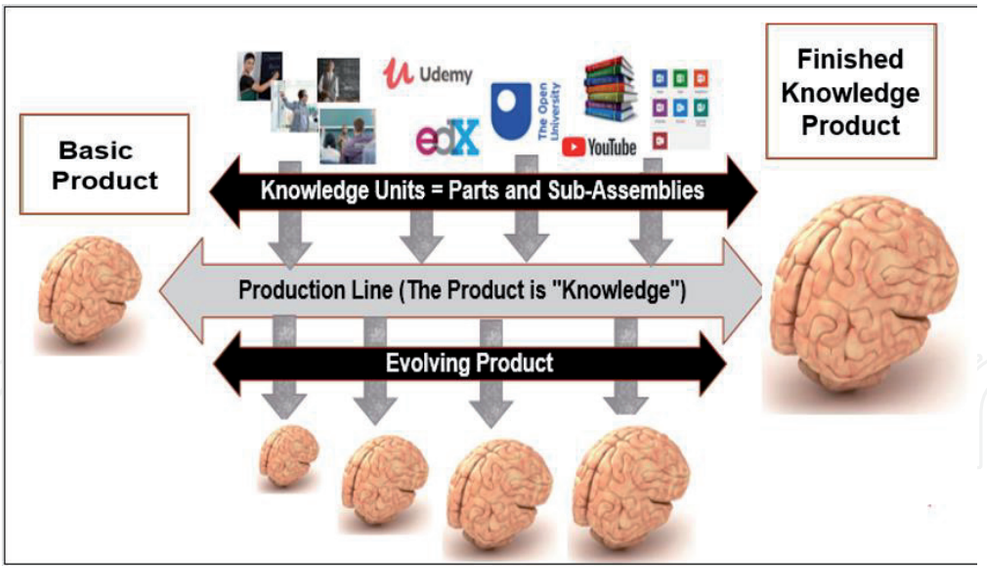

Figure 3.
The evolution of the knowledge product.

23. Changing roles of teachers and students demanded in the twenty-first century

The roles of both "teachers" and "students" are changing; changes wrought by the need to deliver information in higher education institutions as cheaply and efficiently as possible, in what is now a highly competitive environment, and for students to pass successfully through their course as quickly and efficiently as possible. Internally, within the nation, education has developed into a significant cost to the national budget, and as an export industry, is now worth billions to many countries. Fast-track learning in a leagile pedagogical system is also of significant benefit, socially, economically and educationally, to students. Teachers must become mentors, curators of information sources, and learning leaders, and students become researchers and self-learners.

To summarise my view of the role of both teachers and students in the foreseeable future, I make the following recommendations:

1. Teaching academics would be styled "Learning Leaders" with significant responsibility to ensure students achieve at a high level by constant monitoring, mentoring, assisting and evaluating students' progress by forming teaching teams to achieve these responsibilities.

2. Students would work in learning teams for mutual learning support and adopt both learning and teaching roles within the learning team.

3. Both teachers and students must achieve a very high level of digital literacy, sufficient to be able to adopt a significant set of digital resources and aids, and have the ability to proficiently teach the students these Internet-based skills and to be able to communicate between themselves and with students, especially remotely.

4. A high level of blended teaching and learning based first and foremost on Internet technology; e-learning and social media will become prominent, with traditional lectures and formal tutorials abandoned in favour of a substantially e-Teaching environment and the use of social media, with face-to-face learning between members of the teaching team and student project groups.

5. Blended teaching methods also include:

   - Project-based teaching and learning,
   - The flipped classroom,
   - Scrum in the classroom,
   - Connectivism theory

6. Pedagogy terminology that should be understood and applied:

   - student centred learning,
   - "Agile classrooms", "agile pedagogy",
   - "Lean higher education"
   - "Hybrid learning", "technology-mediated instruction", "web-enhanced instruction"

7. For assessment practices, terminology includes:

   - Student self-assessment
   - Peer assessment
   - Longitudinal assessment
   - Formative assessment

(This is not a tutorial on each or any of these methods or terminology, but the reader should use these as keywords for a literature review of each of the concepts. You will be surprised at how much good information and research is available).

24. The digital classroom

A recent article in [41] reported on the adoption of a fully digital approach to Teaching and Learning at a leading Thai university, King Mongkut's Institute of Technology Ladkrabang (KMITL). The following quotes are especially relevant in the context of this proposal:

"Classes today do not have to take place in classrooms—a back-end and centralised university network can significantly yield fruitful learning opportunities and simultaneously reduce the university's daily operation cost".

"In the future, KMITL plans to offer total online courses so that its students, and students at KMITL's partnered universities, or agencies cooperating with KMITL can remotely attend classes from wherever internet is available in the world".

... students, school personnel and society as a whole have been tremendously and rapidly transformed with the actualisation of online learning, allowing modern-day students, particularly in universities, to study whenever and wherever the like as long as they can access learning sources.

We may add [9, 10] here as references to two Australian universities with similar intentions displayed in their building design and teaching and learning spaces, and in their intent on the actualisation of online learning and the roles of modern-day students attending an HEI.

25. The "roomless" class

The "classroom" as we know it, with serried rows of desks or benches where students sit and listen to a "chalk and talk" lecture, or, in K-12 schools, the teacher at the blackboard, should now be abandoned.

Rooms that are learning spaces that are not used to present classes in the usual way are needed. Two news items from the ABC in Australia [9, 10] report on the situations that have arisen in two Australian universities. The provision of appropriate learning spaces benefits students' social interaction, allows them to advance their own knowledge gain at their own pace, meet their fellow learning team members, exchange views and information, quietly view online content which they have selected themselves for that period without being required to sit for 2 hours in a lecture hall to find out what they need to learn. Learning spaces have actually been provided in university libraries for decades, called carrels which, in my experience, were large enough for 4 students to get together and exchange ideas and work together. The twenty-first century learning spaces may need a large TV set, a fast Internet connection, devices for attaching to the Internet, for students who cannot afford their own, and licences for a variety of software products, or may just need a Wi-Fi connection. The teacher in the twenty-first century learning space needs to plan, coordinate, oversee and assess the students learning, relying heavily on Internet technology.

26. Connectivism theory at work

Connectivism has been described as "acquisition of actionable knowledge, where an understanding of where to find knowledge may be more important ...", or "Connectivism provides insight into learning skills and tasks that are needed for learners to flourish in a digital era" [42], and when accurate, up-to-date knowledge is the aim of all connectivist learning activities [43]. Also, Connectivism relates to a community as being "the clustering of similar areas of interest that allows for interaction, sharing, dialoguing, and thinking together".

In [44], there is a description of a practical classroom activity illustrating connectivism theory in the classroom. The activity is considered to be a learner-centred teaching activity where the teacher introduces the topic to be studied and oversees the students at work, but the work is done by the students. The students work in groups (learning teams), each group required to conduct research (project-based learning), applying software tools such as PowerPoint or Prezi® for presentations (see Prezi.com for a software tool for preparing dynamic presentations, using a blogging platform such as Blogster, preparing a video using iMovie or similar technology, perhaps a video recorded on a smartphone.

I personally have contemplated the use of documentaries on TV as learning experiences. I have recently viewed a BBC documentary entitled "Wild Patagonia". As I watched, I saw the Andes Mountains (let us go and learn more about the mountain ranges of the world), I saw a chain of volcanoes (let us do a project on volcanoes), I was interested in the lush western areas and the dry eastern deserts (let us do a project on rain shadows and deserts of the world

and how they arose), I saw strange animals that evolved in that area (let us do a project on evolution). These look like excellent social studies and geography projects.

Movies depicting Napoleonic battles ("Austerlitz", or the "Battle of Leipzig"/"Battle of the Nations") or documentaries on the Vietnam War, World War I and II, the Korean War, the American Civil War, make history come alive, and the lessons can be extended into political and social issues. Historical documentaries such as "The Tudors" and "Mary I of England" ("Bloody Mary") offer great opportunities for further research into British history, the Papacy, religion, albeit with a Euro-centric aspect, but there are also similar documentaries on Indian history, Japanese history, Dutch colonialism in Indonesia, etc.

Not all curriculum in all academic study areas can be learned in this way, but the principle is there. Knowledge units, Internet-based student-led research, project work, use of all kinds of media now allowed by the Internet and smartphones: these are examples of the application of connectivism theory, together with the flipped classroom paradigm, student-led learning, teachers as mentors, curriculum gathered from multiple sources (even learning the tools available on the Internet is excellent practical education).

27. The teacher-as-researcher research paradigm

This chapter has been based very much on the personal opinions, experiences and anecdotal evidence gathered by the author. I refer readers to the literature that supports this approach as being an appropriate qualitative research approach, termed variously The-Teacher-as-Researcher, and Education Action Research [45, 46], and also Educational Action Research [47, 48].

28. Conclusion

Higher Education Institutions are commercial institutions in that they charge fees for a service that is provided to students. The service is provided in what is termed here the pedagogical system. The stakeholders in the pedagogical system include teachers, students, graduates, employers, students' families, curriculum providers and the government which has a political and financial stake in efficient and effective pedagogy. HEIs are subject to competitive pressures and accountability in service provision as is any commercial organisation.

As commercial organisations operating a process that needs to be agile and lean, or "leagile", HEIs need to look to LSCM processes in which agile, lean and leagile paradigms are now well entrenched, as they are in many industries that produce a product.

The Internet has proven to be both a major disruptive force and a significant enabler of research and education. It is now imperative that both teachers and students achieve a high level of digital literacy. Teachers need to become proficient at the use of a variety of Internet-based tools for searching, illustrating, communicating, developing educational materials, and applying these in the pedagogical system.

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Author details

Roy I. Morien
Graduate School, Naresuan University, Phitsanulok, Thailand

*Address all correspondence to: roym@nu.ac.th

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